Ronald Maier

Knowledge Management Systems

Information and Communication Technologies for Knowledge Management

Third Edition

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With 125 Figures and 91 Tables

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Library of Congress Control Number: 2007927186

ISBN 978-3-540-71407-1 Springer Berlin Heidelberg New York
ISBN 978-3-540-20547-0 2nd Edition Springer Berlin Heidelberg New York

Springer is a part of Springer Science+Business Media

springer.com

Production: LE-TEX Jelonek, Schmidt & Vöckler GbR, Leipzig
Cover-design: WMX Design GmbH, Heidelberg

SPIN 12034628 42/3180YL - 5 4 3 2 1 0 Printed on acid-free paper

Preface for the Third Edition

Three years have gone by since the second edition of this book. A number of developments could be observed over this period that have affected knowledge management (KM) and knowledge management systems (KMS). There is much more awareness about the importance of knowledge as strategic asset. Thus, the management part in KM has been strengthened with more emphasis on knowledge-intensive business processes, on process-oriented design of KM activities and on targeted interventions with the help of a set of KM instruments. Supporting KM with information and communication technologies (ICT) has survived the through of disillusionment. KM has gained increasing attention from diverse research disciplines. Indicators are the number of publications, conferences, Bachelor, Master and advanced education programs, new journals or existing journals the mission of which has been changed to focus KM or to extend the existing focus to include KM. After some slow-down, KM is also back on the agenda in many businesses and organizations. Indicators are an increasing number of case studies, growing interest in KM-oriented industry networks, a higher demand for internships, student workers as well as part- and full-time personnel with experience in KM, as well as more attendance on KM conferences, workshops and the like.

Skeptics thought that KM was yet another passing management fad denoting either something that we have always been doing or something that we would (and should) never pursue. In a global trend to cut costs, many KM programs suffered. However, the underlying goal of substantially increasing productivity of knowledge work has paved the ground for an enduring effort that does not shy away from the uneasy questions that arise when it comes to showing the impact of KM initiatives and KMS on the financial results of an organization. Even though economics of knowledge (management) theoretically are only marginally understood, many organizations now use indicators to measure success of their KM initiatives. More and more organizations have implemented KM and KMS in the last decade. Many have included some knowledge-oriented aspects into their standard management practices. From a technical perspective, some innovative developments of the mid to late 90s have turned into Intranet infrastructures in many knowledge-intensive organizations. Other, more recent developments are right on their way to make a profound impact on the way businesses and organizations handle knowledge. This is especially true for easy-to-use content management, collaboration and networking tools that have come to be called social software. Corresponding technologies are thought to profoundly change behavior, i.e. the distribution of producers and consumers on the Internet. Both, technologies and attitudes are often called Web 2.0. Many organizations currently attempt to profit from this trend which has helped to move KM back on management agendas.

This all seemed to point into the direction that a new edition could find a welcoming audience. The book has been extended substantially to reflect some of these developments. Again, updates primarily affect part B, concepts and theories, whereas part C, the empirical study, was left untouched. Additions include a section on the management of knowledge risks, a section on KM instruments and a more profound account of knowledge elements, knowledge stances and KM services which are considered core concepts for understanding the functioning of KMS. The edition also contains more concrete ideas for KM initiatives, e.g., the concept of knowledge maturity, the levers type, process and service for designing KMS and a more in-depth treatment of semantic integration which is considered a core challenge in many KMS implementation efforts.

What still stays the same is my hope that the book will help you, the readers, to navigate the jungle of KMS and to understand the complex matter. The book is intended to provide concrete hints, models and metaphors on how to go about designing, implementing and deploying KMS. I also hope that you will enjoy the ideas presented here and that you will be motivated to develop them further. Any comments are most welcome to ronald.maier@uibk.ac.at!

Many people have influenced my thoughts on knowledge management (systems) during the last couple of years, both in academia and in industry, for which I want to thank them all. Research and teaching at Martin-Luther-University of Halle-Wittenberg, Germany, and, since February 2007, University of Innsbruck, Austria, workshops and projects with companies as diverse as BMW, Leipzig, the IT company GISA, Halle (Saale) or the small and medium enterprises participating in the EU funded KnowCom project helped me to test the fitness of some of the concepts for practice. My special thanks go to Ulrich Remus, University of Canterbury, Christchurch, New Zealand and Johannes Sametinger, University of Linz, Austria, for fruitful discussions and to Florian Bayer, Thomas Hädrich, René Peinl, Stefan Thalmann and Mathias Trögl, all Ph.D. students and current or former research assistants at Martin-Luther-University Halle-Wittenberg, for their help with the sections on management of knowledge risks, the example for a centralized KMS, Open Text Livelink, the conceptualization of knowledge stances, the write-up of lessons learned on the FlexibleOffice project, knowledge cooperations and active documents as well as parts of semantic management which are also reflected in a number of joint publications.

Innsbruck, April 2007

Preface for the First Edition

The term knowledge management systems (KMS) seems to be a misnomer at first glance. On the one hand, knowledge in many definitions as used in the discipline management information systems is either bound to people or extracted from an expert and made available in specially designed systems, so-called knowledge-based systems. On the other hand, management is a term that denotes the software-supported handling, e.g., storing, administering, updating and retrieving of (business) objects when used in connection with information and communication technology (ICT). Examples are data base management systems or document management systems. However, strictly speaking, knowledge management systems neither contain knowledge nor do they manage it.

Even though the definition itself is subject to many misinterpretations, especially from researchers and practitioners who are not enthusiastic about the use of information systems in general, the term has been able to draw the attention of researchers from multiple disciplines and practitioners with diverse backgrounds alike. The term KMS has been a strong metaphor or vision for the development of a new breed of ICT systems. In this view, knowledge management systems create a corporate ICT environment, a contextualized base, an infrastructure that takes into account the complex nature of knowledge and thus supports the handling of knowledge in organizations. In order to achieve this, a number of heterogeneous ICT have to be integrated, improved, recombined and repackaged. Examples are AI technologies, business intelligence technologies, communication systems, content and document management systems, group support systems, Intranet technologies, learning environments, search engines, visualization technologies and workflow management systems. Given the complexity of these “predecessors” or “ingredients”, it seems obvious that the development of knowledge management systems is a complex undertaking.

Within this field, the book amalgamates a considerable number of theories, approaches, methods and tools. The results are presented in the light of strategic issues, the organizational design, particularly roles, collectives, tasks and processes, the contents of KMS, technologies and systems as well as the economics of the application of KMS. I hope that the book will help you, the readers, to understand the complex matter, that you will enjoy the ideas presented here and that you will be motivated to develop them further. Any comments and discussion are most welcome: ronald.maier@wiwi.uni-regensburg.de!

The book presents the results of a four-year research project. During this period I researched and taught at the University of Regensburg, Germany and the University of Georgia, Athens (GA, USA). I felt that it helped substantially in this effort to participate in two different (research) cultures during that period. MIS research in German-speaking countries differs from its Anglo-American counterpart in some distinctive ways. In this research I tried to combine the rigorous, cumulative, primarily quantitative Anglo-American MIS tradition with the more holistic, prototype-oriented, often qualitative MIS tradition in the German-speaking countries.

The research underlying this book has involved many colleagues. First of all, I would like to thank my two academic teachers, Franz Lehner, Chair of MIS at the University of Regensburg and Richard T. Watson, Chair for Internet Strategy at the Terry College of Business, University of Georgia (UGA, Athens, GA, USA). Franz created the freedom and the environment at the University of Regensburg necessary for this work, inspired me with his way of thinking about organizational memory and supported this work in many ways. Rick not only helped me to understand the Anglo-American way of research and teaching, intensively discussed my ideas, the methods and procedures I used and served as a referee on my habilitation thesis. He also created the opportunity for me to fully participate in the MIS department at the Terry College of Business as a Visiting Professor which gave me the chance to work with the excellent scholars that taught there in 1998/1999. I would like to especially thank Bob Bostrom, Chair of Business at UGA, Alan R. Dennis, now Chair of Internet Systems at Kelley School of Business, Indiana University (Bloomington, IN, USA), Dale Goodhue, Professor of MIS at UGA, Antonie Stam, now Professor of Information Systems at the College of Business, University of Missouri-Columbia and Hugh Watson, Chair of Business Administration at UGA for their kind support. I also thank Johannes Sametinger, Professor of MIS at the University of Linz, Austria, for proofreading the manuscript.

My special thanks go to the members of the knowledge management team at the MIS department of the University of Regensburg. Many ideas were created in the countless debates, discussions and workshops that we organized! I would like to especially thank Oliver Klosa, Ulrich Remus and Wolfgang Röckelein for their support and companionship. Our strong commitment to free knowledge sharing paid off! Furthermore, I would like to thank the members of the MIS group who motivated me in difficult times and sometimes just smiled at my frantic sessions in front of the computer: Volker Berg, Stefan Berger, Klaus Bredl, Ulrich Nikolaus, Holger Nösekabel and Klaus Schäfer. Last, but not least, my parents, Helga and Kurt Maier, and my girlfriend, Alexandra Reisinger, always stood by my side when the barriers seemed infinitely high. Many thanks to you all!

Regensburg, February 2002

Contents

PART A *Introduction*

1 Motivation

The transformation of organizations into knowledge-intensive and knowledge-aware organizations takes place at an ever-increasing pace. Knowledge as the key resource, not labor, raw material or capital, changes production functions in organizations significantly. *Knowledge* represents the key concept to explain the increasing velocity of the transformation of social life in general and the way businesses and social institutions work in particular (Drucker 1994). Estimates at leading research organizations suggest that up to 60% of the gross national product in the United States is based on information as opposed to physical goods and services (Delphi 1997, 10). In the last decade, this percentage is likely to have further increased which is reflected by a large number of studies that report similar or higher values. The big share is not surprising as it is estimated that the knowledge-intensive construction and development process of new products and services potentially determines 80 to 90% of the resulting production costs (Scherrer 1999, 131).

There is also a trend towards more complex problem-solving services where the majority of employees are well-educated and creative, self-motivated people. Employees' roles and their relationships to organizations are changed dramatically as information or knowledge workers replace industrial workers as the largest group of the work force. Consequently, businesses should no longer be seen from an industrial, but from a knowledge perspective (Sveiby 1997, 26ff). This is reflected by a share of 60% of US organizations which think that between 60% and 100% of their employees are so-called knowledge workers (Delphi 1997, 10) and by the fact that in 2002, about 75% of workers were employed in the service sector in the United States (U.S. Department of Labor 2003) or about 65% in Germany respectively (Federal Republic of Germany, Common Statistics Portal 2003). The rise of knowledge work is not only visible in absolute numbers. Between 1990 and 2000, most jobs in the U.S. labor market have been created that can be characterized as knowledge work, followed by data work, whereas the number of services and goods job positions has declined, in the latter case a continuous decline since the 1950s (Wolff 2005). This scenario has been termed the information or *knowledge economy* (e.g., Kim/Mauborgne 1999). The transformation of society into a *knowledge society* has changed valuation of knowledge work dramatically. In the beginning of the twenty-first century, it is no longer natural resources (especially oil) that creates money, but knowledge. Today, for the first time in history, the world's wealthiest person, Bill Gates, is a knowledge worker (Thurow 1997, 96).

Knowledge work[1] can be characterized by a high degree of variety and exceptions and requires a high level of skill and expertise. Knowledge work requires that knowledge is continuously revised, and considered permanently improvable, not as truth, but as a resource[2]. *Knowledge workers* gain more and more influence in organizations because businesses focus knowledge and their holders as key competitive factors. Knowledge workers are increasingly supported by advanced information and communication technology (ICT) systems. This is reflected by an increase in the amount of information technology (IT) capital invested per white-collar worker from around US$4,000 in 1980 to US$9,000 in 1990 for the services industry (Quinn 1992, 421). Already in 1998, 20% of Fortune 500 organizations claimed to have established the role of a Chief Knowledge Officer (CKO) in their organization and 42% of these organizations said they would establish such a position within the next three years (see Bontis 2001, 30).

Businesses therefore are transformed into *knowledge-based businesses* (Davis/ Botkin 1994). Organizations move from Max Weber's bureaucratic organization towards the ideal of a *knowledge organization* that can be viewed as an intelligent, complex, adaptive system consisting of networked individual, intelligent agents, the knowledge workers, that together are capable of quickly combining knowledge from anywhere within or beyond the organization to solve problems and thus create superior business value as well as to flexibly adapt to environmental changes[3]. Professional services companies, pharmaceutical or bio-technology firms and software and system houses are typical examples of highly *knowledge-intensive organizations* (Jordan/Jones 1997, 392) as they depend heavily on the expertise of their (individual) employees and the networks between them to create value for their customers. Knowledge-intensive organizations are characterized by a high proportion of highly qualified staff (Blackler 1995, 1022).

The increasing specialization means that knowledge workers have to work together in various kinds of groups and teams which differ in their social structure and interactions. An organization provides the frame to bring together people holding specialized knowledge to be jointly applied to accomplish a task (Drucker 1994). This gives rise to *organizational competency* or, in other words, complex

1. See section 4.1.3 - "From traditional work to knowledge work" on page 46.
2. See Willke 1998, 21; for a detailed discussion of the concept of knowledge work see section 4.1.3 - "From traditional work to knowledge work" on page 46.
3. Bennet/Bennet 2003, 15ff, Bennet/Bennet 2003a, 625ff.

knowledge shared in intra- and inter-organizational networks of knowledge workers. The organizational advantage then is that it offers an environment for joint knowledge creation and application and "gives rise to types of knowledge not supported in a marketplace of individuals linked only by market relations" (Brown/ Duguid 1998, 94f). Virtual teams, expert networks, best practice groups and communities complement traditional organizational forms such as work groups and project teams and aid collaboration between knowledge workers within and increasingly across organizations.

Success of an organization is more and more dependent on its capability to create an effective environment for knowledge creation and application and on the knowledge and talent it can recruit, develop and retain in order to provide value innovation rather than traditional factors of production (Kim/Mauborgne 1999, 41). In management terms, success is determined by a firm's managerial capabilities rather than comparative advantages based on production factors[4]. Consequently, organizations need concepts and instruments that help them to provide such an environment, to hone their managerial capabilities concerning knowledge and, more generally, to improve the way the organization handles knowledge. *Knowledge management (KM)* promises these concepts and instruments. Therefore, KM has recently received a lot of attention. The main driving forces behind these developments are:

Co-evolution of society, organization, products, services, work and workers: Society, organizations, products and services, work and workers are transformed into the knowledge society, intelligent organizations, intelligent products and services as well as knowledge work and knowledge workers (Willke 1998, 19ff). The transformation of work and workers into knowledge work and knowledge workers is at the core of a larger shift at the organizational and at the societal level. Intelligent organizations have to provide a context supportive of knowledge workers and their needs in that they excel in the (constantly changing!) combination of individual expertise into organizational core competencies. On the societal level which provides both, the infrastructure (e.g., communication networks) and the suprastructure (e.g., the regulatory environment) for organizations, there is a strong move towards a general scientification of work and organizations (Wingens 1998). This is not only true for traditional professional work (e.g., medical doctors, lawyers, scientists), but also for all kinds of sectors and areas which were not considered knowledge-intensive before (Willke 1998, 2f). Generally, there is more and more knowledge required for individuals in order to (actively) participate in the knowledge society.

Globalization of businesses: Complex alterations of organizational structures and the blurring of organizational boundaries are the results of organizational activities in the globalizing economy. Examples are mergers, acquisitions[5], the development

4. Hax (1989, 77) made this latter argument with the background of a US economy then considered weaker than the Japanese economy.

of international markets, global sourcing and the organizational expansion into countries with lower wages. Globalization transforms businesses into international or even global ones (e.g., Pawlowsky 1998a, 10f, also Hax 1989, 75). In this setting many benefits, e.g., from synergies or economies-of-scale, can only be realized if knowledge can easily be transferred from one part of the organization or the world into another part.

Fragmentation of knowledge: The latter argument also points to an increasing fragmentation of knowledge. Knowledge is spread over numerous experts, among organizational units, across organizations and does not stop at national borders. Researchers have to cooperate worldwide in order to stay competitive, especially in dynamic fields such as bio-technology, computer science or telecommunications. For an organization, this development means that it has to foster networks of experts across organizational units and even crossing the organizational boundaries in order to guarantee a free flow of knowledge that is necessary to keep their experts up to date. Also, complementary knowledge needed might not be available within the organization. This knowledge can be acquired for example by mergers and acquisitions, strategic alliances or joint ventures with organizations holding complementary knowledge on the organizational level. Other alternatives are the recruitment of experts, consulting, founding cross-organizational (virtual) teams, task forces or networks on the team and the individual level.

Need for speed and cycle-time reduction: This development affects virtually every organizational activity and requires an efficient handling of knowledge. It is necessary to increase the speed at which the organization's environment is scanned for opportunities and threats and to increase the speed at which knowledge flows into an organization and at which knowledge is created and distributed to those organizational members who need it.

Need for organizational growth: Growth can be seen as an important part of the organizations' need to survive. Growth requires a stronger emphasis on innovation and the development of new markets as traditional markets are restricted and do not grow at the pace deemed necessary.

Complex organizational interlacing: Meanwhile, organizations build strategic alliances, both along the value chain—vertically—and also horizontally. These cooperations can also be found between organizations which are competitors in substantial parts of their markets and are most prominently found in the IT and telecommunications industry. This form of alliances between competing organizations is also called co-opetition, a term that draws together *coop*eration and com*petition* (e.g., Dowling/Lechner 1998). Many of these alliances are built because two

5. According to a statistic produced by Mergerstat the number of mergers and acquisitions worldwide soared from less than 2,500 involving less than US$100 million in value in 1990 to approximately 9,000 in 1999 involving approximately US$1,5 billion in value (Späth 2000, 10).

organizations hold complementary competencies that can be aligned so that interesting product or service innovations are realized. These developments also increase the market demand for interoperability between organizations which provides organizational and technological challenges[6].

Increasing pace of organizational redesign and increasing employee mobility: The disruptive nature of work relationships with an increasing number of mobile workers fails to provide a stable, highly interactive, co-located, face-to-face work environment[7]. Such an environment is needed for employees in order to develop trust and identity. It supports the easy sharing of knowledge (Holtshouse 1998, 278). This requires measures that aid a quicker development of networks and an improved locating of knowledge providers, experts or simply employees interested in or working on the same topics. These help to build up trust and social (partly virtual) identities that transcend the memberships in one particular project team or work group. Moreover, stable social environments can be created with the help of collectives, also called communities[8], which endure the constant shift of people between different organizational units.

Business process reengineering and lean management: These management initiatives have resulted in considerable losses of organizational knowledge and networks which have to be substituted. Additionally, the establishment of profit centers and "internal markets" within organizations leads to organizational units competing with each other for scarce resources and consequently hinders knowledge sharing between competing units.

New information and communication technologies: Recently, ICT tools and systems have been developed that provide sophisticated functions for publication,

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6. Examples for organizational challenges are to design and implement business processes that span organizations, to support cross-organizational (virtual) teams and work groups, to negotiate appropriability of knowledge generated in cross-organizational projects and to prevent that the organization's competitive advantages are transferred to competitors. Examples for technological challenges concerning interoperability are to standardize interfaces between or to integrate important knowledge-related information and communication systems, such as experience data bases, document and content management systems, asynchronous and synchronous communication and collaboration tools, to establish shared work spaces for virtual teams across organizational boundaries or to handle access and security of ICT systems.
7. Mobile is understood in a broad sense here. It comprises mobility within and between jobs. Within one organization, employees play multiple roles and participate in multiple projects at the same time often requiring them to switch work environments. Additionally, the duration of projects decreases and employees often take on new job assignments with different co-employees. On the other hand, the duration of employment with one employer decreases and the rate of employees moving to a new city to take on a new job increases. Thus, on the one hand, the networks of employees in terms of the number of people they know in many different organizations might get bigger due to the numerous changes in environments. On the other hand, the intensity of interactions within the networks might decrease.
8. See also section 6.1.3.3 - "Communities" on page 180.

organization, visualization, contextualization, search, retrieval and distribution of knowledge as well as functions supporting communication, collaboration, cooperation and linking of individuals in social networks, sometimes called social software, at comparably low cost. They are also relatively easy to use. The situation as found in many organizations is that there is an advanced ICT infrastructure in place. This is regularly a solution based on a set of Internet technologies (Intranet) or based on a Groupware platform, such as Lotus Notes or Microsoft Exchange.

Many organizational units experiment locally with easy-to-use knowledge sharing tools. This can be seen as an attempt to profit from the seemingly uninhibited success of a set of technologies that has come to be termed Web 2.0 or social software. Examples are forums, Wikis, Weblogs, "social" bookmarking, recommendation or tagging solutions. The ICT infrastructure and the manyfold tools that have been implemented on top of it need strategy to define knowledge goals. Corresponding strategic plans not only need further development of the ICT infrastructure, primarily (semantic) integration services[9], but also have to be subsequently implemented with the help of organizational instruments, roles, processes, the creation of awareness and an organizational culture supportive of reflected handling of knowledge in order to create benefits for the organization.

The fundamental transformation of businesses and the enormous changes in organizations due to these driving forces have also created considerable reflection in the corresponding literature. Recent approaches that transform businesses using a combination of organizational and ICT instruments are studied under concepts such as Internet economy, network economy or e-conomics in the discipline Economics, e-business, e-government, e-commerce, e-health, collaborative business, m-commerce or u-commerce[10] in the discipline Business Administration at the (inter-) organizational level and customer or supplier relationship management, business intelligence, e-learning, and—last but not least—knowledge management[11] on the intra-organizational level.

The field of knowledge management draws concepts and ideas from a variety of fields and disciplines. Examples are organization science, particularly organizational learning and organizational memory, human resource management (HRM), strategic management, pedagogy, psychology, sociology, artificial intelligence, computer science and management information systems (MIS). Researchers with a background in all of these disciplines show a vivid interest in knowledge management[12].

9. See section 7.7 - "Semantic Integration" on page 374.
10. The u in u-commerce stands for ubiquitous, universal, unique and unison (Watson 2000).
11. See also Wiig 1993, Nonaka/Takeuchi 1995, Davenport/Prusak 1998, Probst et al. 1998, Bach/Österle 2000, Grothe/Gentsch 2000, Hildebrand 2000, Lehner 2000, Watson 2000, Zerdick et al. 2000, Alavi/Leidner 2001, Gora/Bauer 2001 and the literature cited in section 4.1 - "Knowledge management" on page 21.

The ever-increasing pace of innovation in the field of ICT support for organizations has provided numerous technologies ready to be applied in organizations to support these approaches. Examples for information and communication technologies that are related to knowledge management are[13]:

- *Intranet infrastructures* provide basic functionality for communication—email, teleconferencing—as well as storing, exchanging, search and retrieval of data and documents,
- *document* and *content management systems* handle electronic documents or Web content respectively throughout their entire life cycle,
- *workflow management systems* support well-structured organizational processes and handle the execution of workflows,
- *artificial intelligence technologies* support for example search and retrieval, user profiling and matching of profiles, text and Web mining,
- *business intelligence tools* support the analytic process which transforms fragmented organizational and competitive data into goal-oriented "knowledge" and require an integrated data basis that is usually provided by a data warehouse,
- *visualization tools* help to organize relationships between knowledge, people and processes,
- *Groupware* and collaboration software supports for example the time management, discussions, meetings or creative workshops of work groups and teams,
- *e-learning systems* offer specified learning content to employees in an interactive way and thus support the teaching and/or learning process.

Knowledge management systems (KMS) promise significantly enhanced functionality through an integrated combination of a substantial portion of the above mentioned information and communication tools and systems from the perspective of knowledge management[14]. KMS should not be seen as a voluminous centralized data base. They can rather be imagined as large networked collections of contextualized data and documents linked to directories of people and skills and provide intelligence to analyze these documents, links, employees' interests and behavior as well as advanced functions for knowledge sharing and collaboration. Goals of using KMS are for example to generate, share and apply knowledge, to locate experts and networks, to actively participate in networks and communities, to create and exchange knowledge in these networks, to augment the employees' ability to learn and to understand relationships between knowledge, people and processes.

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12. The influences of the various fields and disciplines on knowledge management are investigated in section 4.1.1 - "From organizational learning to knowledge management" on page 22.
13. For a detailed discussion of these ICT technologies and their impact on knowledge management systems see also section 4.3 - "Knowledge management systems" on page 82.
14. For a detailed analysis and a definition of KMS see also section 4.3 - "Knowledge management systems" on page 82.

Examples show the often substantial size of KMS. Already in 2000, Ernst & Young managed more than a million documents in more than 5,000 networked internal Lotus Notes data bases and a large number of external sources, such as online data bases provided e.g., by Reuters, the Gartner Group, Forrester or One-Source (Ezingeard et al. 2000, 810). In 2004, Siemens had more than 85,000 users of the company's KMS built on the basis of Open Text Livelink, more than 1,600 communities, more than a million documents accounting for more than 1,500 GB, more than 13,000 attributed knowledge objects and 2-5% new documents or versions per month[15].

Knowledge management systems require a systematic knowledge management initiative in order to be used effectively and efficiently. This includes a KM strategy and the development of KM goals, an appropriate organizational design describing KM instruments to be used, roles responsible for knowledge-related tasks and processes that use KMS, a supportive organizational culture and a corresponding KMS controlling that evaluates whether the goals of using these systems have been achieved.

This book reviews the state of theory—concepts, approaches and theories from a variety of contributing fields and disciplines—and the state of practice—initiatives, projects and activities in organizations—of KMS to support knowledge management initiatives. The focus is on KMS or, more generally, on information and communication technology for KM initiatives. In order to get a more holistic picture of how organizations deploy KMS, this focus is extended to include KM strategy, organization and economics which are studied from the perspective of KMS. In the following, the goals of this book will be discussed in detail.

15. These figures were presented during the years 2005 and 2006 at KM conferences and workshops by Dr. Hofer-Alfeis, then Siemens AG, Corporate Technology, now Amontis.

2 Goals

The leading research question of this book therefore is: To what extent can information and communication tools and systems support holistic knowledge management initiatives aimed at improving an organization's way of handling knowledge?

On the one hand, the focus has to be broad enough to cover the interesting mixture of perspectives, concepts approaches, theories and results fueling KM research and practice that are due to the cross-disciplinary, multi-faceted nature of the field. On the other hand, it is a clear goal to rigorously study the notion of KMS in theory and practice in order to gain insights into the implementation and deployment of ICT technologies to support an organization's KM initiative. The result is a compromise between rigor—a focussed study of KMS in theory and practice—and relevance—a holistic perspective on the field of KM. Goal of this book is to investigate the state of theory and practice of KMS supported KM initiatives using this perspective. The complexity of this undertaking is reflected in the volume of the book. There are a lot of unresolved research questions in this area. The following ones will be addressed in this book:

Strategy: How can KM initiatives be linked to an organization's strategy? What knowledge management strategies can be distinguished? How can a KM strategy be described and detailed? Which factors influence the selection of a strategy for an organization? Which strategies are potentially successful? What are important success factors, barriers and risks for the deployment of KMS?

Organization: What alternatives for the organizational design of KM initiatives are there and which ones are actually implemented in organizations? What instruments are there for systematic interventions into the way an organization handles knowledge? What knowledge management tasks and processes can be distinguished? Which knowledge management roles can be differentiated? How can KM initiatives support the handling of knowledge in formal work groups and teams and informal networks and communities? Who should be responsible for what kind of KM tasks? What impact does the application of knowledge management systems have on organizational culture and vice versa? What models can be used to aid the design of KM initiatives as well as the design and implementation of KMS?

Systems: How can KMS be defined and classified? What are the differences to other types of ICT systems? What are the technological roots of KMS? What architectures for KMS can be distinguished? What kinds of KM technologies exist or what kinds of technologies are proposed for the use in KM approaches? What services do KMS provide? To what extent are KMS and particularly KMS services implemented and actually used in organizations? How can these services be integrated? What types of contents and media are used in KMS? How are these contents related to each other? How can the quality or maturity of knowledge elements be determined and what concepts are there to manage the process of maturing knowledge?

Economics: How can success of KMS and KM initiatives be measured? What could a KMS controlling look like? How should KM initiatives be funded? What is the state of practice concerning evaluation of success of KMS and KM initiatives?

Moreover, the relationships between these four main areas describing KMS supported KM initiatives will be studied. The general research question underlying this investigation is: What could a KM initiative look like in which strategy, organization, contents as well as KMS match each other effectively and efficiently?

In the following, the procedure of this investigation to answer the research questions will be outlined along with the methods used. Part A will be concluded by an overview of the structure of the book.

3 Procedure, Methods and Overview

Due to its interdisciplinary nature, knowledge management is a field that is still far from being consolidated[16]. The substantial complexity and dynamics of the field have turned theory-based investigations into knowledge management as well as knowledge management systems into challenging enterprises. During the last decade, researchers, with varying backgrounds as described above, and practitioners, especially in knowledge-intensive businesses such as professional services companies, biotechnology, pharmaceutical, chemical, computer and telecommunications companies, have shown considerable interest in the field of KM. Consequently, it seemed appropriate to answer the research questions of this book on the basis of a *combined theoretical and empirical investigation* of KMS.

Figure A-1 shows the general research design of the research program on knowledge management (systems) directed by the author.

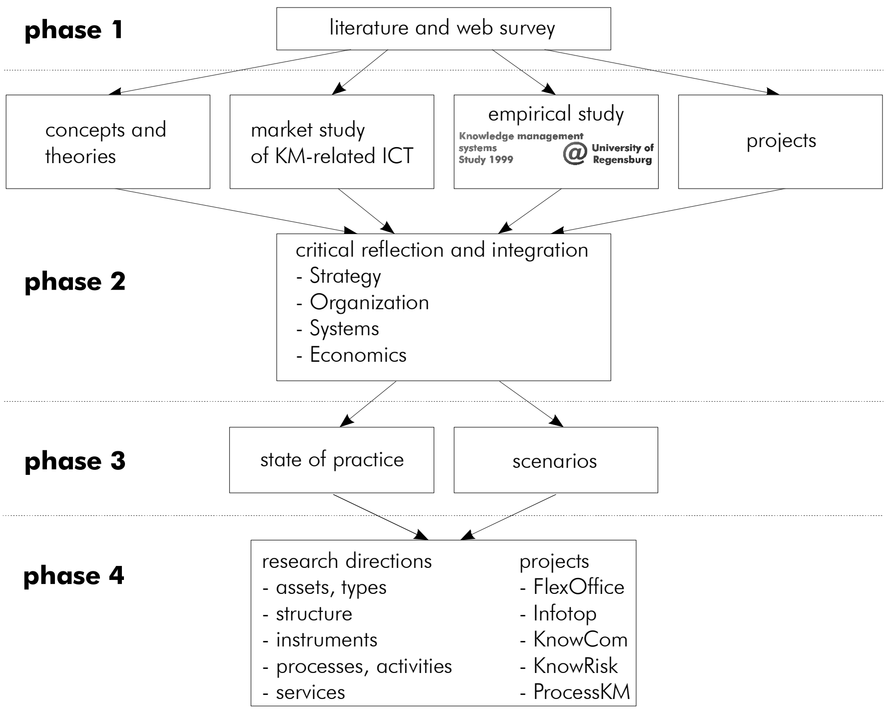

FIGURE A-1. General research design

The program was started with the research project *Knowledge management systems: concepts for the use in organizations* at the Department of Management

16. See section 4.1 - "Knowledge management" on page 21.

Information Systems III, University of Regensburg, Germany that lasted from 1997 to 2001, then taken to the Department of Management Information Systems, Martin-Luther-University Halle-Wittenberg, Germany for the years 2002-2007 and in February 2007 moved to the University of Innsbruck, Austria[17].

The project comprises the first three phases depicted in Figure A-1. The *first phase* consisted of a detailed literature and Web survey on KM and related concepts. It turned out that KM has been a broad, complex and dynamic field. Various management approaches and scientific disciplines have played a role in the development of KM approaches. The perspective taken on the literature was that the approaches, theories and concepts should aid the implementation and deployment of KMS. The results of the first phase were summarized and integrated.

The *second phase* of the project consisted of four activities that were based on this extensive discussion of related work and the clarification of focus. The *concepts and theories* found in the literature were identified, analyzed and compared to each other in order to build a sound theoretical basis for the subsequent empirical activities.

A *market study* on knowledge management tools and systems was performed[18]. The study compared several KMS available on the market in the sense of platforms that provide an integrated set of functions for KM (a KM suite) and derived a list of KMS functions that was used in the empirical study.

The central activity was the *empirical study* which consisted of a questionnaire and numerous interviews with knowledge managers of large German corporations.

The study was complemented by a number of knowledge management *projects* in which the author and his colleagues participated or which were observed. The latter was in most cases accomplished with the help of a number of graduate students who performed KM-related activities at the author's department, joined several companies and reflected their KM initiatives or wrote up a series of case studies in several companies in the course of their master theses[19].

The manyfold results of these four activities were bundled and compared, reflected and integrated into the four major areas of theoretical and empirical consideration: *strategy*, *organization*, *systems* as well as *economics*.

These empirical and practical activities were backed by the theoretical work of an interdisciplinary work group at the University of Regensburg. This group was initiated and co-led by the author, consisted of MIS researchers and psychologists who met every two weeks for a period of 15 months to discuss a set of theories and approaches to guide the implementation and use of KMS. The author also participated in a knowledge community focused on knowledge management (AG Wissensmanagement), a lively network of approximately 40 research assistants, Ph.D. and habilitation students, from industry, research institutes and Universities. The

17. URL: http://iwi.uibk.ac.at/maier/kms/.
18. A list of knowledge management tools and systems can be found on the support Web site for this book http://iwi.uibk.ac.at/maier/kms/.
19. See Igl 1999, Schierholz 1999, Seidel 1999, Hädrich 2000, Hassberg 2000, Jahn 2000, Gebuhr 2001, Paur 2001, Wäschle 2001.

members of this community had different backgrounds—computer science, MIS, pedagogy, psychology, sociology, strategy, organization science and HRM—and met twice a year to share knowledge about knowledge management. The discussions in the interdisciplinary work group and the knowledge community were particularly useful to ensure that the investigation never lost sight of the holistic nature of the research topic in spite of the concentration on information and communication technologies supporting knowledge management.

In the *third phase*, the results of the second phase were used to paint a comprehensive picture of the *state of practice* of knowledge management systems and to develop *scenarios* for their use. The scenarios describe ways to apply information and communication technologies potentially successfully to support KM initiatives and thus can be used as general architectures and blueprints for the design of such systems and their embedding in a holistic KM initiative.

In the *fourth phase* of the program, on the one hand the concepts, models and techniques developed in the first three phases have been applied to a number of research projects, for example

- FlexibleOffice[20], a project in which KM-oriented criteria were used in an optimization solution for the assignment of office space to work groups, teams and learning communities,
- Infotop[21], an information and communication infrastructure for knowledge work that experiments with peer-to-peer approaches and simple shared ontologies in order to support management of distributed knowledge work spaces,
- KnowCom[22], Knowledge and Co-operation-Based Engineering for Die and Mould Making Small and Medium Enterprises, a project funded by the European Union,
- KnowRISK[23], an empirical study to investigate how organizations manage knowledge risks and how this affects knowledge transfer, diffusion and quality, a project funded by the German National Research Foundation (DFG),
- ProcessKM[24], the design and implementation of process-oriented KM strategies with the help of process-guided determination of knowledge management services.

On the other hand, five promising research directions have been studied[25]:

20. See section 6.5.2 - “Example: FlexibleOffice” on page 231.
21. See section 7.5.3 - “Example: Infotop” on page 349; also Maier/Sametinger 2002, 2003, 2004, 2007.
22. For a detailed description of the KnowCom project see KnowCom 2003, Enparantza et al. 2003.
23. See section 5.3.4 - “Management of knowledge risks” on page 140; also Bayer/Maier 2006.
24. See section 6.3.3 - “Example: Process-oriented KM” on page 217; also Maier/Remus 2002, 2003, 2007.
25. See also chapter 18 - “Outlook” on page 621 for a more in-depth coverage of these four research directions.

- *assets and types*: the economic consideration of knowledge as intellectual capital, the analysis of an organization's (core) competencies and the evaluation of success of KMS supported KM initiatives as well as the distinction of a number of knowledge types that can be classified according to the level of maturity,
- *structure*: the development of knowledge structures, taxonomies and ontologies that represent pivotal elements in the semantic integration of the large variety of knowledge management services offered by KMS,
- *instruments*: the investigation of KM instruments that consist of person-oriented and organizational as well as product- and process-oriented measures including supporting ICT solutions,
- *processes and activities*: the design of knowledge-intensive business processes and knowledge processes to support a business process-oriented KM approach. This approach is complemented by an approach for modeling knowledge work based on activity theory that consists of a description of a situation, or stance, in which certain knowledge activities, actions and operations are performed,
- *services*: a central concept that is not only used to specify KMS functions in a standardized way in order to integrate them into service-oriented architectures, but also can be seen as a metaphor guiding the design of KM services in organizations in general, no matter whether these services are IT-supported or not. Services in this view are the result of knowledge activities or processes that can be triggered by occasions in (knowledge-intensive) business processes.

Figure A-2 gives an overview of the structure of this book and shows how the chapters of the book are related.

Part A motivates the investigation, defines its goals and gives an overview of the procedure and the sequence of the chapters in the following parts.

Part B starts out to introduce the reader into the multi-faceted field of *knowledge management*, its history, interdisciplinary roots, its goals and ambition and its critics (chapter 4). It turned out that a large part of the inconsistencies between various approaches to knowledge management have their roots in different perspectives on the term *knowledge*. Therefore, the chapter continues with an overview of perspectives on and classifications or typologies of knowledge and discusses aspects of knowledge that influence the implementation of KMS. As *knowledge management systems* are the primary focus of the investigation, the chapter finally discusses and defines the term KMS and analyzes related concepts.

Then, the constructs are presented which play a role in the implementation of KM initiatives that use knowledge management systems. These constructs are discussed according to the following levels of intervention of a KM initiative:

- *strategy* (chapter 5) embeds the knowledge management approaches in strategic management, proposes a framework for process-oriented knowledge management strategies and reviews the literature about KM goals and strategies,
- *organization* (chapter 6) discusses new forms of organizational designs, structure, instruments, processes, roles and stakeholders, issues of the organizational culture as well as approaches to modeling for knowledge management,

- *systems* (chapter 7) is dedicated to knowledge management systems and discusses architectures, contents and functions of KMS, platforms and systems which are classified accordingly,
- *economics* (chapter 8) discusses approaches to measure success of KMS and KM initiatives as well as alternative ways to fund KM initiatives.

At the end of part B, the most important theoretical findings are summarized (chapter 9).

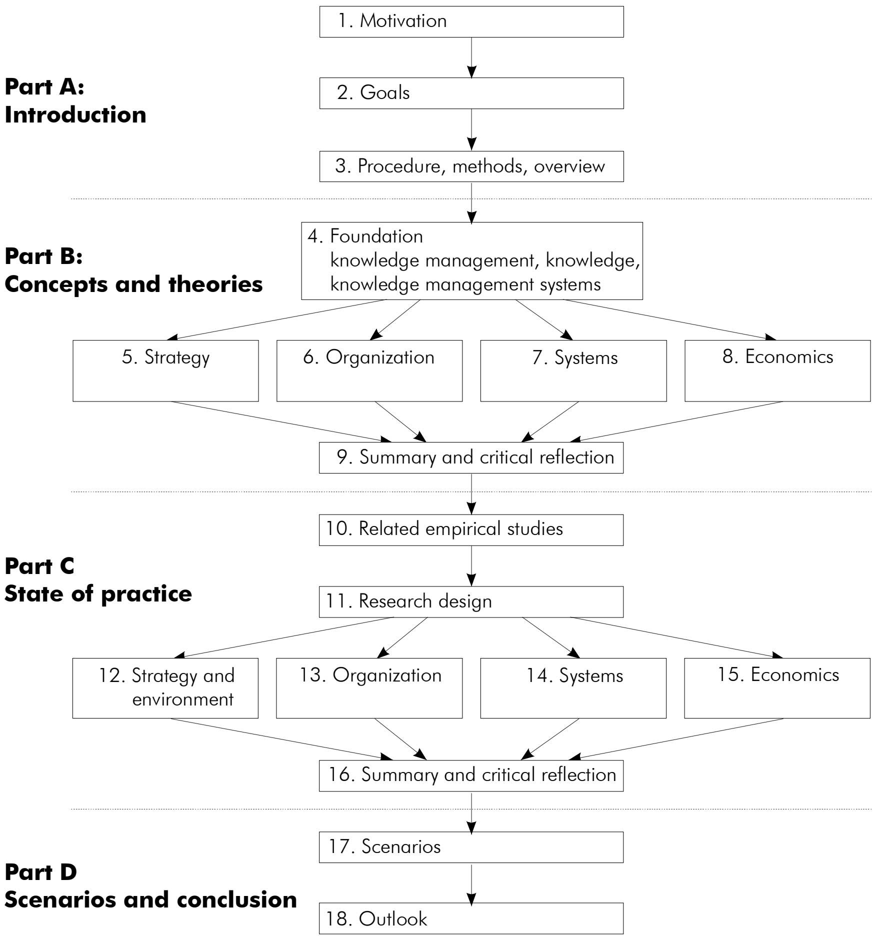

FIGURE A-2. Overview of the book chapters and their relationships

Part C presents empirical results challenging the theoretical concepts, approaches and theories. It starts out with an overview of related empirical studies (chapter 10). The design of the empirical study is laid out in chapter 11 together with a summarized presentation of the hypotheses. Then, the results of the empirical study are presented and compared to the related empirical studies according to the same structure as used in chapters 5 to 8 of part B:

- *strategy and environment* (chapter 12) shows the organizational and business environment of the participating organizations and the KM goals at which these organizations aim as well as the ones that they have achieved,
- *organization* (chapter 13) presents the findings about organizational designs, structure, processes, roles as well as certain concepts describing the organizational culture,
- *systems* (chapter 14) discusses the state of practice of knowledge management systems, the platforms and KMS used, their functionality as well as the contents handled in these systems,
- *economics* (chapter 15) discusses to what extent organizations invest in KM, how they fund their KM initiatives, and what benefits they gain with the help of their KMS and KM initiatives.

Chapter 16 summarizes the descriptive empirical results and the hypotheses tested and discusses the state of practice of KMS in organizations.

Part D comprises a set of *scenarios* of the application of KMS in organizations and an *outlook* to the future of KMS. Chapter 17 presents the essence of the combined analysis of theoretical and empirical results in the form of scenarios for the successful application of KMS in holistic KM initiatives. Chapter 18 gives an outlook on probable future developments in the market for KMS.

Finally, the bibliography is structured into literature (chapter 19) and links to online resources (chapter 20).

Since the first edition of this book, the author has been involved in several KM projects, has participated in a large number of knowledge management conferences as member of the program committee, track chair, presenter, keynote speaker, tutor and discussant and has supervised or reviewed a large number of papers, projects, bachelor, diploma and Ph.D. theses. Results of the projects, of research activities in the five research directions assets and types, structure, instruments, processes and activities as well as services, of discussions and of additional coverage of literature, concepts, methods, techniques and tools have found their way into many chapters of the book.

The 3rd edition particularly substantially extends coverage of the two main pillars of implementing KM initiatives, i.e. organization and systems. Among other additions, the organization part now contains a systematic assessment of KM instruments. The systems part now provides more background on the concept of knowledge (management) service and a KM service architecture before it presents the individual services. Due to recent advances in the topic, integration services are treated in much more detail in a separate section on semantic integration. Also, the book now includes a section on management of knowledge risks. This perspective reverses the usual KM focus on increasing transparency of knowledge, codifying it and enhancing knowledge sharing in order to improve (re-)use of knowledge assets which also bears the risk that knowledge-based competitive advantages are diluted. While working on the 3rd edition, also the comprehensive list of KM tools and systems and related ICT tools that support KM initiatives has been updated. Finally, the 3rd edition includes an update of the bibliography that provides an overview of the developments in KM which is neither restricted to a technocratic, nor to an HRM or organizational perspective.

Due to the dynamic nature of this research field, a portion of the results and considerations has a short half-life. This is especially true for the market supply of KMS and generally of information and communication technologies supporting KM initiatives. Consequently, this quickly changing part has been moved to a Web site[26] that keeps information about KM technologies and links to important KM-related Web sites up to date. Also, for reasons of keeping the book within a reasonable page limit, the detailed results of the empirical study that were part of the appendix in the first edition can be found at the book's support Web site[27].

26. URL: http://iwi.uibk.ac.at/maier/kms/.
27. URL: http://iwi.uibk.ac.at/maier/kms/.

PART B Concepts and Theories

Part B gives an overview of concepts, theories and approaches that can be used to guide implementations of knowledge management (KM) in general and knowledge management systems (KMS) in particular. Published articles on knowledge management are available in abundance so that there has been a need to select approaches. The focus used for the selection was that the approaches should provide (partial) answers to the question: How can an organization effectively and efficiently use modern information and communication technology (ICT) in order to improve its way of handling knowledge? Figure B-1 gives a more detailed overview of the chapters of part B.

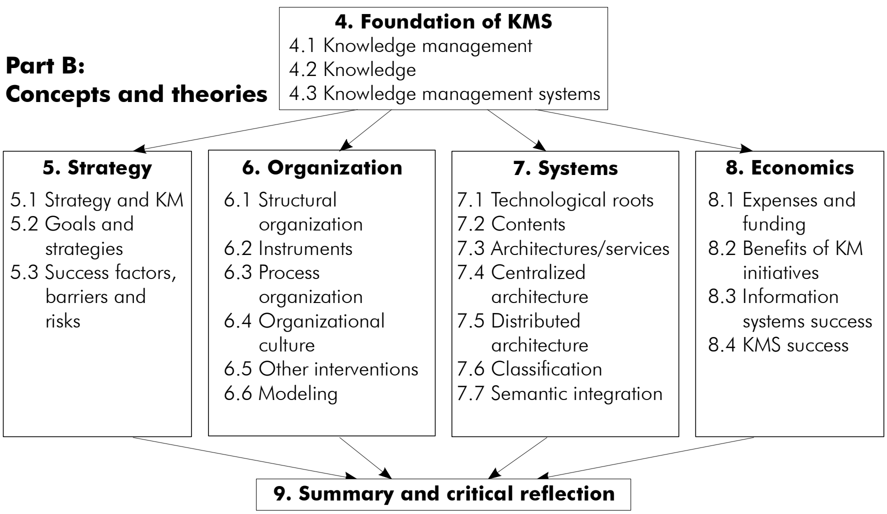

FIGURE B-1. Detailed structure of part B

Clearly, this focus gives the presentation of concepts a direction, though it is still broad enough to cover a substantial amount of approaches. Overall goal of part B is thus to structure and organize these approaches to the systematic design and implementation of strategically relevant KM initiatives supported by information and communication technologies. Chapter 4 lays out the theoretical foundation of knowledge management systems. The starting point will be the study of the origin of knowledge management with respect to the theories, approaches and fields that fueled its development. Then, knowledge management will be defined, basically as the translation of concepts from organization science and organizational psychology and sociology into a management discipline. As the application of KMS is the primary focus here, this presentation is oriented towards the use of KMS.

The main levels of intervention analyzed here are strategy (chapter 5), organizational design (chapter 6), systems (chapter 7) and the economics of KM initiatives (chapter 8). Strategies and goals for the use of KMS are reviewed in chapter 5.

Chapter 6 studies alternatives for the design of the organizational environment of KMS, especially organizational structure, knowledge management instruments, business and knowledge processes, organizational culture and other interventions. Modeling also plays an important role in the design of KM initiatives and of KMS.

Chapter 7 describes KMS in detail. After an overview of the technological roots that are combined and integrated in KMS, typical KMS contents are presented. In the course of defining knowledge elements, a model of maturity of knowledge is presented. KMS are then described according to the services they offer. On the basis of a number of architectures found in the literature, an amalgamated ideal architecture for a KMS is presented. A typical architecture of a centralized KMS is then studied in detail and contrasted with an architecture of a distributed or peer-to-peer KMS. The state of the art of KMS offered on the market is presented showing a broad classification of ICT tools and systems that are deemed useful for KM. Finally, semantic integration as the primary challenge of KMS implementation is studied in detail.

Chapter 8 discusses the challenging task of a cost-benefit analysis of KM initiatives in general and the application of KMS in particular. Part B is closed by a summary of the theoretical findings in chapter 9.

4 Foundation

Recently, knowledge management has received a lot of attention in scholarly as well as in practitioner-oriented literature and in professional services companies as well as in business organizations of all industrial sectors. Due to the large demand for concepts and theories to support a systematic intervention into the way an organization handles knowledge, the field has attracted researchers from different disciplines and has absorbed a wide array of research questions and approaches to solve these questions. This chapter is devoted to give an overview of the roots of knowledge management, the historical development of the literature and practice in some of its predecessors, especially organizational learning and organizational memory approaches.

Having set the perspective on knowledge management with ICT as the enabling factor, the term knowledge will be discussed as it is used in knowledge management. Research on the term knowledge has a long tradition in philosophy, but also in the social sciences. A brief historical overview shows the influences of various disciplines on the view of knowledge as taken in knowledge management. Then, several classifications of knowledge will help to define what exactly it is that is addressed in a knowledge management system and what consequences different perspectives have on their design.

The chapter then turns to knowledge management systems and sets the definitional focus for this book on the basis of a brief historical review of the technological roots of these systems. ICT in general and KMS in particular play the role of an enabling technology for knowledge management, but have to be viewed as only one part in an integrated, holistic knowledge management initiative (McDermott 1999a). Thus, strategic, organizational and economical issues of the use of KMS have to be discussed in the later chapters of this book[1].

4.1 Knowledge management

The importance of knowledge for societies in general and organizations in particular is rarely questioned and has been studied for a long time[2]. Thus, it is not surprising that the field of knowledge management has drawn insights, ideas, theories, metaphors and approaches from diverse disciplines. This section briefly reviews the history of knowledge management. The tracing of the roots helps to understand the perspective which knowledge management has or can have on organizations.

1. See chapters 5 - “Strategy” on page 93, 6 - “Organization” on page 153 and 8 - “Economics” on page 395. A detailed discussion of knowledge management systems, their architecture, functions contents and a classification can be found in chapter 7 - “Systems” on page 273.
2. The foundation for the Western thinking about knowledge can be traced back to the Greek philosophy, Heraclitus, Sokrates, Plato and Aristoteles, see also section 4.2 - “Knowledge” on page 60.

4.1.1 From organizational learning to knowledge management

The roots of the term knowledge management can be traced back to the late 60s and the early 70s in the Anglo-American literature (Zand 1969, Rickson 1976). However, although Zand strikingly closely foresaw the emergence of the knowledge society, the transition to knowledge workers and the huge changes that would be required to manage this new type of knowledge organization in his 1969 article, he did not exactly speak of knowledge management, but of *management of the knowledge organization*. And Rickson, a sociologist, actually used the term knowledge management, but in a different context. He studied the role that big industrial corporations played in the creation and application of technical knowledge on the aggregated level of society. Thus, the term knowledge management was used to analyze the processes of development and application of knowledge *in societies*, not organizations. Thus, it is not surprising that the term did not get much resonance and was neither used in theoretical nor in practitioner-oriented literature. It took almost 20 years until the term emerged again in the mid 80s in the context as it is still used today (e.g., Sveiby/Lloyd 1987, Wiig 1988, 104ff[3]). This time it got a tremendous amount of attention.

The underlying concepts used and applied in knowledge management, though, have been around for quite some time. There have been a large number of fields and disciplines dealing with the handling of e.g., knowledge, intelligence, innovation, change or learning in organizations. It is important to analyze the literature from these fields and disciplines that may provide a number of concepts useful for KM (also e.g., Teece 1998a, 289). However, it is the *organizational learning* literature and tradition and its more recent structural counterpart—the *organizational memory* or the *organizational knowledge base*—that influenced knowledge management most.

Various management approaches and scientific disciplines have played a role in the development of the theory of organizational learning and organizational memory, some of which enjoy a long and respected tradition of their own. The most profound effects have come from the following research disciplines[4]: organization science and human resource management (HRM), computer science and management information systems, management science, psychology and sociology.

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3. Many early ideas can be traced back to a series of roundtable conferences with the title *Managing Knowledge Assets into the 21st Century* started in 1987 and hosted by Digital Equipment Corporation (DEC) and the Technology Transfer Society at Purdue University (Wiig 1997b, 10, Amidon 1999, 15). One of the first published documents that presents a general KM concept was a keynote address given at the Technology Assessment and Management Conference of the Gottlieb Duttweiler Institute Rüschlikon/Zurich (CH) in late 1986 by Karl M. Wiig (Wiig 1988). At about the same time, Karl Erik Sveiby and his colleagues Anders Riesling and Tom Lloyd (Sveiby/Lloyd 1987) published their book *Managing know-how*. The book contains a number of early ideas on knowledge management and particularly on the intellectual capital approach developed from 1983 on as a Swedish-English cooperation based on the analysis of several hundred “know-how organizations”. The results of this analysis influenced many Scandinavian companies (the best known being Skandia, Sveiby 1998, 254ff).

Within these disciplines, several fields can be distinguished that have had a profound impact on knowledge management. These will be discussed in the following.

4.1.1.1 Organization science and human resource management

Organization science has a long tradition in looking at organizational change processes from a variety of perspectives. The most important influences on knowledge management come from the fields organizational change and the management of change, from organizational development, particularly from organizational learning and organizational memory, from organizational intelligence, organizational culture and from theories of the evolution of organizations. Additionally, the field of knowledge management is based on approaches from HRM that have a long research tradition in areas highly relevant for KM such as developing employee's skills, recruiting and retaining talent.

Organizational change, management of change. Generally, a large number of approaches in organization science are concerned with changes within organizations and changes of organizations. Organization scientists' interest in change has risen steadily during the last 25 years. There are many schools of thought in organizational change. Examples are the natural selection view, the system-structural view, the strategic choice view and the collective-action view (Wiegand 1996, 85). Within these schools of thought there are various fields some of which are described in more detail subsequently: e.g., organizational development, organizational learning, theories of the evolution of organizations, and management theories such as innovation management. Theories and approaches of organizational change can be characterized by (1) the extent of change they conceptualize (first order versus second order change), (2) the change processes and (3) factors that trigger or influence change (Wiegand 1996, 155ff).

Organization development (OD). OD is a long-range effort to improve an organization's problem-solving and renewal processes with respect to personal, interpersonal, structural, cultural and technological aspects. This is achieved particularly through a more effective and collaborative management of organization culture with special emphasis on the culture of formal work teams. OD efforts are initiated by consulting and planned by management with the assistance of a change agent, or catalyst, and the use of the theory and technology of applied behavioral science, including action research (French/Bell 1978, 14). Building on Lewin's well-known phases of social change—unfreeze, change (move), refreeze (Lewin 1947, 34f)—OD has the individual as the most important element of organizations and intends to improve participation, learning through experience, development of personality

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4. For an overview of some of the roots of knowledge management or the two most prominent underlying concepts organizational learning and organizational memory e.g., Huber 1991, Frese 1992, Lehner et al. 1995, 165ff, Nonaka/Takeuchi 1995, 1997, Schüppel 1996, 13ff and 186f, Spender 1996, Wiegand 1996, 77ff, Kieser 1999, 133ff, 253ff, Tuomi 1999, 21ff, Lehner 2000, Roehl 2000, 88ff.

of the individuals and performance and flexibility of the organization[5]. Among other characteristics specific to OD (French/Bell 1978, 18) is the distinction between a *change agent* and a *client system* with the first being the catalyst to support the planned change of the second, the social system, which actively participates in the change process (Thom 1992, 1479).

Over time, the concepts and approaches discussed under the term organization development have varied increasingly which has rendered a clear definition of the field virtually impossible.

Organizational learning (OL). Even though OL has emerged as a field only in the 70s and 80s itself, it soon became a recognized way of looking at change processes in organizations[6]. Many authors explicitly base their theories in part on concepts of the sociology of knowledge. OL theories and approaches can be classified according to the primary theoretical orientations as found in the literature body of organizational science: behaviorist theories, cognitive theories, personality/dominance oriented theories, systemic theories (Schüppel 1996, 14).

These different theoretical perspectives share the common hypothesis that phenomena of change in organizations are connected with collective or inter-personal processes of learning. The definitions of OL differ with respect to the question whether behavioral change is required for learning or whether new ways of thinking and, thus, new possibilities for action, are enough. "An entity learns if, through its processing of information, the range of its potential behaviors is changed" (Huber 1991, 89) is an example for the first category. Entity in this definition can refer to a human, a group, an organization, an industry or a society. "First, organizational learning occurs through shared insights, knowledge, and mental models [...] Second, learning builds on past knowledge and experience—that is, on [organizational] memory" (Stata 1989, 64) is an example for the second category.

There are clear differences between traditional organization development and OL. For example in OL, change is considered the rule, not the exception as in OD. OL views change as endogenous, as part of the organization's processes, and the—indirect—management of change is considered an organizational competence in OL rather than an (external) expert's competence as in OD (also Schreyögg/Noss 1995, 178ff). However, it is hard to clearly distinguish between modern OD and OL approaches as modern OD approaches consider some of the earlier critics to OD. In spite of the different perspective on change, OD concepts—and their per-

5. See for example Trebesch 1980, 1982 for a comprehensive list of OD definitions and approaches, French/Bell 1978, 14ff, Wohlgemuth 1981, 51ff, Thom 1992, Wiegand 1996, 146, Schubert 1998, 19ff.
6. For early approaches on organizational learning see e.g., Cyert/March 1963, March/Olsen 1976, 54ff, Argyris/Schön 1978, Duncan/Weiss 1979, Jelinek 1979; see also e.g., Stata 1989, Brown/Duguid 1991, Geißler 1991, Reber 1992, Kim 1993, Probst/Büchel 1994, Geißler 1995, Nevis et al. 1995, Geller 1996, Wahren 1996, Wiegand 1996, Klimecki/Thomae 1997, Pawlowsky 1998a, Schreyögg/Eberl 1998, Crossan et al. 1999, Kieser et al. 1999, Nothhelfer 1999, Wilkesmann 1999.

ceived limitations—can be seen as one of the most important driving forces of OL (Wiegand 1996, 146ff).

OL processes aim at the connection of individual knowledge into organizational knowledge and can be classified into *micro-organizational learning* (i.e., learning in groups) and *macro-organizational learning* (i.e., learning on the organizational level, Reber 1992, 1247ff). Individual experiences and learning potentials are organizationally connected mostly in groups which represent the smallest micro-social unit of organizational learning. The macrostructure represents the core of OL. It connects the groups' learning results and thus turns individual and microsocial learning results into organizational learning success (Reber 1992, 1243). From a management perspective, OL approaches provide concepts, methods and instruments to support organized *collective learning (processes) in organizations* (Wilkesmann 1999, 15ff).

The term *learning organization* was coined in order to stress an organization's skills in performing organizational learning[7], in more detail: its "skills at creating, acquiring, and transferring knowledge, and at modifying its behavior to reflect new knowledge and insights" (Garvin 1993, 80). This definition already shows how closely later OL or LO approaches resemble to the early definitions of knowledge management[8].

Organizational memory (OM). The basic idea of the organizational memory[9] approach, also called *corporate memory*[10], *organizational knowledge base*[11] or an *organization's DNA*[12] is as follows[13]: Learning, no matter whether individual or organizational, is not possible without memory. In general, the term memory is defined as a system capable of storing things perceived, experienced or self-constructed beyond the duration of actual occurrence, and of retrieving them at a later point in time (Maier/Lehner 2000, 685). Using this metaphor, organizational memory is repeatedly proposed as a prerequisite for organizational learning as the corresponding individual memory is a prerequisite for learning of individuals.

As with many metaphors, the analogy between organizational and individual memory is a weak one and the corresponding processes are entirely different on the individual versus on the organizational level. Thus, the intuitive understanding of the term organizational memory is often misleading, e.g., regarding the OM as a

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7. See e.g., Senge 1990, 1990a, Garvin 1993, 80ff, Schreyögg/Noss 1995, 176ff, Lang/Amelingmeyer 1996, Güldenberg 1997, 105ff, Wieselhuber et al. 1997.
8. See section 4.1.4 - "Definition" on page 52.
9. See e.g., Hedberg 1981, Nelson/Winter 1982, 99ff, Huber 1991, 90, Walsh/Ungson 1991, 61ff, Sandoe/Olfman 1992, Kim 1993, 43, Stein 1995, Stein/Zwass 1995, Walsh 1995, Buckingham Shum 1998, Eulgem 1998, 144ff, Herterich 1998, Eulgem 1999, Cross/Baird 2000, Lehner 2000, 160ff.
10. See e.g., Kühn/Abecker 1997, Dieng et al. 1998.
11. See e.g., Duncan/Weiss 1979, 86f, Pautzke 1989, Müller-Stewens/Pautzke 1991, 192, Probst/Büchel 1994, 17ff, Amelingmeyer 2000, 39ff.
12. See Spear/Bowen 1999.
13. For the following explanation of organizational memory see also Lehner 2000, 75ff, Maier/Lehner 2000.

"brain" to which organizations have access or the more technical interpretation which uses the often cited, but nevertheless in many respects unsuited analogy between computers and brains[14]. The term is simply meant to imply that the organization's employees, written records, or data contain knowledge that is readily accessible (Oberschulte 1996, 53). However, this static definition of memory is not very useful in the context of OL. Emphasis has shifted to active memory—that parts of the OM that define what an organization pays attention to, how it chooses to act, and what it chooses to remember from its experience: the individual and shared mental models (Kim 1993, 43f).

Moreover, the static perspective does not take communication into account. Communication is the central constituting factor determining social systems in general and organizations in particular[15] and the complex phenomena taking place when groups or organizations jointly "process" knowledge[16]. Many approaches have been developed which claim to guide organizations to use their common or shared memory in a more efficient way[17]. Existing approaches focus on organizational issues and consider the OM as a resource, which has to be managed like capital or labor (e.g., Lehner 2000).

Organizational intelligence (OI). The OI approach[18], also called *competitive intelligence*[19] or *enterprise intelligence*[20] provides a slightly different focus on organizational information processing than OL with an emphasis on collective processing of information and decision making (Lehner et al. 1995, 241ff) or, alternatively, on the organization's ability to learn, the organizational knowledge and the organizational memory (Oberschulte 1996, 46ff).

Organizational culture. Concepts, such as trust, norms and standards, unwritten rules, symbols or artifacts, are investigated under the lens of organizational culture. These concepts are shared by the members of an organization and provide orientation in a complex world. Organizational culture is to a large extent an implicit phenomenon and thus hardly observable and up to interpretation (Schein 1984, Schreyögg 1992, 1526). It is the result of a learning process and is handed on to new members of the organization in a process of socialization (Schreyögg 1992, 1526). Organizational culture impacts the behavior of members of the organization

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14. See e.g., Spitzer 1996, 12ff and 209ff who compares the functioning of computers and of brains.
15. See Luhmann's definitions of social system and organization (Luhmann 2000, 59); see also Krause (1999, 26ff and 39f).
16. See for example the interesting concepts and theories regarding e.g., transactive memory systems (Wegner 1986), group remembering (Hartwick et al. 1982), and the social cognition theory (Pryor/Ostrom 1986); see also Kim 1993, 43ff, Maier/Kunz 1997, 5ff.
17. See also section 4.3 - "Knowledge management systems" on page 82.
18. See e.g., Matsuda 1992, Müller-Merbach 1996, 1998, 1999, Oberschulte 1996, Schuhmann/Schwaninger 1999, Tuomi 1999, 22ff, also mentioned in March/Olsen 1976, 54 and Huber 1990.
19. See e.g., Vedder et al. 1999, 109.
20. See e.g., Jacobsen 1996.

in general and—in this context of particular interest—their willingness to share knowledge (e.g., Hofstede et al. 1990). A supportive organizational culture is considered one of the most important success factors for faster organizational learning (Schein 1993) or the implementation of a KM initiative (e.g., Davenport et al. 1998). It positively affects knowledge creation and especially knowledge sharing, even across sub-cultures, such as the ones of executives, engineers and operators (Schein 1996). A supportive organizational culture has been conceptualized as a resource[21] reflecting the character of social relations within the organization: organizational *social capital* (Leana/van Buren 1999). However, the concept is only vaguely defined and it remains largely uncertain if, how and to what extent organizational culture can be assessed and influenced in a systematic way (for a critic e.g., Drumm 1991).

Theories of the evolution of organizations. This field comprises a large number of approaches which apply for example evolution theories originally developed in the disciplines philosophy, biology[22] and the social sciences to organizations. Examples are the population-ecology approach, approaches describing the internal evolution of organizations, approaches to describe the long-term evolution of organizations, self-organizing systems and evolutionary management[23]. Early evolution theoretic concepts disregarded learning processes because structural inertia hindered organizations from (risky) changes. However, later approaches have taken critics into account and provide concepts for the explanation of possible processes and effects of organizational learning and knowledge management as well as of the sometimes positive effects of inertia with the help of the concepts variation, (goal-oriented) selection, retention and isolation.

A particularly interesting concept within the theories of evolution of organizations is the concept of *organized chaos* which postulates that management should draw its attention to the organization's perception of relevant environmental changes, their (internal) communication and processing. Chaos theory is applied in that quick changes in organizations require quantum leaps (small cause, great effect). This includes viewing organizations as open social systems where manag-

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21. See also the resource-based view in strategic management discussed in section 5.1.1 - "From market-based to knowledge-based view" on page 94.
22. The biological theory of evolution (Wallace, Darwin) was based on earlier work on evolution theories by philosophers and social scientists (Mandeville, Hume, Adam Smith, Ferguson). The success of the biological theory of evolution motivated the development of an abstract, general *synthetic evolution theory* which can be applied to generally explain phenomena of adapting development, not only biological phenomena. The biological theory of evolution in the 20th century was widely used as a model for evolution theories in the social sciences, e.g., anthropological approaches, macro-sociological approaches, approaches describing the evolution of behavior and sociobiological approaches. These approaches represent the basis on which theories of the evolution of organizations are built (Segler 1985, 88ff, Kieser 1992, 1758ff, Hayek 1996, 103ff).
23. See e.g., Weick 1969, 54ff, Greiner 1972, Hannan/Freeman 1977, 1984, McKelvey/Aldrich 1983, Astley 1985, Segler 1985, 168ff, Maturana/Varela 1987, Probst 1987, Ulrich/Probst 1988, Lutz 1991, 105ff, Kieser 1992, 1999, 253ff, Wiegand 1996, 93ff, Weibler/Deeg 1999.

ers have to “manage self-organization” in the sense that they encourage structures and a culture which are suited for the observation of the market and for the implementation of the necessary organizational changes (Heitger 1991, 118ff). Thus, the concept is closely related to self-organizing systems.

Human resource management (HRM). In addition to theories and approaches of organization science which explain the behavior of social systems, people-oriented approaches represent a central element in KM. Employees create, hold and apply knowledge. New employees bring their knowledge and ideas to an organization. Individuals that are already members of the organization learn individually as well as in teams and networks and participate in organizational training and development programs. Employees who leave the organization take their knowledge with them. These are only some examples where HRM strongly interrelates with knowledge management[24], provides concepts for a strategic knowledge or competence management or is even transformed into a knowledge- or competence-oriented HRM (Bruch 1999, 132f and 137ff).

HRM in an institutional sense denotes an organizational subsystem (e.g., HRM department) that prepares, makes and implements personnel decisions which are economically legitimated, basically to secure availability and effectiveness of personnel (Kossbiel/Spengler 1992, 1950). HRM provides concepts and approaches to describe functions such as planning of personnel demand, selection/recruiting, training and development, compensation and benefits as well as outplacing of individuals and to explain for example individual behavior, motivation, performance, leadership (e.g., Staehle 1991, 718ff, Drumm 2000) which all influence the handling of knowledge in organizations. Moreover, it is the personnel development function of HRM which is affected most by concepts of OL and KM. Examples are the recent founding of corporate universities in business organizations, e.g., at Lufthansa or DaimlerChrysler, aiming at an integration of these concepts into institutionalized personnel development (e.g., Heuser 1999).

On the other hand, HRM can help to identify the crucial knowledge base, knowledge barriers and gaps as needed to define a KM strategy (e.g., Ryan 1995, 9). OL and KM approaches tend to use a decentralized approach to personnel development with an emphasis on individual members of the organization and collectives. Examples for collectives are work groups, teams as well as networks and communities in which members learn on the job, share knowledge and thus learn from each other. At least in a more centralized implementation of KM strategies, a systematic, methodical planning of education and training measures will still be a necessity and thus require traditional HRM in an institutionalized sense (Drumm 2000, 414f). HRM then shares a great part of its responsibilities with an enterprise-wide KM initiative (Wiig 1999, 159). HRM departments might be well positioned e.g., for knowledge identification and mapping, to identify knowledge gaps and

24. See e.g., Freimuth et al. 1997, Sattelberger 1999, 18ff and 149ff, Bullinger et al. 2000, 79f, Vorbeck/Finke 2001a; for an overview of HRM software to support KM see Koubek et al. 2000.

barriers, for general education and training programs and to foster an organizational culture supportive for KM and thus ensure the success of KM initiatives (Soliman/Spooner 2000, 337 and 343f).

4.1.1.2 Computer science and management information systems

Information and communication technology represents a key enabler for knowledge management initiatives[25]. Consequently, both, computer scientists and MIS researchers show substantial interest in the field. This is especially true for both, researchers and practitioners in the field of AI who have changed their research focus from expert and knowledge-based systems to knowledge management systems. The theory most notably used as the underlying basis of socio-technical system research in general is systems theory. Additionally, the perspective on organizations as knowledge processing systems provides useful insights for knowledge management.

Information processing approach. This approach views organizations as knowledge and/or information processing systems[26] and develops a model explaining individual behavior (e.g., problem solving, decision making) based on findings of cognitive psychology using concepts such as attitude, personality and definition of the situation as well as short term and long term memory[27] (Kirsch 1970, Reber 1973, 354ff). Thus, individuals are considered as information processing systems. The information processing approach has influenced MIS views substantially. Even though it is hard, if not impossible, to translate these concepts to organizational information or knowledge processing, some of the ideas can be used to frame the context for individuals participating in OL or KM initiatives. An example is the similarity of individual attitudes and possibly the joint definition of situations within a community or network[28].

Systems theory. Concepts of systems theory provide the (implicit or explicit) basis for many investigations, theories and concepts developed within computer science and MIS, e.g., in order to explain the application of technology, particularly information and communication technology, in organizations. Systems theory is an entire scientific discipline that aims at the formulation of general laws and rules about states and behaviors of systems (Heinrich/Roithmayr 1989, 459). In its modern form, systems theory and cybernetics can be traced back to the works of von Bertalanffy (1949) and Wiener (1948). Systems theory studies the static structures as well as dynamics and functions of closed and open systems (Lehmann 1992, 1839ff). The term *system* is used in a variety of ways within systems theory, although there is a common core that views a system as a set of elements that can

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25. See also section 4.3 - “Knowledge management systems” on page 82.
26. In German: Informationsverarbeitungsansatz; introduced into business administration theory in German speaking countries by Kirsch (1970).
27. In German: *Einstellung*, *Persönlichkeit*, *Definition der Situation*, *Kurzzeit-* and *Langzeitgedächtnis*.
28. See also section 6.1.3 - “Groups, teams and communities” on page 177.

be described with attributes and relationships which determine the states and behavior of the system and can be characterized by the exchange of energy, matter and information (Lehmann 1992, 1839). The extensive literature on systems theory has received much attention within e.g., information management (e.g., Heinrich 1996, 23), systems analysis and design, system dynamics and socio-technical systems theory (e.g., Heinrich 1994). The latter has also been used by some authors in order to reframe existing research questions in knowledge management, such as the "processing" of knowledge in technology-equipped social systems (e.g., Spender 1996a, 54ff).

Artificial intelligence (AI). Together with its psychological sibling, the *cognitive sciences*, the field of artificial intelligence has tried to establish the analogy between human and computer problem solving[29]. The promise in the 50s, 60s and 70s of the last century was that in a matter of years we would see machines that could think and that were as intelligent as human beings (e.g., Dreyfus/Dreyfus 1986). As a consequence, there were substantial philosophical questions to be discussed. For example, knowledge would no longer be bound to individuals, machine learning would resemble human learning. However, even though there were significant success stories about the use of specialized *expert or knowledge-based systems* mainly in the 80s[30] and even though there is still research going on trying to build thinking machines, the original AI research goals were abandoned to a large extent. Instead of trying to build androids or general problem solvers, most AI research institutes nowadays apply AI methods, tools and techniques, e.g., mathematical logics, pattern recognition and search heuristics, to a wide variety of problem domains, e.g., image processing, robotics, speech analysis, expert systems (Heinrich/Roithmayr 1989, 285).

Recently, knowledge management has gained increasing attention as one of these problem domains[31]. Advanced AI technologies, such as neural networks, genetic algorithms and intelligent agents, are readily available to provide "intelligent" tools e.g., for semantic text analysis, text mining, user profiling, pattern matching. Packaged in comprehensive KMS solutions, these tools can be considered as technologies enabling organization-wide support for the handling of knowledge and, thus, for knowledge management.

4.1.1.3 Management science

As pointed out in the introduction[32], the transformation of businesses into knowledge-based or knowledge-intensive businesses and intelligent organizations also has a profound impact on organizations in general and management in particular.

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29. See e.g., the architectures of general systems and computer simulations trying to explain cognition in Anderson 1983, 2ff.
30. See e.g., Hertz 1988, Kleinhans 1989, 49ff for an overview of the use of AI technologies and expert systems for businesses.
31. For a detailed analysis of the relationship between knowledge-based systems and KM see Hendriks/Vriens 1999.
32. See chapter 1 - "Motivation" on page 1.

Due to the importance of these developments, a number of authors have attempted to make knowledge the basis of a new theory of the firm (e.g., Spender 1996a). During the last decade, knowledge and competencies have also been investigated in strategic management as the resource-based view of an organization. In addition to strategic management, other management approaches and concepts also influence knowledge management which is by definition a management function itself.

Strategic management. The concept of strategic management determines the long-term goals and positioning of an organization, its policies as well as instruments and ways to achieve these goals (e.g., Staehle 1991, 563) and is based on the concept of planned evolution (Staehle 1991, 571). It encompasses strategy formulation, implementation and evaluation and has, as an ultimate objective, the development of corporate values, managerial capabilities, organizational responsibilities, and administrative systems which link strategic and operational decision-making, at all hierarchical levels (Hax/Majluf 1984, 72). On the basis of the resource-based view of the organization (Wernerfelt 1984, Grant 1991), several authors conceptualized the strategic relevance of knowledge in general and knowledge management in particular.

Knowledge in this view is a strategic asset (e.g., Zack 1999c, vii) or the principal productive resource of the firm (Grant 1996a, 385), and an organization's speed and efficiency in integrating knowledge and in extending its knowledge base, termed the organizational capability, is critical for creating competitive advantage (Grant 1996a, 385). Resources in general and knowledge—or competencies—in particular have to be valuable, rare, inimitable and reasonably durable in order to provide sustained competitive advantage[33].

Thus, knowledge management comprises the organization's ability—or capability—to create and sustain the knowledge resource (von Krogh/Venzin 1995). A knowledge strategy (e.g., Bierly/Chakrabarti 1996) or knowledge management strategy has been seen either as an (important or principal) part of the business strategy or as a perspective in its own right suggesting to view organizations as networks of (core) competencies (Prahalad/Hamel 1990): the knowledge-based view of the organization[34].

Other management approaches. There are a number of management concepts, theories and approaches that focus certain aspects of knowledge management, such as *innovation management* (e.g., Hauschildt 1993) or *management of change*[35]. Other management approaches provide an alternative view on management, such as *systemic or system-oriented management* and *evolutionary management* (e.g., Ulrich/Probst 1988). For example the *"management by" approach* provides a

33. See Barney 1991, 106ff; see also chapter 5 - "Strategy" on page 93.
34. See e.g., Grant 1996b, Spender 1996a, Zack 1999b, see also section 5.1.1 - "From market-based to knowledge-based view" on page 94.
35. Management of change has strong interdependencies with organization science, see section 4.1.1.1 - "Organization science and human resource management" on page 23.

framework for the development of managerial systems to integrate knowledge-oriented aspects into management instruments. One representative of the management by approaches, the management by objectives (MbO) approach (e.g., Odiorne 1971, Staehle 1991, 892), was extended to the definition of knowledge goals and was called the management by knowledge objectives (MbKO) approach (Probst et al. 1998, 88ff).

4.1.1.4 Psychology and sociology

Organizations have long been the central focus of active fields of psychology and sociology, called organizational psychology and organizational sociology. The fields deal with behavior of human beings in organizations from an individual and a collective perspective. Many concepts and ideas have found their way from organizational psychology and sociology into organization science in general and more recently into knowledge management. Additionally, the concepts developed in the sociology of knowledge provide a basis for the explanation of socially constructed knowledge as used in organizations which can be found frequently as the underlying implicit foundation of KM approaches.

Organizational psychology. The field has its roots in the mid 60s in the works of e.g., Katz and Kahn (1966), Pugh (1966), Bass (1965) and Schein (1965). It gained massive attention in the 70s and 80s, as a shift from an exclusive focus on individual behavior in work settings towards a more broadly defined contextual framework was proposed[36]. Organizational psychology studies human behavior and experience in organizational settings and explicitly considers the system characteristics of organizations with different levels of abstraction—individual, group or subsystem and organization[37]. Organizational psychology is sometimes also termed *sociological psychology* (e.g., Berger/Luckmann 1967, 186) and *social psychology of organizing/in organizations* (Weick 1969, 1995, Murninghan 1993). The latter combines the study of individuals with an emphasis on context, e.g., in the form of other individuals, their immediate space, the greater society, to study organizations and organizational phenomena (Murninghan 1993, 1). Last but not least, in the mid 80s a new area of cognitive psychology emerged which is called *knowledge psychology*. This field can be characterized by its close ties to computer science in general and artificial intelligence in particular (Spada/Mandl 1988).

Organizational sociology. This field of sociology analyzes the structural similarities of organizations which are seen as social systems of activity (Pfeiffer 1976, 9). Organizational sociology shares its research object—the organization—with many other fields and even disciplines, and is thus in itself, though tied to sociology, an interdisciplinary field. The boundaries, notably to organizational psychology, are blurred and at least in the 60s the two terms were in some cases used to denote the

36. See Nicholson/Wall 1982a, 6 and the literature cited there.
37. See Nicholson/Wall 1982a, 6ff; see also Gebert/Rosenstiel 1996 for an overview of organizational psychology.

same area (Shimmin 1982, 237). Organizational sociology deals with a wide variety of research questions that for example question the assumption of rationality in organizational behavior (socially constructed systems of activity), investigate organizations as permanently moving phenomena (dynamics of organizational theories; development, selection and learning models) or study cultural phenomena and political processes in organizations (Türk 1992, 1639ff).

Research results of organizational sociology influenced organization theory, e.g., in the form of theoretical perspectives such as contingency theory, resource dependence theory, neo-Marxist theory and institutional theory (Scott 1994, xv) or tried to influence organizational practice (e.g., Johns 1973, ix) and vice versa. Thus, a strict separation of these two fields is not possible, although the primary research interest in organization science is not so much a descriptive and explanatory interest, but aims at the normative design of effective and efficient organizational structures and processes (Pfeiffer 1976, 10f). Organizational sociology offers a variety of perspectives and approaches to interpret events and processes in organizations, whereas the state of research does not allow for practical recommendations for "organizational design" (Türk 1992, 1646). Organizational sociology influences knowledge management because the latter also analyzes social phenomena on an organization-wide level (e.g., Weick 1995, Willke 1998),

Sociology of knowledge. The theories of the sociology of knowledge view knowledge as socially constructed on the basis of a world view (Weltbild) and comprise theories of social construction of reality which in both, terminology and conceptualization, influenced organizational learning and knowledge management theories[38].

4.1.1.5 Summary of conceptual roots

Table B-1 summarizes the variety of the research fields and disciplines that fuel developments in the knowledge management field. The fields will only be briefly characterized instead of defined. In most cases, a commonly accepted definition is not available. Also, fields such as organizational change, organizational development, organizational learning and organizational intelligence as well as organizational psychology and organizational sociology do not evolve separately, but researchers are aware of the advancements in other fields and thus the boundaries are permeable. There seems to be a trend towards convergence in all organizational sciences with researchers including methods from other fields and disciplines into their studies which seems all the more the case in increasingly realistic problem-centred investigations with less emphasis on purely theoretical or methodological considerations (Nicholson/Wall 1982a, 8). Knowledge management can be seen as

38. For the roots of the sociology of knowledge see Mannheim 1924, Scheler 1924; see also Berger/Luckmann 1967 for a theory of social construction of reality and for a good overview, development and critics Curtis/Petras 1970, Ant 1991; finally, see e.g., Brosziewski 1999, Degele 2000 for recent discussions of the concepts under the perspective of knowledge management or knowledge society.

one of these problem-centred domains in which methods and perspectives of many, if not all of the fields described in Table B-1 are applied.

TABLE B-1. Summary of research fields that form roots of KM

research field	**characterization**
organizational change	is concerned with changes within organizations and changes of organizations with the help of development, selection and learning models and thus represents an umbrella term for fields such as organizational development or organizational learning.
organization development (OD)	is a methodical strategy for intervention, initiated through consulting and planned by management with the assistance of a change agent, which supports the development of organizations with respect to personal, interpersonal, structural, cultural and technological aspects.
organizational learning (OL)	approaches share the common hypothesis that (observable) phenomena of change in organizations are connected with (unobservable) collective or inter-personal processes of learning on a micro-social (group) as well as a macro-social level (organization).
organizational memory (OM)	is used in analogy to an individual's memory to denote the collective memory of an organization which is capable of storing things perceived, experienced or self-constructed beyond the duration of actual occurrence, and then retrieving them at a later point in time.
organizational intelligence (OI)	provides a slightly different focus on organizational information processing than OL with an emphasis on collective processing of information and decision making.
organizational culture	is to a large extent an implicit phenomenon only indirectly observable with the help of concepts such as trust, norms, standards, unwritten rules, symbols, artifacts which the organization's members share and which provide orientation. The organizational culture is the result of a learning process and is handed on in a process of socialization.
theories of the evolution of organizations	apply evolution theories originally developed in the disciplines philosophy, biology and the social sciences to organizations, e.g., the population-ecology approach, self-organizing systems, organized chaos and "evolutionary management".
human resource management (HRM)	in an institutional sense denotes an organizational subsystem that prepares, makes and implements personnel decisions to secure availability and effectiveness of personnel, e.g., planning of personnel demand, recruiting, training, development, laying off of employees.
information processing approach	develops a model explaining individual behavior (e.g., problem solving, decision making) based on findings of cognitive psychology using concepts such as attitude, personality and definition of the situation as well as short term and long term memory.

TABLE B-1. Summary of research fields that form roots of KM

research field	characterization
systems theory	is an entire scientific discipline that aims at the formulation of general laws and rules about states and behaviors of systems and provides the basis for many investigations, theories and concepts developed within organization science and MIS.
artificial intelligence (AI)	has tried to establish the analogy between human and computer problem solving and applies a common set of methods, e.g., mathematical logics, pattern recognition and search heuristics, to a wide variety of problem domains.
strategic management	determines the long-term goals and positioning of an organization and encompasses the complete process of formulation, implementation and evaluation of strategies to link strategic and operational decision-making.
other management approaches	focus on certain aspects of management, such as innovation management, or provide an alternative view on management, such as systemic or system-oriented management, and evolutionary management.
organizational psychology	is a field that studies human behavior and experience in organizations and was later extended to explicitly consider the system characteristics of organizations with different levels of abstraction: individual, group or subsystem and organization.
organizational sociology	is a field of sociology that analyzes the structural similarities of organizations which are seen as social systems of activity. Organizational sociology offers a variety of perspectives and approaches to describe and interpret events and processes in organizations.
sociology of knowledge	views knowledge as socially constructed on the basis of a world view[a] and comprises theories of social construction of reality which in both, terminology and conceptualization, influenced organizational learning and knowledge management theories.

a. in German: Weltbild

Apart from these roots of knowledge management which in large parts influenced the literature on knowledge management, the topic is also discussed in other disciplines, such as pedagogy (e.g., Mandl et al. 1994) or anthropology (e.g., Harrison 1995). Figure B-2 shows the conceptual roots of knowledge management that were discussed above and the main concepts and constructs playing a role under the umbrella of this field.

Knowledge management renews an old promise of a great part of the organization science literature, especially organizational development, namely to provide concepts to improve the systematic handling of knowledge in organizations. Fried and Baitsch see the difference between OL and KM basically in a more centralized approach to explicit existing knowledge in KM rather than the decentralized approach aimed at generating new knowledge as in OL (Fired/Baitsch 2000, 36ff).

However, this perspective fails to consider that KM concepts are not limited to a centralized organizational unit managing the processes of gathering, organizing and handling explicit knowledge, but also comprise a (large, if not larger) decentralized part[39].

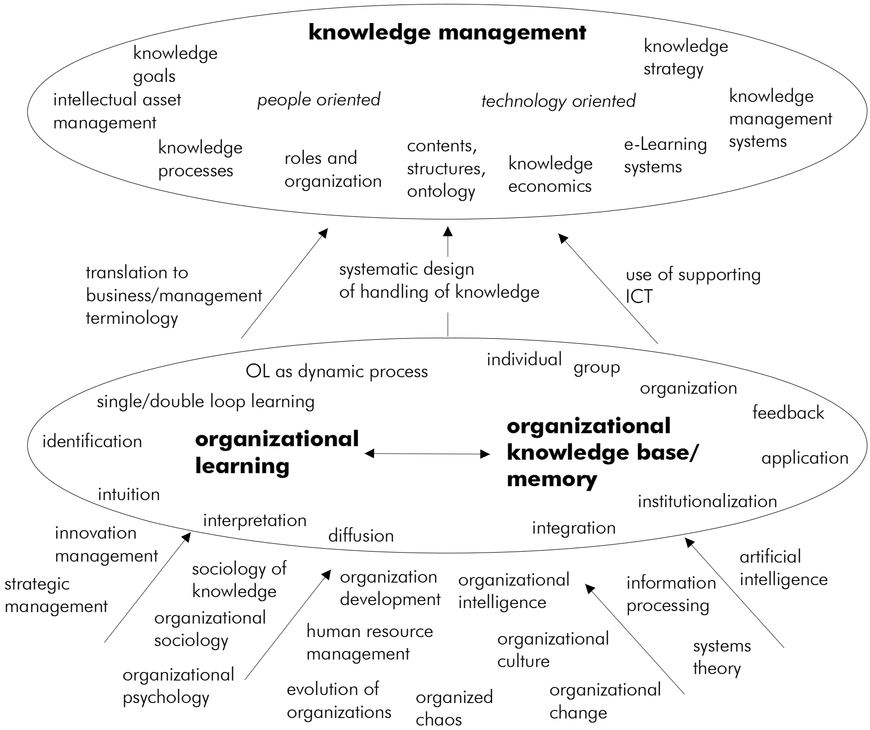

FIGURE B-2. Conceptual roots of knowledge management

Thus, knowledge management can basically be viewed as a *translation* of organizational learning and organizational memory approaches to management terms and an integration with management concepts, such as strategic management, process management, HRM, information management. The management focus also encourages the *goal-oriented design of the handling of knowledge, capabilities or (core) competencies* on a strategic, organization-wide level. Finally, central to knowledge management is the *use of modern information and communication technologies* as an enabler, a catalyst for the organizational instruments implemented to improve the way an organization handles knowledge. This implies that especially practitioners expect that knowledge management produces expectable, manageable improvements in the handling of knowledge. As this is a recent inter-

39. See also the empirical results presented in part C which show that KM in organizations is a decentralized, though often systematically supported approach.

pretation of knowledge management it is understandable that although the term knowledge management has been around for a long time, it is only recently that it has received greater attention.

Since the late 80s and the early 90s there has been a tremendous growth in the number of publications about knowledge management. A large number of books and papers focusing on knowledge management have been published[40]. Additionally, several management journals have produced special issues on knowledge management[41]. Specialized journals with knowledge management or knowledge organization in the title have mushroomed[42] and numerous Web portals have been created that specialize on knowledge management both in the Anglo-American world and the German-speaking countries[43]. These developments are paralleled by a vivid interest in the topic from professional consultants who, among other things, present their own articles, case studies and entire Web sites on the topic[44]. The field has absorbed and developed a substantial influx of ideas from a variety of fields and disciplines[45]. It seems as if managers—and scholars—have awakened to the power of viewing organizations from a knowledge perspective and now engage

40. Some examples for books or papers focusing on knowledge management, knowledge flow management, managing know-how or the organization of knowledge are Sveiby/Lloyd 1987, Hertz 1988, Wiig 1988, Kleinhans 1989, Stata 1989, Nonaka 1991, Kogut/Zander 1992, Quinn 1992, Albrecht 1993, Hedlund/Nonaka 1993, Strasser 1993, Wiig 1993, Blackler 1994, Hedlund 1994, Nonaka 1994, Schreinemakers et al. 1994, Zucker/Schmitz 1994, Blackler 1995, Davenport 1995a, Nonaka/Takeuchi 1995, Bierly/Chakrabarti 1996, Grant 1996b, Schmitz/Zucker 1996, Schneider 1996, Schreyögg/Conrad 1996, Schüppel 1996, Allee 1997, Demarest 1997, Güldenberg 1997, Ruggles 1997, Skyrme/Amidon 1997, Wiig 1997, Allweyer 1998, Baecker 1998, Brown/Duguid 1998, Choo 1998, Davenport et al. 1998, Davenport/Prusak 1998, Dieng et al. 1998, Pawlowsky 1998, Probst et al. 1998, Willke 1998, Bach et al. 1999, Bullinger et al. 1999, Duhnkrack/Bullinger 1999, Hansen et al. 1999, Weggemann 1999, Zack 1999a, Zack 1999c, Amelingmeyer 2000, Astleitner/Schinagl 2000, Bach/Österle 2000, Despres/Chauvel 2000, Götz 2000, Krallmann 2000, Lehner 2000, Mandl/Fischer 2000, Mandl/Reinmann-Rothmeier 2000, Roehl 2000, Alavi/Leidner 2001, Eberl 2001, Mertins et al. 2001, Schreyögg 2001, Haun 2002, Hanged 2002, Ackerman et al. 2003, Holsapple 2003.
41. Examples are the Strategic Management Journal, Winter Special Issue 1996, Spender/Grant 1996, Gablers Magazin, August 1997, Probst/Deussen 1997, the California Management Review, Spring 1998, Cole 1998, the Journal of Strategic Information Systems, Fall 1999, Galliers 1999, and Fall 2000, Leidner 2000, the journal IEEE Intelligent Systems and their Applications, O'Leary/Studer 2001, and the Journal of Management Information Systems, Summer 2001, Davenport/Grover 2001, or in the German-speaking countries, the journal Informationsmanagement, January 1998, e.g., Allweyer 1998, the journal Personalwirtschaft, July 1999, Jäger/Straub 1999, the journal HMD, August 1999, Heilmann 1999.
42. Examples are the Journal of Knowledge Management, the Electronic Journal of Knowledge Management, the Knowledge Management Magazine, Knowledge and Process Management or the Journal of Intellectual Capital, see Table D-5 on page 710.
43. Examples are: URL: http://www.kmworld.com/, http://www.knowledgeboard.com/, http://www.brint.com/km/, http://www.knowledgeMARKT.de/ (see also Table D-6 on page 710).
44. Examples are URL: http://www.sveiby.com.au/, http://www.krii.com/, http://www.entovation.com/, http://www.skyrme.com/.
45. See "From organizational learning to knowledge management" on page 22.

in knowledge practice across industries, functions and geography[46]. Wiig (1997b, 6 and 10f) gives numerous examples of events and publications showing the increasing attention that scholars and practitioners pay to the topic. Shariq (1997) even proposes to develop a *knowledge management discipline*.

The extensive literature produced since then has tempted some authors, though mostly on conference panels or in public newspapers, to question whether knowledge management was just a passing "management fad", a "buzzword" or an "overhyped label" (e.g., Roehl 2000, 79, Schneider 1996, 7, Skyrme/Amidon 1997, 29). It has to be admitted that especially in the mid to late 90s there was an inflation of "new" and heterogeneous approaches to knowledge management. Since then, some definite trends have emerged, several authors have attempted to classify KM approaches in order to show the breadth of the concepts developed[47] and most authors agree on a *common core of concepts* which make up knowledge management, although the field is still far from being consolidated. The common core of concepts that has been developed can also be observed in relatively broad agreement among leading practitioners or practitioner-oriented literature about best and good practices in knowledge management[48].

Now, at the beginning of the new millennium there is still considerable and growing interest in the topic and the number of authors, scholars and practitioners, optimistic about a positive impact of knowledge management on organizations seems to grow as well (e.g., Cole 1998, 20, Miles et al. 1998, 286, McCampbell et al. 1999, Götz 2000, Alavi/Leidner 2001, Mertins et al. 2001). Expectations have settled to a more realistic level, though.

The growing number of success stories from organizations applying KM in general and adequately designed ICT in particular have fueled the interest in the topic. Information and communication technology is one, if not *the* enabling factor for an improved way of handling knowledge in organizations which can support organizations to deal with the problem of how to implement changes prescribed by orga-

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46. See Amidon (1998, 45 and 52) who coined the term "Ken awakening" in this context. The english word *ken* means to know, to recognize, to descry, to have an understanding as a verb and perception, understanding, range of vision, view, sight as a noun. According to Amidon ken ideally characterizes the joint way of thinking of many executives during the last decade that has the power to fundamentally transform businesses (Amidon 1999, 15ff).
47. See e.g., Binney 2001, 34ff who identifies six categories of KM applications in what he calls the KM spectrum: *transactional KM* (case based reasoning, help desk and customer service applications, service agent support applications), *analytical KM* (e.g., data warehousing and mining, business intelligence, customer relationship management), *asset management KM* (e.g., intellectual property, document and content management, knowledge repositories), *process-based KM* (e.g., based on TQM and business process reengineering programs, best practices, process improvement and automation, lessons learned), *developmental KM* (e.g., skills development, staff competencies, teaching and training) as well as *innovation and creation* (communities, collaboration, discussion forums, networking, virtual teams)
48. See the empirical studies cited in chapter 10 - "Related Empirical Studies" on page 439; see also e.g., Skyrme/Amidon 1997, Davenport et al. 1998, Skyrme 1999, Skyrme 1999a, Wiig 1999, Sveiby 2001.

nizational learning or knowledge management concepts effectively and especially efficiently into organizational practice.

Put in a nutshell, knowledge management seems to be a lasting phenomenon with concepts applied systematically and consciously by an increasing number of organizations and its lessons learned are here to stay. The share of organizations that take advantage of this approach therefore should increase. Additionally, the support by information and communication technologies is on the rise as well. The following hypothesis will be tested:

Hypothesis 1: The share of organizations with a KM initiative has increased compared to earlier studies

Even though generally the application of KM has great potentials in all industry sectors, it is supposedly the service sector where KM penetrates the organizations most. This is expected because of the higher share of knowledge workers in service organizations than in industry organizations (see also part A) and the higher share of non-routine business processes in service organizations. As a consequence, access to KM-related systems should be targeted at a higher portion of employees in service organizations than in industry organizations:

Hypothesis 2: Service organizations have a higher share of employees with access to KM-related systems than industrial organizations

4.1.2 From data to knowledge management

In addition to the interdisciplinary perspective on KM as presented in the last section, there is yet another quite popular conceptualization which compares knowledge management to data management and information (resource) management (e.g., Kleinhans 1989, 26f, Lehner 2000, 76ff, Rehäuser/Krcmar 1996). This is especially true for the German *business informatics* literature that claims data and especially information management as its primary research object (e.g., Heinrich 1996, 12). The corresponding *information function* is seen in analogy to other business functions such as purchasing, production, sales and marketing, finance or HRM (Heinrich 1996, 8) and is represented in many organizations by a Chief Information Officer – CIO. The CIO is (primarily) responsible for the development and administration of information and communication systems and infrastructure. Thus, there is a clear focus on ICT.

Consequently, the perspective on KM in these approaches can be characterized as primarily technology-oriented. Basically, many MIS researchers and quite a few researchers from the field of Artificial Intelligence try to translate the findings and ideas of the more human-oriented KM approaches to the development of so-called knowledge management systems. In this view, ICT is regularly considered the driving force for the successful implementation of KM initiatives. In the following, this perspective will be applied to briefly survey the development from the management of data to the management of knowledge.

In most cases, the terms data, information and knowledge are still ambiguous and vaguely defined[49]. This is especially true if definitions are compared between different research disciplines (e.g., philosophy, sociology, natural sciences, MIS and computer science[50]. However, many authors who went to the trouble of making a clear distinction between these terms within the MIS discipline, seem to agree on some form of a *hierarchical relationship between data, information and knowledge*[51]. Each higher level is based on or extends the preceding one. This conceptualization is used to postulate different demands for management (goals, approach, organizational roles, methods, instruments) and different resulting systems (data base systems, data warehouses, information and communication systems, knowledge management systems) on each of these levels.

Historically, in the seventies and the beginning of the eighties the focus certainly was on data management (see Figure B-3). In the following, the steps will be discussed subsequently.

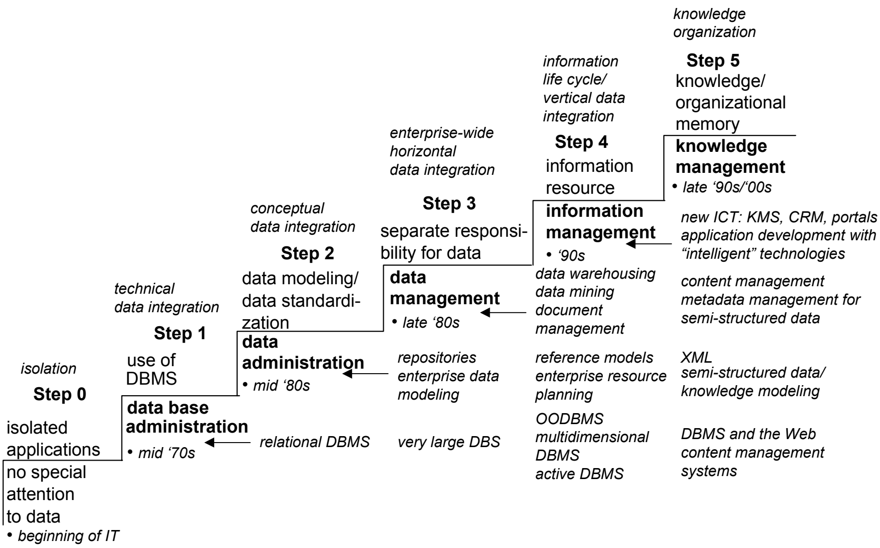

FIGURE B-3. Historical development of information processing[52]

Step 0: isolated applications. The starting point for the historical development of information processing can be described by a joint consideration of program logic and data. There is no special attention being paid to data. Application systems hold their own data storages leading to redundancies and inconsistencies between different application systems.

49. For a survey on the different definitions used see Lehner/Maier 1997.
50. See also section 4.2.1 - "History and related concepts" on page 60.
51. Examples are Augustin 1990, 15f, Eulgem 1998, 24, Greschner/Zahn 1992, 14, Willke 1998, 13.
52. The figure is based on Ortner 1991.

Step 1: data base administration. In the first step, technical issues therefore mattered most. Data base administration is concerned with the technical integration of previously isolated data storage units. Examples for tasks are to guarantee efficient data storage avoiding or controlling redundancies, to implement and administer the data base management systems (DBMS) that provide instruments for technical integration between application systems or to tune the performance of data base systems.

Step 2: data administration. As DBMS penetrated organizations, semantic or conceptual data integration, data modeling and data handling were the most important questions to be resolved. These tasks together provide semantic data integration which is the primary goal of step 2.

Step 3: data management[53]. Separate organizational units were institutionalized, which were responsible for the co-ordination of data management tasks throughout an organization. Often, this coincided with the development of enterprise data models which were seen as an instrument for the integration of project or departmental data models on an organization-wide level. Sophisticated methods for data modeling and data base modeling have been developed, many data base languages have been introduced, SQL became the industry standard for the definition (data definition language), manipulation (data manipulation language) and query of data structures (query language) as well as the administration of user privileges (data control language).

With the advent of an organization on a certain step, tasks introduced at a previous step still play a role. For example data base administration on step 1 covers not only hierarchical and network DBMS, but also relational DBMS (step 2), very large DBS (step 3), object-oriented, active and multidimensional DBMS in step 4 as well as content management systems and the access of DBMS from the Web (both Internet and Intranet) in step 5 (see Figure B-3). Data management tasks have been extended during the introduction of information management and knowledge management as well. Information management requires for example the introduction of a data life cycle, responsibilities for data elements and sophisticated systems and procedures for the provision of data supporting decision making: data warehousing and data mining technologies.

Figure B-4 shows a simple data life cycle model which gives an overview of the most important technologies the data part of which has to be handled by data management: transaction processing systems (TPS) and data base systems, data warehouses and business intelligence tools and systems (especially OLAP, reporting and data mining tools) which support decision making.

Soon it became clear that data could not be the sole focus of a *data resource management* which claimed to be on the board of executives and therefore on the

53. Due to their importance for KM, the following three steps will be discussed in more detail.

same hierarchical level of the organization structure as traditional management functions such as production management or marketing/sales management. Data had to be accessible by the users in a way which supported the tasks that users had to fulfil.

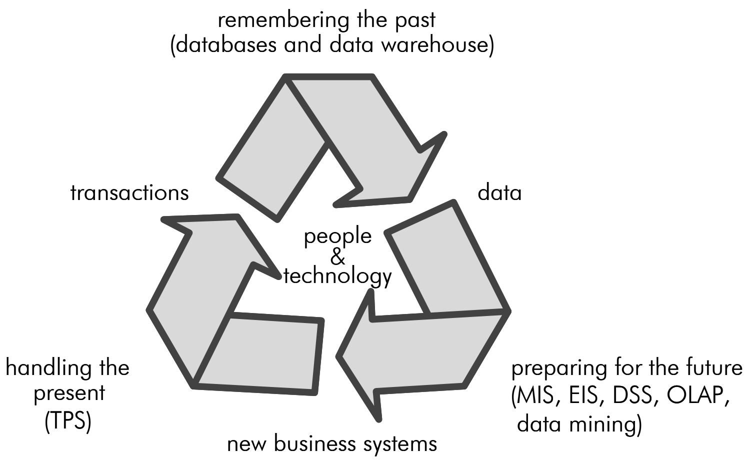

FIGURE B-4. "Closed loop" of data handling in an organization[54]

Step 4: information management. As a consequence *information* was understood as a production factor which had to be managed like other production factors (capital, labor). Thus, the scope of the *information resource management* was a much broader one as compared to data management[55]. The most important aspects were the extension from the management of syntactic and semantic to pragmatic aspects of information understood as an instrument for preparing decisions and actions, information logistics, the contingency approach to information—the different interpretation of information in different situations—and the perspective-based approach to information which means that different groups of users might interpret the same data differently.

From an organizational perspective, information management was understood as the management of the information life cycle (see Figure B-5, also Krcmar 2003, 76ff): (1) the systematic acquisition of *information sources*, (2) which are

54. Source: Watson 1999, 11.
55. A large number of books and papers on information management or information resource management have been published with a peak in the 80s and beginning of the 90s of the last century. More recently, there is less talk about information (resource) management. However, the basic ideas are applied, updated and extended in fields such as management of information systems, strategic planning for information systems, strategic information systems or information systems leadership. For recent collections of material on information management and related areas see e.g., Galliers/Leidner 2003, Heinrich 2002, Krcmar 2003, Pearson 2001, Ward/Peppard 2002, Watson/Brohman 2003).

then made physically accessible as *information re-sources* and thus provide (3) the *information supply* which is compared to (4) the *information demand* of the organization. These ideas of information logistics (Levitan 1982, Lehner et al. 1995, 232ff) and an internal information market (Kuhlen 1995) are supported by (5) the management of the *information and communication infrastructure* as well as the application systems in support of the organizational processes, rules and regulations.

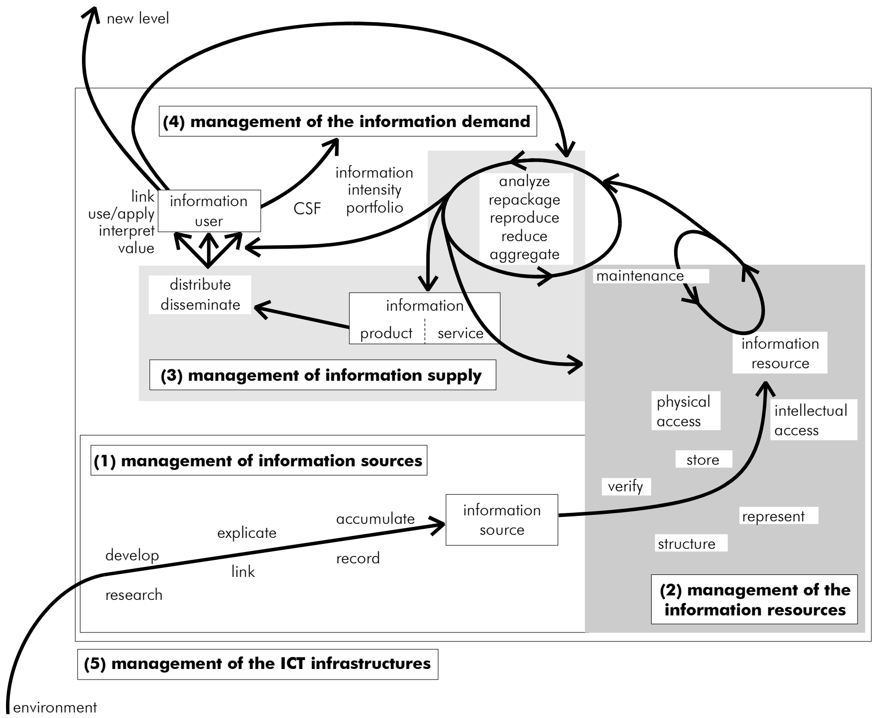

FIGURE B-5. The life cycle model of information management[56]

The recent approaches in the field of business process modeling and their technical counter-part, workflow-management systems, reflected the respective developments in organization science, namely the orientation towards business processes: *business process management* or *business process (re-)engineering*.

As a consequence, organizations invested heavily in business process reengineering (BPR) programs (e.g., Hammer/Champy 1993, 1995, Grover/Kettinger 1995) in order to orient their organizational structures towards customers, both internal and external ones. Effective and efficient business process management was considered a dynamic organizational core competence (e.g., Osterloh/Frost

56. Source: Krcmar 2003, 77.

1996, 175ff). Only recently, the smooth functioning of business processes has become a kind of a commodity in many industry sectors. ICT support for business processes, especially routine business processes, has been widely applied in the form of *workflow management systems*[57]. Much effort has gone into the translation of business processes into workflow models so that new or changed designs of business processes could be implemented highly effectively and efficiently (e.g., Galler 1997, especially 31ff).

Wide application of business process reengineering and management produced as a result fierce competition based on prices and (delivery) time. In order to improve organizational goals such as profitability and growth, executives focused speed of innovation as the most important competitive factor because new products and services would stimulate demand and thus increase the overall market whereas otherwise growth was only possible at the cost of competitors.

In the course of this changed focus, it was often cited that only "fast" organizations would survive. "Fast" in this case means the ability to quickly react to opportunities and threats from the environment and to produce innovative ideas and turn them into products and services at a quicker pace than the competition. Organizations identified learning and knowledge as the key concepts that had to be focused on. As mentioned before, organizations started to apply the extensive literature from organization science about innovation, change and organizational learning to design improved flows or processes of knowledge. *Knowledge management* entered the management community.

Step 5: knowledge management. Whereas organizations have realized substantial benefits from BPR in terms of quality of products and services, productivity, throughput time and in terms of customer satisfaction, knowledge has proven to be difficult to manage. Knowledge work and knowledge-intensive business processes have been difficult to reengineer (Davenport 1995b, 8). BPR has provided a number of instruments which could also be applied to the improvement of knowledge processes and some authors have tried to pave the way to an integration of BPR with more traditional approaches to organizational change known from organization science[58]. However, their successful implementation requires a different focus or perspective on organizations, the focus on knowledge and knowledge processes. This perspective spans business processes rather than focusing on exclusively one business process. The reason for this is that whereas the flow of knowledge within a business process is (1) easier to determine and (2) easier to optimize, it is the flow of knowledge between business processes, the interfaces between different organizational units and topics that might provide the highest potential for innovation and competitive advantages. Thus, it is expected that organizations support several, if not all business processes rather than focusing on one single business process. The following hypothesis will be tested:

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57. See also section 4.3 - "Knowledge management systems" on page 82.
58. For example Osterloh/Frost 1996, Kock et al. 1997, Liebmann 1997.

Hypothesis 3: Knowledge management activities span business processes rather than focusing on exclusively one business process

An organization's ability to learn or handle knowledge processes (process view) or its ability to handle knowledge (product view) have been considered the new key success factor. This has required new organizational design alternatives and also new information and communication systems to support the smooth flow of knowledge which consequently have been called knowledge management systems.

Already existing tasks on lower steps have been once again extended. With the advent of advanced data base and network technologies as well as the availability of sophisticated AI technologies for purposes such as text mining, user profiling, behavior analysis, pattern analysis, semantic text analysis, *knowledge management* extended the focus of *information management* to the handling of new information and communication technologies as well as to enrich *application development with intelligent technologies* (see Figure B-3 on page 40).

With respect to data, knowledge management needs to handle networks of semi-structured, context-rich data, experts, participants and their combination. *Data management* has been once again extended to cover *meta-data and content management* for semi-structured data on an enterprise-wide level. This includes the design and the handling of meta-data for the corresponding new tools and systems such as content management systems, tools and procedures to support data exchange and data access between a multitude of new systems and technologies, e.g., Web and Intranet technologies, mobile technologies, document management technologies. Certainly, KMS cannot be reduced to their data and meta-data structures, but offer a new variety of ways to support the handling of knowledge in organizations[59].

To sum up, in many organizational contexts and several approaches in the literature, knowledge management is simply viewed as the next consequent step in the development of organizational information processing[60]. Indeed, from a data-oriented perspective, this view can be justified and has its advantages. It explains, for instance, what data management tools and methods, what information logistics and ICT infrastructures are required in order to effectively build knowledge management systems.

However, the concepts of knowledge management also require a much broader view which includes organizational functions and processes traditionally not viewed as part of information management[61]. As opposed to the first four steps in the model, the last step, knowledge management, consequently is not implemented

59. See section 4.3 - “Knowledge management systems” on page 82.
60. For an approach that is most closely related to information management see the model for the management of knowledge presented in Rehäuser/Krcmar 1996, 20 who reuse the life cycle model presented in its latest version in Krcmar 2003, 77 which was originally developed for the management of information, see also Figure B-5 on page 43.
61. See section 4.1.1 - “From organizational learning to knowledge management” on page 22.

by adding tasks to an already existing organizational unit, in this case an IT department. In organizations, this gap between information management and knowledge management is reflected by the fact that generally, if a separate organizational unit is created held responsible for knowledge management, this unit is not positioned in the realm of an IT function. For example, the departments headed by a Chief Knowledge Officer (CKO)[62] of pioneering professional services companies were separated from the IT departments headed by a Chief Information Officer (CIO).

Both historical roots of KM—the interdisciplinary field of organizational learning and the step model tracing the management of knowledge back to the management of data and information—have to be considered for a definition of KM.

4.1.3 From traditional work to knowledge work

As mentioned in section 1 - "Motivation" on page 1, the transformation of society and economy into a knowledge society and a knowledge economy has substantially changed the work places of the majority of employees. The concept of knowledge work was coined in order to stress the corresponding changes in the work processes, practices and places of employees and thus the differences to more traditional (often manual) work. In the following, the concept of knowledge work is briefly discussed from the perspective of an (ICT supported) KM initiative. This focus is also used to visualize the differences to more traditional work, such as routine office work.

Knowledge work can be characterized as follows[63]:

- *target*: solves ill-structured problems in complex domains with a high degree of variety and exceptions,
- *content*: is creative work, requires creation, acquisition, application and distribution of knowledge and bases inputs and outputs primarily on data and information,
- *mode of work*: consists of a number of specific practices, e.g., creating new knowledge, interpreting, integrating, representing, retaining and securing it, producing and reproducing knowledge or, in Schultze's (2003, 50f) terms, practices of informing, such as expressing or extracting experiences, monitoring what can be learned from happenings, translating knowledge to other domains, interpreting and absorbing knowledge and networking with other people,
- *personal skills and abilities*: uses intellectual abilities and specialized knowledge rather than physical abilities and requires a high level of education, training and experiences resulting in skills and expertise,
- *organization*: is often organized decentrally using new organizational metaphors, such as communities of specialized knowledge workers, has strong communication, coordination and cooperation needs and is highly mobile, flexible and distributed,

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62. See section 6.1.2.1 - "Knowledge manager (CKO)" on page 163.
63. See also Kelloway/Barling 2000, Hayes 2001, 81f, Schultze 2003, 43.

- *ICT*: requires a strong yet flexible personalized support by information and communication technologies.

Knowledge work can be defined as work that creates, translates or applies new knowledge. This definition is a rather narrow one so that only a small percentage of actual work being done in organizations would qualify as knowledge work. The broader term, information work, takes into account that not all work with information necessarily generates, translates or applies new knowledge and comprises knowledge work, management work and data (service) work (Drucker 1993, Schultze 2003, 45).

Data or service work relies on established procedures, is well defined and does not require equally high levels of education than in the case of knowledge work. Management work is performed by business owners, executives, legislators, senior officials and supervisors whose daily work practices comprise the processing, communication and translation of (abundant) information and the preparation, taking and execution of decisions[64]. In this narrow view, knowledge work is restricted to (re-)producing new knowledge whereas data (service) work transforms information, but does not produce new knowledge. However, in actual work practices, it might be difficult to separate knowledge work from data or service work so that actual KM initiatives or KMS might be most useful when supporting information work in general and not be limited to restrictively to a narrow definition of knowledge work.

A number of authors have used the concept of knowledge work to classify occupations or positions of actual workers into knowledge and non-knowledge workers or routine, manual etc. workers[65]. This distinction, however, is not without trouble because on the one hand all human work requires some kind of knowledge and on the other hand even within one profession actual workers might differ widely according to the portion of their work that qualifies as knowledge work. The term knowledge work refers to (Kelloway/Barling 2000):

Professions. Occupations or job positions are classified into knowledge workers and non-knowledge workers or routine, manual etc. workers. This distinction is not without trouble because on the one hand all human work requires some kind of knowledge and on the other hand even within one profession actual workers might differ widely according to the share of their work that qualifies as knowledge work.

Group characteristics. Education, training and years of work experience are a necessity for a worker to be called an expert. In this case, knowledge work refers to experts' work and thus defines a group of individuals who share certain characteristics, e.g., the ones mentioned above. However, on the one hand experts might not always be engaged in knowledge work, but also have to do for example routine

64. See Drucker 1993, 5ff and 75ff who elaborates on the characteristics and productivity of knowledge workers and service workers; see also Schultze 2003, 45.
65. One example is Machlup 1962, Wolff 2005; see also Schultze 2003 and the literature cited there.

data work and on the other hand less experienced employees might be engaged in just the same type of work than experts are. This would then require just the same organizational and ICT design, so that the distinction is not appropriate for defining a target group of individuals for KMS design.

Activities/behavior. Thus, knowledge work should not be restricted to a certain class or group of employees. It should rather be used as a concept that allows a focus on commonalities across professions and positions for the application of KM instruments, KM-oriented organizational design and ICT support. As an increasing portion of employees is engaged in this type of work (Wolff 2005), the corresponding design of an ICT environment throughout an organization gains importance.

In this book with its focus on (ICT supported) KM initiatives, knowledge work relates to this latter category of specific activities and behavior that require specific organizational and ICT design. Table B-2 compares the traditional, routine work environment of an office employee with the work environment of a knowledge worker. It shows the changed requirements for the organizational design and the ICT support for knowledge work that have to be considered by a KM initiative and some aspects of economics that affect the management of knowledge work.

Organizational design. When compared to traditional work, knowledge work can be characterized by stronger communication needs, weakly structured and less foreseeable processes, the assignment of multiple roles to one person rather than a single job position per person and the increasing importance of teamwork in the form of project teams, networks and communities in addition to work groups and departments. These changes are reflected by a decentral organizational design that uses the metaphors of a network, a spider's web or a hypertext organization[66] in addition to the traditional hierarchy and that strengthens the position of decentral units.

Business process reengineering and business process improvement programs aim primarily at highly structured, deterministic processes as can be found in more traditional work settings. In the realm of knowledge work, however, knowledge processes cannot be designed as easily so that other management techniques are required. Examples are knowledge management and knowledge process redesign. The latter aims at combining the positive experiences made in BPR efforts with the promises of knowledge management.[67] The boundaries of an organization are blurry and knowledge workers are engaged in a large number of communication, coordination and cooperation processes and practices that cross the organizational boundaries. Alliances, clusters, joint ventures, (virtual) networks and professional communities are some examples for types of institutional settings that have been developed to organize these exchanges. More recently, so-called knowledge cooperations are cooperations between independent legal organizations which have been established in order to overcome specific knowledge problems the goal of

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66. See section 6.1 - "Structural organization" on page 158.
67. See section 6.3 - "Process organization" on page 207.

which is to develop new, applicable knowledge as product or as process by a combination and integration of existing, possibly secured knowledge that the partners hold or by joint knowledge development[68].

TABLE B-2. Traditional office work versus knowledge work

criterion	traditional office work	knowledge work
organizational design		
orientation	data-oriented	communication-oriented
boundaries	organization-internal focus	focus across organizational boundaries, (knowledge) cooperation[a], co-opetition, (virtual) networks
centralization	central organizational design	decentral organizational design
structure	hierarchy	network, hypertext organization[b]
process	highly structured, deterministic processes; pre-structured workflows	weakly structured, less foreseeable processes; ad-hoc workflows
(re-) design	business process reengineering, business process improvement	knowledge management, knowledge process redesign
group	work group, department	project team, network, community
role	one job position per person	multiple roles per person
ICT support		
type of contents	structured data, e.g., tables, quantitative data	semi-structured data, e.g., content, links, hypertext documents, container, messaging or learning objects, workflows
storage	(relational) data base management systems, data warehouses	document and content management systems, Weblogs, Wikis, experience data bases, learning repositories, newsgroups, mail folders etc.
data handling	coordination of accesses, integrity, control of redundancy	synchronization, information sharing, distribution of messaging objects, search and retrieval
coordination	workflow management system	messaging system, Groupware
modeling	data, business process, workflow	ontology, user profile, communication, activity/work practice
workspace	fixed workspace	mobile office, virtual office, multiple workspaces

68. See also Badaracco 1991, Doz/Hamel 1998, Aulinger 1999, Moser 2002, Maier/Trögl 2005.

TABLE B-2. Traditional office work versus knowledge work

criterion	**traditional office work**	**knowledge work**
equipment[c]	personal desktop computer; poor resources	laptop, personal digital assistant, mobile phone; rich resources
applications	small range of applications	wide range of applications, including Web applications
connectivity	isolated; stand-alone	connected; permanent, fast network connections, mobile devices
economics[d]		
management focus	finance, past orientation, periodic reporting	balanced set, future orientation, instant access
location of value	things	flows
tangibility	tangible	intangible
metrics	production statistics, metrics for reporting	innovation statistics, metrics for managing
standardization	standards; standard products and services	common, yet customized products and services

a. See Maier/Trögl 2005.

b. See Nonaka 1994, 32ff and section 6.1 - “Structural organization” on page 158.

c. For a more detailed description of hardware and basic software differences between early personal computers and today’s personal ICT equipment of knowledge workers and the consequences for the design of a supportive infrastructure see Maier/Sametinger 2002, 2003.

d. See also Skyrme 2000, 322.

ICT support. From an ICT perspective, the main changes in the requirements occur due to the considerably higher complexity of data and the focus on organization-wide and inter-organizational communication and mobility of personally responsible knowledge workers. Storage and handling of semi-structured data, e.g., hypertext documents, messaging and learning objects, experiences or skill directories require additional ICT systems, such as document and content management systems, e-learning platforms, messaging systems etc. in addition to the traditional relational data base management systems and data warehouses. Consequently, the challenges in the handling of data are no longer restricted to the provision of integrity, control of redundancy and coordination of accesses as in the relational data base world. New challenges are complex synchronization needs of mobile workspaces, information sharing within and across organizational boundaries as well as search and retrieval in documents and messaging objects that are encoded in a large number of heterogeneous formats for semi-structured data and reside in a variety of data and document sources spread throughout the organization.

Coordination in traditional office work is provided by workflow management systems that implement operative business processes. The lesser structured knowledge work can be coordinated by messaging systems and Groupware. Consequently, modeling used to focus largely on data (entity relationship modeling), objects and classes (object-oriented modeling) and business processes (business process modeling). Knowledge work requires content- and communication oriented modeling techniques that define meta-data and provide taxonomies, ontologies, user models, communication diagrams, knowledge maps and diagrams that show what objects, persons, instruments, roles, communities, rules and outcomes are involved in the main knowledge-related activities[69]. Finally, the increased mobility of knowledge workers requires multiple, virtual workspaces that can be personalized according to the demands and practices of their users.

This fundamental change in ICT support is backed by a corresponding major shift in the ICT infrastructure. PCs are no longer equipped with weak resources and used in an offline, stand-alone mode. Computers have rich resources, provide information-rich modes of interaction with the user, permanent, fast network connections as well as highly flexible wireless and mobile connections and comprehensive communication features. Mobile appliances, such as notebooks, PDAs and mobile phones are equipped with a wide range of applications.

To sum up, this calls for (1) the systematic, flexible handling of context, (2) intelligent functions to handle the vast amounts of substantially extended types of contents, i.e. semi-structured data in the organizational "knowledge base", and (3) extended functionality for collaboration. These functions have to be realized in or seamlessly integrated with the knowledge workers' personal workspaces[70].

Economics. Correspondingly, management focus has shifted from a mere periodical financial focus with its past orientation to a flexible and balanced set of criteria that show the current status of the organization's resources, processes, innovation and performance. The interest thus has shifted from tangible to intangible assets, from things to flows as Skyrme (2000) puts it, from standards and standard products and services to common yet customized products and services. Metrics are required not simply for reporting the production statistics of goods and services, but to manage the innovation process(es) in the organization. Knowledge management in this realm provides for more visibility of organizational resources, skills and knowledge processes and allows for a more systematic strategic management of (core) competencies in an organization[71].

Consequently, KM initiatives primarily aim at fostering an organizational and ICT environment that is suited for knowledge work[72]. The substantially changed

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69. See section 6.6 - "Modeling" on page 237.
70. See also section 4.3 - "Knowledge management systems" on page 82 for a discussion of knowledge management systems and their differences to more traditional information systems.
71. See section 5.1.1 - "From market-based to knowledge-based view" on page 94.

work practices of their largely increased main target group, the knowledge workers, together with recent innovations in ICT infrastructure demand a strategic initiative, knowledge management, that not only improves organizational effectiveness, but systematically realizes the potentials of a learning- or a knowledge-intensive organization for creating and sustaining superior competitive positions.

4.1.4 Definition

Knowledge management is still a young field with multidisciplinary roots. Thus, it is not surprising that there seem to be almost as many definitions to the term than there are approaches or "schools" of authors contributing to the field. On the one hand, this situation can be characterized as a positive development because the lack of clear boundaries has allowed the free influx of ideas, concepts and approaches. On the other hand, the blurry and vague boundaries led to considerable confusion, especially among practitioners, regarding the question what exactly they would have to do in order to "implement knowledge management" into their organizations. Neither the goals were clarified which could be set for a KM initiative, nor were there strategies, a comprehensive list of instruments, procedures or methods how to implement these instruments, their value propositions and how to measure the results of this approach. Apart from general statements, both, the question as well as the answers which knowledge management provided, were unclear.

This situation has changed, both in the literature and to a large extent in practice. Many branches have emerged from the healthy KM tree which more or less build on the same basis. Recently, several authors went to the trouble to review the various approaches of knowledge management more or less extensively. They tried to elicit the prevalent lines of development and to classify the KM approaches[73]. Generally, there is agreement about the distinction between *human* and *technology oriented KM approaches* which basically reflects the origin of the approaches, either in a human/process-oriented organizational learning, organization science background, or on the other hand in a technological/structural organization science, a MIS or computer science/artificial intelligence background[74].

There is also agreement that there are more holistic KM conceptualizations which encompass both directions. However, even the more holistic concepts do not really integrate the two directions. Most holistic approaches seem to focus on the human oriented side and *mention* technology as *one* of the enabling factors without really integrating it. Recently, technology-oriented concepts pay more attention to the human side with the help of knowledge processes and business processes and

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72. Knowledge work is the primary target of knowledge management, but corresponding organizational instruments and ICT tools and systems might also aim at improving information work which includes management and data or information service work.
73. Examples are Schneider 1996a, 17ff, Schüppel 1996, 187ff, Güldenberg 1997, 231ff, Roehl 2000, 88ff, Amelingmeyer 2000, 15ff, Swan 2001, 1f, Swan/Scarbrough 2001, 10, Walger/Schencking 2001.
74. The distinction between human-oriented and technology-oriented approaches has a long tradition in organization science (e.g., Trebesch 1980, 10 uses the framework to distinguish approaches for organization development).

the integration of "packaged" instruments[75]. Figure B-6 shows the two sides of knowledge management and some examples for concepts developed in holistic approaches aimed at their integration.

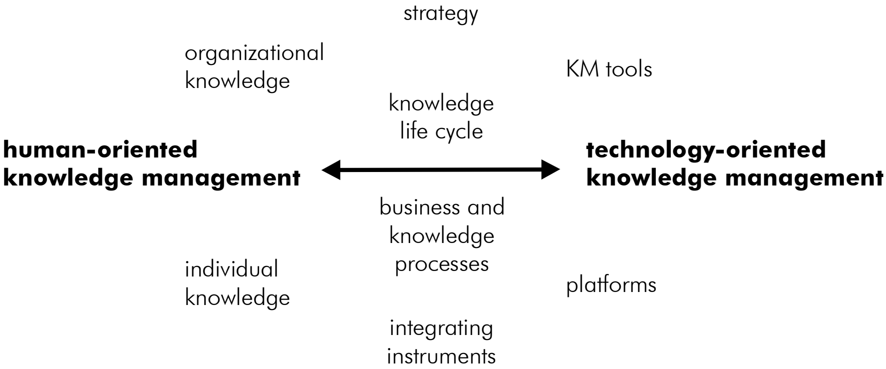

FIGURE B-6. Human versus technology-oriented KM and approaches to their integration

In the following, this basis shall be discussed with the help of a brief review of definitions. Recently, many authors have concentrated on the development of a specific idea or concept without even trying to define knowledge management. The definitions presented here were selected and classified to provide an overview of the most important (in terms of citation) and the most promising (in terms of the current and foreseeable developments of KM in practice) approaches of defining the subject in the literature. They will then be summarized in a working definition for knowledge management.

Definitions focusing on a life cycle of knowledge tasks, functions or processes. These approaches view knowledge management as a life cycle or a complex organizational "function", "task" or "process" and basically break it down into subtasks, sub-functions, sub-processes or (process) activities. The goal of knowledge management is to improve these sub-tasks, in most cases the creation or generation; acquisition; identification or capture; validation and evaluation; conversion; organization and linking; formalization or storage; refinement or development; distribution, diffusion, transfer or sharing; presentation or formatting; application and evolution of knowledge, with the help of systematic interventions, instruments or measures[76].

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75. See also section 6.3.2 - "Knowledge management processes" on page 212.
76. See Wiig 1988, 104ff, Schüppel 1996, Güldenberg 1997, 247ff and 370ff, O'Dell/Grayson 1997, 11, Choo 1998, 18ff and 105ff, Mentzas/Apostolou 1998, 19.3, Probst et al. 1998, Rey et al. 1998, 31f, Amelingmeyer 2000, 28, Nissen et al. 2000, Pawlowsky 2000, 115ff, Roehl 2000, 154ff, Alavi/Leidner 2001, 115ff, Bhatt 2001, 71ff, Mertins et al. 2001a, 3f.

Examples: Knowledge management comprises all possible human and technology oriented interventions and measures which are suited to optimize the production, reproduction, utilization and logistics of knowledge in an organization[77] (Schüppel 1996, 191f).

Fraunhofer Berlin defines knowledge management on the basis of their benchmarking study as comprising methods, procedures and tools which support the core activities generate, transfer, store and apply knowledge. Knowledge management contributes to business goals as a closed core process in all areas and levels of the organization[78].

Strategy- or management-oriented definitions. These definitions elaborate on the management side of KM and focus the strategic relevance of a KM initiative, program or agenda.

Example: "Applying Knowledge Management broadly throughout [the] organization [...] requires taking a systematic and holistic view of the knowledge agenda—understanding the strategic role of knowledge, linking it to key management decisions and business processes, and improving processes for knowledge creation, sharing and use" (Skyrme/Amidon 1997, 30).

Technology-oriented definitions. These perspectives build on the concepts of data and information management and thus represent an MIS viewpoint. Authors of these approaches usually extend the object of information management to include knowledge, both in the form of somewhat more valuable information or context-enriched information to be stored and distributed with the help of information and communication systems, and in the form of knowledge in people's heads (e.g., Kleinhans 1989, 26f, Rehäuser/Krcmar 1996). As a consequence, knowledge management has to fulfill some functions traditionally attributed to HRM. Some technology-oriented definitions encompass a technology-oriented version of the life cycle of knowledge tasks, functions or processes mentioned above[79] (e.g., Allweyer 1998, 44). Additionally, there are several authors who define KMS or technologies in support of KM and implicitly presuppose a KM definition[80].

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77. The original definition in German is: "Wissensmanagement ist [...] als ein Entwurf zu verstehen, der alle möglichen human- und technikorientierten Interventionen und Maßnahmenpakete umfaßt, die dazu geeignet sind, die Wissensproduktion, -reproduktion, -distribution, -verwertung und -logistik in einer Organisation zu optimieren" (Schüppel 1996, 191f).
78. The original definition in German is "Wissensmanagement umfaßt alle Methoden, Verfahren und Werkzeuge, die die Kernaktivitäten fördern und als geschlossener Kernprozeß in allen Breichen und Ebenen der Organisation zur Realisierung der Organisationsziele beitragen." (Heisig/Vorbeck 1998, 3, see also section 10.1.8 - "Fraunhofer Berlin" on page 444).
79. See "Definitions focusing on a life cycle of knowledge tasks, functions or processes." on page 53. Regularly, the life cycle of knowledge functions is extended to include the "deletion" or "archiving" of knowledge as in the technology-oriented definitions explicit knowledge is considered storable and thus is not bound to a person as in people-oriented definitions.
80. See "Multiple definitions and no explicit definition at all." on page 55 below.

Example: Knowledge management comprises the management of data, information and knowledge processing in organizations. Knowledge and information are viewed as objects which generally can be handled and which are stored on knowledge or information media in material form (as data). Knowledge management is not confined to the technical realm like traditional data and information management. It includes the personal and institutional knowledge potentials and their processing. Thus, it takes over certain functions of HRM[81] (Kleinhans 1989, 26).

Definitions focusing collective or organizational knowledge. These approaches view the organization as a social system and as the primary object of knowledge management. Goal of KM initiatives or strategies is to improve the collective intelligence or collective mind of organizations so that the resulting systematic coordination of knowledge and intellect throughout the organization's often highly disaggregated network of individuals is applied to meet customer needs (also Quinn 1992, 72).

Example: Knowledge management means all organizational strategies to create an "intelligent" organization. These strategies comprise (1) with respect to individuals the organization-wide level of competencies, education and ability to learn of the members of the organization, (2) with respect to the organization as a system creating, using and developing collective intelligence and the collective mind and (3) with respect to the technological infrastructure if, to what extent and how efficiently the organization uses ICT suitable for the organization's way of doing business (Willke 1998, 39).

Multiple definitions and no explicit definition at all. In addition to this broad variety, there are also quite a few authors who give more than one definition in order to show different challenges or solutions which would be out of the boundaries of either one of the definitions. Additionally, there are quite a few articles, especially technology and/or practitioner-oriented ones, which present specific ideas about knowledge management and do not define this term at all[82]. Their implicit definitions all fall more or less in one of the categories mentioned above.

Example: (1) KM comprises "the practices and technologies which facilitate the efficient creation and exchange of knowledge on an organization-wide level in order to enhance the quality of decision making", (2) "KM enables the re-use of information and experience to increase the velocity of innovation and responsive-

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81. The original definition in German is "Wissensmanagement umfaßt das Management der Daten-, Informations- und Wissensverarbeitung im Unternehmen. Wissen und Informationen werden dabei als grundsätzlich handhabbare Objekte angesehen, die direkt oder indirekt über Wissens- bzw. Informationsträger in materieller (Daten-)Form vorliegen. Wissensmanagement beschränkt sich jedoch nicht nur auf den technischen Problemkreis, wie das traditionelle Daten- und Informationsmanagement, sondern es verwaltet auch insbesondere die personellen und institutionellen Wissenspotentiale und deren Verarbeitung. Es übernimmt damit spezielle Funktionen des Personalmanagements."
82. Examples are Abecker et al. 1998, Bach 1999, Bach/Österle 1999, Nedeß/Jacob 2000, 94, Wildemann 2000, 65ff.

ness. Knowledge in these definitions is seen as “the information resident in people’s minds which is used for making decisions in previously unencountered circumstance” (both definitions are taken from Delphi 1997, 12).

A comprehensive definition for knowledge management which can serve as a basis and context for the subsequent investigation into the potentials of systems supporting such an initiative, thus has to consider the following areas (for details see also the following chapters):

Strategy. The definition has to show that systematic interventions into an organization’s knowledge base have to be tied to business strategy. The resource-based view in general and the knowledge-based view in particular provide a suitable theoretical basis.

Knowledge life cycle tasks. In order to give a more detailed picture about what KM is about, the definition can list a number of functions, tasks or processes which a KM initiative supports or tries to improve. Examples are[83]:

operative or *specific knowledge management tasks* such as the identification, acquisition, creation, capturing, collection, construction, selection, evaluation, linking, structuring, formalization, dissemination, distribution, retention, evolution of, access to and last but not least the application of knowledge or

(strategic) knowledge management tasks such as the anchoring of knowledge orientation in the vision and mission of the organization, the support of a knowledge-oriented organizational culture, the setting of knowledge goals and the selection of knowledge strategies to achieve these goals, the identification of knowledge gaps or barriers, the (economic) evaluation of the handling of knowledge in an organization, the implementation of knowledge strategies with the help of a (re-) design of KM tasks, roles, processes or ICT infrastructure.

Instruments. The same argument as in the case of tasks is also true for KM instruments. Pioneering organizations developed new instruments to promote the handling of knowledge in the course of the implementation of their knowledge management initiatives which show what knowledge management (currently) is about. Examples are[84]: expert yellow pages, skill data bases, communities, balanced scorecards, learning laboratories, distance, tele or Web based training and education, expert networks or intellectual Webs[85], new roles such as knowledge brokers or subject matter specialists, knowledge maps, lessons learned, best practices, mentoring and coaching, space management, competence centers, integration of external knowledge media (persons, material, ICT) and the management of legal aspects of knowledge (patents, licensing, appropriability of knowledge). Instruments affect the objects of knowledge management, usually a combination of objects.

83. See section 6.3.1 - “Knowledge management tasks” on page 207.
84. See also Probst et al. 1998, Roehl 2000, Amelingmeyer 2000, 118ff and chapter 6 - “Organization” on page 153.
85. Quinn et al. 1996, 78.

Objects. Depending on the perspective on knowledge management, objects can be *objectified knowledge resources*, *people*, *organizational* or *social structures* and *knowledge-related technology* (especially ICT). In the case of the view of knowledge as a resource, there are plenty of taxonomies distinguishing between different types of knowledge, e.g., tacit versus explicit, declarative versus procedural, narrative versus abstract, internal versus external[86].

Linking to organizational or collective learning. Knowledge management is not exclusively about individual learning. It is the collective learning processes as theorized in the OL literature, that make this approach so interesting. Collective learning is of differing types (e.g., single loop, double loop, deutero learning), takes place on different levels of the organization (e.g., work group or project, community or network, organization, network of organizations) and in different phases (e.g., identification or creation, diffusion, integration, application, feedback). One of the most important facets of the OL approach is the idea that all the processes of learning in collectives are different from individual learning. Thus, it is the dynamics of OL—sometimes called the OL cycle—that is of interest here.

None of these areas explicitly focuses on the *contents*, that is the actual subjects, topics or knowledge area(s) around which a KM initiative builds a supportive environment. The reason for this is that the definition of KM should be general enough so that all kinds of different knowledge areas can be supported by strategies and instruments. Certainly, a specific KM initiative has to define what concrete knowledge areas will be supported, to what extent this knowledge is readily available in an the organization and how much knowledge has to be created or acquired[87]. Box B-1 presents the definition for knowledge management as used here.

> Knowledge management is defined as the management function responsible for the regular selection, implementation and evaluation of goal-oriented knowledge strategies that aim at improving an organization's way of handling knowledge internal and external to the organization in order to improve organizational performance. The implementation of knowledge strategies comprises all person-oriented, organizational and technological instruments suitable to dynamically optimize the organization-wide level of competencies, education and ability to learn of the members of the organization as well as to develop collective intelligence.

BOX B-1. **Definition of knowledge management**

The term management is used here in a *functional sense* (managerial functions approach) in order to describe the processes and functions, such as planning, organization, leadership and control in organizations as opposed to the institutional

86. See section 4.2.2 - "Types and classes of knowledge" on page 66.
87. See also chapter 5 - "Strategy" on page 93.

sense (managerial roles approach) which describes the persons or groups that are responsible for management tasks and roles (Staehle 1991, 64).

In the more recent approaches to knowledge management, most authors suggest to follow a holistic approach overcoming the distinction between human-oriented and technology-oriented knowledge management as discussed above (see Figure B-6 on page 53). Consequently, a KM initiative should combine organizational and technological instruments. For example Ruggles (1998, 88) suggests to keep a balance of 50% people-oriented, 25% process-oriented organizational measures and 25% technological measures from the start of a KM initiative. This leads to the following hypothesis:

Hypothesis 4: Organizations with systematic knowledge management that has been established for at least one year are more likely to have installed KMS than organizations without systematic knowledge management.

Organizations with an established formal KM initiative supposedly apply an in-depth approach to knowledge management and thus should be aware of the positive results that are expected from a joint application of organizational and ICT measures for KM. However, this might not be true for the first year of implementation as it takes some time until complex ICT is selected to support the initiative.

4.1.5 Critique to knowledge management

Is knowledge manageable? Is knowledge management just another passing management fad? Is it too complex a concept for being researched rigorously? What are the main research barriers to the utilization of knowledge? What is it about knowledge management that is distinctly different from older theories and concepts such as organizational learning, organizational change etc.? These are some of the questions knowledge managers and researchers face. Moreover, more traditional software like document management systems, data warehouses and analysis tools and data bases are marketed increasingly as knowledge management systems. Thus, as with every emerging discipline or field of research, there is considerable variety in the perspectives taken and there is no consensus yet what knowledge management is all about and how to proceed.

Many authors have criticized knowledge management and/or suggested new directions for research. Some examples are: Miles et al. identify general conceptual and research barriers to knowledge management (Miles et al. 1998). Holtshouse and Teece propose some research directions for knowledge management intended to overcome these shortcomings (Holtshouse 1998, Teece 1998a). Teece also suggests to view knowledge management as an umbrella to integrate work in accounting, economics, entrepreneurship, organizational behavior, marketing, sociology, and strategy (Teece 1998a, 289). Roehl questions the manageability of knowledge and suggests to focus on the (social) environment instead in which knowledge is generated, shared and used (Roehl 1999). Nonaka and Konno present quite a similar idea with their concept of *Ba*, a shared space for emerging relationships, a platform for knowledge creation which has to be fostered by management (Nonaka/

Konno 1998, 40, 53f). Schmitz/Zucker warn that many knowledge management approaches tend to view knowledge as an object and suggest to rename management *of* knowledge into management *for* knowledge (Schmitz/Zucker 1999, 181). Fahey and Prusak reflect their experiences gained in over one hundred "knowledge projects" and come up with eleven "sins" of knowledge management (Fahey/Prusak 1998). On the basis of two case studies, Swan et al. (1999, 265ff) show the dangers of IT-led KM initiatives that neglect the pre-existing organizational structures, norms and cultural values and as a consequence might even reduce the sharing of *tacit knowledge* in an organization (i.e., knowledge that is not easily communicated, section 4.2). Finally, Pawlowsky (2000) asks provocatively why we need knowledge management at all.

Most of these authors agree that there are substantial benefits to be gained from the systematic and conscious treatment of knowledge-related processes in organizations. The diversity, interdisciplinary nature and dynamics of the field have resulted in a large variety of KM approaches some of which seem to fail to recognize the abundant "lessons learned" in the approaches that form the roots of KM, namely organizational development, organizational learning and strategic management. As a consequence, organizations eager to improve their way of handling knowledge are confronted with several theoretical "schools of thought" on the one hand (human-oriented versus technology-oriented approaches, but also the intellectual capital approach, newer forms of organizational learning approaches, HR approaches etc.) and a vast and not transparent market supply of KMS on the other hand. Moreover, a theory-driven implementation of ICT to support a strategically relevant KM initiative not only has to select a KM perspective and often a combination of KM tools and systems, but also integrate organizational design- and culture-oriented instruments with the supporting technology.

In other words, even though many authors regularly put emphasis on the (individual and organizational) human side of KM, it is technology that all too often is employed as an enabler, a catalyst, a vehicle to complement or implement the concepts that should change the way organizations handle knowledge. Information and communication systems are used as enablers because they provide a cost-efficient and time-efficient way of changing organizational routine or at least managers believe so. Even though KMS can act as catalysts for KM initiatives, it has to be warned against an implementation of such systems without considering the human and organizational side. Instead, a careful coordination with a corresponding strategy, an organizational design and people-oriented measures is required in order to provide a systematic and potentially successful intervention into an organization's way of handling knowledge.

4.2 Knowledge

The term *knowledge* is used widely, but often quite vaguely within business administration[88] and MIS in general and within the field of knowledge management in particular. There are a large number of definitions of this term with varying roots and backgrounds which unfortunately differ not only between scientific disciplines contributing to KM, but also within these disciplines (e.g., Lehner et al. 1995, 165ff, Lehner/Maier 1997) and consequently also within the KM field. Moreover, the different definitions of the term knowledge lead to different perspectives on organizational knowledge and, thus, to different concepts of interventions into an organization's way of handling knowledge (Schneider 1996a, 17ff).

There are also related concepts such as (core) competence(ies) (e.g., Prahalad/ Hamel 1990), organizational capability(ies) (e.g., Grant 1996a) or know-how. They all play a role in knowledge management. It is well worth to briefly review these concepts because the distinctive definitions of knowledge (and related concepts) help to understand the different perspectives taken in the literature and also allow for a characterization of KM approaches. It is neither intended to give a comprehensive overview of knowledge definitions because even a limited review of the work done e.g., in philosophy and sociology would fill bookshelves, nor is it intended to give an all-encompassing definition of knowledge. Instead, the most important conceptualizations of knowledge will be reviewed (section 4.2.1) which have made their way into the various classes of KM approaches as described above (section 4.2.2)[89]. Then, important facets of the term knowledge will be selected to discuss the implications on the definition, the design and the implementation of KMS (section 4.2.3). Finally, the term knowledge will be defined for the following investigation, keeping its limitations well in mind (section 4.2.4).

4.2.1 History and related concepts

The many connotations and meanings attributed to the term knowledge and the difficulties that both, science and also every-day life, experience in defining this concept are reflected by a multitude of terms that all denote a particular piece or process in the scope of knowledge[90]. Examples are: ability, attribution, capability, competence, conviction, discovery, estimation, evidence, experience, explanation, finding, hunch, idea, intelligence, interpretation, intuition, invention, know-how,

88. The term "business administration" is used here to describe the discipline represented by the corresponding programs at business schools (Master of Business Administration, MBA), in German "Betriebswirtschaftslehre" and comprises e.g., controlling, finance, HRM, management science, marketing, organization science, production and logistics, strategic management etc. Management information systems are in most business schools considered as a part of the MBA program, but are treated separately here. Due to the integration of information and communication technologies MIS reflects a different perspective on knowledge management than the rest of business administration does.
89. See section 4.1 - "Knowledge management" on page 21.
90. See e.g., Rich 1981a, 38, Prahalad/Hamel 1990, Weick 1995, 17ff, Grant 1996a, Lehner 2000, 141.

observation, opinion, persuasion, proficiency, proof, sensemaking, skill, tradition, understanding, wisdom. Thus, it is not surprising that so far none of the definitions of knowledge has succeeded in bringing all these conceptions under one umbrella. However, it is doubtful whether such an all-encompassing definition could still be operationalized and would remain meaningful for all the different disciplines that deal with this concept in the sense that it could be used as a basis for subsequent studies[91].

Traditionally, knowledge has been at the core of philosophical considerations. Philosophy has striven for a common and accepted definition or conceptualization of knowledge for centuries with great philosophers contributing to the subject. Examples are[92]:

Greek philosophy. Heraclitus, Sokrates, Plato and Aristoteles among others laid out the foundation for the European thinking of the term knowledge and conceptualized the process of knowing or acquiring knowledge. The most important distinction to today's (scientific) use of the term knowledge is that the Greeks did not believe in certain types of knowledge, but in harmony that was achieved through the unification of physical, ethical and political thought. Most of these philosophers believed in the notion of an *objective reality* which would be *knowable* by a systematically or scientifically observing and analyzing subject and therefore knowledge would represent objective *truth*,

Revolution of thought. Bacon, Descartes, Hobbes, Hume, Leibnitz and Locke among others challenged in the 17th and 18th centuries the commonly held equivalence of *knowledge* and *faith* and the Church as the *one institution* responsible for determining what was "true". Kant and Hegel tried to integrate the various new philosophical fields, namely rationalism and empiricism (best visible in Kant's concept of *justified true belief*),

Multi-perspectivism. Since the 19th century many philosophical schools of thought have emerged. Examples are:

- *positivism* argues that knowledge is gained from the observation of an objective reality, thus distinguishing between an observing subject and an observed object, in this case an organization and its environment. Positivism, represented e.g., by Comte, is the basis of natural science also extensively applied as the foundation of management science.
- *constructivism* claimed the idea that all our knowledge is constructed in our minds therefore challenging the notion of an objective reality. Constructivism is

91. See also Grant 1996a, 110 who argues that the "right" definition for knowledge has to be selected for each specific purpose and research goal.
92. Many authors have made the philosophical roots of their definitions of knowledge visible. Examples are Gardner 1985, Musgrave 1993, Rich 1981a, 12ff, Spender 1996a, 47ff and the sources cited there, also Ayer 1982, Coreth et al. 1993, Fleischer 1996, Lutz 1999, Russel 1961, Scruton 1984 for an extensive overview of the general contributions of the Western philosophers.

a term originating in art and architecture used differently in the Anglo-American versus the German literature and is represented for example by the Erlangen school in Germany[93].

- *critical theory* was developed from a critical attitude towards traditional theory. Critical theory tried to overcome the tension between traditional theory which is developed in separation of the reality of society and the real, societal function of science. The normative elements of theory have to be integrated into the theory itself. Critical theory was developed by the Frankfurt school, represented by Horkheimer, Adorno, Habermas.
- *critical rationalism* developed the argument that all our knowledge is tentative and must be open to empirical falsification and is represented by Popper[94].
- *empiricism* is based on the assumption that knowledge can be created solely from experiences and thus only natural sciences and mathematics can offer secure knowledge and undoubted truths. Empiricism is represented by Hobbes, Locke, Hume and Russel who called it logical atomism and was convinced that the smallest elements of reality can be perceived and named.
- *sociology of knowledge* viewed knowledge as *socially* constructed and was founded by Mannheim and Scheler who built on ideas of Francis Bacon[95].
- *pragmatism* is not concerned with universal truth, but with a more immediate concept of knowledge representing the local reality of our experience since no practice ever engages more than a fraction of the universe ("what works"). Pragmatism was developed by e.g., Peirce, James, Lewis and Dewey[96].

These are just some prominent philosophies which had a profound effect on the conceptualization of knowledge in KM and on the implementation of KM initiatives in practice. These schools of thought have presented competing approaches about the construction of knowledge and truth in societies and there has been a long and substantial debate about the "right" perspective (e.g., Hayek talks 1974 in his Nobel Memorial Prize Lecture about the pretence of knowledge of scientists in the social sciences, Hayek 1996, 3). However, the different schools have not found a consensus in the sense of a common understanding of knowledge (yet). Russel thinks that some vagueness and inexactitude of definitions of concepts, such as knowledge, truth or believe, are inevitable (Russel 1948, 170). The main research questions have always circled around (objective) truth, the limitations of the human mind and belief.

Due to the fact that these philosophical research interests are quite different from the research goals in knowledge management, it can be doubted that either

93. See e.g., Berger/Luckmann (1967) for the Anglo-American perspective, see the Erlangen school, Lorenzen, Kamlah and their disciples for the German perspective, also Hayek 1996, 17, Scherer/Dowling 1995, 218f.
94. See Popper 1972, 1994 for his ideas on objective knowledge.
95. See also section 4.1.1.4 - "Psychology and sociology" on page 32.
96. See Ayer 1982, 69ff and Spender 1996a, 49 who analyzes perspectives on knowledge of pragmatism and other philosophies as the basis for a theory of the firm.

one of the philosophical perspectives can provide a solid basis for investigations into aspects of knowledge management systems[97], though the philosophical concepts certainly have influenced KM perspectives on the term knowledge. One difference between philosophical considerations and KM is that the philosophical definitions tend to restrict the term to (verbally) expressed or expressible (scientific) knowledge which can be challenged by peers whereas organization science also considers those experiences and ideas that implicitly guide actions and communication, but of which the individual is either not aware or which the individual cannot (or chooses to not) express: the so-called *tacit knowledge*[98].

Even the conceptualizations of knowledge in the *cognitive sciences*[99], which can be seen as one of the leading fields in the definition of knowledge within the social sciences (e.g., Wiegand 1996, 164), are not suited as exclusive definitions for knowledge management. One reason for this is that these definitions are restricted to the individual or the individual brain as opposed to the focus on *collective knowledge, networks of competencies* or the *organizational knowledge base* as conceptualized in organizational learning and knowledge management.

This view is based on the perspective as outlined in the philosophical field *constructivism* and its counterpart in the social sciences: the *sociology of knowledge*[100]. In the latter, knowledge is considered as socially constructed, that is as influenced by a society's "Weltanschauung" (world concept)[101]. Thus, it postulates that a particular language structure implies a unique world view and perception of reality. Social processes influence the "process of knowledge" (generation, application). As a consequence, knowledge cannot be described as objective truth (even though we might strive for that), but as what a social system considers as being true.

These approaches were a product of their time and particular interests and were criticized heavily (e.g., by Popper 1970). Still, the *concept of socially constructed knowledge* has been well received within the OL and KM community. Business organizations regularly do not strive for "objective truth" which is the primary goal of science[102] (see also Luhmann's system of functions of societies, Reese-Schäfer 1999, 176f). Instead, in many cases organizations pragmatically look for knowl-

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97. The danger of simply borrowing the philosophical definition of knowledge for psychology was analyzed e.g., by Musgrave (Musgrave 1993, 62f).
98. See section 4.2.2 - "Types and classes of knowledge" on page 66, also Polanyi 1966, Wiegand 1996, 164.
99. E.g., Gardner 1985 who even uses the subtitle "A History of the Cognitive Revolution" in his book "The Mind's New Science", also Payne 1982, Squire 1987, Mandl/Spada 1988, Singley/Anderson 1989.
100. For literature on the topic see section 4.1.1.4 - "Psychology and sociology" on page 32; see also e.g., Curtis/Petras 1970 for a good overview on early and also later developments.
101. Later, the term Weltanschauung was extended to cover not only societies, but also social groups within societies.
102. As mentioned above, there are a number of schools of thought that conceptualize objective truth or objective knowledge differently. Scientific knowledge can be thought of as being the most dependable, most definite, the *best* knowledge that we have (Bentley 1935, 131) *at a certain point in time*.

edge that can be applied efficiently (in terms of "cash value", Spender 1996a, 49) to support the objectives of business organizations[103]. Moreover, business organizations rather strive for sufficient (in terms of efficiency) than for absolute or complete knowledge about their practice (see also Simon's concept of rational behavior and rational decision making in organizations, Simon 1957a).

In *business administration*, the term knowledge in and of organizations is also used in a variety of ways and a variety of relationships to other concepts and to the concept of organization itself[104]. Examples are:

Knowledge as production factor. Knowledge can be viewed as an immaterial potential factor (e.g., Wittmann 1982) along with creativity, good-will, image, capacity for problem solving or other factors which are hard to quantify. Organizational knowledge receives high attention within organizations as it is the basis for all decisions and organizational activities. Due to the increasing knowledge intensity of society in general and business in particular, knowledge is often considered to be the key production factor that has to be handled accordingly. This conceptualization is most prominent in the knowledge-based view (e.g., Grant 1996a, Grant 1996b, Spender 1996a), a specialization of the resource-based theory of the organization (Grant 1991), where knowledge is also seen as key resource for the provision of competitive advantages and, thus, as a success factor. However, it is the services that can be offered with the help of managerial knowledge that produce competitive advantages[105].

Knowledge as product. Knowledge not only guides organizational actions, but can also be sold. For example, professional services companies sell knowledge services. Pharmaceutical companies hold *patents* and license the production of drugs. Knowledge can also be part of *intelligent*, *smart, knowledge-based* or *knowledge-intensive products* (e.g., Davis/Botkin 1994, 165, Glazer 1999, 59) which then can be seen as *knowledge medium*, as "frozen knowledge" (Probst et al. 1998, 170),

Knowledge and its relation to decision and action. Apart from the fact that many authors do not make an explicit distinction between knowledge and information, the most prominent perspective in the German business administration literature is Wittmann's definition of information as being "knowledge oriented towards a purpose" (Wittmann 1959). This perspective views information as a (situational or purpose-specific) subset of knowledge. Both, knowledge and information guide organizational interpretation and action in the sense of activities. On the one hand,

103. These objectives can be e.g., to increase the shareholder value and/or stakeholder value of the organization, to survive and be profitable, to increase customer and/or employee satisfaction. Certainly, there are ethical responsibilities that managers have to consider. However, according to Spender most U.S. executives these days declare themselves as pragmatists (Spender 1996a, 49). Thus, knowledge in organizations is oriented towards a purpose and has to be (efficiently) applicable in the local reality of the organization handling it.
104. See also e.g., Lehner et al. 1995, 170ff, Roehl 2000, 11ff.
105. See also chapter 5 - "Strategy" on page 93.

knowledge is the basis for organizational action. On the other hand, organizational activities generate knowledge which in turn influences future activities. The effect of knowledge and to a much greater extent the effect of information on decision making in organizations has been studied in decision theory for years (e.g., Mag 1990, Gersbach 1991).

Rationality of individual decisions is restricted by incomplete knowledge, difficulties in the valuation of future events, limited selection of alternatives and, more recently, information overload. Due to limited rationality, a perfectly knowledge-based decision was characterized as unrealistic (e.g., Hayek 1945, 519ff and 1996, 3ff), even though at least within organizations (and thus in a social setting) human behavior can be described as "intendedly rational" (Simon 1957, 196ff and 1957a, 61ff). The ideal construct of perfect information for decision making was abandoned in favour of an economic information problem guiding organizations under variable imperfect information. The goal is to determine the optimum degree of information with respect to cost and potential benefits of additional information (Albach 1969).

Knowledge as constituent property of a special breed of organizations. Organizations which follow the knowledge-based view or (primarily) manage and/or sell knowledge, are called *intelligent organizations* (e.g., Quinn 1992, Schwaninger 1998, 1999, Tuomi 1999, 105ff), *knowledge-intensive organizations* (e.g., Starbuck 1992, 715ff who uses this term in analogy to capital or labour-intensive, Mahnke 1997, Tuomi 1999, 75ff, Weggemann 1999, 83ff), *know-how organizations* (e.g., Roithmayr/Fink 1997), *knowing organizations* (e.g., Choo 1998), *knowledge-based organizations* (e.g., Willke 1998, 20), simply *knowledge organizations* (e.g., Sveiby 2001), (distributed) *knowledge systems* (Tsoukas 1996, 13), or, in an older terminology, *learning organizations* (e.g., Garvin 1993, 80, Senge 1990a). These concepts all have in common that in these organizations knowledge is considered to be the most important asset which accordingly receives high management attention. Knowledge intensity or the type of knowledge emphasized is also used to distinguish different classes of organizations requiring different KM activities and systems support[106].

Knowledge on the organizational level. Knowledge can also be viewed as the outcome of organizational learning, as information that has been understood by all or at least a critical mass of members of the organization[107]. This perspective distinguishes individual knowledge from organizational knowledge. On the organizational level, information in the sense of an established, institutionalized organizational *information resource* (Levitan 1982) is considered to be a precursor of knowledge. Additionally, organizations base their actions on *opinions* which denote the beliefs, convictions, persuasion and views of the members of the organization, the valued knowledge, etc. Knowledge and information in this perspective

106. See section 4.2.3 - "Consequences for knowledge management" on page 70.
107. For example Matsuda 1992, 1993 calls it intelligence, also Müller-Merbach 1994-1999.

are also part of a life cycle of information production in organizations (Picot/ Franck 1988).

The roots of the term knowledge as used within organizational learning and knowledge management approaches are manyfold and can be traced back to different disciplines. Even within the KM field, knowledge is used in a multi-faceted way. The following section will give an overview of types of knowledge, taxonomies and different viewpoints as used within the OL and KM area.

4.2.2 Types and classes of knowledge

In addition to the abundant definitions of knowledge, there have been many authors who proposed classifications or categorizations of knowledge. Many classifications use a dichotomy to describe one type of knowledge and its opposite. These pairs can be used to describe *knowledge processes* (Romhardt 2000, 10ff). The knowledge processes transform knowledge of one type into knowledge of the opposite type. In the following, a list of knowledge dimensions is presented with respect to the corresponding main "area of intervention", e.g., individual, organization, information and communication system, content, knowledge life cycle. The dimensions are then populated with an amalgamated and extended list of paired types of knowledge[108] (transforming processes are in parentheses):

1. **Content of knowledge or knowledge application:**
   - abstraction: narrative/concrete/surface/every-day/knowledge of the particular circumstances of time and place vs. scientific/abstract/deep knowledge (abstract; illustrate),
   - generalization: particular/specific vs. universal/general knowledge (generalize; specialize),
   - contextualization: contextualized vs. objectified/decontextualized knowledge (generalize; contextualize),
   - form: declarative vs. procedural knowledge (explain; describe),
2. **Holder of knowledge or valuation of an individual:**
   - value: knowledge valuable for storing vs. knowledge not valuable for storing (devalue; value),
   - relation to person: implicit/tacit/background/non-communicable vs. articulated/explicit/foreground/communicable knowledge (externalize; internalize),
   - existence: knowledge vs. not knowledge (forget; learn),
3. **Organizational design:**
   - relevance: relevant vs. irrelevant knowledge (render irrelevant; make relevant),

108. See also e.g., Hayek 1945, 521ff, Hedlund/Nonaka 1993, 118ff, Zucker/Schmitz 1994, 63, Schneider 1996, 8f, 521f, Schüppel 1996, 54ff and 76ff, Thurow 1997, 102, Zack 1999a, 46, Amelingmeyer 2000, 43ff, Frese/Theuvsen 2000, 25ff, Lehner 2000, 139ff, Romhardt 2000, 10ff, Bhatt 2001, 70, Schreyögg 2001a, 9.

- informal support: unsupported/minority vs. supported/dominant knowledge (inter-subjectively approve; disapprove),
- formal authorization: unauthorized/informal vs. authorized/formal knowledge (authorize; remove authorization),
- secrecy: public/open vs. secret/confidential knowledge (classify; publish),
- truth: false/unsupported vs. true/supported knowledge (prove; falsify/disprove),
- organizational scope: knowledge spanning functional areas vs. knowledge restricted to a functional area (specialize; standardize),
- focus: focused vs. scattered knowledge (laissez-faire; focus),
- holder: individual/personal vs. collective/public/social knowledge (teach/collectivize/make available; learn/socialize/individualize),
- integration: knowledge vs. counter-knowledge (exclude; integrate),

4. **Legal system and/or organizational boundaries:**
   - security: unsecured/public vs. secured/private knowledge (patent/protect; expire/open),
   - legality: illegal vs. legal knowledge (legalize; forbid/make unlawful),
   - ownership: organization-external vs. organization-internal knowledge (acquire/buy; disseminate/sell),
5. **Information and communication systems:**
   - access: inaccessible vs. accessible knowledge (make accessible; deny accessibility),
   - medium: not electronic/not computer-resident (e.g., paper- or people-based knowledge) vs. electronic/computer-resident knowledge (store; delete),
   - codability: non-codable vs. codable knowledge (codify; decodify),
6. **Knowledge life cycle:**
   - preservation: preserved vs. newly acquired knowledge (develop; preserve),
   - novelty: existing vs. new knowledge (explore; exploit),
   - refinement: unrefined vs. refined knowledge (format/label/index/sort/abstract/standardize/integrate/categorize; clutter/disorganize/mix/unformat),
   - actuality: obsolete vs. actual knowledge (actualize; decay)
7. **Business processes:**
   - relation to process: knowledge about the process vs. knowledge within the process vs. knowledge derived from the process (derive; model; apply).

In addition to the paired classifications, Table B-3 presents an exemplary list of classifications to give an indication of what differentiations authors think as most useful for organizational theory and practice.

TABLE B-3. Classifications of knowledge

approach	**categories**
Scheler (1926, 250)	1. instrumental knowledge (Herrschaftswissen) 2. intellectual knowledge (Bildungswissen) 3. spiritual knowledge (Erlösungswissen)
Machlup (1962, 21f), builds on Scheler (1926)	1. practical knowledge 2. intellectual knowledge 3. small-talk / pastime knowledge 4. spiritual knowledge 5. unwanted knowledge
Hayek (1945, 521f)	1. scientific knowledge 2. knowledge of the particular circumstances of time and place
Ryle (1949, 25ff)	1. knowing that 2. knowing how
Sackmann (1992, 141f) builds on Ryle	1. dictionary knowledge (what?) 2. directory knowledge (how?) 3. axiomatic knowledge (why?) 4. recipe knowledge (what should?)
Quinn et al. (1996, 72), similarities to Sackmann (1992)	1. cognitive knowledge (know-what) 2. advanced skills (know-how) 3. systems understanding (know-why) 4. self-motivated creativity (care-why)
Anderson 1976, 114ff, 1983, 10ff[a], Squire 1987, 242, Fayol 1994, build on Ryle 1949)	1. declarative knowledge (episodic and semantic knowledge) 2. procedural knowledge 3. meta-knowledge
Heideloff/Baitsch (1998, 69), similarities to cognitive sciences	1. fact knowledge (about things) 2. episodic knowledge (about events) 3. procedural knowledge (about relationships)
Russel (1948, 17ff)	1. individual knowledge 2. social knowledge
Polanyi (1966, 4ff)	1. tacit knowing 2. explicit knowing
Spender (1994, 360), builds on Polanyi (1966) and Russel (1948)	1. conscious knowledge (explicit individual knowledge) 2. automatic knowledge (implicit individual knowledge) 3. objectified knowledge (explicit social knowledge) 4. collective knowledge (implicit social knowledge)
Willke (1998, 63, builds on Polanyi)	1. implicit knowledge 2. explicit knowledge 3. public knowledge 4. proprietary knowledge

TABLE B-3. Classifications of knowledge

approach	categories
Wiig (1988, 102) defines knowledge to be managed in businesses	1. public knowledge 2. expert knowledge 3. private knowledge
Collins (1993, 96ff) classifies knowledge according to its location	1. embrained knowledge (brain) 2. embodied knowledge (body) 3. encultured knowledge (social system) 4. symbol-type knowledge (symbols)
Bohn (1994, 63) suggests stages of knowledge	1. complete ignorance 2. awareness 3. measure 4. control of the mean 5. process capability 6. process characterization 7. know why 8. complete knowledge
Blackler (1995, 1023ff) adapts Collins' classification to summarize OL concepts	1. embrained knowledge (depends on conceptual skills) 2. embodied knowledge (depends on physical presence) 3. encultured knowledge (shared understanding, socialization) 4. embedded knowledge (in systemic routines) 5. encoded knowledge (signs, symbols)
Sveiby (1997, 35) views knowledge as process	1. explicit knowledge 2. skill 3. experience 4. value judgements 5. social network
Baecker (1998, 6ff) categorizes knowledge in organizations	1. product knowledge 2. societal knowledge 3. leadership knowledge 4. expert knowledge 5. milieu knowledge
Hansen et al. (1999), Zack (1999a, 46) view knowledge as manageable	1. knowledge as object (codified, independent of person) 2. knowledge as process (personalized)
Zack (1999b, 133f) categorizes industry knowledge	1. core knowledge 2. advanced knowledge 3. innovative knowledge

a. This differentiation is common in the literature on AI and cognitive sciences. Anderson proposed a general framework for a production system describing the architecture of (human) cognition (ACT) that consists of a *declarative*, a *production* and a *working memory* (Anderson 1983, 19).

These classifications have in common that they use a couple of categories which are thought to provide a comprehensive classification of knowledge in organizations. Generally, the categories are not comparable to each other, although there are conceptualizations that build on each other or otherwise show similarities (e.g., Machlup builds on Scheler, Quinn et al.'s classification is similar to Sackmann's). There are also homonyms and synonyms and some adaptations do not carry the same meaning as their basis (e.g., Blackler builds on Collins' classification but uses the terms in a different way).

The interested reader may consult the original literature for a detailed description of each of these pairs or classifications. The entire list was presented here to give an indication of the heterogeneity with which the field defines its most important term and, thus, how difficult it is to integrate the views into a single perspective. In the following, the most important distinctions will be briefly characterized which form the basis for the investigation of concepts and scenarios of the application of KMS. A detailed description of the tasks and processes of the KM life cycle and of the operationalization of the distinctions for the empirical study (see part C) can be found in the later sections of this work[109].

4.2.3 Consequences for knowledge management

The variety of definitions of the term knowledge is due to the variety of research subjects which require more or less focus on knowledge. Knowledge is at the center of scientific investigations and an understanding of its philosophical foundation and debates is certainly an anchor in the rough sea of the knowledge management hype. There are still numerous definitions and classifications within the field of knowledge management which are not integrated showing the enormous influx of ideas from related fields. At least to some extent, there is agreement among KM researchers about the most important dichotomies and characteristics of knowledge, such as individual versus organizational, implicit versus explicit, organization-internal versus organization-external knowledge.

In the following, the most important characteristics of knowledge will be summarized which have consequences or provide challenges for the design of knowledge management systems:

"Transfer" of knowledge. Several authors dealing with ICT support for KM have written about KMS which support the transfer or distribution of knowledge. In this area, not only explicit knowledge is considered which can be transferred with the help of knowledge products (See "Knowledge as a product versus knowledge as a process." on page 73 below), but also the tacit side of knowledge. The latter can only be handed on directly from teacher to apprentice (socialization). Knowledge management systems can help

- to locate experts or teachers suited to hand on tacit knowledge to a member of the organization searching for knowledge,
- to pro-actively suggest individuals working on or reflecting about similar subjects to form a network. This improves the efficiency of knowledge creation

109. See chapter 6 - "Organization" on page 153.

through joint observation and inference and communication of results, problems and solutions, and last but not least

- to aid the sharing, dissemination and distribution of knowledge.

According to most definitions of data, information and knowledge[110] *only data can be transported or communicated* which in turn is interpreted by individuals or social systems. Therefore, even KMS essentially contain and support the communication of data only. However, keeping the goals and background of this work in mind, it is opportune to distinguish between the "simple" transmission of data and the "transfer" or "distribution" of knowledge. The latter denotes the simplified and shortened process including the interpretation of the message (information) and the actualization or extension of the knowledge of the receiving system. Figure B-7 shows the complete process of the communication of information and knowledge. Transfer of knowledge implies that the sender is quite certain that the receiver will interpret the data accordingly, (re-) construct the knowledge and use it to actualize the receiver's knowledge in a way that the sender intends.

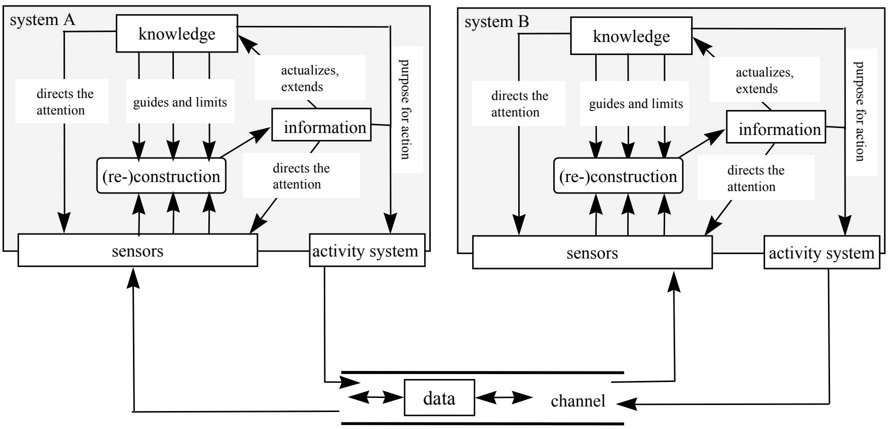

FIGURE B-7. The transfer of information and knowledge

It must be noted that the sender cannot be sure that the receiver will interpret the data in a way that the sender intended. Additionally, according to modern theories in the cognitive sciences with each transfer of knowledge, the knowledge itself is changed not only at the receiving end, but also at the sending end of the communication as it is not just "retrieved" in memory, but reconstructed and the knowledge's context (Cohen 1998, 30ff) is thus changed with each transfer.

Relation to context. Knowledge is developed in a cultural context with social, political, economic and ideological dimensions that exert continual forces on both the substance and the process of scientific knowledge creation (Nelson 1981, 44,

110. See Lehner et al. 1995, especially 170ff for an extensive survey of these definitions.

also Cohen 1998). What has been said about scientific knowledge creation is all the more true in organizational settings. Organizations are not regularly striving for absolute truth, but for a socially constructed reality that allows for successful organizational actions[111]. Knowledge cannot be separated easily from the social context of its generation and reception, both in terms of the environment and situation in which it was generated and in terms of the individuals that created the knowledge.

Economic differences to information. Unlike information, knowledge is not easily transferred between different settings. The costs for the "distribution" of knowledge can be very high (Rehäuser/Krcmar 1996, 11). It takes time until individuals take over knowledge. The corresponding learning processes are complex social phenomena. Knowledge is reconstructed and thus changes when "transferred", as it is newly combined each time when it is handed on. The social process of communication changes the communicated knowledge. Thus, it requires substantially more effort to implement a systematic management of knowledge transfer as compared to the transfer of information. There are a number of institutions that provide an environment conducive to knowledge transfer or learning. This environment can be viewed as an activity system in which "knowledge seekers", "students" or "apprentices" not only directly learn from "knowledge providers", "teachers" or "masters", but also from participating in a community of practice[112] of all the knowledge seekers and knowledge providers in a joint setting (e.g., schools, universities[113], management centers, corporate universities, industry organizations offering apprenticeships). Unlike in the case of information, the transfer of knowledge takes up substantial resources and its outcome is hard to predict.

Protection of knowledge. One of the most important challenges within KM in organizations is the protection of valuable knowledge, e.g., against industrial espionage. Examples for measures that prevent the unwanted use of organizational knowledge are classification or property laws and also organizational instruments such as incentives, conduct rules or postponing of rewards because a great deal of knowledge valuable to an organization resides with (individual) employees (Liebeskind 1996).

In some cases it is opportune for organizations to share knowledge with competition (co-opetition) and thus systematically manage the diffusion of otherwise restricted (patented, classified, confidential) knowledge, e.g., through mechanisms such as visiting each other's production facilities, consortia, benchmarking (Appleyard 1996, 138f). One implication on the design of KMS is that as valuable knowledge must be protected from leaving the organization unintentionally, it might not be appropriate to make it completely transparent (e.g., to publish it on the organiza-

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111. See also section 4.2.1 - "History and related concepts" on page 60 for this argument.
112. Lave/Wenger 1991, 54ff, 91ff, see also section 6.1.3.3 - "Communities" on page 180.
113. See Mandl et al. 1994 for a discussion of the applicability of the community approach to university learning.

tion's Intranet), but instead to disaggregate the knowledge so it cannot be taken easily to a competitor[114].

Knowledge as a product versus knowledge as a process. Both concepts have important, though differing implications on the design of KMS. Basically, explicit knowledge can be documented and stored in knowledge repositories whereas (more) implicit knowledge has to be supported indirectly through ICT use to broker and handle communications[115].

"Right" quantity of knowledge. Many KM approaches implicitly hold the presupposition that *the more knowledge* an organization holds, *the better* for the organization (e.g., Davis/Botkin 1994, 168). The application of this simple equation can be dangerous because it does not consider e.g.:

- that the knowledge that is built up in an organization may not be useful,
- that the communication of knowledge expects quite a lot from the receiving system (individual or social), namely that the system rebuilds its knowledge structures,
- that knowledge is in a sense provisional and is held until better knowledge is generated,
- that more measurable knowledge in terms of e.g., publications or documents not necessarily means that the organization can act or interpret more intelligently,
- that the more we know the more we know what we do not know (knowledge increases "not knowledge") which causes the paradox that the more an organization knows the more knowledge it demands which in turn leads to less efficient daily operations (also e.g., Schneider 1996, 7f, Baecker 2000, 107f, Roehl 2000, 292, Soukup 2000).

As a consequence, KMS have to be built with this danger of information overload and inefficient "oversupply" of knowledge in the sense of too much focus on knowledge generation and too little focus on the application in mind. Therefore, attention has to be paid to e.g., contextualization, filtering, profiling and to determining the optimal portion, level and granularity of knowledge that is presented to a knowledge seeking system. This should guarantee that the system can work more efficiently without getting "lost in knowledge space" and being paralyzed.

Knowledge and knowing. Knowledge always undergoes construction and transformation when it is used. The acquisition of knowledge in modern learning theories is not a simple matter of taking in knowledge, but a complex cultural or social phenomenon (Lave 1993, 8, also e.g., transactive memory systems, Wegner 1986, group remembering, Hartwick et al. 1982). Thus, some authors suggest not to

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114. It is not knowledge, but networked knowledge in the sense of an organization's (core) competencies that are hard to imitate for the competition (see section 5.1.1 - "From market-based to knowledge-based view" on page 94.
115. For a more detailed analysis see chapter 7 - "Systems" on page 273, also e.g., Zack 1999a, 46ff.

speak of knowledge with its connotations of abstraction, progress, permanency and mentalism, but of the processes of knowing and doing which take place in a (*socially-distributed) activity system*[116]. These systems provide a new unit for the analysis of the dynamic relationships among individuals, their communities and the conception(s) they have of their activities. Blackler suggests not to study the concepts of knowledge, individuals, organization or factors that mediate between them in isolation, but to focus on the *dynamics of knowing* with the help of the socially-distributed activity system. Knowing in this perspective is a phenomenon which is

- *mediated*: manifest in systems of language, technology, collaboration and control,
- *situated*: located in time and space and specific to particular contexts,
- *provisional*: constructed and constantly developing,
- *pragmatic*: purposive and object-oriented,
- *contested*: interrelated with the concept of power in organizations which are observable in hierarchies of domination and subordination, leadership etc. (Blackler 1995, 1040ff).

To sum up, the concept of knowing rather than knowledge and the concept of socially-distributed activity systems rather than isolated entities (individuals, knowledge, organization and ICT systems) suggest that the crucial aspects of KM might be missed if we concentrate on separable entities too much. As a consequence, KM instruments supported by KMS have to consider the context in terms of the agents and communities which they are applied in (see also part D).

Multi-faceted knowledge. Design and implementation of KMS differ from design and implementation of more traditional application systems. The term knowledge as used here comprises among others valuations, opinions or forecasts, whereas more traditional application systems more or less exclusively focus on hard data. Also, the design of KMS has to consider the multiple electronically available sources of data such as documents, files, messages, contributions in newsgroups, multimedia elements or links to these sources which all might contain useful knowledge once structured, linked and contextualized. Thus, KMS can be combined with an organization's already existing information systems.

Role of knowledge in different types of organizations. Classifications of knowledge can be used to postulate different requirements or perspectives for KM initiatives and supporting ICT. For example, Blackler uses his classification of knowledge (see Table B-3) to distinguish four types of organizations which also require the support of different ICT (Blackler 1995, 1026ff). Table B-4 shows the four types of organizations distinguished.

The distinction uses the organizational level from which the primary contributions to the fulfilment of organizational goals is expected (individual versus collec-

116. Blackler 1995, Spender 1996a, see section 6.6.2 - "Activity modeling" on page 250 for an account of the modeling of socially-distributed activity systems.

tive) and whether the focus is on familiar or on novel problems. Based on a survey of the literature on knowledge work in organization science Blackler suggests trends that organizations are transformed from type I, II and III into type IV organizations (see Blackler 1995, 1029).

TABLE B-4. Characterization of organizations according to types of knowledge[a]

	Type I: expert-dependent	**Type II: knowledge-routinized**	**Type III: symbolic-analyst-dependent**	**Type IV: communication-intensive**
organizational level	focus on individual	focus on collective	focus on individual	focus on collective
type of problems	familiar problems	familiar problems	novel problems	novel problems
type of knowledge	embodied competencies of key members	knowledge embedded in technologies, rules and procedures	embrained skills of key members	encultured knowledge and collective understanding
characterization	performance of specialist experts is crucial; status and power from professional reputation	capital, technology or labor-intensive; hierarchical division of labor and control	entrepreneurial problem solving; status and power from creative achievements	key processes: communication, collaboration, empowerment through integration
example	professional bureaucracy, e.g., hospital	machine bureaucracy, e.g., traditional factory	knowledge-intensive firm, e.g., software house	adhocracy, innovation-mediated production
role of ICT	computer displacement of action skills	computer integrated work systems	information support and XPS design	development of CSCW systems

a. Source: Blackler 1995, 1030.

However crude Blackler's analysis of the role of ICT is, it does not fail to show that different organizations require different supportive KMS. If Blackler's hypothesis is true that all organizations are moving towards type IV, this would mean that current organizations find themselves on different stages of KM maturity (see the knowledge management maturity model proposed by Ehms/Langen 2000, see also APQC's four-stage model of knowledge management development, Lopez 2001, 20ff), and possibly require in the end the same kinds of ICT systems. These systems just comprise an integrated set of technologies suited for all types of organizations, a path on which the vendors of comprehensive KMS seem to follow[117].

117. See chapter 7 - "Systems" on page 273.

This hypothesis can be tested by taking a look at the developments in the application of KMS over time. There should be a trend that organizations converge in their use of ICT to support the handling of knowledge.

The corresponding hypothesis for the empirical study could then be written as follows:

Hypothesis 5: Organizations converge in their use of ICT and increasingly use communication-oriented functions of knowledge management systems.

4.2.4 Definition

Keeping the abundance of classifications of knowledge in mind, it is clear that the conceptualizations influence the design of KM initiatives and the implementation of KMS in many ways. Thus, it is probably best to define knowledge broadly and openly (see Box B-2) and discuss some implications of the term in detail.

Knowledge comprises all cognitive expectancies—observations that have been meaningfully organized, accumulated and embedded in a context through experience, communication, or inference—that an individual or organizational actor uses to interpret situations and to generate activities, behavior and solutions no matter whether these expectancies are rational or used intentionally.

BOX B-2. **Definition of knowledge**

Actor is meant here in the sense of an agent. Thus, both individuals or social entities such as teams or communities or entire organizations might act as knowledge-processing entities[118]. Examples of knowledge are scientific findings and theories, heuristics, rules of thumb, techniques, experiences, opinions, cultural customs and norms, world views[119]. Actors are always part of a *social context* which influences the processing of knowledge (organization, accumulation and embedding in a context) of the actor and thus both the interpretation and the actions. Put in a nutshell, knowledge can be defined as the *capacity to interpret and act* (also Sveiby 1997, 37, Sveiby 1998, 65).

In the following, this complex definition will be studied in more detail. The definition encompasses almost all of the categories as distinguished in section 4.2.2 - "Types and classes of knowledge" on page 66 and does not make a distinction between implicit and explicit knowledge, although these categories will prove useful in the more detailed considerations in part D. On the contrary, Polany's tacit

118. The term *actor* is preferred to *agent* as in the MIS literature *agent* regularly also refers to computer systems (intelligent agents). The old question whether computers can "think" and thus process and apply knowledge is out of the focus of this book (for a brilliant treatise of this topic see e.g., Dreyfus/Dreyfus 1986).

119. See also Segler 1985, 138, Wiegand 1996, 163f, Probst et al. 1998, 44, Willke 1998, 11, Zack 1999a, 46.

dimension of knowledge is explicitly included in the definition as expectancies do not have to be used consciously or intentionally.

Knowledge elements are embedded in a contextual network of meaningful experiences of the system (Willke 1998, 11). These experiences have proven meaningful for the survival of the system (individual or social system). In other words, knowledge is what we come to believe and value through experience, communication, or inference (Zack 1999a, 46). Thus, knowledge is always connected to the system's history, to suitable events and episodes and therefore is bound to a memory.

On the organizational level, this memory comprises the individual brains as well as links to documented knowledge and to other individual's brains and their respective links[120]. As opposed to individual "knowledge processing", organizational "knowledge processing" can be viewed as a social phenomenon where individuals commonly process information and "weave" it into a social web of knowledge elements. The constituting element of knowledge on the organizational level therefore is communication. Both, the links and communication are not limited to the organizational boundaries and thus knowledge used for organizational activities comprises organization-internal as well as organization-external knowledge.

The definition of the term knowledge as presented here describes the perspective of knowledge management. As the goals of this work are to investigate concepts and scenarios for the application of KMS as part of knowledge management initiatives, this definition needs further operationalization. This is a difficult task as the discussion of certain aspects of the definition or certain entities that deal with or hold knowledge (individuals, organizations or even documents) will necessarily challenge the definition. Figure B-8 summarizes this discussion and gives an overview of the specifics of the term knowledge as used in this work. The figure shows a selection of seven paired types of knowledge which help to study the possibilities to support the handling of knowledge by KMS. Interviews with knowledge managers in the empirical study suggest that these are the most important types of knowledge that require distinctive treatment in KMS. In the following, the implications of KMS support will be discussed for the various *types of knowledge*, the *medium* to which knowledge is bound as well as the *knowledge content*.

Source. The dimension source distinguishes between *organization-internal* and *organization-external* knowledge. Even though organizational boundaries are increasingly blurry in a time of virtual (project) organizations, cooperations, mergers and acquisitions, just to name a few, the organization as a legal or social institution remains a focal point for the distinction of internal and external knowledge. Internal knowledge is knowledge that originates from within the organization either from members of the organization or in the form of e.g., organizational routines or documented experiences. Organization-external knowledge is brought into the organization, e.g., personally by newly recruited employees, consultants, part-

120. See the perspective of transactive memory systems according to Wegner 1986.

ners, suppliers or customers or in documented form with the help of studies, reports or benchmarking reports.

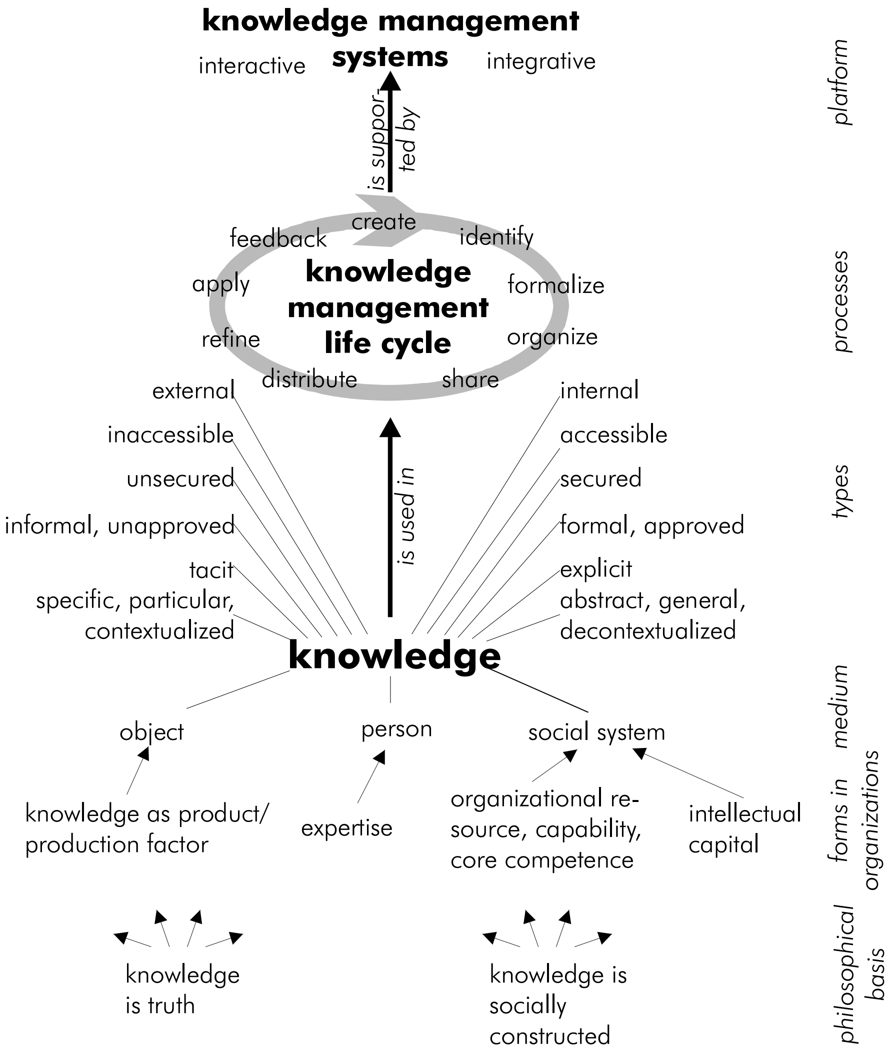

FIGURE B-8. The term knowledge and its application in KM[121]

Accessibility. This dimension contrasts *electronically accessible* and *electronically inaccessible* knowledge. Knowledge that is published e.g., on an organiza-

121. This model has been called the butterfly model of knowledge management by my student assistants Nadine Amende, Stefanie Hain, Alexander Sandow and Stefan Thalmann and features in a WBT on knowledge management available from the author.

tion's Intranet or in a document management system can be accessed by all members of the organization that have access to these systems whereas documented knowledge that is stored on the individual hard disc of one employee cannot be found by interested knowledge seekers. Additionally, it refers to access to experts that hold knowledge about a specific topic. If KMS support the identification of experts, his or her knowledge is thus implicitly accessible.

Security. The dimension security comprises *secured* and *unsecured* knowledge. The current trend in many organizations is towards more transparency of knowledge, a trend from implicit to explicit knowledge (e.g., Spender 1996a, 51). The higher visibility of experts, knowledge, networks and structures increases the risk that important knowledge flows to competitors and threatens an organization's competitive advantages.

Thus, security is an important issue at hand. It refers to legal mechanisms such as patents and licenses, copyrights and trade secrets (e.g., Liebeskind 1996, 95) as well as organizational mechanisms such as incentives to employees, employee conduct rules or job design to secure knowledge. In addition to these measures, KMS have to be designed, e.g., by protecting knowledge by disaggregation. There is also the whole range of IT security issues, e.g., threats from hackers, that have to be considered.

Formality. This dimension distinguishes between *formal, institutionalized, approved* and *informal, unapproved* knowledge and reflects the degree of institutionalization of knowledge in an organization. As today's business organization more or less rely on the hierarchy, rules, roles and (standard operating) procedures, there is a host of institutionalized knowledge which is applied by the organization's members. This knowledge evolves as the person or collective responsible for a certain area of the organization formally approves new knowledge as being part of the standard procedures in the organization. In addition to this type of knowledge, employees develop and apply knowledge independently of the formal approval system and might also share it within their community. This important part of the organization's knowledge base is less transparent than the formally approved one and thus needs special treatment when one considers the implementation of a KMS.

Externalization. Externalization turns *tacit knowledge* into *explicit knowledge*. Ever since Polanyi postulated that "we know more than we can tell" (Polanyi 1966, 4), the tacit dimension has been a popular distinction used in the KM literature, although not in Polanyi's originally intended way. Many authors distinguish between tacit and explicit knowledge[122], whereas Polanyi postulated that *every knowledge* has got a tacit *dimension* (Polanyi 1966, 24f). In the KM literature, tacit

122. One of the best known applications of this distinction is by Nonaka 1991, 16, also e.g., Hedlund/Nonaka 1993, 118ff, Rüdiger/Vanini 1998 and Bonora/Revang 1993, 203ff who call it knowledge abstraction.

knowledge is subconsciously understood and applied, difficult to articulate, developed from direct experience and usually shared through highly interactive conversation and shared experience (*socialization*, apprenticeship, Nonaka 1991, 98f, 1994, 18f). Explicit knowledge can be formally articulated and shared through meetings, conversations, mathematical formulas, models or even documents and the like (*combination*, Nonaka 1991, 99, 1994, 19). If explicit knowledge is documented, it is removed from its original context of creation or use. KMS can help the receivers of explicit knowledge to reconstruct its context.

Nonaka calls the process of turning implicit into explicit knowledge *externalization*[123] and the reverse process of turning explicit into implicit knowledge *internalization* (Nonaka 1991, 99 and 1994, 19). Not any knowledge that is explicable is actually explicated in an organization (Zack 1999a, 47). There might also be inappropriately explicated knowledge (explicated knowledge that is not explicable). The distinction between tacit (or sometimes called implicit) and explicit knowledge helps to postulate different KM activities and different systems to support these activities (e.g., Nonaka/Takeuchi 1997,74ff).

Generalization. The level of context of knowledge defines another continuum which extends from *specific, particular, contextualized* knowledge describing one particular episode or event e.g., in a story to *abstract knowledge, general, decontextualized knowledge* captured e.g., in a mathematical formula. Before knowledge is distributed to a larger group of people, particular experiences can be generalized to lessons learned e.g., by extracting the factors that might have influenced the outcome, aggregating similar experiences to describe a practice (good or best practice). The degree of generalization has to be considered when KMS are used to support the transfer of (the documented part of) knowledge. The more specific a knowledge element is, the more context has to be provided in order for the knowledge seeker to be able to understand, learn and reuse the knowledge.

Medium. The medium on which knowledge resides can be an *object*, a *person* or a *social system*. Person represents *individual* whereas social system represents *collective* knowledge. A central element of most of the OL theories and approaches is the hypothesis that organizations have an inter-personal body of knowledge that their individual members share: collective knowledge, collective practice or organizational knowledge (e.g., Spender 1994, 355ff). Collective knowledge is materialized in organizational routines no matter whether explicit in e.g., bureaucratic rules, role expectations or implicit in the norms, values and shared understanding of the organizational culture. It is separated from individual knowledge held by each individual member of the organization.

Many authors also make a distinction between knowledge as a product and knowledge as a process, especially those who use the definition of the term knowledge for a subsequent analysis of the suitability of ICT to support corresponding

123. In his earlier work, Nonaka called the process of turning implicit into explicit knowledge *articulation (*Nonaka 1991, 99).

organizational processes[124]. Knowledge as an object[125] is independent of a holder whereas knowledge as a process can be viewed as a process of simultaneously knowing and acting (applying expertise).

Knowledge as a product comprises documented experiences. A couple of terms were coined in the practitioner-oriented literature to underline the higher value of documented knowledge as opposed to data or (documented) information. Examples are lessons learned, best practices, experience data bases, benchmarks, customized reports or context-enriched documents. In this perspective, knowledge is basically seen as *information plus context*, as networked information (Rehäuser/Krcmar 1996, 6). The distinction between information and knowledge is a gradual one, a continuum (e.g., Probst et al. 1998, 36). The common denominator of this perspective is that (a portion of the) knowledge used in organizations can be explicated and externalized (Nonaka 1994, 24f) and as a consequence untied from its creator and made available for "easy" reuse by other members of the organization. However crude and pragmatic this distinction is, it helps to understand why the term KMS is used, what is required for the design and implementation of KMS and what the differences to other information and communication systems are.

Content. In addition to the generalized types of knowledge as discussed so far, organizational knowledge can be divided according to the main organizational area in which it is applied or in which it has been generated: knowledge about products and processes can be attributed regularly to the production division of an organization whereas knowledge about customers and competitors is usually gained in the market-oriented divisions of an organization (marketing, sales, customer service). Examples for contents that can be distinguished in KMS are product knowledge versus market versus expert versus leadership knowledge (e.g., Baecker 1998, 6ff, Glazer 1999, 66).

These different types of knowledge are systematically handled by the tasks of the KM life cycle which in turn is supported by KMS (see Figure B-8 on page 78). The design and implementation of KMS therefore depends on the KM initiative's perspective on knowledge.

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124. Examples are Rehäuser/Krcmar 1996, 14ff, Hansen et al. 1999, Sveiby 2001, Zack 1999a.

125. Some authors mix the notion of *knowledge as an object* and *explicit knowledge* although explicit knowledge not necessarily has to be documented. Thus, we have to distinguish between the dimension *relation to individual* with knowledge either being part of an individual's mind or separate as an object and the dimension *explicitness* with knowledge either being implicit or not reflected by the individual and thus applied unconsciously or knowledge being explicit and thus communicable by the individual. Only explicit knowledge can be documented, though.

4.3 Knowledge management systems

4.3.1 Overview and related concepts

Even though there is considerable disagreement in the literature and business practice about what exactly KM is[126], there are a number of researchers and practitioners who stress the role of ICT as enabler or vehicle for implementating these approaches. KMS should help particularly to overcome the shortcomings of current practices of business engineering with respect to organizational performance. IT-Research forecasted in a study on KM that the market for KM software in Europe and North America would grow from US$400 million in 1999 to around US$1.5 billion in 2002 (NN 2000, 1). There are a number of approaches to define ICT that supports KM. This is reflected by the large number of terms in use, such as:

- *knowledge management system*[127],
- *information and communication systems or technology for knowledge management* or *knowledge management technology*[128],
- *knowledge-based information system*[129],
- *knowledge infrastructure*[130],
- *knowledge services*[131],
- *knowledge management software*[132],
- *knowledge management suite*[133],
- *knowledge management support system*[134],
- *knowledge management tools*[135],
- *knowledge-oriented software*[136],
- *knowledge portal*[137],
- *knowledge warehouse*[138],
- *organizational memory system*[139],
- *organizational memory information system*[140].

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126. See also section 4.1 - “Knowledge management” on page 21.
127. e.g., Neumann et al. 1998, McDermott 1999a, 104, Gray 2000, Mertens/Griese 2002, 47, Meso/Smith 2000, Alavi/Leidner 2001, Staab et al. 2001, 3ff, Hasan/Gould 2003, Riempp 2004.
128. Borghoff/Pareschi 1998, Schultze/Boland 2000, Riempp 2004.
129. Bullinger et al. 1999.
130. Maier et al. 2005, Strohmaier 2005.
131. Conway 2003.
132. Mentzas et al. 2001, 95f, Tsui 2003.
133. Seifried/Eppler 2000.
134. Figge 2000.
135. Borghoff/Pareschi 1997, 1998, Ruggles 1997a, 3ff, Bach/Österle 1999, 22, Böhmann/Krcmar 1999, Astleitner/Schinagl 2000, 173f.
136. Koubek 2000, 16.
137. Firestone 1999, 2003, Collins 2003, Fernandes et al. 2005.
138. Nedeß/Jacob 2000.
139. Rao/Goldman-Segall 1995, Habermann 1999, Lehner 2000, 323ff.
140. Stein/Zwass 1995, Kühn/Abecker 1997.

Some of these terms have been extended by the adjective *enterprise* in order to stress that these systems attempt to create a comprehensive platform for a business or other organization, e.g., enterprise knowledge portal (Firestone 1999) or enterprise knowledge infrastructure (Maier et al. 2005). The adjectives *ontology-based* or *semantic* stress semantic integration as core functionality at the heart of KMS, e.g., ontology-based KM solution (Staab et al. 2003). Lehner (2000, 161ff) focuses on ICT support for organizational memory. He stresses the differing viewpoints of the various disciplines that use *organizational memory systems (OMS)* as their research object which result in quite heterogeneous definitions of the term. Lehner proposes the following six perspectives on OMS which can be used to investigate OMS related phenomena from different viewpoints (Lehner 2000, 163ff): (1) OMS as a new type of the use of application systems, (2) as a concept, (3) in a functional view, (4) as a property of information systems, (5) in a behaviorist view and (6) in a technological view.

Stein/Zwass define organizational memory information system as "a system that functions to provide a means by which knowledge from the past is brought to bear on present activities, thus resulting in increased levels of effectiveness for the organization" (Stein/Zwass 1995, 95, for a discussion of organizational effectiveness e.g., Lewin/Minton 1986). This definition stresses the importance of information and knowledge of the past. Figure B-9 shows an overview of their framework concept. The framework is based on the competing values model (goals of the use of organizational memory information systems) and on a list of mnemonic functions which are founded in psychological memory theories. The functions use the analogy to an individual's memory. The mnemonic functions can be seen as the memory basis for individual learning which in turn is used as an analogy in organizational learning.

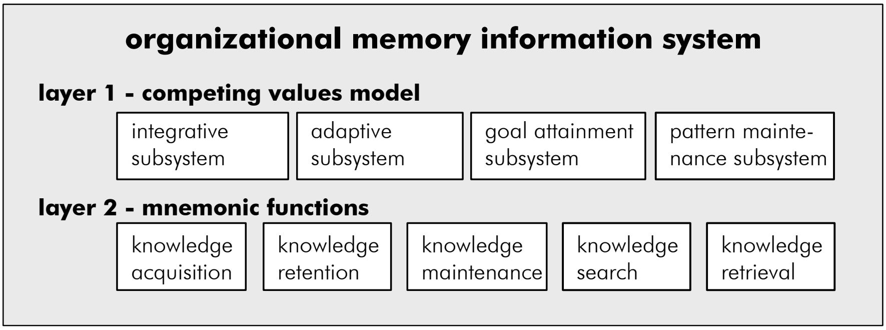

FIGURE B-9. Concept of organizational memory information systems[141]

In addition to the terms organizational memory system and organizational memory information system, many authors use the terms *knowledge management tools*

141. Source: Stein/Zwass 1995, 98.

or *knowledge management system* to describe systems with quite similar intentions and functions. Additionally, there are a number of vendors of software systems that stress that their systems support KM. So far, there has been no clear distinction between these two terms. The terms organizational memory system or organizational memory information system as used in the literature stress more the theoretical basis of organizational learning, the analogy to an individual's memory as well as the dynamics of the application of a collective memory. The terms knowledge management tools or system stress more the resource-oriented view of organizational learning, the business and management aspects introduced by concepts, approaches and theories of knowledge management[142]. However, as with most emerging technologies, neither the literature, nor the market of products, tools and systems clearly distinguish between these tendencies.

Apart from these terms with a clear focus on KM, OL or OM, there is also another group of software systems that provides support for these approaches, e-learning platforms. These are platforms for Web-based teaching and learning environments with roots in computer-based training. Respective approaches are termed e-learning or, in a more recent twist to reformulate the vision and the employed metaphors, particularly in the European Union, technology-enhanced learning[143]. Again, there are a number of terms that are used to denote this group of software systems:

- *corporate learning portals*[144]*,*
- *e-learning suites*[145]*,*
- *integrated curriculum management systems*[146]*,*
- *learning content management system*[147]*,*
- *learning environment*[148]*,*
- *learning management systems*[149]*,*
- *Web-based education systems*[150]*.*

These platforms not only support the presentation, administration and organization of teaching material on the Web or an organization's Intranet, but also support interaction among teachers and students[151] as well as interaction between students themselves (Astleitner/Schinagl 2000, 114). The two categories *knowledge man-*

142. See also section 4.1 - "Knowledge management" on page 21.
143. E.g., Rogers 2002.
144. See for example URL: http://www.teamscape.com/products/learning_portals.htm; see also the list of e-learning platforms on the support Web site for this book http://iwi.uibk.ac.at/maier/kms/.
145. E.g., URL: http://www.hyperwave.com/e/products/els.html.
146. Astleitner/Schinagl 2000, 114ff.
147. E.g., Ismail 2002, 332.
148. E.g., Jonassen et al. 1999.
149. E.g., URL: http://www.saba.com/english/products/learning_enterprise/index.htm.
150. Astleitner/Schinagl 2000, 131ff; Web-based education systems are also called Internet-based learning systems or on-line-learning systems.
151. The terms teachers and students are not limited to the traditional university setting, but also comprise e.g., organized learning in businesses.

agement systems with roots in document management systems or communication systems and *e-learning suites* with roots in computer-based training seem to converge. As turned out in the market survey of KMS, the systems from these two categories already share a substantial portion of functionality[152]. Moreover, on a conceptual level KM concepts are applied in tele-learning concepts (e.g., Trosch/Bickmann 1999).

There has been a shift in perspective of KMS vendors as well as organizations applying those systems from this focus on the explicit side of KM to a combination and integration of the implicit side of KM. Advanced tools supporting collaboration or collectives of people working together (teams, communities), tools linking knowledge providers and seekers as well as e-learning functionality have been integrated into many KMS. Also, several vendors of learning management systems have begun to extend the functionality of their systems to include KMS functions[153]. KMS offered on the market more and more live up to the expectations put forward by theory-driven conceptualizations.

The term knowledge management system is used here as a synonym for organizational memory system. This is particularly important when the term is used within the empirical study to make sure that respondents are not confused by a new term which is not widely accepted in the market. Recently, the terms KM tools or KMS have gained wide acceptance in the literature, whereas vendors of systems still package and market their solutions according to the most recent ICT challenges that have to be solved by companies and organizations. Examples are solutions for business or organizational intelligence, for collaboration, for compliance to risk management regulations, such as Sarbanes-Oxley-act and Basel II, for customer-generated content, for email retention management, for exploiting the promises that are marketed as social software or Web 2.0, for initiatives that are enriched with the adjective "semantic", for just-in-time or on-demand knowledge management, for knowledge integration, (knowledge) portals and other integration initiatives, for knowledge visualization, for technology-enhanced or workplace learning, just to name a few[154]. However, none of these terms have replaced the term KMS and it is still a worthwhile perspective on a portion of the organizational ICT infrastructure and application systems landscape. Thus, the term KMS is used being well aware that there are a number of similar conceptualizations that complement the functionality and architectures of KMS.

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152. An example for a software vendor that integrates a knowledge management platform and an e-learning environment formerly separated is Hyperwave with its KMS solution Hyperwave Information Server and Hyperwave Information Portal on the one hand and the Hyperwave E-Learning Suite on the other hand; see also Maier/Klosa 1999c; see section 7.1 - "Technological roots" on page 273 for examples and a definition of the roots; see also the support Web site for this book http://iwi.uibk.ac.at/maier/kms/ for a list of KM tools and systems as well as e-learning suites available on the market.
153. One example is Centra's Knowledge Server which can be integrated with the company's learning management system Symposium 5.0; see also the support Web site for this book http://iwi.uibk.ac.at/maier/kms/ for details about the software solutions mentioned here.
154. See also section 7.4.9 - "Example: Open Text Livelink" on page 336.

4.3.2 Definition

As in the case of the terms knowledge management and knowledge, knowledge management systems can be viewed from different perspectives. Examples are:

- a focus on ICT support for the KM life cycle and/or for specific organizational instruments which are implemented as part of a KM initiative,
- a focus on the proposed analogy between human and organizational information processing, learning and memory,
- a review of a set of functions that are part of KMS as offered on the market,
- extensions and/or the integration of existing software tools, such as Intranet solutions, document management systems, workflow management systems, Groupware, AI technologies, communication systems.

The KM life cycle provides a basis for the definition of application areas from which KMS are designed and consists of a number of KM tasks, e.g., creation, construction, identification, capturing, acquisition, selection, valuation, organization, linking, structuring, formalization, visualization, distribution, retention, maintenance, refinement, evolution, accessing, search and application of knowledge[155].

The KM life cycle describes the collective development, distribution and application of knowledge and thus can be used to extend Stein and Zwass's definition of organizational memory information system which is limited to the analogy of an individual's memory. It lacks all functions that do not bear this analogy. These added functions are based on *communication* as the constituent property of social systems. Communication also distinguishes the memory of a social system from an individual memory. Therefore, those functions that uniquely occur in collective memory and learning processes are added to the mnemonic functions used in Stein and Zwass' definition. Thus, the definition of KMS used in this book is based on (1) the analogy between human and organizational information processing and (2) the life cycle of KM tasks and processes (see Box B-3).

> A knowledge management system (KMS) is an ICT system in the sense of an application system or an ICT *platform* that combines and integrates functions for the *contextualized* handling of both, explicit and tacit knowledge, throughout the organization or that part of the organization that is targeted by a *KM initiative*.
> A KMS offers integrated *services* to deploy *KM instruments* for networks of *participants*, i.e. active knowledge workers, in knowledge-intensive business *processes* along the entire knowledge life cycle.
> Ultimate aim of KMS is to support the dynamics of organizational learning and organizational effectiveness.

BOX B-3. **Definition of knowledge management system**

155. See also section 4.1.4 - "Definition" on page 52; for a detailed discussion of these KM tasks see section 6.3.1 - "Knowledge management tasks" on page 207.

The main differences between KMS and more traditional ICT systems, such as document management systems, Intranet solutions or Groupware can be characterized along the following lines:

Initiative. Goals are defined by the KM initiative in which the KMS is deployed. Therefore, KMS are designed "with KM in mind", i.e., their implementation is embedded in a comprehensive KM initiative. Stein/Zwass' (1995) definition stresses the primary goal of KMS as to increase organizational effectiveness by a systematic management of knowledge. Thus, KMS are the technological part of a KM initiative that also comprises person-oriented and organizational instruments targeted at improving productivity of knowledge work. KM initiatives can be classified e.g., according to strategy in human-oriented, personalization initiatives and technology-oriented codification initiatives[156] or along several organizational dimensions that will be developed in the next chapters. The type of initiative determines the type of information system for its support which can be regarded as a KMS from the perspective of its application environment.

Context. KMS are applied to managing knowledge which is described as "personalized information […] related to facts, procedures, concepts, interpretations, ideas, observations, and judgements" (Alavi/Leidner 2001, 109, 114). From the perspective of KMS, knowledge[157] is information that is meaningfully organized, accumulated and embedded in a context of creation and application. KMS primarily leverage codified knowledge, but also aid communication or inference used to interpret situations and to generate activities, behavior and solutions. KMS combine and integrate services e.g., for the publication, organization, visualization, distribution, search and retrieval of *explicit* knowledge as well as identification of skills and experts, communication and collaboration in order to support the handling of *implicit* knowledge.

Thus, on the one hand KMS might not appear radically different from existing IS, but help to assimilate contextualized information. On the other hand, the role of ICT is to provide access to sources of knowledge and, with the help of shared context, to increase the breadth of knowledge sharing between persons rather than storing knowledge itself (Alavi/Leidner 2001, 111). The internal context of knowledge describes the circumstances of its creation, e.g., the author(s), creation date and circumstances, assumptions or purpose of creation. The external context relates to retrieval and application of knowledge. It categorizes knowledge, relates it to other knowledge, describes access rights, usage restrictions and circumstances as well as feedback from its re-use (Barry/Schamber 1998, 222; Eppler 2003, 125f). Contextualization is thus one of the key characteristics of KMS (Apitz et al. 2002). Management of context is central to personalizing KMS services for participants and connecting them to KM instruments which in turn are implemented with the help of KM processes.

156. See Hansen et al. 1999, see also chapter 5 - "Strategy" on page 93.
157. See also section 4.2 - "Knowledge" on page 60.

Processes. KMS are developed to support and enhance knowledge-intensive processes[158], tasks or projects (Detlor 2002, 200; Jennex/Olfman 2003, 214) of e.g., creation, construction, identification, capturing, acquisition, selection, valuation, organization, linking, structuring, formalization, visualization, transfer, distribution, retention, maintenance, refinement, revision, evolution, accessing, retrieval and last but not least the application of knowledge, also called the knowledge life cycle, ultimately to support knowledge work (Davenport et al. 1996, 54). In this view, KMS provide a seamless pipeline for the flow of explicit knowledge through a refinement process (Zack 1999a, 49), or a thinking forum containing interpretations, half-formed judgements, ideas and other perishable insights that aims at sparking collaborative thinking (McDermott 1999a, 112).

Participants. Users play the roles of active, involved participants in knowledge networks and communities fostered by KMS[159]. This is reflected by the support of context in KMS. Systematic management of context is needed in order to provide semantic links between codified knowledge and people or collectives, such as teams, work groups or communities as the holders of knowledge, between the handling of explicit and implicit knowledge and between documented knowledge and meta-knowledge, feedback, valuations and comments about the application of knowledge elements by other participants respectively. Context enhances the simple "container" metaphor of organizational knowledge by a network of artefacts and people, of memory and of processing (Ackerman/Halverson 1998, 64). Communities or networks of knowledge workers that "own the knowledge" and decide what and how to share can provide important context for a KMS (McDermott 1999a, 108, 111ff). KMS designs reflect that knowledge is developed collectively and that the "distribution" of knowledge leads to its continuous change, reconstruction and application in different contexts, by different participants with differing backgrounds and experiences. De- and re-contextualization turn static knowledge objects into knowledge processes (Ackerman/Halverson 1998, 64). Meta-knowledge in a KMS, e.g., in the form of a set of expert profiles or the content of a skill management system, is sometimes as important as the original knowledge itself (Alavi/Leidner 2001, 121).

Instruments. KMS are applied in a large number of application areas, e.g., in product development, process improvement, project management, post-merger integration or human resource management (Tsui 2003, 21). More specifically, KMS support KM instruments[160], e.g., (1) the capture, creation and sharing of best practices, (2) the implementation of experience management systems, (3) the creation of corporate knowledge directories, taxonomies or ontologies, (4) expertise locators, yellow and blue pages as well as skill management systems, also called

158. See section 6.3 - "Process organization" on page 207.
159. See also section 6.1.2 - "Knowledge management roles" on page 162 and section 6.1.3 - "Groups, teams and communities" on page 177.
160. See section 6.2 - "Instruments" on page 195.

people-finder systems, (5) collaborative filtering and handling of interests used to connect people, (6) the creation and fostering of communities or knowledge networks, (7) the facilitation of intelligent problem solving (e.g., Alavi/Leidner 2001, 114; McDermott 1999a, 111ff; Tsui 2003, 7). KMS in this case offer a targeted combination and integration of knowledge services that together foster one or more KM instrument(s).

Services. KMS are described as ICT platforms on which a number of integrated services[161] are built. The processes that have to be supported give a first indication of the types of services that are needed. Examples are rather basic services, e.g., for collaboration, workflow management, document and content management, visualization, search and retrieval (e.g., Seifried/Eppler 2000, 31ff) or more advanced services, e.g., profiling, profile matching and network analysis in order to link participants with similar interests, similar search or communication behavior, or similar learning capabilities, text analysis, classification or clustering to increase the relevance of retrieved and pushed information, advanced search techniques and graphical techniques for navigation, personalization services, awareness services, shared workspaces, (distributed) learning services as well as integration of and reasoning about various (document) sources on the basis of a shared ontology (e.g., Bair 1998, 2; Borghoff/Pareschi 1998, 5f).

Platform. Whereas the foci on initiatives, processes and participants can be seen as a user-centric approach to KMS design, an IT-centric approach relies on instruments as well as services and provides a base system to capture and distribute knowledge (Jennex/Olfmann 2003, 215). This platform is then used throughout the organization. This can be the entire organization or, especially in the case of large multi-national organizations a part of the organization, such as a business line, a subsidiary, or a business function, such as R&D or construction and engineering. The organization-wide focus is reflected e.g., by a standardized taxonomy or knowledge structure (ontology, e.g., Staab et al. 2001) applied throughout the organization or organizational unit. Thus, KMS can be differentiated from Groupware or group support systems which have a narrower focus on work groups or project teams. Also, the KMS is not an application system targeted at a single KM initiative, but a platform that can either be used as-is to support knowledge processes or that is used as the integrating base system and repository on which KM application systems are built. Comprehensive means that the platform offers extensive functionality for user administration, messaging, conferencing and sharing of (documented) knowledge, i.e. publication, search, retrieval and presentation.

Figure B-10 gives an overview of these characteristics. The three characteristics initiative, process and participants can be assigned to the business and user focus. Instruments, services and platform are IT- or function-oriented characteristics. Context is the linking pin connecting business and IT as well as user and function

161. See section 7.3 - “Architectures and services” on page 302.

foci. Goals stated by a KM initiative help to define processes and participants which are implemented with the help of KM instruments that should be supported by the KMS' services on the basis of a comprehensive platform and control their deployment. Participants and communities or knowledge networks are the targeted user groups that interact with KMS in order to carry out knowledge tasks.

The knowledge tasks are organized in acquisition and deployment processes required to establish the KM initiative. The KMS itself consists of a comprehensive platform rather than individual tools with advanced services built on top that explicitly consider the specifics of knowledge, i.e. information or content plus context. The services are combined and integrated in order to foster KM instruments. A KMS has to be aligned (1) with the business environment, i.e. the knowledge-intensive business processes that are affected, (2) the user environment with the expectation of a rich user experience and personalized on-demand KMS services, (3) the IT infrastructure environment which determines the technical base and (4) the function environment that determines the service interfaces for KMS design.

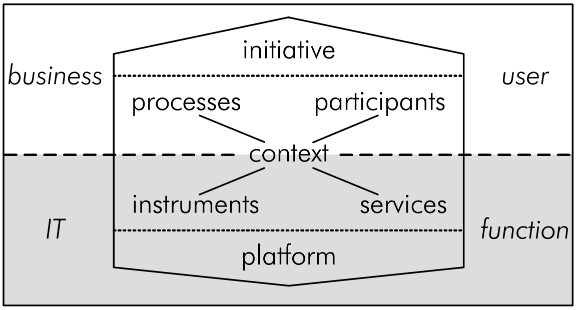

FIGURE B-10. Characteristics of KMS

The characteristics can be used as requirements in order to judge whether an actual system is a KMS or not. Many systems marketed as KMS have their foundations e.g., in document or content management systems, artificial intelligence technologies, business intelligence tools, Groupware or e-learning systems. These systems are more or less substantially extended with advanced services. Thus, actual implementations of ICT systems certainly fulfill the requirements of an ideal KMS only to a certain degree. Therefore, one might imagine a continuum between advanced KMS and other systems that can partially support KM initiatives.

The characteristics discussed in this section can be seen as arguing for a certain set of services. *Platform* requires the inclusion of infrastructure services for storage, messaging, access and security which is built on data and knowledge sources. *Context* calls for the handling of contextualized information which requires integration services that describe resources pulled together from a variety of sources. Advanced *services* build on top of these integration services and provide support for *instruments*. These knowledge services have to support the entire set of acquisition and deployment *processes* defined in a KM *initiative*. From an ICT perspective, these are services for publishing, collaboration, learning and discovery. The knowledge services need to be tailored on the one hand to the individual needs of participants and on the other hand to the requirements of the roles they perform in business processes and projects. This calls for personalization services. Finally, *participants* might choose to access KMS with a host of appliances and applications for which access services have to offer translations and transformation. These services have to be aligned with each other in architectures for KMS[162].

The definition of KMS corresponds to the functional view combined with the view of KMS as a new type of the use of application systems which realize parts of the organizational knowledge base according to Lehner (2000). The term KMS can be used to describe two different types of systems[163].

KMS as application system. The KMS is built on the basis of an already existing ICT platform that provides basic functionality for e.g., data and document management, office management as well as communication. Examples are an Intranet solution or a Groupware platform, such as Lotus Notes.

KMS as platform. In this case, the KMS not only provides these advanced functions, but also integrates the basic functionality of an ICT platform.

Many KMS offered on the market show a tendency towards the first category as most organizations already have an ICT platform in place. These KMS then provide an integrated set of intelligent tools, functions and services that use the ICT platform's functions. However, there are a number of platform-type customizable solutions as well, e.g., Open Text Livelink[164].

As discussed in the beginning of this section, KMS to support KM initiatives are on the rise. More and more vendors integrate KM functionality into their products or offer specialized KMS. The support of KM initiatives by information and communication technologies in organizations is therefore likely to rise as well. The following hypothesis will be tested:

Hypothesis 6: Compared to earlier studies significantly more organizations use ICT in general and knowledge management systems in particular to support their KM activities.

4.4 Résumé

This chapter investigated the notion of knowledge management and of ICT support for this approach, especially in the form of KMS. The detailed discussion of the historical development was meant to shed some light on the variety of perspectives

162. See section 7.3 - “Architectures and services” on page 302.
163. A more detailed analysis of KMS, their architecture, functions and classification can be found in chapter 7 - “Systems” on page 273.
164. See section 7.4.9 - “Example: Open Text Livelink” on page 336.

on the topic in the literature. Also, the chapter set the focus for the discussion of concepts and approaches for the use of KMS.

It turned out that knowledge management is an inter-disciplinary field that draws from organization science, HRM, management science, psychology, sociology, management information systems, computer science and artificial intelligence. Many KM approaches can be classified with respect to their background as human-oriented or technology-oriented. Neither direction provides a sufficient basis for the implementation and development of KMS. Thus, the challenge will be to bridge the gap between these two directions which has consequences for strategy, organization, systems as well as economics of KM initiatives[165].

The definitions for the term knowledge are as diverse as the concepts and approaches of KM. The main distinction between the wide variety of conceptualizations is whether knowledge is attributed exclusively to people—a position held by the human-oriented KM fraction—or whether knowledge is separable from people and thus can be documented and stored in ICT systems—a position held by the technology-oriented KM fraction.

Finally, the term knowledge management systems was discussed as a powerful metaphor that draws the attention of vendors of tools and systems from a variety of backgrounds. It seems that the KMS metaphor not just draws and integrates a wide variety of technologies. There are also a large number of tools and systems that are termed—or marketed— as KMS, as "KM enabled" or as supporting KM.

In the following, KM initiatives as well as KMS will be investigated in detail. Starting point will be the strategic perspective on knowledge management (chapter 5). Then follows a discussion of the organizational design for the implementation of a KM initiative (chapter 6), of architectures, contents and services of KMS (chapter 7) and, finally, of the economics of knowledge management systems (chapter 8).

165. See also chapter 9 - "Summary and Critical Reflection" on page 434.

5 Strategy

Considering knowledge as the key resource in an organization has substantial strategic implications. It seems evident that an organization's strategic choices have to consider the way it handles its knowledge assets.

This chapter is intended to answer the following questions: why should an organization invest in knowledge management? Along which basic lines could it proceed? What general initiatives can be suggested for a KM effort? Which strategies have proven to be successful? As knowledge management is understood quite differently by different scholars and comprises heterogeneous concepts[166], it is not surprising that KM goals as well as procedures, starting points and perspectives to develop KM strategies vary widely as well.

Firstly, recent developments in strategic management will be reviewed in order to understand the possible relationships between a knowledge or knowledge management strategy and business strategy (section 5.1). Then, an array of different knowledge management goals and strategies will be presented (section 5.2) which will be compared to each other in the light of the perspective taken in this book. Finally, success factors and barriers to a KM initiative will be discussed which have to be addressed when a KM strategy is implemented (section 5.3).

5.1 Strategy and knowledge management

There is broad agreement in the management literature that knowledge management has to be solidly linked to enterprise, corporate, business or functional area strategy[167] and therefore ultimately to the creation of economic value and competitive advantage, in order to be a sustained effort (e.g., Earl/Scott 1999, 36f, Zack 1999a, 57, Zack 1999b, 142). However, this link has not been widely implemented in practice[168]. This is due to the lack of strategic models to link knowledge management efforts (in the sense of knowledge-oriented processes, organizational structures, culture-related activities and the implementation of technologies) on the one hand and strategic management on the other hand.

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166. See section 4.1 - "Knowledge management" on page 21.
167. For a discussion of the differences between *enterprise strategy*—the umbrella that encompasses all further strategies and considers the organization's relationships to the non-business environment, *corporate strategy*—what businesses the organization should be in, *business strategy*—how should the organization compete in a given business, and *functional strategy*—linking functional area policies to the functional area environments, see Schendel/Hofer 1979, 11ff, also Hofer/Schendel 1978, 46ff. At this point, it still remains unclear on which level, if not on all levels, knowledge management should be linked to strategy. Thus, the following investigation will only refer to strategic management in general which encompasses the complete process of formulation, implementation and evaluation of strategies on all levels.
168. See Zack 1999b, 126 and the empirical studies cited there; see also part C.

5.1.1 From market-based to knowledge-based view

The field of strategic management has exerted considerable influence on businesses and business policies during the more than 40 years of its existence[169]. During this period, organizations have been increasingly inventive and creative in their search for competitive advantages. Thus, it is not surprising that the field of strategic management has also undergone substantial development. Moreover, scholars at leading business schools, such as the Harvard Business School, and professional services companies, such as McKinsey & Co. (e.g., Hax/Majluf 1984, 20), have added a wide variety of models, portfolios, approaches and concepts to the field. Scherer and Dowling not only speak of a theory-pluralism in the field of strategic management, but also warn that the multitude of underlying paradigms could cause difficulties because managers get contradictory advice from different schools of thought due to competing, possibly incommensurable theories[170].

The origins of the word "strategy" can be traced back to the ancient Greek word "strategós". The word has been used within the military sector for a long time. However, it is the "business policy" concept as laid out in the LCAG-framework that marks the first stage of development in strategic management (Scherer/Dowling 1995, 198). The LCAG-framework was named after its authors, Learned, Christensen, Andrews and Guth (1965, 170ff). This framework was later renamed in SWOT analysis and has been widely applied in businesses. The SWOT analysis in its original conception has put equal importance to the analysis of organization-internal resources—Strengths and Weaknesses—and to the analysis of the organization's environment—Opportunities and Threats—which jointly determine the business policy. Thus, the goal of strategic management was to find a "fit" between the organization and its environment that maximizes its performance: the contingency theory of strategy (Hofer 1975).

In the subsequent refinements of the framework, the emphasis was clearly put on the external side: the market-oriented perspective. In the process of strategic management which is depicted in Figure B-11, the analysis of the organizational resources plays only a minor role, whereas the environmental analysis is a prominent activity influencing strategy evaluation.

The so-called *market-based view* was most prominently developed and pushed by the frameworks proposed by Porter. The frameworks have been well received in the literature, especially the five-forces model (Porter 1980, 4), the value chain (Porter 1985, 36ff) and the diamond (Porter 1990, 71f). The frameworks help to analyze the organization's environment, namely the attractiveness of industries and competitive positions[171]. In its extreme form, the market-based view almost exclu-

169. The need for *strategic change* in the sense of giving guidance to the transformation of the firm, its products, markets, technology, culture, systems, structure and relationships with governmental bodies caught the attention of management in the mid-1950s (Ansoff 1979, 30).
170. See Scherer/Dowling 1995, 196ff; see also McKinley 1995, Scherer 1999, 19ff. The term "incommensurable", introduced by Kuhn (1962, 4ff), means that one cannot decide objectively between competing theories if they come from different paradigms.

sively pays attention to the competitive position of an organization and it is mostly only during strategy implementation that the organizational resources are considered. The main focus of a strategy in the market-based view is the selection of an attractive industry and the attractive positioning of an organization within this industry through one of the two generic strategies cost-leadership or differentiation. Along with the two possibilities of industry-wide activities versus a concentration to a specific niche within the industry, a resulting set of four generic strategies is proposed.

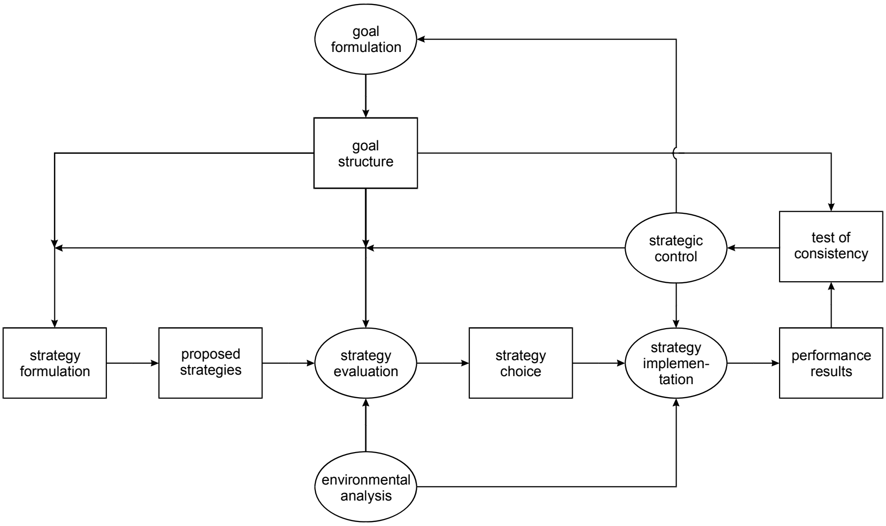

FIGURE B-11. The process of strategic management[172]

Attractiveness of an industry is determined by the intensity of competition. The less competition there is, the more attractive is the industry. Thus, ultimately, strategies in the market-based view seek to avoid competition (Hümmer 2001, 31) or implicitly assume that the characteristics of particular firms do not matter with regard to profit performance (Zack 1999b, 127). Resources are considered as homogeneous and mobile.

One of the central results of the strategic management process in the market-based view is the selection of product-market combinations in which an organization wants to be active using the four strategies as described above. These combinations are called strategic business fields (SBF). The resulting organizational units are called strategic business units (SBU).

Even though the market-based view recognizes resources as the underlying basis of competitive advantages, it shows in its original form a tendency to neglect

171. For the following see Porter 1980, 3ff, Porter 1985.
172. Source: Schendel/Hofer 1979, 15.

what an organization needs to do in order to create and integrate sustained competitive advantages based on unique resources[173]. Case studies have also shown that critical and complementary capabilities of an organization might be spread across strategic business units and thus it might be difficult to leverage them for future products and services that cross existing strategic business fields (e.g., Hümmer 2001). In his later work, Porter recognizes the increasing importance of the organization's resources and discusses their inclusion into his theoretical framework as addressing the longitudinal problem: how organizations can sustain competitive positions over time (Porter 1991, 108, Porter 1996, 68ff). The central concept of Porter's additions are the organization's *activities* which Porter classifies into *primary activities* (inbound logistics, operations, outbound logistics, marketing and sales as well as service) and *support activities* (procurement, technology development, HRM and firm infrastructure, Porter 1985, 39ff). Strategy then rests on a *strategic fit* of a *system of activities*, not individual activities (Porter 1996, 70ff). Strategic positioning in this view means performing different activities from competitors' or performing similar activities in different ways whereas operational effectiveness means performing similar activities better than competitors perform them (Porter 1996, 62).

Critique to the one-sided orientation of the market-based view resulted earlier in the development of the *resource-based view.* The term resource-based view was originally coined by Wernerfelt (1984) who built on the ideas presented in Penrose's theory of the growth of the firm (Penrose 1959). In the mid to late 80s, a number of articles were published that dealt with organization-internal resources, assets and skills as the basis for competitive advantage[174]. However, it was not until the beginning of the 90s that Wernerfelt's work received broader attention and the resource-based view was established as a new paradigm in strategic management. Since then, numerous researchers have built on the ideas and a lot of literature has been published on how an organization should deal with its strategically important resources[175].

Central idea of the resource-based view is that an organization's success is determined by the existence of organization-specific unique resources. As opposed to the market-based view, competitive advantages thus are not due to a superior positioning of an organization in an industry, but to superior quality of resources or

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173. See e.g., Zack 1999b, 127; see also Ansoff 1979, 43f who already recognized the problem of an almost exclusive focus of literature on strategies of action in the external environment.
174. See e.g. Teece 1984, 89, Coyne 1986, Aaker 1989 and Rumelt 1984 who analyzed resources as isolating mechanisms creating sustained rents in his proposal for a strategic theory of the firm.
175. For example Prahalad/Hamel 1990, Barney 1991, Conner 1991, Grant 1991, Leonard-Barton 1992a, Black/Boal 1994, Barney 1996, Grant 1996a, Teece et al. 1997, see also e.g., Rumelt et al. 1991 and Nelson 1991 who analyze the relationship between strategic management and economic theory and postulate that economic theory should consider differences between firms in terms of resources or capabilities (Rumelt et al. 1991, 22); see also the authors contributing to the knowledge-based view, an offspring of the resource-based view discussed on page 102 below.

a superior use of the organizational resources. The postulated heterogeneity of resources in different organizations which enables sustained competitive advantages is determined by the individual historical developments of the organization, the development of specific material and immaterial resources, the creation of complex organizational routines which in turn causes specific historical trajectories and lead to unique idiosyncratic combinations of resources in organizations (Barney 1991, 103ff).

Another central hypothesis of the resource-based view is that in an uncertain and dynamic competitive environment, products and services demanded in the market change quickly, whereas resources and capabilities are more enduring. As a consequence, proponents of the resource-based view suggest to base a strategy on resources and capabilities rather than on product-market combinations as suggested in the market-based view (Zack 1999b, 127). Resources are seen as platforms for the development of varying products and services.

Due to the fact that the resource-based view has been developed by a multitude of authors with varying backgrounds and research interests, the key term of this approach—the "resource"—has remained quite vaguely and broadly defined. Wernerfelt in his original paper on the resource-based view ties the definition of a resource to the internal side of the SWOT analysis: A resource is "... anything which could be thought of as a strength or weakness of a given firm" (Wernerfelt 1984, 172). Wernerfelt bases his view of a resource on Caves' definition: "More formally, a firm's resources at a given time could be defined as those (tangible and intangible) assets which are tied semi-permanently to the firm" (Caves 1980, cf. Wernerfelt 1984, 172). This latter organization-specific element is what distinguishes resources in the resource-based view from the traditional viewpoint in economics or business administration with its primary production factors land, labor and capital. Resources in the resource-based view typically have to be built and cannot be bought. Moreover, resources of interest for strategic management have to be of strategic relevance.

In order to avoid confusion with the traditional view on the term resource and in order to stress the strategic relevance of organization-internal assets, several other terms have been proposed. Examples which carry important implications for knowledge management are:

- *(core) capabilities* (e.g., Leonard-Barton 1992a, 112ff, Grant 1996a and for an early treatment Nelson/Winter 1982, 96ff) or *(core) competencies* (e.g., Prahalad/Hamel 1990). These terms are seen as integrated combinations, consolidations or applications of resources in an organizational context, as "teams of resources working together" (Grant 1991, 120) or an "interconnected set of knowledge collections—a tightly coupled system" (Leonard-Barton 1992a, 122).
- *dynamic capabilities* (Teece et al. 1997): In recent years, some authors pointed out that in situations of quickly changing complex environments, dynamic capabilities are crucial. Dynamic capabilities are defined as the firm's ability to inte-

grate, build, and reconfigure internal and external competencies to address rapidly changing environments (Teece et al. 1997, 516, Eisenhardt/Martin 2000).

As mentioned in Wernerfelt's definition cited above, organization-specific resources can be classified in a multitude of ways. The most prominent one is the distinction of *tangible* and *intangible resources* (Wernerfelt 1984, 172). The latter can be further classified according to whether they are tied to individuals or not. This simple classification can be detailed along a variety of dimensions, e.g., individuals versus collectives, organizational routines versus organizational culture, legally secured versus legally unsecured (or not securable) resources.

Figure B-12 presents a typical classification of resources with some examples that give an indication of what is meant by the terms. Tangible resources are detailed in financial and physical resources. Intangible resources are classified into person-dependent and person-independent ones. Person-independent resources are further divided into

- *intangible assets* which have a relationship to the organization's environment because they are either legally secured (e.g., patents, intellectual property), they refer to the organizations' business partners (e.g., networks, customer relationships) or the business partners or society's image of the organization (reputation) and
- *organizational assets* which refer to the organization's culture (e.g., willingness to share knowledge, perception of service and quality) and routines (e.g., learning cycles, managerial systems) and do not have a direct relationship to the organization's environment.

The detailed classes overlap to some extent, especially with respect to the dimension person-dependency as e.g., the smooth functioning of networks (classified here as person-independent) certainly depends on the contacts of individual employees. Their combination is termed an organizational capability.

Figure B-12 also shows that the value of organizational resources has to be determined in relation to the competition. A comparison reveals so-called differentials. Five types of capability differentials can be distinguished (Coyne 1986, 57f, Hall 1992, 136):

- *functional/business system differentials*: result from the knowledge, skills and experience of employees and others in the value chain, e.g., suppliers, distributors, lawyers, agents working for the organization etc.,
- *cultural differentials*: applies to the organizational culture as a whole; however, organizational routines are considered as functional differentials because they are transparent and subject to systematic and intended change as opposed to the organizational culture. Cultural differentials are closely related to
- *organization or managerial quality differentials*: result from an organization's ability to consistently innovate and adapt more quickly and effectively than its competitors. As it is probably easier to influence the quality of managerial systems than it is to influence organizational cultures, managerial systems might constitute a factor that can be distinguished from cultural differentials,

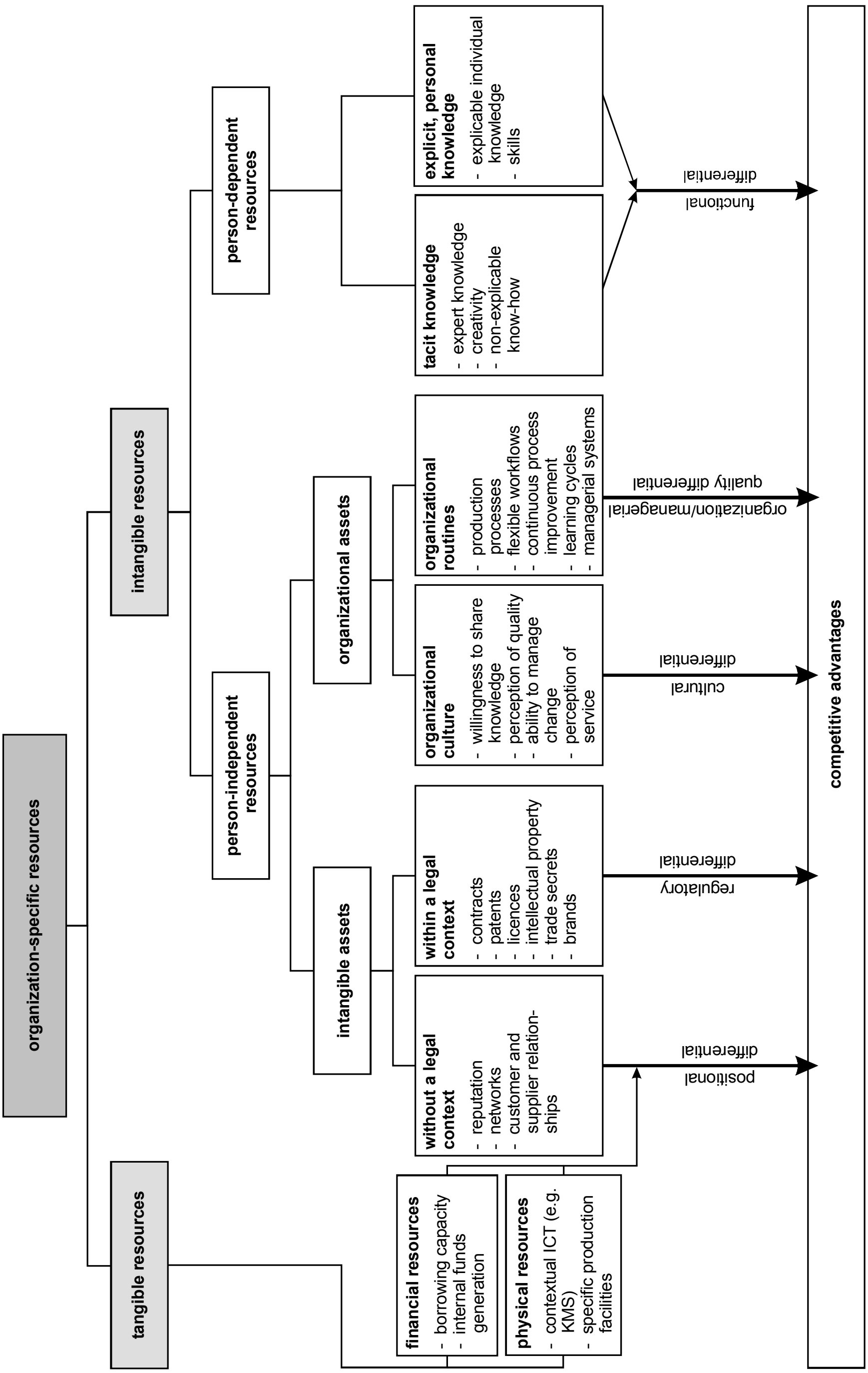

FIGURE B-12. Classification of resources in the resource-based view[176]

- *positional differentials*: are a consequence of past actions which build reputation with business partners, especially customers,
- *regulatory/legal differentials*: result from governments limiting competitors to perform certain activities. Regulatory differentials thus are based on those resources that are legally secured, such as patents, contracts, licences, trade secrets.

To sum up, resources are the basis for capability differentials. Capability differentials provide competitive advantages which can be leveraged in order to produce superior products and services.

In order to be *strategically relevant* and capable of generating sustained competitive advantages, resources must have the following characteristics[177]:

- *scarce:* Resources must be rare, otherwise competitors can access them easily.
- *competitively superior/valuable/relevant:* Resources must either enable organizations to create value for their customers, thus contributing significantly to the perceived customer benefits or to substantially improve effectiveness and efficiency of the organization's processes. Additionally, the value of a resource depends on the relative advantage it bears when compared to the competition.
- *multi-purposeful:* Core competencies must provide potential access to a wide variety of markets. In other words, resources must be applicable in a multitude of products and services and a multitude of markets in order to be of strategic relevance.
- *non- or imperfectly imitable:* Resources must not be easily replicated in a rival organization. Replication is difficult, e.g., due to *unique historical conditions* in the creation of the resources, *causal ambiguity* (i.e., imperfect information and/ or lack of transparency), *social complexity* (i.e., several individuals jointly provide the competitive advantages) or *embedding in organizations* (i.e., several resources can be complexly interrelated and integrated within an organization's routines and/or culture). Thus, there exist so-called barriers to imitation in analogy to the entry or mobility barriers in the market-based view.
- *non-substitutable*: Resources must not be easily substituted by other resources in order to generate sustained competitive advantages.
- *non-transferable*: A competitive advantage will be the more sustained, the more difficult it is to purchase the resource on the market or to acquire it in coopera-

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176. The classification as presented here integrates the resource distinctions as made in Aaker 1989, 94, Barney 1991, 112f, Grant 1991, Hall 1992, 136ff, Lehner et al. 1995, 185, Grant 1998, 111ff and integrates it with the capability differentials as suggested by Coyne 1986, 57f and Hall 1992, 136ff. The distinction between intangible assets and organizational assets does not, however, correspond to Sveiby's classification of resources into external structure and internal structure because he views intangible assets within a legal context that are applied within the organization (e.g., patents, licenses) as internal structure and only customer relationships, brands and reputation as external structure (Sveiby 1998, 29).
177. See Barney 1991, 106ff, Collis/Montgomery 1995, 119ff, Grant 1991, 123ff, Grant 1998, 128ff, Prahalad/Hamel 1990, 83ff.

tion with other organizations. The reasons for a lack of transferability are partly the same as the ones presented for lack of imitability, e.g., the geographical immobility, imperfect information or the fact that resources are firm-specific.

- *durable*: The longevity of competitive advantages depends upon the rate at which the underlying resources depreciate or become obsolete. Durability varies considerably, e.g., technological resources depreciate quickly due to the increasing pace of technological change whereas reputation and brands are a lot more durable.
- *appropriable/legally undisputed*: Profits from a resource can be subject to bargaining, e.g., with business partners, such as customers, suppliers or distributors, and employees. The more the so-called knowledge worker is on the rise, the more employees know of their capabilities and negotiate with their employers about the value of their contributions. The more an employee's contribution is clearly identifiable, the more mobile this employee is and the easier his or her capabilities can be transferred to other organizations, the stronger is the employee's position in the negotiations with the organization.

Organizations are therefore interested in keeping their competitive advantages up by protecting their resources. Table B-5 shows what organizations can do in order to protect their resources and/or capabilities from erosion, imitation and substitution. It is important to keep these protective activities in mind when designing a KMS solution. Table B-5 also shows which strategies are primarily supported by the introduction of KMS and where an organization has to carefully design these systems in order not to threaten its favorable resource position.

TABLE B-5. Threats to favorable resource positions of organizations, strategies for their protection and influence of KMS[a]

measures defending existing resource positions	**potential threats**			**contribution of KM/KMS**
	imitation	**substitution**	**erosion**	
retain causal ambiguity	x		x	!
increase complexity of bundled resources	x		x	+/!
increase organization-specificity of resources	x		x	+/!
reduce mobility of resources			x	!
secure appropriability of disposal rights (e.g., patents)	x		x	+
protect confidential information	x		x	+/!
secure access to critical resources	x		x	+/!

TABLE B-5. Threats to favorable resource positions of organizations, strategies for their protection and influence of KMS[a]

measures defending existing resource positions	potential threats			contribution of KM/KMS
	imitation	substitution	erosion	
reduce incentives for competitors' threatening	x		x	no influence
credible threatening linked with retaliation	x	x	x	no influence
impede competitors' resource development	x	x		no influence
collectivize individual and "hidden" knowledge	x	x	x	+

a. The table is based on: Hümmer 2001, 316. The last column was added by the author. Legend: + means a positive influence can be expected of the application of KM/KMS; ! means the KM/KMS design has to take care not to threaten the defending measures

The relationship between resources and the more recent concept of organizational capabilities or competencies and in turn their relationship with competitive advantages has been subject to discussion during the last years. Figure B-13 depicts a framework which shows the chain of arguments used in the resource-based view (Grant 1991, 115). A consequent management of the organizational resources thus has to handle the identification, selection, development, synergistic connection, transformation and retention of organizational resources and their integration into capabilities.

During the last five years many authors within the resource-based view specifically looked at knowledge as the key resource in organizations. Their contributions can be summarized under the label *knowledge-based view*[178]. Organizational capabilities or competencies in this view are based on a combination or integration of the (individual and common or organizational) knowledge in an organization (Grant 1996a, 376f). Capabilities can be hierarchically broken down, e.g., in single-task or single-process capabilities, specialized capabilities, activity-related capabilities, broad functional capabilities and cross-functional capabilities (Grant 1996a, 378). According to the knowledge-based view, competitive advantage of an organization depends on how successful it is in exploiting, applying and integrating its existing capabilities and in exploring and building new capabilities that can be applied to the market.

178. See e.g., Leonard-Barton 1992a, Spender 1994, Grant 1996a, 1996b, Spender 1996, Zahn et al. 2000, 251ff; see also Quinn 1992, 31ff and 71ff who postulates a reorientation of strategy on core intellectual competencies and talks of knowledge and service based strategies.

However, both the resource-based view and its offspring, the knowledge-based view show a tendency to repeat the error made by the extreme market-oriented proponents: an unbalanced perspective, this time in favor of the organization-internal side. It is a non-trivial task with strategic relevance to turn resources—which can also be looked at as rent-potential—into actual revenue (Spender 1994, 354). Thus, the resource-based view should not be seen as an alternative theory of strategy, but the stress on resources must complement, not substitute for, stress on market positions (Porter 1991, 108). Several authors have proposed integrating concepts that attempt at bridging the gap between the market-based view and the resource-based view (e.g., Haanes/Fjeldstad 2000).

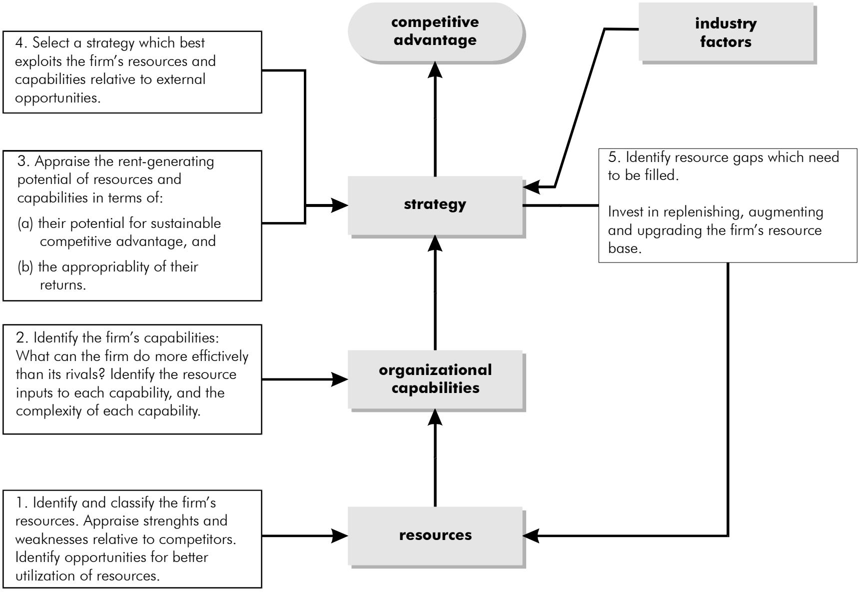

FIGURE B-13. Relationship between resources, capabilities, competitive advantages and strategy[179]

Put in a nutshell, the knowledge-based view provides the linking pin for the integration of knowledge management and strategic management. Knowledge management provides instruments to build capabilities which can be used in a strategically intended way to provide competitive advantages. Due to the importance of knowledge as the key resource, some authors also suggest that knowledge management has a strategic dimension in its own right. In the following, the link between knowledge management and organizational capabilities and competencies will be discussed in detail. Then, knowledge or knowledge management strategies will be reviewed as suggested in the literature.

179. The figure is based on Grant 1991, 115 and Grant 1998, 113.

5.1.2 Knowledge (management) strategy

Knowledge is considered the key resource in the knowledge-based view. A systematic management of this key resource should have its place on the strategic map of an organization. In the literature, many authors discuss knowledge management as an initiative that encompasses the whole organization (e.g., Probst et al. 1998). In many business organizations, knowledge management has received high attention from top executives and many organizations have established the position of a Chief Knowledge Officer—CKO on the board of directors[180]. So far, however, the link between concepts and instruments of knowledge management on the one hand and corporate or business strategy on the other hand has not been widely discussed[181].

The starting point for a framework of an organization's "knowledge strategy" (Zack 1999b, 126) or knowledge management strategy can be seen in the traditional SWOT analysis (strengths, weaknesses, opportunities, threats) in which strategy is seen as balancing the external environment of an organization (its opportunities and threats) with its internal capabilities (strengths, weaknesses).

A *knowledge strategy* can be defined as balancing an organization's knowledge resources and capabilities to the knowledge required for providing products and services superior to those of competitors (Zack 1999b, 131). According to traditional strategic management a *strategic gap* is the difference between what an organization must do to compete and what it is actually doing. Strategies try to close this gap by aligning what an organization can do considering its strengths and weaknesses with what it must do in order to act on opportunities and threats. This concept is translated to the area of knowledge strategy which addresses *knowledge gaps* – differences between what an organization must know to execute its strategy and what it actually knows (Zack 1999b, 135).

Knowledge maps are suggested as the instruments to identify knowledge gaps. A knowledge map in this case represents a high-level description of the organizational knowledge base. In order to position an organization against its competitors, the following three categories of knowledge have to be identified per area of competence, or per strategic business unit, division, product line, function or market position (Zack 1999b, 133f):

- *core knowledge* is the minimum knowledge commonly held by members of an industry, also considered the basic industry knowledge barrier to entry.
- *advanced knowledge* enables an organization to be competitively viable. Competitors may generally hold about the same level, scope or quality of knowledge,

180. See section 6.1.2.1 - "Knowledge manager (CKO)" on page 163, see also the empirical results in part C.
181. One of the rare positive exceptions is Galliers' attempt at the integration of knowledge management strategy into an information systems strategy framework which in turn is linked to the business policy and environment (Galliers 1999, 231). However, this places the knowledge management strategy close to information (systems) strategy and might result in neglecting the human and organizational side of KM as has been criticized many times.

but knowledge differentiation can take place with competitors holding specific knowledge.

- *innovative knowledge* enables an organization to lead its industry and to significantly differentiate itself from its competitors.

The link between business strategy and knowledge strategy ultimately comes down to direct an organization's KM initiatives towards closing strategic knowledge gaps. The knowledge gap in turn is directly derived from the strategic gap. This is true at an abstract level, however, it remains a big challenge to identify core, advanced and innovative knowledge and even more to find out how competitors score in these three categories. Also, as Zack states as well, knowledge requirements change quickly and what is innovative knowledge today may well be core knowledge in a matter of months. Thus, it is also important to identify and close so-called "learning cycle gaps" with which the dynamics of knowledge are addressed. However, it seems quite challenging to come up with knowledge requirements needed to fulfill future business strategies on a corporate level which in turn are concrete enough to direct KM initiatives. Zack's approach may be considered as a quite abstract, high-level first step in the process of designing a KM strategy which is linked to an organization's business strategy.

Figure B-14 gives a more detailed picture of the relationships between knowledge management and a simplified version of the strategic management process (see also Figure B-11 on page 95). The first step of this process is the identification of the key resources related to knowledge management. The classification of resources as presented in Figure B-12 on page 99 can be used to support this process. At the same time, the competitive environment has to be analyzed in order to provide a focus for the identification of the resources. Resources are only meaningful and valuable because they allow organizations to perform activities that create advantages in particular markets (Porter 1991, 108). Knowledge management supports the identification, development and acquisition of knowledge-related resources. Zack's concept of knowledge gap can be found on this level.

The next step is the selection of strategically relevant resources in order to provide organizational *competencies* or *capabilities*. Resources have only an indirect link with the capabilities that the firm can generate. A competence or capability consists of an integrated, linked and networked set of resources, a "team of resources" (Grant 1991, 120). Knowledge management aims at *leveraging resources* e.g., by concentrating them upon a few clearly defined goals, accumulating resources through mining experience and accessing other firms' resources, complementing resources, conserving them to use resources for different products and markets and recovering resources by increasing the speed of the product development cycle time (Grant 1998, 126).

Figure B-14 also shows a circle model visualizing the four dimensions of capabilities: skills and the organizational knowledge base, technical systems, managerial systems and the values and norms associated with organizational knowledge (Leonard-Barton 1992a, 113f). Capabilities can be compared to the competition. Capabilities and competencies are considered core if they differentiate a company strategically. The resulting capability differentials give rise to competitive advantages which can be realized by applying the competencies in selected strategic business fields. It is important that competencies are identified spanning strategic business fields, hierarchies and functional areas (Probst/Raub 1998, 135), thus showing which complementary competencies are spread across different strategic business units. Many organizations today orient their activities around their (core) competencies. In the ILOI study done in 1996, 57% of the organizations reported that they had established competence centers to support the core competence approach (ILOI 1997, 28f). Competencies are difficult to imitate because the functioning of these networks is hard to understand for a competitor. Competencies are in other words the results of processes of organizational learning.

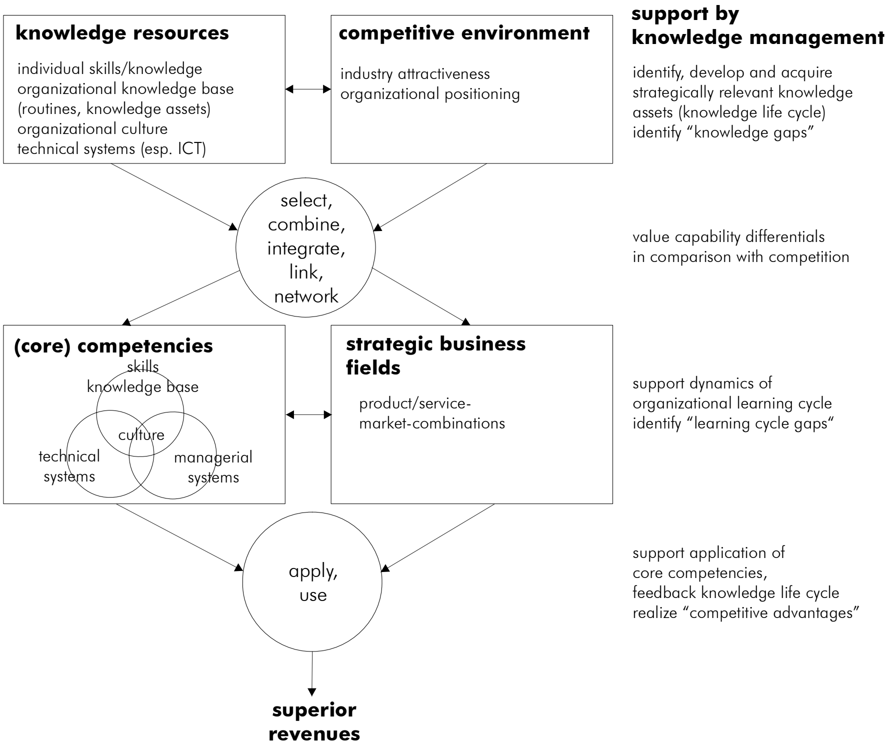

FIGURE B-14. Relationship between knowledge management and strategic management

Knowledge management supports the integration of resources into capabilities, the valuation of capability differentials and drives the dynamics of the organizational learning cycle as sustained capability differentials require continuos improvement of the competencies. This organizational learning cycle is also closely related to the "meta-capability" of organizations which supports the permanent process of integration, combination, linking and networking of resources into new competencies, also called dynamic capabilities (Teece et al. 1997). This meta-capability determines how efficiently an organization can change the competencies it applies. Organizational competencies are used to carry out those activities which an organization commands so that these activities differentiate the organization from its competition.

Dynamic capabilities can be described in terms of the organizational and managerial processes which are the basis for the coordination and integration of resources into capabilities, the learning cycle and the reconfiguration and transformation of capabilities to rapidly changing environments (Teece et al. 1997). This viewpoint has been called the dynamic capabilities perspective, a new paradigm in strategic management which bases its theory on a Schumpeterian model of competitive advantages generated by "creative destruction" (Teece et al. 1997, 526f).

The *Knowledge Management Maturity Model* (KMMM) was suggested in analogy to the well-known Capability-Maturity-Model (CMM, Paulk et al. 1993) which can be used to analyze an organization's position with respect to its meta-capabilities in knowledge management (Ehms/Langen 2000). Like the CMM, the KMMM distinguishes between five steps: initial, repeatable, defined, managed, optimizing. It analyzes the organization's (1) knowledge goals and strategy, (2) environment, cooperations and alliances, (3) employees' skills and competencies, (4) culture, (5) the managerial systems and management support, (6) knowledge structures and contents, (7) technological infrastructure and (8) processes, roles and organization. The organization's knowledge strategy is then stated depending on the step on which the organization's KM is and aims at bringing it to the next, higher step with respect to the eight areas of analysis which can also be seen as the main points of intervention into an organization's way of handling knowledge.

Knowledge management should also support the application of competencies which provides feedback for the development of (complementary) resources. KM research has often concentrated on the identification and creation of knowledge and neglected the application side (Wiig 1999). Ultimately, these strategies should lead to sustained superior revenues for the organization.

Thus, KM activities do not directly provide or improve competitive advantages, but ideally support the development of knowledge-related resources, their integration, linking and networking into organizational competencies, as well as their application which realizes the competitive advantages.

The main aim of a business strategy is to develop competitive advantages. The main goal of a *knowledge management strategy* is to support the development and application of organizational competencies. A knowledge management strategy can be seen as the general, abstract, high-level approach to align an organization's knowledge resources and knowledge-related capabilities to the knowledge requirements of its business strategy (also Zack 1999b, 135ff). Thus, the knowledge management strategy tries to close the organization's knowledge and learning cycle gaps.

There is still a lot of research work to do to clearly define the concept of organizational competence or the concept of collective or organizational knowledge. Thus, even though this model provides a theoretical foundation for the development of a KM strategy, there is still a lot of room for improvisation in the implementation of these strategies. In the following, process-orientation will be used as an instrument to further detail the implementation of KM strategies.

5.1.3 Process-oriented KM strategy

As mentioned earlier, the resource-based view in general provides a sound basis for the link between strategic management and KM, and thus ultimately of the use of KMS. However, this link, though established conceptually, remains quite vague. Process-orientation can provide an instrument to integrate the external orientation of the market-based view and the internal orientation of the resource-based view on the one hand and provide a framework for a more concrete derivation of KM strategies on the other hand[182]. In the following, the discussion of a process-oriented knowledge management strategy will provide useful insights required in the scenarios proposed in part D[183].

The definition of corporate goals and corporate analysis identify on the one hand *strategic business units (SBU)* and on the other hand *fields of core competencies*. These tasks are at first independent of the organizational design which represents the next step of the strategic management process. Besides designing the organizational structure, it is necessary to design the corresponding tasks and workflows. This can be done by defining business processes.

Business processes can be organized in terms of strategic business units or fields of core competencies. That means that processes can be designed guided by market- as well as resource-oriented considerations.

The market-oriented corporate strategy is strongly oriented towards customers and markets which is all the more emphasized by the concept of process-orientation. The latter means the design of customer-related business processes. In this case, the design of business processes is guided by delivering value to the customer who triggers and receives the output of the value chain (=”end to end-view”, see Davenport et al. 1996) and does not focus organizational core competencies.

With respect to the resource-based corporate strategy which is at first oriented towards internal factors, process orientation can provide a useful means to avoid the danger of “*core rigidity*” (Leonard-Barton 1992a). Core rigidity means that an organization does not consider market-oriented factors, like new business fields, customer groups, new competitors and therefore might loose competitiveness. Many authors of the resource-based view suggest to consider market-oriented factors when identifying core capabilities or competencies (e.g., Prahalad/Hamel

182. A general overview of process-orientation, business processes and process modeling can be found in e.g., Scheer 1998.
183. A detailed description of process-oriented KM strategies can be found in Maier/Remus 2001, Remus 2002.

1990, Leonard-Barton 1992a, Teece et al. 1997). However, it remains unclear what instruments could be used to support the definition of KM strategies that simultaneously consider internal and external factors. Process orientation can be such a vehicle[184].

This is due to the fact that the implementation of business processes inherently considers market-oriented factors because of its “end to end view” from customer to customer. If the resource-based view is compared to the market-oriented view with respect to design business processes, it might well be that the two resulting sets of business processes are equal independent of the orientation of the strategy that guided the design process.

A typical example is the order fulfillment process which can be derived directly when customer needs are considered or the generic competence of transaction is bundled in the order fulfillment process (Maier/Remus 2001). Clearly, resource-orientation and market-orientation are related as business processes require core competencies to deliver marketable products and services.

Figure B-15 presents a framework that integrates market-orientation and resource-orientation with the help of a process-oriented KM strategy. Market-oriented factors (the competitive environment) are considered in the definition of strategic business fields. Simultaneously, resource-orientation (knowledge resources) is considered in the definition of organizational core competencies. A process-oriented KM strategy should be able to balance both orientations, by considering the organization’s core competencies when defining strategic business units. Additional strategic business fields have to be selected which are needed for the development of (complementary) core competencies.

These tasks are guided by *strategic knowledge assets* which are developed and managed by KM activities. A strategic knowledge asset is a concept that views core competencies in the light of their application for products and services, in Porter’s terms systems of activities (Porter 1996) that make a difference visible for the customers (external perspective). On the other hand, strategic knowledge assets help to orient the development and management of core competencies (internal perspective). Consequently, knowledge resources are selected, combined, networked and integrated into strategic knowledge assets.

Strategic knowledge assets guide the design of business processes and therefore bridge the gap between strategic business fields and core competencies. In the following, two scenarios will be discussed from which organizations can start to formulate a process-oriented KM strategy. The two scenarios represent the two extreme positions of an exclusive market oriented or resource-oriented strategy.

184. See Maier/Remus 2001 for a preliminary version of the following argumentation, also Remus 2002 who develops this argument and analyzes process-oriented knowledge management activities in detail.

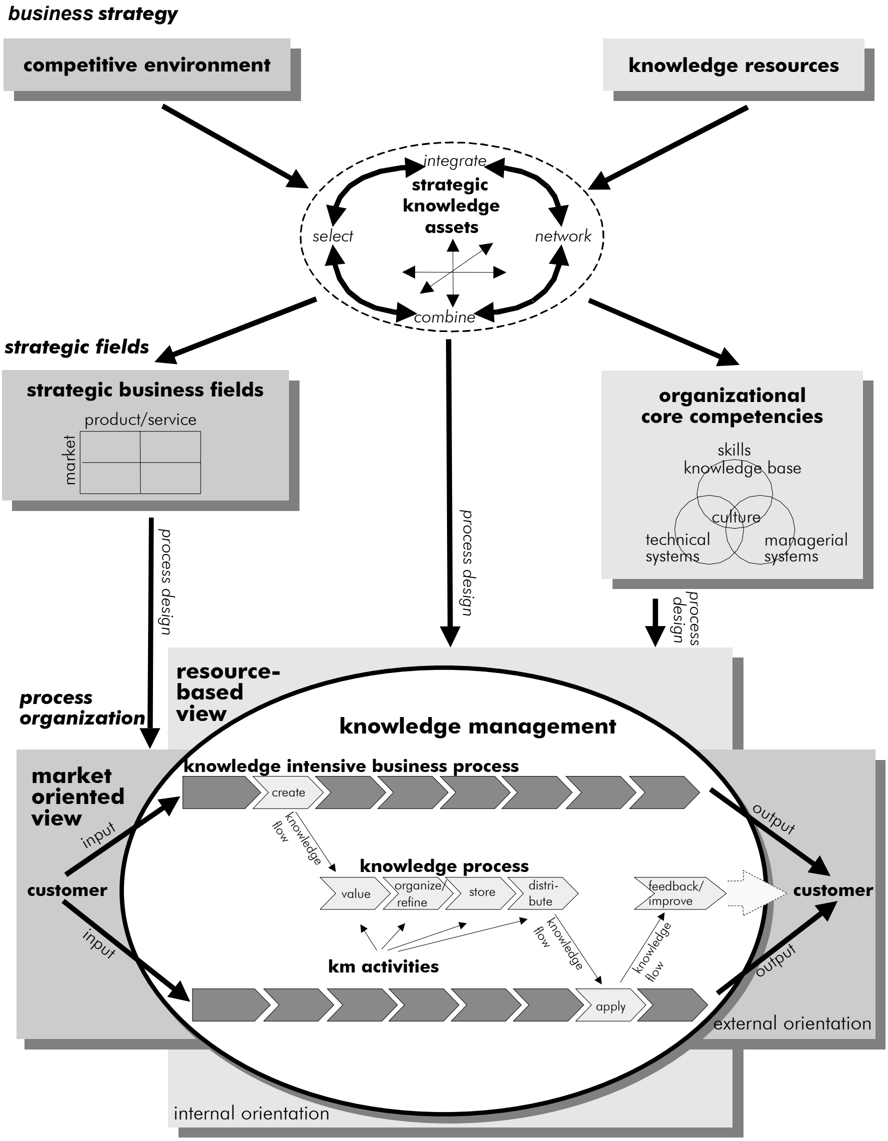

FIGURE B-15. A framework for a process-oriented KM strategy[185]

185. For a description of the resulting design of business and knowledge processes see section 6.3.2 - "Knowledge management processes" on page 212, especially Figure B-25 on page 214

Scenario 1. If an organization so far has applied an exclusive *market-oriented strategy*, then external determinants such as customers' demands, the organization's market position and competitors' process designs have been explicitly considered in the process design. One of the most important factors towards customer orientation is to personalize offerings according to customer needs. This is implemented e.g., by the management of variants and complexity as well as by the concept of triage. The idea of triage is to organize three variants of a process that differ in the amount of complexity encountered in different markets, situations or inputs (Hammer/Champy 1993, 55f).

In this scenario, a process-oriented KM strategy will consider the organization's resources in the bundling of core competencies in separate knowledge-intensive business processes and/or knowledge processes in the sense of service processes for the organization's business processes[186]. These newly designed processes are managed e.g., by centers of competence (Töpfer 1997) or specific KM roles, such as knowledge brokers, subject matter specialists[187], expert networks or communities[188].

Scenario 2. If an organization has exclusively applied a *resource-based strategy*, then business processes have been derived from core competencies. Thus, knowledge processes that manage core competencies supposedly are already defined. To avoid core rigidity, this organization has to additionally consider market-oriented factors.

In this scenario, a process-oriented KM strategy and the definition of strategic knowledge assets have to consider these external factors in the definition of knowledge-intensive business processes. An example is the bundling of competencies in business processes that make a visible difference to the organization's customers. This can be institutionalized in so-called "centers of excellence" visible to the customers or in specific KM roles, such as boundary spanners[189] and cross-organizational expert networks and communities.

Generally, the process-oriented view offers the following advantages for the definition of a KM strategy (Maier/Remus 2001, 4):

Value chain orientation. The process-oriented view combines the task-oriented and the knowledge-oriented viewpoint into a value chain-oriented perspective. Knowledge that contributes to value creating activities can successfully be linked to the relevant business processes. Thus, knowledge can be offered to a knowledge worker in a much more targeted way avoiding information overload, since only information relevant to the value creating activity is filtered and made available (Schreiber et al. 1999, 72).

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186. See section 6.3.2 - "Knowledge management processes" on page 212.
187. See section 6.1.2 - "Knowledge management roles" on page 162.
188. See section 6.1.3 - "Groups, teams and communities" on page 177.
189. See section 6.1.2.6 - "Boundary spanner" on page 166.

Context relevance. Business processes can provide part of the context that is important for the interpretation and construction of process-relevant knowledge. This includes knowledge about business processes that is to be linked with knowledge derived from processes during their operation.

Widely accepted management methods. In many organizations there are at least ten years of experience in reengineering business processes[190]. The adaptation of activities within business process reengineering (BPR) for the specific needs of reengineering knowledge-intensive business processes (Davenport et al. 1996) can be a promising area. This includes adapted business process models, expanded modeling activities (Allweyer 1998, Remus/Lehner 2000), reference models and tools (Allweyer 1999). Expertise in BPR is readily available in many organizations and professional services companies.

Improved handling of knowledge. In addition to the advantages resulting from an organization's analysis of its own business processes, process-oriented KM activities can also be the starting point for a more targeted improvement in the handling of knowledge in terms of knowledge process redesign (Davenport et al. 1996, Allweyer 1999, Eppler et al. 1999).

Process benchmarking. The analysis of successful knowledge-intensive business processes supports activities in the field of KPR. Since these weakly structured processes are often difficult to describe, efforts in this field seem to be quite reasonable. An example is the success of the MIT process handbook which also includes many typical knowledge-intensive business processes (Malone et al. 1999).

Support for process-oriented knowledge management. KM ideas and concepts are included in the BPR methodology. For example, knowledge processes that handle the flow of knowledge between processes can be established. The corresponding organizational position of a "process owner" might be assigned to a knowledge broker[191]. These knowledge processes handle the flow of knowledge as service processes for the operative business processes. The implementation of process management which also comprises the idea of continuous process improvement (CPI) can integrate the life cycle models of KM.

Process controlling. One of the most prevalent problems in KM is to achieve transparency about costs and benefits[192]. Knowledge controlling could profit from a process-oriented approach as for example the costs generated by the activities of specialized knowledge functions such as subject matter specialists or knowledge brokers who carry out service processes can be accounted. Some approaches within

190. See also section 4.1.2 - "From data to knowledge management" on page 39.
191. See section 6.1.2 - "Knowledge management roles" on page 162.
192. See chapter 8 - "Economics" on page 395.

the field of active-based costing seem to be appropriate and have to be adapted to knowledge-intensive processes as well.

Design and introduction of KMS. Last but not least the analysis of business processes can be a good starting point to design and introduce KMS, e.g., the CommonKADS methodology for knowledge engineering and management (Schreiber et al. 1999). Information derived from processes can also be used to specify KMS more precisely, e.g., by process-oriented navigation structure, process-oriented knowledge maps and knowledge structure diagrams.

The role of KM is to develop strategic knowledge assets that build core competencies with respect to strategic business fields. Strategic knowledge assets connect strategic business units and core competencies and thus relate the external and internal perspective resulting in *core competencies visible to the customers*. The relevance of an integrated view on process orientation and KM is underlined by strong dependencies between these two approaches on the operational level. Knowledge is created within operative business processes and shared with other business processes. Knowledge is used in business processes to create value for the business.

Knowledge also plays a crucial role when an organization decides to implement the concept of process management. The development and distribution of process knowledge (= knowledge about and derived from business processes) in improvement or change processes is a key factor for successful continuous process improvement which contributes to the adaptation of an organization to environmental change.

Certainly, the application of process orientation in general and a process-oriented KM strategy in particular has got *limits*. The traditional perspective which considers business processes is the model of value chains by Porter (1985). The organization is analyzed in terms of value creating activities, which basically rely on the underlying business processes. However, expanded value configuration models like the value shop and the value network are suitable instruments to analyze and describe new alternative value creation technologies, especially for knowledge-intensive business processes (Stabell/Fjeldstad 1998, 415). Central point of all these approaches is the orientation towards value creation. Organizations that can be described by a process-oriented framework like the Porter (1985) model not necessarily use a process-oriented KM strategy.

Generally, a KM strategy which uses process orientation as the primary perspective to analyze an organization is strongly dependent on the following requirements and conditions:

- The core business of the organization which is about to design a KM strategy is viewed and managed using a process-oriented perspective. Business processes are modeled and described and therefore visible to the employees.
- Process-oriented management activities have already been carried out. Process-orientation in general and these activities in particular are well known and accepted by the employees. Some weak spots in handling knowledge have been

identified. There are some measures and indicators about the processes which are collected regularly, e.g., time, cost and quality.

Process orientation can and should be seen as an additional dimension within a bundle of possible dimensions describing a complex KM strategy, especially for process-oriented organizations. Other dimensions are e.g., the type of knowledge, the target group of employees, the KMS that should be used or the cultural environment. A framework consisting of these dimensions is presented in (Maier/Remus 2001) and is intended to provide the integrating basis for the description of a process-oriented KM strategy.

In the following, the main goals will be investigated which KM initiatives aim at. Thus, the investigation moves from the abstract level of strategic management in general and KM strategies in particular to the more concrete KM initiatives or instruments and therefore to the implementation of KM strategies.

5.2 Goals and strategies

This section first targets strategic goals (section 5.2.1) and strategic options (section 5.2.2) of a KM strategy and then finally turns to generic KM strategies (section 5.2.3).

5.2.1 Strategic goals

There are many goals that companies can direct their KM efforts to. Generally, in the literature there are three different approaches to determine goals of KM initiatives all of which are based on empirical studies:

Business justification for knowledge management. These abstract KM goals are usually high-level, knowledge-related challenges that should be addressed with the help of KM. Examples are (Earl/Scott 1999, 31[193]):

- *correct the inattention to the explicit or formal management of knowledge* in ongoing operations,
- *leverage the hidden value of corporate knowledge* in business development,
- *correct the inability to learn* from past failures and successes in strategic decision making,
- *create value from knowledge* embedded in products or held by employees (sell knowledge).

193. Earl and Scott found the first four of these goals in a survey of 20 chief knowledge officers (CKO) in the US (Earl/Scott 1999, 31). The CKOs were appointed to correct one or more of the perceived knowledge-related problems. Apart from these four goals the CKOs primary tasks were: to develop a corporate "knowledge management program" and to "sell" the idea of knowledge management throughout the organization to gain acceptance and commitment for the program and to reduce resistance. The last KM goal has been identified by many authors (e.g., Davenport et al. 1998, 44ff performed an empirical investigation of 31 KM projects).

- *manage knowledge as an asset* the aim of which is to treat knowledge like any other asset on the balance sheet.

However, supposedly most of the organizations will address all of these issues at the same time. Thus, these justifications are not suited to characterize organizations' KM initiatives.

Strategic knowledge management activities. Many authors simply present a list of strategic KM activities which an organization can invest in. These activities can be used as instruments to achieve KM goals, or to implement KM strategies[194].

Detailed knowledge management goals. These goals address certain aspects of an organization's way of handling knowledge and are detailed enough to provide a means to distinguish different KM initiatives from each other.

Consequently, this last alternative was selected as the basis for the description of the question "What are the main aims of KM initiatives?" in the empirical study (part C). The list of goals is based on:

- *case studies* documented in the literature[195],
- *empirical data* found in studies on (aspects of) knowledge management[196],
- *knowledge management life cycle models* which were used in order to determine completeness of the list of goals[197], as well as
- *expert interviews* with CKOs and KM project managers conducted by the author.

Most of the studies and also the interviewees mixed KM goals and instruments to achieve KM goals. For example many authors list "create knowledge repository" as a KM goal, though repositories are instruments to e.g., the goals *improve the documentation of existing knowledge* and *improve access to knowledge sources*. Additionally, the authors list high-level goals such as "manage knowledge as an asset" which has to be detailed, e.g., by the goals *improve management of innovations* and *sell knowledge*. The following consolidated list of goals gives a good overview of what goals KM initiatives could aim at and will be used in the empirical study:

Identify existing knowledge. The aim is to make existing knowledge transparent, to give an overview of the knowledge existing in the organization. This goal is the basis of or at least supports many other goals and thus can be seen as a prerequisite,

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194. See section 5.2.2.5 - "Strategic knowledge management activities" on page 125.
195. See e.g., Davenport et al. 1998, who derive a list of objectives of knowledge management projects.
196. See e.g., APQC 1996, ILOI 1997, Bullinger et al. 1997, Ruggles 1998, 85f, Earl/Scott 1999, 31.
197. See sections 4.1.4 - "Definition" on page 52 and 6.3.1 - "Knowledge management tasks" on page 207.

a “conditio sine qua non” of systematic knowledge management. Thus, it is likely that most, if not all organizations will pursue this goal.

Improve documentation of existing knowledge. Knowledge is captured as an entity separate from people who create and use it. Knowledge is supposed to be embedded in (enhanced) documents and/or forms of discussion data bases. The goal includes the improvement of the quality of the contents (of knowledge elements) and the structure of knowledge (ontologies, e.g., Staab et al. 2001). Easier maintenance, refinement and repackaging are also part of this goal.

Change (parts of) the organizational culture. The aim is to establish an environment conducive to more effective knowledge creation, transfer, and use. Awareness is built and organizational norms and values are changed to improve people’s willingness to share knowledge and their willingness to reuse existing knowledge (or their willingness to accept help).

Improve communication and cooperation. This goal is about facilitating knowledge transfer between individuals. Communication is supported both, within and between formal work groups, teams or projects with an emphasis on peer-to-peer, bilateral communication as opposed to the *distribution of knowledge* in the sense of a broadcast to every employee interested[198].

Externalization (explication). Externalization means to turn implicit, “subjective” knowledge into explicit, “objective” knowledge. This goal thus addresses a transformation of the existing knowledge to make it more visible. According to many authors, there is a general trend towards the handling of more explicit knowledge in organizations (“scientification of organizations”, e.g., Wingens 1998).

Improve training, education and networking of newly recruited employees. The integration of newly hired employees into the organizations’ work processes as well as their socialization to the organizations’ norms and values should be accelerated. It targets job starters, such as trainees, apprentices, graduates, as well as newly hired experienced employees, experts or, especially recently, formerly self-employed founders of start-up companies that now turn to established organizations.

Improve training and education of all employees. This goal comprises the classic function of personnel development as part of the HRM. Approaches of knowledge management can extend the traditional instruments, e.g., by supporting mentoring, learning from “peer groups”, tele-teaching, communities, best practice groups.

Improve retention of knowledge. Some organizations see one of the biggest threats to their competitiveness in retaining knowledge from experts that are facing

198. See “Improve distribution of knowledge.” on page 117.

retirement or otherwise leaving the organization. The goal is to capture knowledge before it leaves the organization, e.g., through reserving time for employees facing retirement to externalize knowledge and to socialize with their successors or peers, or through retaining alliances with employees after they have left, e.g., through consulting.

Improve access to existing sources of knowledge. The aim is to provide access to documented knowledge and/or to connect knowledge seekers and knowledge providers. The yellow pages or expert directories serve as the metaphor to improve accessibility of experts that can be used to share tacit knowledge.

Improve acquisition or purchasing of external knowledge. In this case, knowledge external to the organization is targeted. Organization-external knowledge is provided e.g., by research institutions, professional services companies or knowledge brokers or on-line data bases, but also by business partners, customers and suppliers, alliances as well as competitors.

Improve distribution of knowledge. This goal aims at a better support for the transfer or broadcasting of knowledge to interested (known and also unknown) other members of the organization (knowledge push).

Improve management of innovations. This goal targets primarily a better management of the results achieved by the organizations' departments for research and development, e.g., more innovations leveraged faster, more patents, but also the avoidance of unwanted multiple developments of the same concept.

Reduce costs. Some KM concepts, especially the use of technology, also provide opportunities for cost reductions, e.g., by reduced organizational redundancy due to double developments, by reduced time of standstills in production plants, by reduced costs for the acquisition of knowledge or the use of commercial knowledge sources, by reduced use of paper due to electronic storage and transfer of documents or by reduced travel expenses due to tele-consulting.

Sell knowledge. Organizations that hold patents might want to improve earnings from licensing, or otherwise sell their knowledge, e.g., by consulting or by charging for the access to organization-internal KMS.

In addition to these goals specific to KM, organizations investing in a KM initiative expect a positive influence on the achievement of *business goals*. However, at this point the link between these KM goals and the business goals as cited in the literature (e.g., ILOI 1997, 15[199]) or stated by the interviewees is rather weakly

199. The business goals as stated by the respondents of the ILOI study were partly taken over, e.g., *improve productivity*, and partly broken down in order to give a more detailed picture of the suggested contributions of KM to business goals, as in the case of the business goals *improve an organization's position in a market*, *secure competitiveness* and *make more systematic and efficient use of resources and synergies*.

defined. There is a m:n-relationship between these two concepts with many KM goals contributing to a number of business goals. The list of KM goals is related to business goals according to their *primary* contributions to the goals. For example, the goal *change (parts of) the organizational culture* is an underlying goal which in turn should lead to improvements with respect to all of the following business goals:

- *reduce (non-labor) costs*: reduce costs, improve communication and cooperation, improve acquisition or purchasing of external knowledge, improve distribution of knowledge,
- *improve productivity*: improve education, training and networking of newly recruited employees, improve training and education, improve communication and cooperation, improve distribution of knowledge,
- *improve the speed of innovation*: improve management of innovations,
- *develop new business fields or topics*: improve management of innovations, sell knowledge,
- *reduce business risks*: improve the ability to react to environmental changes, especially the ones stemming from fluctuation, improve retention of knowledge, improve training, education and networking of newly recruited employees, identify existing knowledge, externalization, improve documentation of existing knowledge, improve access to existing sources of knowledge,
- *improve employee satisfaction and motivation*: change (parts of) the organizational culture,
- *improve growth of the organization*: improve management of innovations,
- *improve product quality*: improve documentation of existing knowledge,
- *improve customer satisfaction and/or service quality*: improve communication and cooperation, identify existing knowledge, improve distribution of knowledge,
- *improve scheduling, reduce throughput/running time, improve meeting of deadlines*: improve communication and cooperation, improve distribution of knowledge.

Organizations differ not only with respect to what goals they aim at with their KM initiatives. There are also differences in the *level of management* of the KM goals. Many organizations experience difficulties in answering the questions how to turn strategic KM goals into operational KM goals and also how to assess the level of achievement of KM goals (e.g., Probst/Deussen 1997, 8f, Probst et al. 1998, 63ff and 317ff). The following aspects have to be considered concerning the level of management of strategic KM goals[200]:

200. The economics of the application of knowledge management systems, the analysis of costs and the estimation of benefits, will be discussed in section 8 - "Economics" on page 395.

- the process of *goal setting*: Who sets the goals? Are the goals well documented and precisely defined?
- the process of *goal evaluation*: Who evaluates the goals? What level of measurement is applied?

In the literature, a large number of approaches and instruments to the assessment of knowledge in general and the achievement of KM goals in particular exist. However, most of these approaches lack practicability. As a consequence, as the expert interviews conducted before the empirical study showed, it is likely that only a small portion of the organizations have clearly defined and documented KM goals and established procedures to their measurement[201]. Thus, the following three levels of documentation of KM goals are distinguished:

General statements/declaration of intent. Many organizations simply take over some general, abstract goals from the literature. These goals are e.g., part of a presentation to senior management showing the general advantages of a KM initiative. Examples are: “We want to become a learning organization”, “We want to improve the learning from our failures”, “We want to hire only the best employees”, “We want to install an Intranet to support knowledge sharing”.

Well documented and described. This level of documentation details the general statements about KM goals. The goals are selected according to the organization’s needs, documented and accessible by all participating employees. The goals are also described well so that their achievement can be assessed at least subjectively.

Precisely defined. This is the most detailed definition of KM goals. For every goal, there are a number of variables which can be measured quantitatively or semi-quantitatively. For each goal, there is a goal object (the domain), characteristics of goals (the variables to measure the goal achievement), a goal dimension (rules for the measurement and evaluation), planned values of goal achievement, a relation to time (when should the goal be achieved) and an evaluating person or an evaluation team (e.g., Hauschildt 1993, 205ff and 315ff).

Additionally, the process of evaluation will be studied by a distinction between the following three classes (Hauschildt 1993, 317ff):

Subjective assessment. This qualitative approach involves the valuations of individuals which can be participants, the project manager or individuals not involved in the process, individuals with a technical or a business background etc. Regularly, in case of subjective assessment, it is the senior management, the project manager or a sample of participants who assess the KM initiative.

201. See the overview of the related empirical studies as described in chapter 10 - “Related Empirical Studies” on page 439.

Audit/evaluation team. In this case, a group of individuals assesses the KM initiative on the basis of a structured evaluation process. Audits usually use so-called semi-quantitative techniques which convert the judgements of a selected group of people into some measures using statistical methods, such as factor analysis or cluster analysis. Thus, the result is a small set of interesting factors which are in turn subjectively assessed by a number of individuals using a number of variables.

Measuring. Quantitative techniques are based on precisely defined variables which can be repeatedly measured rendering consistent results.

Most of the organizations probably use a combination of these measures, e.g., quantitative measures such as the number of accesses to a KMS and a semi-quantitative audit[202].

5.2.2 Strategic options

There are a number of goals that companies can direct their KM efforts to[203]. In the following, a number of dimensions are discussed which provide the strategic options an organization has to decide on a KM strategy.

5.2.2.1 Business areas

Broad KM initiatives might attempt to improve the organization-wide handling of knowledge by e.g., measures to raise awareness about the importance of knowledge and the advantages of sharing knowledge (cultural infrastructure), investments into the ICT infrastructure or the organization of business processes and/or organizational units around competencies. Additionally, KM strategies can be targeted to improve the handling of knowledge within specific business areas which are considered to contain the most important organizational capabilities. Examples are:

Customer relationship management. Generally, customer relationship management (CRM) aims at an organizational and ICT support of customer-oriented processes for the entire customer life cycle and thus requires the customer-oriented integration of ICT systems (see Rosemann et al. 1999, 107ff). A number of instruments can be applied to access and jointly develop knowledge that customers have about the products and services an organization offers (e.g., Davenport/Klahr 1998). Examples are user groups, joint ventures, beta-testing, Web sites, email, toll-free numbers, customer care centers, customer advisory boards, conferences and social gatherings (Zack 1999b, 139). The corresponding IT support is called CRM systems[204].

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202. See also chapter 8 - “Economics” on page 395.
203. See section 5.2.1 - “Strategic goals” on page 114.
204. See chapter 7 - “Systems” on page 273.

Research and development (R&D). In many organizations, R&D contains the most knowledge-intensive business processes. Thus, many KM initiatives might start in this area, especially if complementary knowledge is spread across multiple organizational units. Technologically, the frequently large collections of documents, blueprints, studies, lessons learned etc. have to be easily accessible by all knowledge workers participating in the R&D process.

Value chain management. The increasing integration with business partners requires attention to the knowledge flowing across the boundaries of the participating organizations. The technological basis supporting this integration can be an Extranet (= an Intranet spanning the organizational boundaries which uses Internet technologies, but is secluded from the public Internet) or the definition of interfaces for the exchange of documents (e.g., with XML).

Geographical expansion. Often the geographical expansion of an organization marks the starting point for a KM initiative as the traditional mechanisms for knowledge exchange do not work anymore (the mechanisms cited most often are informal gatherings in the coffee kitchen or cafeteria). The flow of knowledge between subsidiaries in different parts of the world poses a big challenge for many organizations. In ICT systems, the switch from unilingual to bilingual or multilingual document bases often requires major adjustments or the acquisition of new platforms that provide the functionality needed to manage documents in multiple languages.

Post-merger integration. In many cases, complementary competencies represent one of the most important reasons for mergers and acquisitions. In order to profit from possible synergies, knowledge sharing between the beforehand separated and even competing organizations has to be fostered. Especially big multinational organizations establish post-merger integration projects in which KM is one facet of the integration process (e.g., DaimlerChrysler, United Bank of Switzerland). Technologically, the technical and especially the semantic integration of the ICT platforms, the corporate Intranets, document bases and communication systems is a challenge in many mergers.

Virtual organizations. The most prevalent question in virtual organizations is the bargaining about knowledge that is developed in the cooperation and cannot be easily attributed to one of the partners. Also, as the members of the organization regularly work in geographically dispersed offices, it is important that virtual work environments are created that make up for the loss of a social environment. The main challenge for the ICT platforms is to maintain the openness and flexibility to integrate systems from new partners entering the virtual organization and to prevent the loss of knowledge.

5.2.2.2 Types of knowledge and organizational learning

An organization also faces several strategic decisions concerning what types of knowledge it should target in its organizational knowledge base and what basic types of learning it should encourage. The following strategic options have been suggested in the literature[205]:

Exploitation—exploration. This dimension focuses on the degree to which an organization needs to increase its knowledge. Exploitation, also called *incremental learning*, means to turn knowledge that already exists into new products and services. Exploitation is supported by the design and installation of techniques and processes to create, protect, and use known knowledge. Exploration, also called *radical learning*, means the development of new knowledge through either creation or acquisition. Exploration requires the design and creation of environments and activities to discover and release knowledge that is not known. Radical learning challenges basic assumptions about the business an organization is engaged in whereas incremental learning extends and adapts the existing organizational knowledge base step-by-step.

Internal—external. This dimension describes an organization's primary source of knowledge. Internal knowledge is knowledge readily available within the organization, such as individual knowledge (in the heads of employees), knowledge embedded in behaviors, procedures, software and equipment as well as codified knowledge (in documents, data bases and on-line repositories). External knowledge can be acquired from outside the organization, e.g., publications, universities, government agencies, professional associations, personal relations, professional services companies, vendors, knowledge brokers and inter-organizational alliances. Internal learning aims more at the development of organization-specific core competencies whereas external learning extends the organizational knowledge base and improves flexibility.

Slow—fast learning speed. Fast learning is not always advantageous as it can lead to rash conclusions and to a premature freezing of searches to one single knowledge thread, whereas slow learning sometimes eases the integration of different knowledge threads.

Narrow—broad organizational knowledge base. A narrow knowledge base can lead to core rigidity whereas a broad knowledge base enables the combination of different knowledge threads and improves flexibility.

Explicit—tacit knowledge. This dimension describes the main type of knowledge focused [206].

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205. See Bierly/Chakrabarti 1996, 123ff, Earl/Scott 1999, 30ff, Zack 1999b, 135ff, Zahn et al. 2000, 262ff.

Technological—organizational socio-technological focus. This strategic option refers to the common distinction between a more human oriented (organizational focus) and a more technology-oriented KM initiative[207].

An organization can choose a position on each of these dimensions for every area of knowledge which the business strategy requires. However, the first four options are strongly inter-dependent and do not mark completely separable dimensions. A broad knowledge base for example will regularly require to effectively combine both, internal and external sources of knowledge.

This effect of combining the two extremes is not the same for every strategic option. It is plausible that a *combination* might be useful in the case of the dimensions internal-external, explicit-tacit knowledge and technological-organizational socio-technological focus. Organizations thus should try to target all these poles at the same time (see e.g., the results presented in Earl/Scott 1999, 32). A concrete knowledge management strategy has to balance these strategic options (Zahn et al. 2000, 262). On the other hand, in the case of exploration versus exploitation, slow versus fast learning and a narrow versus a broad organizational knowledge base the two ends are exclusive, thus forcing a strategist to take a decision rather than to balance the two ends.

Organizations might for example engage in both, exploration and exploitation, in different areas of knowledge at the same time. Choosing different strategic options for complementary areas of knowledge might cause spill-over effects, though. There are time-related, cultural and/or organizational barriers between exploration and exploitation (Zack 1999b, 137). An example would be that (a group of) experts that are used to radical learning, cannot simply "change their minds" and get acquainted to incremental learning when they turn to another area of knowledge where the organization might have chosen an exploitation strategy.

The combination of the strategic options characterizes the *aggressiveness of knowledge management strategies*. The more an organization relies on e.g., exploitation of existing knowledge, on slow learning, a narrow knowledge base and the more internal the primary source of knowledge, the more *conservative* the strategy. The opposite—e.g., exploration, fast learning, a broad knowledge base and both, internal and external sources of knowledge—is called an *aggressive* strategy. However, the last two categories do not fit as easily into this polarization as one cannot tell which extreme would be more aggressive. Having said this, in many organizations there seems to be a tendency towards the more explicit knowledge and also towards more ICT support, so that relying (exclusively) on tacit knowledge and an organizational socio-technological focus might be viewed as a more conservative strategy whereas an aggressive strategy certainly will try to effectively combine both types of knowledge and both foci.

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206. See section 5.2.3 - "Generic knowledge management strategies" on page 129; see also section 4.2.2 - "Types and classes of knowledge" on page 66 for a description of these two types of knowledge.
207. See section 4.1.4 - "Definition" on page 52.

The positioning along these dimensions has to be seen in the context of the industry in which the organization or the relevant strategic business unit engages in. The overall flow of knowledge in an industry, also called the strategic knowledge environment of an industry, is seen as the sum of the interactions among the knowledge strategies of the individual organizations in the industry (Zack 1999b, 141). Thus, the strategic options can also be used to position a whole industry and compare it to the organization's own position.

An entirely different approach to distinguish between different KM strategies is Glazers "Open-Minded Inquiry" information acquisition system which might be used to distinguish between a KM focus on different aspects of an organization's learning system (Glazer 1998, 182f). KM activities thus have to support one or more of the following key concepts:

- *active scanning*: knowledge seekers systematically search for environmental cues,
- *self-critical benchmarking*: continual comparison of new knowledge is institutionalized, especially from outside the organization, with a set of internal standards or references,
- *continuous experimentation and improvement*: members of the organization systematically plan and observe the effects of changes in procedures and practices,
- *informed imitation*: employees systematically study "best practices" of peers, role models, or competitors,
- *guided inquiries*: a separate organizational unit is institutionalized which serves as a center for comprehensive information used by all members of the organization.

Glazers theoretical model describing the key attributes of a system supporting organizational learning can be used to further characterize KM strategies.

5.2.2.3 Target group

Knowledge management strategies can also be classified according to the main target group the strategy focuses:

Employee rank. The strategies differ in which level of employees is considered the primary focus of KM activities: employee – manager – executive.

Employee life cycle. One could imagine special knowledge-related activities for newly recruited employees, e.g., starter packages for KMS, communities specially designed for newly recruited employees, for employees facing retirement, e.g., one day per week off to document experiences and lessons learned, or to act as a mentor for newly recruited employees, or for employees preparing for or immediately after a step in their career, e.g., role-specific packages for KMS, communities linking employees who are on about the same career track, like high potentials, functional specialists etc.

Employee role. The strategies differ in what roles of employees are focused.

Organizational scope. The target group is not necessarily limited to the organizational boundaries. At least four scopes can be distinguished along this dimension (the corresponding technologies are given in parenthesis to illustrate the scopes): core group (work space) – organization (Intranet) – organization and partners (Extranet, virtual private network) – unlimited (Internet-communities).

5.2.2.4 Business process focus

KM initiatives can also be described according to the business process(es) they focus and the type of business processes that are supported[208].

Process focus. KM initiatives can be distinguished according to the process scope that is focused. The focus on processes can stretch from a single process over a number of processes to an organization-wide perspective, including all relevant business processes (core and service). Defining an initiative starting from operative business processes instead of knowledge processes is much more targeted towards the value-creating activities of an organization. Starting with a single business process may have some advantages concerning the acceptance for further KM activities in other business processes. “Quick wins” that show significant improvements of the handling of knowledge in one business process might be important success factors for the implementation of organization-wide KM efforts (Bach/Österle 1999, 30).

Type of process. The question which types of processes are promising candidates for process-oriented KM initiatives is strongly related to the identification of knowledge-intensive business processes. Several authors have suggested some characteristics that describe the knowledge intensity of business processes (e.g., Davenport et al. 1996, 55, Eppler et al. 1999). Within the group of knowledge-intensive business processes, it can be distinguished between simple and highly complex processes and between management, core and service processes. These examples show what criteria an organization could apply to select business processes that will be (primarily) targeted by their KM initiative.

5.2.2.5 Strategic knowledge management activities

There are also a number of authors who pragmatically suggest a series of strategically relevant KM activities, efforts or strategies without much differentiation between these concepts. Most of these authors base their findings on empirical studies investigating KM initiatives in organizations. Examples are[209]:

Map sources of internal expertise. The issue is to make knowledge assets visible and to increase managers' attention. The focus is on the personal side of the knowl-

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208. See Maier/Remus 2001, 7; see also section 6.3.2 - “Knowledge management processes” on page 212.
209. See APQC 1996, 18ff, Wiig 1997b, 8, Ruggles 1998, 85f, Holtshouse 1998, 277f; see also section 12.2 - “Strategy” on page 471.

edge in an organization, e.g., expert directories, skill data bases, yellow pages organized according to knowledge areas.

Establish new knowledge roles. Either a separate organizational unit headed e.g., by a chief knowledge officer is created, or positions or roles responsible for knowledge-related tasks, such as knowledge broker, knowledge engineer or subject matter specialist are established[210].

Create a (virtual) work environment. The sharing of tacit knowledge is commonly considered a highly interactive social process which requires a co-located, face-to-face work environment (Holtshouse 1998, 277). However, this kind of stable work environment has changed into a situation where the number of mobile workers increases and social connections within a work community are disrupted. The issue is to create virtual workspaces, which provide an alternative environment to the co-located workspace, thus enabling the sharing of tacit knowledge.

Create networks of knowledge workers. Communities bring people together who work on the same problems, hold complementary knowledge or who are interested in the same knowledge areas.

Support knowledge flows in an organization. Knowledge seekers and knowledge providers should be connected using systems and tools which provide for a balancing of pull and push of knowledge. KMS are needed which adapt to usage and communication patterns of knowledge seekers and providers, both on the individual and on the team and community level.

Transfer of knowledge and best practices. Systems and practices are implemented to improve the obtainment, organization, restructuring, storing, repackaging for deployment and distributing of knowledge as well as the corresponding rewards given for knowledge sharing. This means a systematic approach to knowledge reuse and the transfer of "best practices". This strategy covers both, the informal sharing of knowledge in teams and informal networks without capturing it as well as the organized knowledge sharing which is supposed to reach more members of the organization. Goal is to make knowledge available at points of action.

Personal responsibility for knowledge. In this strategy, the members of the organization themselves are held responsible for identifying, maintaining and expanding their own knowledge as well as for understanding, renewing and sharing their knowledge assets. Central assumption underlying this strategy is that knowledge of an individual cannot be "micro-managed", but must be managed by the individual, thus suggesting a "pull" approach to knowledge exchange rather than a "push" approach.

210. See section 6.1.2 - "Knowledge management roles" on page 162.

Customer-focused knowledge. The aim of this strategy is to capture knowledge about customers, their needs, preferences, businesses, reactions to actions taken by the organization etc. Thus, the organization's knowledge can be used to improve solutions designed for customers for the purpose of making loyal customers.

Innovation and knowledge creation. Basic and applied R&D as well as motivation of employees to innovate and capture lessons learned are focused to enhance innovation and the creation of new knowledge.

Intellectual asset management strategy. The aim of this strategy is the enterprise-level management of patents, technologies, operational and management practices, customer relations, organizational arrangements, and other structural knowledge assets. Individual instruments could support the renewing, organizing, valuating, safekeeping, increasing the availability and marketing of these assets. In order to bring knowledge management into business focus, it is necessary to increase managers' awareness of an organization's way of handling knowledge: its importance, its location, its movement, its effects and "its overall state of health" as compared to competition (Holtshouse 1998, 279). Efforts already undertaken to quantify assets like patents, brands or customer relationships might be extended to incorporate the collective knowledge of an organization and an organization's participation in knowledge flow networks.

Knowledge management as a business strategy. KM is either integrated within the overall business strategy or treated as a separate business strategy in parallel with other strategies. This is the most comprehensive and enterprise-wide approach to KM and is the all-encompassing "umbrella" for the other activities.

Most of these activities certainly focus on the organizational side of knowledge management, although KMS can help substantially to achieve the underlying goals. The first three activities can be characterized as providing an *organizational and technological infrastructure* for KM. The activities four to six all clearly aim at an improved *sharing of knowledge*. These two areas are strongly interdependent. Taking into account Nonaka's four knowledge processes—*internalization*, *externalization*, *socialization* and *combination* (Nonaka 1991, 98f, Nonaka 1994, 18f), it is clear that activity three supports activity five, because the joint development of tacit knowledge might ultimately lead to improved knowledge flows (because explicit knowledge is easier to hand on than tacit knowledge). Activities eight and nine can be characterized as *focused on specific functional areas*, the management of customer relations and research and development. As opposed to all these concrete, goal-oriented efforts, activities ten and eleven target the organization as a whole in a top-down perspective. They link KM to business strategy or to finance and controlling (intellectual asset management) and thus can be characterized as having an *organization-wide top-down focus*. Last but not least, activity seven points in an entirely different direction. It stresses the individual's responsibility for his or her own handling of knowledge, thus reacting to the critics saying that an external "management of knowledge" is virtually impossible. It can be called *personal knowledge management*. The substantial implications of this perspective will be discussed in detail in part D.

Even though all these strategic KM activities do not qualify as KM strategies, they can help to describe concrete KM initiatives, efforts, systems and instruments in terms of their contributions to strategic activities.

5.2.2.6 Application of the dimensions

A concrete intervention into the way an organization handles knowledge has to be balanced with respect to every dimension. The model of a quadrant of intervention describes this aspect (Raub/Romhardt 1998). A dimension of an intervention can be described as having two opposite interventions into an organizational knowledge base as the ends and every combination of the two along the dimension (e.g., internal orientation vs. external orientation or orientation towards known knowledge vs. orientation towards the development of new knowledge). Either of the two interventions can be exaggerated leading to problems of "over-stretching" an organization. Only the right combination of the two which can be found in one quadrant leads to positive results. Raub and Romhardt discuss their model with the two poles external orientation and internal orientation. The corresponding exaggeration of these two poles can be called "over-stretching" and "core rigidity" (see Figure B-16, see also Raub/Romhardt 1998, 154).

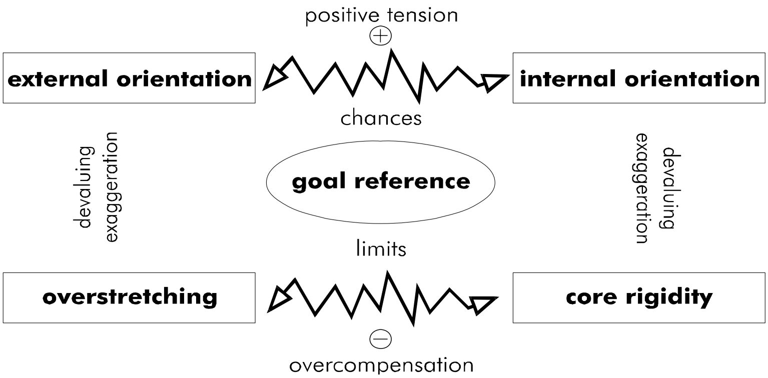

FIGURE B-16. An example for a quadrant of intervention "reference to goals"[211]

The most important lesson to be learned of this approach is that if a KM initiative solely concentrates on one end of a dimension of intervention and completely neglects the other end, it misses the potentials of a positive tension between the two interventions and can also lead to exaggeration of one strategy. Thus, it is important to describe possible dimensions of interventions so that organizations can choose between a set of positive combinations of strategic choices.

211. Source: Raub/Romhardt 1998, 154.

5.2.3 Generic knowledge management strategies

Even though many authors have stressed the importance of a solid link between KM activities and an organization's strategy, there are few authors who actually propose a knowledge or knowledge management strategy. In the following, the rare approaches found in the literature will be briefly reviewed including their relationships to the strategic options.

One of the best known concepts for KM strategies is the duality proposed by Hansen, Nohria and Tierney (Hansen et al. 1999). They suggest that there are two different strategies which can be applied in the implementation of knowledge management in companies: the *codification strategy* and the *personalization strategy* (Hansen et al. 1999, 109). The codification strategy focuses on the documentation and institutionalization of (explicit) knowledge[212]. The personalization strategy supports the direct communication link between individual (human) experts and knowledge users. In the former strategy, KMS play the role of a kind of "container" for knowledge elements, in the latter the systems are used as "knowledge expert finders". The distinction between these two strategies which was derived from several case studies analyzed by Hansen et al. (Hansen et al. 1999) corresponds to the two "research streams" of knowledge management, one being an instrumental-technical one and the other one being a more human-oriented learning organization approach[213].

Six of the strategic options of a knowledge management strategy[214] can be combined with Hansen et al.'s distinction in personalization and codification strategy to form a multi-dimensional *knowledge management strategy hypercube*[215] (see Figure B-17).

As stated in the critical reflection of the link between business and knowledge management strategies[216], this approach rises a lot of unresolved questions. It is not clear how concrete KM initiatives could be positioned along the dimensions. As turned out in the expert interviews, KM activities target a combination of e.g., exploitation and exploration, codification as well as personalization, tacit and explicit, the technological as well as the organizational infrastructure and most certainly an unbounded use of knowledge sources. The KM strategy hypercube might not be suited to describe concrete KM strategies, apart from the basic distinction between a *conservative*, a *moderate* and an *aggressive knowledge strategy*[217]. The hypercube might rather be suited to show a *portfolio of knowledge management*

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212. See also Zack 1999a who defines a framework for the management of explicit knowledge and expertise.
213. See also section 4.1.4 - "Definition" on page 52.
214. See section 5.2.2 - "Strategic options" on page 120.
215. The strategic options "explicit-tacit knowledge" and "technological-organizational socio-technical focus" are the two main determinants of the distinction made by Hansen et al. Codification means targeting explicit knowledge with a more technological focus whereas personalization means targeting tacit knowledge with a more organizational focus.
216. See section 5.1.2 - "Knowledge (management) strategy" on page 104.
217. See section 5.2.2.2 - "Types of knowledge and organizational learning" on page 122.

initiatives, position them on a corporate level and link them in a general way to business strategy.

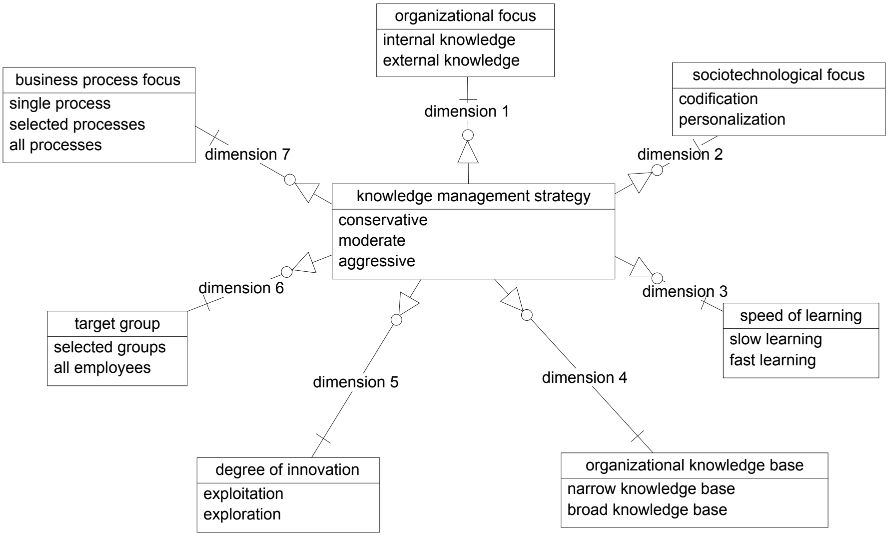

FIGURE B-17. The knowledge management strategy hypercube

Bierly and Chakrabarti investigated the knowledge strategies in the U.S. pharmaceutical industry in their empirical study (Bierly/Chakrabarti 1996). They used a set of four strategic options measured by five variables[218]. With the help of a cluster analysis they identified the following four groups of organizations (Bierly/ Chakrabarti 1996, 128f):

- *innovators*: these are the most aggressive learners who effectively combine internal and external learning,
- *loners*: are the ineffective (or isolated) learners. They are slow in applying new knowledge, have a narrow knowledge base and their external linkage is lower than that of all the others,
- *exploiters*: spend the lowest amount on R&D, have a broad knowledge base, a high level of external linkage and focus external rather than internal learning,
- *explorers*: put much emphasis on fast, radical learning. As compared to innovators, explorers spend less on R&D and have a lower focus on external learning.

218. See section 5.2.2 - “Strategic options” on page 120. The five variables were: R&D budget (internal learning), average number of patent citations to the scientific literature (external learning), technological distribution of the patents (narrow-broad organizational knowledge base), median age of the patents cited by a given organization’s patents (slow-fast learning) and the ratio of new chemical entities and approved new drug applications (exploitation-exploration).

A comparison of the financial performance of the four groups revealed a tendency for the innovators and explorers to be more profitable than the exploiters and the loners. However, from three five-year periods analyzed, the innovators were leading in two and the explorers were leading in one period. This suggests that different strategies might lead to the best results depending on environmental circumstances. Also, these tendencies might paint a valid picture of the pharmaceutical industry, but one has to be careful in taking these results to a different, say, less innovation-aggressive industry. Additionally, those organizations that remained in the same group for all three periods appeared to be more profitable than organizations that changed their strategies. Those organizations that became more aggressive learners were also very profitable, though.

However questionable the representativeness of these results is, the categorization shows that successful generic KM strategies seem to balance several strategic options and to decide on the more aggressive options in the dimensions where a decision is necessary.

Brown and Duguid suggest to look at KM strategies as enabling architectures for organizational knowledge (Brown/Duguid 1998, 103). They suggest to implement *social strategies* to promote the sharing and spreading of knowledge between communities. Basically, these social strategies comprise the institutionalization of organizational roles – translators and knowledge brokers[219] – and boundary objects (Brown/Duguid 1998, 103ff). The latter can be physical objects, technologies or techniques shared by communities. They support active empathy[220], because communities come to understand the perspectives of different communities. This in turn encourages reflection about practices of the own community and enables “second-loop” learning (Argyris/Schön 1978).

Apart from these generic KM strategies, many organizations might apply an “implicit” KM strategy. These organizations might articulate the purpose and nature of managing knowledge as a resource and embody KM activities in other initiatives and programs, e.g., embed it in other projects for organizational change. This “implicit” strategy reflects the lack of a clear agenda for KM. There are a lot of other management programs in organizations which can be used as a vehicle for KM activities. Examples are:

- *technology-oriented programs*: the development of an Intranet, the switch to a new office management or Groupware platform,
- *HRM-oriented programs*: the development of new training programs, recruitment programs, outplacement programs,
- *business-oriented programs*: BPR-projects, e.g., focusing the redesign of knowledge-intensive business processes, post-merger or post-acquisition integration programs, quality management programs.

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219. See section 6.1.2 - “Knowledge management roles” on page 162.
220. See section 6.4.2 - “Willingness to share knowledge” on page 223.

5.3 Success factors, barriers and risks

Goals and strategies show that implementing a KM strategy represents a comprehensive initiative, a fundamental intervention into one of the prime factors of organizational design and culture, namely the way an organization handles knowledge. From a management perspective, ensuring success of such an initiative requires the systematic consideration of success factors (section 5.3.1) and barriers (section 5.3.2) to KM. Section 5.3.3 takes a rather different perspective and introduces the concept of knowledge risk. Management of knowledge risks in section 5.3.4 studies the most important factors in governance of knowledge risks that avoid negative consequences resulting from either sharing knowledge too freely or from overprotection. Section 5.3.5 introduces an empirical study on this subject matter.

5.3.1 Success factors

This section briefly reviews factors influencing success of a KM initiative in general and the implementation of KMS in particular[221]:

Holistic, integrated and standardized approach. KM should not be interpreted as a one-sided technology, culture, coordination, leadership or reorganization problem. On the contrary, all these components as well as the relationships and interdependencies between them have to be considered in order to turn potentials into profits. Isolated solutions, e.g., different, incompatible communication systems, no standards, different knowledge processes, should be avoided. Rather, knowledge processes and ICT platforms for KM should be standardized throughout the organization and integrated with the existing business processes.

Knowledge-oriented culture. A supportive organizational culture is one of the most important factors for a successful KM initiative. An open and communicative atmosphere can thrust the sharing of knowledge, the identification, creation and acquisition of new knowledge by employees. KM initiatives have to take the organizational culture into account and have to support a knowledge-oriented culture through e.g., communication of success stories and best practices, through the acceptance of errors as well as through stressing that every employee is responsible for his or her own learning processes[222].

Management support. As in all efforts of organizational change, it is important that top management sets strategic knowledge goals, allocates sufficient budgets to the initiative and gives a good example for the change of behavior required to improve the handling of knowledge. A knowledge champion can act as a coordinator for management support as well as key speaker and motivator for the initiative.

221. See e.g., Skyrme/Amidon 1997, 33, Davenport/Prusak 1998, 292ff, Alex et al. 2000, 50ff, Holsapple/Joshi 2000, Wäschle 2001, 76ff.
222. See also section 6.4 - “Organizational culture” on page 221.

Clear economic benefits. The establishment of a “knowledge controlling” is required that coordinates goal setting (planning) and goal assessment, e.g., on the basis of the intellectual capital approach in order to show that a KM initiative really is worth the investment[223].

Exact vision and language. Terms such as knowledge, information, learning, knowledge base or organizational learning are subject to interpretation. A KM initiative should define these terms with respect to the organization’s knowledge-related goals so that the perspective on what is and what is not knowledge management is clearly communicable within the organization.

Effective aids for motivation. Incentive systems have to be installed that reward an improvement of the organizational knowledge base. This is especially true for immaterial incentives, such as additional training for effective knowledge providers or “elite” communities for the organization’s experts.

Appropriate process orientation. The integration of KM activities into the organization’s business processes is an important factor as an effective and efficient handling of knowledge requires it being part of the organization’s daily routine. However, Davenport/Prusak (1998) warn not to exaggerate the definition, description and standardization of knowledge processes as one might miss the essence of knowledge: the creativity that generates ideas and inventions.

ICT and organizational infrastructure. ICT can be the enabling factor in a KM initiative. There are also limits to its use and the installation of a good platform does not guarantee success. A good organizational infrastructure is regularly connected with a separate organizational unit or position that coordinates the initiative.

Stable knowledge structures. Knowledge structures (ontologies) are required to enable participants to search and navigate the abundance of (documented) organizational knowledge. Successful KM initiatives thus require a well-documented, stable knowledge structure. Knowledge itself is not stable, but dynamically evolves, though. Therefore, organizations have to allow a certain amount of flexibility in the evolution of their knowledge structures in order to avoid rigid and outdated knowledge structures.

Redundant channels for knowledge transfer. Knowledge is shared and distributed with the help of multiple channels, e.g., personal interaction in the cafeteria, telephone, email, newsgroups, bulletin boards, business TV, video conferences, documents. The transfer of redundant knowledge with the help of several channels supports the learning process. New communication channels introduced with KMS should not be seen as replacements for existing channels, but as aids to improve the effective and efficient use of the existing channels.

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223. See also chapter 8 - “Economics” on page 395.

Continuous participation of employees. As with the implementation of most organizational and ICT instruments, participation of employees helps that the solutions are well received by the employees so that motivation to cooperatively use the new ICT and organizational instruments is high. In the case of KM, several initiatives seem to show a pattern of "emergent" strategy where employees generate KM-related ideas, develop an initial solution (e.g., within a community that discusses KM) which in turn gets management attention and support.

The author coordinated a case study concerning success factors of KMS at *sd&m AG*, a software and system house based in Munich that is one of the pioneers in the application of KMS in Germany[224]. In a series of personal interviews with sd&m's knowledge manager as well as five selected participants of sd&m's KMS, those factors were elicited that were important for the successful implementation of KMS in the case of sd&m (see Table B-6).

TABLE B-6. Importance of success factors at sd&m

success factor	**importance[a]**	**description**
holistic, integrated and standardized approach	o	sd&m's KM initiative has a bias towards a technology-oriented perspective, though a knowledge-oriented culture and the organizational infrastructure are well established. This is not surprising as sd&m is a technology company. Leadership, economic or reorganization issues are underrepresented.
knowledge-oriented culture	+ +	Repeated surveys of employees[b] have shown that sd&m employees have an exceptionally positive attitude towards knowledge sharing. sd&m paid a lot of attention to its organizational culture when implementing its KMS.
management support	+	The board of executives has supported the KM initiative with a substantial budget for a separate organizational unit. Lower management levels (i.e., project managers) in most cases give a good example for the use of the KMS.
clear economic benefits	-	Economic success of the KM initiative is assessed on the basis of success stories, subjective assessments as part of regular surveys of employees and crude measures for KMS usage (e.g., number of accesses, actuality and extent to which skills profiles are voluntarily provided and maintained by employees). There is no systematic approach to determine the economic benefits quantitatively.

224. See Wäschle 2001, 47ff and 76ff, see also Box B-9 on page 396 where sd&m is described.

TABLE B-6. Importance of success factors at sd&m

success factor	**impor-tance**[a]	**description**
exact vision and language	++	sd&m devoted a lot of effort to set up a clear and communicable vision for its KM initiative and to define the terms used (e.g., knowledge, knowledge broker, skill). These are documented explicitly within the organization's KMS. The interviewees were committed to the vision and shared the language.
effective aids for motivation	- -	sd&m does not believe in incentive systems for KM. There are almost no explicit incentives that aid motivation for knowledge sharing which, according to the interviewees, do not play a role in knowledge-related behavior. sd&m's positive knowledge-oriented organizational culture rewards knowledge sharing, though.
appropriate process orientation	o	Knowledge processes are loosely coupled to sd&m's business processes (project management). KM is explicitly integrated in the kick-off and touch-down phases of the project processes. Apart from this simple integration, knowledge processes are neither described, nor communicated within the organization.
ICT and organizational infrastructure	++	The KM initiative is well supported by KMS that can be accessed by every employee. The organizational infrastructure is realized as a well-funded separate organizational unit that coordinates the KM initiative, maintains the KMS and monitors their usage and acts as knowledge broker.
stable knowledge structure	+	sd&m identified three stable core components of its knowledge structure: employees, projects and organizational units. Apart from this core structure, the ontology is decentralized so that all employees can flexibly extend the knowledge structure. The structure is centrally reviewed and reorganized regularly.
redundant channels for knowledge transfer	o	sd&m's skills data base supports locating experts and initiating communication between employees. Also, the sharing of codified knowledge is improved as knowledge brokers evaluate and refine documented knowledge. sd&m does not support additional channels, e.g., expert networks, communities, newsgroups.
continuos participation of employees	++	The idea for sd&m's KM initiative was created within a group of employees and immediately found support from management. sd&m employees have always shared in the development of the KM initiative through an organization-wide brainstorming process, workshops, regular surveys and personal participation.

a. Importance was subjectively assessed on the basis of a multi-item questionnaire as well as documentations of sd&m by the author and by Wäschle (2001, 88ff). A five-point scale was used extending from -- (very low importance) to ++ (very high importance).

b. The surveys were administered by a professional consultant specialized in employee surveys on the basis of an electronic questionnaire. Response rates were regularly above 90%.

5.3.2 Barriers

Successful KM initiatives also focus on lowering *barriers to knowledge management*. In addition to barriers negatively affecting individual learning, there are numerous barriers to an effective organizational learning and consequently to an effective KM. Due to space limitations, only the most important barriers can be listed here as well as some literature references for the interested reader[225]. Barriers to KM are due to the following characteristics of:

- *knowledge providers*: lack of motivation, provider not perceived as reliable, ignorance, lack of skills to explicate knowledge, skilled incompetence,
- *knowledge seekers*: lack of motivation, limited absorptive, processing and learning capacity, limited retentive capacity, lack of knowledge about what knowledge already exists in organization, conservative tendency to avoid innovative learning due to an orientation towards the individual history, role-constrained learning, superstitious learning,
- *transferred knowledge*: causal ambiguity, unproven knowledge, inadequate context, inadequate framing/problem representation, inadequate temporal context,
- *infrastructural context*: barren organizational context, e.g., inflexible power structures, lack of management support, vertical, horizontal and lateral information filters, specialization and centralization, lack of resources and time, lack of ICT support, problems with the use of ICT,
- *cultural context*: lack of social relationships between knowledge provider and recipients, group think, exaggerated unified culture and inward-orientation.

5.3.3 Knowledge risks

Knowledge intensity of activities, products and services has increased substantially over the last decades. Knowledge assets as a subset of organizational assets more and more form the basis of competitive advantages (Mentzas et al. 2003, 1). Organizations are increasingly dependent on intangible resources, particularly knowledge assets as primary sources of competitive advantage[226]. KM typically aims at increasing documentation and thus visibility of knowledge, specifically knowledge domains, sources, media, structure, processes and systems that support handling of knowledge. KM also helps to codify knowledge, eases access to knowledge and enhances knowledge sharing in order to improve (re-)use of knowledge assets[227]. However, this bears the risk that knowledge-based competitive advantages are diluted. A large number of KM activities, measures, instruments, processes and tools can be applied striving to improve productivity of knowledge work, but do not consider how knowledge can be secured (Desouza/Vanapalli 2005, 76).

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225. E.g., March/Olsen 1976, 56ff, Schüppel 1996, 107ff, Szulanski 1996, 30ff, Glazer 1998, 178ff, Alex et al. 2000, 50f, Astleitner/Schinagl 2000, 139ff.
226. See section 5.1.1 - "From market-based to knowledge-based view" on page 94, particularly Figure B-12 on page 99.
227. This is evident in the list of goals that KM initiatives direct their attention to which has been described in section 5.2.1 - "Strategic goals" on page 114.

This section defines the concept of knowledge risk. The concept employs an operational risk perspective that is focused on business processes and knowledge assets that are affected by knowledge risks. Moreover, a process for management of knowledge risks is defined in section 5.3.4. Section 5.3.5 then gives an outlook to an explorative empirical study in this increasingly important research field within KM.

Risk management has long been recognized as integral part of management, but companies have embraced this topic only recently as consequence of e.g., dynamic environments, networked IT-infrastructures, prominent bankruptcies and subsequent regulations like Sarbanes-Oxley-Act, EU's 8th Directive, Basel II, HIPAA or KonTraG. Despite the acknowledged importance of knowledge assets, predominantly market, credit and operational risks are targeted, whereas risks that affect knowledge assets, also called knowledge risks, are considered marginally at most.

From the perspective of strategic management, the knowledge-based view which has been developed on the basis of the resource-based view [228] stresses the importance of knowledge assets for competitive advantage. The term asset can be defined "as firm-specific resources that are indispensable to create value for firms" (Nonaka et al. 2000, 20). Tangible assets can be subdivided into physical assets like plants or machines as well as in financial assets, whereas intangible assets lack physical embodiment and include for example brands, reputation, licenses or skills[229]. Knowledge assets are considered as the subset of intangible assets (Teece 2002, 15) that is based on knowledge.

Knowledge can reside on different media[230] (see Figure B-18). The primary media knowledge resides on are employees who provide skills and experiences[231]. Knowledge can be embedded in organizational routines, procedures and structures[232]. Organizational capabilities bundle knowledge assets in order to contribute directly or indirectly to the creation of value (Grant 2001, 118). Knowledge can also be incorporated into objects which comprise different forms of intellectual property, e.g., patents, as well as products and services[233]. From the perspective of the knowledge-based view, IT infrastructures can also be seen as knowledge assets that support the incorporation of knowledge into products and services by helping to document, by administrating and by providing access to documented, codified knowledge (Marr et al. 2004, 562).

The term risk is discussed heterogeneously in management and economics and focuses either on its causes or its impacts. As one of the pioneers, Knight (1921, 231) defined risk as "measurable uncertainty" whereas in Gallati's view risk is "a condition in which exists a possibility of deviation from desired outcome that is

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228. See e.g., Wernerfelt 1984, Barney 1991, Grant 1991, 1996a, 1996b, Spender 1996a and section 5.1.1 - "From market-based to knowledge-based view" on page 94.
229. E.g., Barney 1991, 110f, Hall 1992, 136ff, Grant 2001, 111ff, Lev 2005, 300.
230. E.g., Nonaka et al. 2000, 20ff, Cummings/Teng 2003, 43f.
231. E.g., Mentzas et al. 2003, 27, Marr 2004, 4.
232. E.g., Matusik 2002, 465, Szulanski/Jensen 2004, 348.
233. E.g., Sullivan 1999, 133, Contractor 2000, 245, Lev 2005, 200.

expected or hoped for" (Gallati 2003, 8). Deviations can refer to targets, plans or results of a decision. Positive deviations are considered as opportunities and negative deviations are called threats or risks in a narrow sense (Hillson 2003, 17). Risks can be analyzed on a strategic or on an operational level. Compared to operational risks, strategic risks are characterized by long-term impact, more interacting variables, and higher degree of abstraction and are thus harder to identify, assess and manage. Risks on an operational level are focused on day-to-day business and can be defined as the "risk of loss resulting from inadequate or failed internal processes, people and systems or from external events" (Basel 2005, 140).

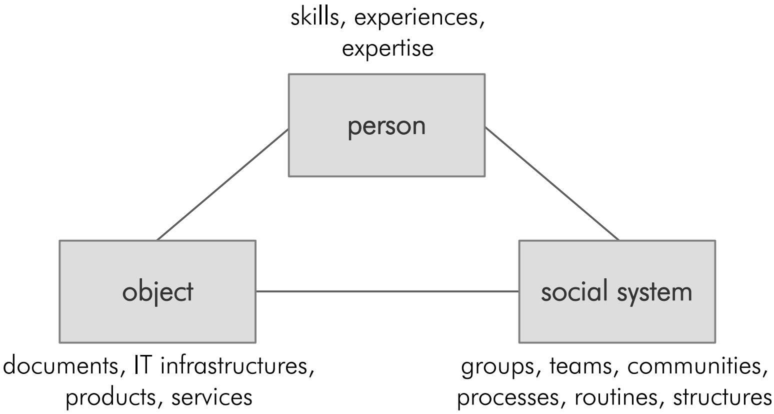

FIGURE B-18. Knowledge assets focussed in knowledge risk management

KM initiatives certainly should be regarded as strategic interventions. Thus, it is worthwhile thinking about (1) strategic risks involved in the organization's (core) competencies and strategic knowledge assets as well as (2) strategic risks involved in the KM initiatives and the planned measures, instruments and systems themselves. However, it is difficult to identify, assess and control strategic knowledge assets the reason of which lies in their intangible nature. Consequently, the challenges of corresponding risk assessments are even higher compared to the already substantial challenges involved in strategic risk management focussed on tangible or financial assets. Thus, in the following the focus is on operational risks involved in the handling of knowledge being well aware that an organization's strategy ultimately should include aspects of strategic management of knowledge risks. Knowledge risks as a subset of operational risks are consequently focused on the operational business processes and defined as in Box B-4.

Knowledge assets as the medium knowledge resides on are the targets that are affected by knowledge risks. This means that knowledge risks can concern knowledge bound to persons, knowledge incorporated in objects or social systems[234].

234. See Figure B-18 on page 138.

This definition stresses both, the causes and the effects of knowledge risks. The five causes dependency, limited quality, insufficient transfer, loss and diffusion lead to the two effects lack or non-exclusivity of knowledge assets. A lack negatively affects designing, planning, monitoring, continuously improving and, in the perspective of operational risks, primarily execution of business processes. From a strategic and specifically a resource-based perspective, exclusivity of resources is a necessary condition for competitive advantages (Jordan/Lowe 2004, 243). The causes of knowledge risks are briefly discussed in the following together with some examples.

> Knowledge risks are a subset of operational risks, i.e. risks of loss resulting from inadequate or failed internal processes, people and systems or from external events, that are caused by (1) a dependency on, (2) a limited quality, (3) insufficient transfer, (4) loss or (5) diffusion of knowledge assets and result in a lack or non-exclusivity of these assets.

BOX B-4. **Definition of knowledge risks**[235]

1. *Dependency* on knowledge assets can result in a lack of these assets during the execution of business processes that can be characterized as shortage or non-availability. Dependencies can for example concern key employees or key skills of these employees as well as services of an alliance or outsourcing partner. Also, problems with IT infrastructures that administrate documented knowledge, e.g., insufficient availability, inconsistency or data loss can lead to a lack.
2. *Limited quality* of knowledge assets can be assessed according to the four aspects content, i.e. e.g., correctness or timeliness of knowledge, the community in which knowledge is created and used, the development and deployment processes that provide the knowledge as well as the quality of the IT infrastructures used to provide access to documented knowledge or meta-knowledge about the knowledge sources[236]. Consequently, limited correctness, low applicability of knowledge or restricted accessibility of the supporting IT infrastructure can result in a lack of knowledge assets during execution of business processes.
3. *Insufficient knowledge transfer* in this case primarily refers to processes in which organizations attempt to get access to external knowledge that they can not create internally for reasons of time or cost which is an important means to extend the organizational knowledge base[237]. This is especially the case in knowledge cooperations. The very reasons for their establishment are to overcome specific knowledge problems and to develop new, applicable knowledge by a combination and integration of existing, possibly secured knowledge or by joint knowledge development[238] which therefore requires uninhibited knowl-

235. Also Probst/Knaese 1998, 27, Lindstaedt et al. 2004, 2, Basel 2005, 140.
236. See section 7.2.5 - “Quality of contents” on page 299, also Eppler 2003, 68.
237. Baughn et al. 1997, 103; Teece 2000, 138.

edge transfer between the partner organizations. An attempt to transfer knowledge that cannot be carried out sufficiently supposedly can be caused by too rigid rules for knowledge transfer, also called overprotection, but also by vague rules. The latter leave employees hesitant about freely sharing knowledge because they are not aware what is expected from them and what would be considered an act against the interests of the organization. This can result in a lack of the required knowledge assets.

4. *Loss* of knowledge assets is unrecoverable and also leads to a lack at the level of operational business processes. Examples are fluctuation of employees with unique knowledge, skills, social networks or experiences to other jobs within the organization (intra-fluctuation), to other organizations (inter-fluctuation) or due to their retirement (extra-fluctuation), non-documentation of knowledge, deletion of documented knowledge or malfunctioning of IT infrastructures including backup services[239].
5. *Diffusion* means access to sensitive or competitive knowledge by non-authorized persons. Contrary to knowledge loss, diffusion means that knowledge is still available, but not exclusively to the organization. Some authors stress this risk and the possibly resulting dilution of competitive advantages, especially in inter-organizational settings as strategic alliances, clusters, joint ventures, (virtual) networks and professional communities[240]. Examples for knowledge diffusion risks are access to unauthorized persons, social or reverse engineering, loss or theft of unsecured, especially mobile devices with replicated documented knowledge or unsecured access to IT infrastructures.

Causes are not isolated from each other, but can also interact. For example, fluctuation of employees on the one hand leads to knowledge loss for processes, routines and practices in which the employees participated. On the other hand, fluctuation bears risks that knowledge diffuses and its exclusivity is lost by re-applying firm-specific knowledge at a competing organization (Matusik/Hill 1998, 687).

5.3.4 Management of knowledge risks

Risk management typically comprises identification, assessment, control and evaluation as core processes or basic steps[241] that are executed in a life cycle that targets and revolves around the main media of knowledge assets (see Figure B-19).

Identification. The starting point for the knowledge risk management process is the identification of knowledge risks that can use different sources such as review of contracts, policies and their compliance, penetration tests for IT systems or analysis of dependencies on different knowledge assets.

238. Badaracco 1991, Doz/Hamel 1998, Aulinger 1999, Moser 2002, Maier/Trögl 2005.
239. Matusik/Hill 1998, 687, Desouza/Awazu 2006, 37, Mohamed et al. 2006, 3.
240. Hamel et al. 1989, Hamel 1991, Bleeke/Ernst 1993, Lei 1993, Das/Teng 1999, Davies 2001.
241. Archbold 2005, 32, Williams et al. 2006, 70.

Assessment. Identified knowledge risks have to be assessed concerning their probability and severity of the resulting losses. This assessment has to be based on the value of the knowledge assets and also interactions between knowledge assets have to be considered. However, the valuation of knowledge assets is still in its infancy and consequently the assessment of knowledge risks is still challenging[242].

Control. Governance measures have to be selected to control knowledge risks. Governance means the set of processes and policies affecting the way handling of knowledge is directed, administered or controlled (Zyngier et al. 2006, 3). Examples are using intellectual property rights, measures to reduce dependencies, retention planning for leaving employees, organizational conception of access rights and their technical implementation and maintenance as well as insurance policies.

Evaluation. Finally, treatment of knowledge risks is an ongoing process since risks, probabilities, severity as well as the efficiency of governance measures change over time.

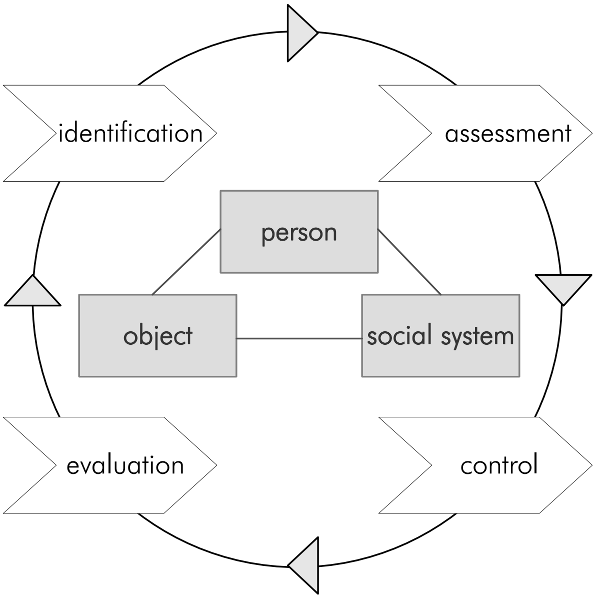

FIGURE B-19. Knowledge risk management process

Due to its importance, the control step is illustrated in the following with the help of the example of governance of knowledge transfer, particularly showing the trade-off that has to be made between intentional and unintentional knowledge transfer (Bayer/Maier 2006).

242. See chapter 8 - "Economics" on page 395.

Knowledge transfer can be classified into organization-internal and -external transfer. From a risk perspective, external knowledge transfer is of primary interest and is initiated intentionally or unintentionally by the source, happens by chance or is initiated on purpose by the recipient (Kogut/Zander 1992, 384, Teece 2000, 134). Success of the transfer can be determined e.g., by the extent to which the source's knowledge is recreated at the recipient's end (Cummings/Teng 2003, 41).

Intention refers to the macro-level and is considered as the intention of the organization. However, knowledge transfer can also be intended by an individual employee as sender on the micro-level, but not by the organization. Such conflicts can be the consequence of e.g., lack of awareness concerning the value of transferred knowledge or employees' opportunistic behavior.

Risks concerning knowledge transfer in (knowledge) cooperations are primarily focused on the level of operative business processes since particularly middle managers and engineers interact in day-to-day business with their counterparts (Baughn et al. 1997, 104). Intended and balanced reciprocal knowledge transfer is conducive to stability of alliances (Escribá-Esteve/Urra-Urbieta 2002, 340f).

The risk of insufficient or imbalanced intended as well as unintended knowledge transfer[243] in alliances depends on a number of characteristics that can be structured into (1) source and recipient, (2) transferred knowledge and (3) context in which knowledge transfer occurs (see Figure B-20).

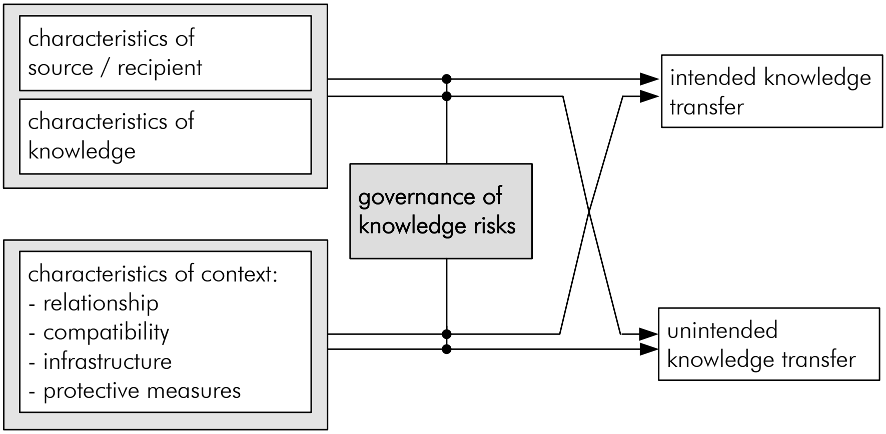

FIGURE B-20. Characteristics influencing knowledge transfer[244]

(1) *Characteristics of source and recipient* include e.g., the source's capability to explicate knowledge, the source's reliability, the receiver's absorptive capacity,

243. For the empirical study which is briefly sketched out in section 5.3.5 - "Empirical study: KnowRisk" on page 146, unintended knowledge transfer was reconceptualized as knowledge diffusion.
244. Source: Bayer/Maier 2006.

i.e. acquisition, assimilation, transformation and exploitation of knowledge, as well as the motivation of both partners[245]. High values of these characteristics positively influence both, intended and unintended knowledge transfer.

(2) *Characteristics of knowledge* comprise e.g., its ambiguity, specificity, complexity, dependency on other knowledge and tacitness[246]. The more these characteristics apply to the transferred knowledge, the more difficult it is to realize a successful replication at the recipient's side. This means that risk of unintended knowledge transfer decreases and risk of insufficient intended knowledge transfer increases with these characteristics.

(3) *Characteristics of the context* in which knowledge transfer occurs can be subdivided into the four categories relationship, compatibility, infrastructure and protective measures. These are focussed by governance measures since they are subject to influences by organizational routines and practices whereas the other characteristics are either domain- and knowledge-specific or are dependent on the involved individuals which cannot be directly influenced. For each of the four categories, factors influencing knowledge transfer that have been found in the literature are discussed. The factors are structured according to their impact on intended versus unintended knowledge transfer and to what consequences they bear for setting up governance rules in Table B-7 and are emphasized in Italic in the text.

TABLE B-7. Potential effects of factors influencing knowledge transfer risks

factor	**intended knowledge transfer**	**unintended knowledge transfer**	**governance of knowledge risk**
joint negative influence			
organizational distance	-	-	< / !
cultural distance	-	-	< / !
knowledge distance	-	-	< / !
joint positive influence			
physical closeness	+	+	> / !
collaborative use of information systems	+	+	> / !
number of channels for interaction	+	+	> / !
boundary spanners	+	+	> / !
negative-positive influence			
competition	-	+	<

245. Lei 1993, 36, Szulanski 1996, 31, Zahra/George 2002, 189f.
246. Matusik/Hill 1998, 687, Simonin 1999, 598ff.

TABLE B-7. Potential effects of factors influencing knowledge transfer risks

factor	**intended knowledge transfer**	**unintended knowledge transfer**	**governance of knowledge risk**
intent to outlearn	-	+	<
opportunistic behavior	-	+	<
trust	+	-	>
negative-indifferent influence			
transfer policies	+/-	-	!
information security policies	+/-	-	!
inter-organizational agreements	+/-	-	!
gatekeepers	+/-	-	!
intellectual property rights	+/-	-	!

Relationship. The simultaneous occurrence of cooperation and competition in an alliance has been described as co-opetition[247]. Thus, the partnership is influenced by the level of *competition*, i.e. by similarity of the business line, overlapping products and customers as well as the partners' learning intents that can range from mere access to internalization of knowledge[248]. Partners differ how aggressively they want to realize these intents and behave eventually opportunistically with an *intent to "outlearn"* the partner[249]. *Opportunistic behavior* presumes as preconditions possession of privileged information, opportunity and motive (Davies 2001, 45ff). The importance of reputation in the considered industry reduces the risk of opportunistic behavior of the partner by limiting opportunity (Gulati et al. 2000, 209).

Relational capital or *trust* is built over a long period of time and positively influences willingness to share knowledge[250] and mutuality of the transfer. If trust exists, one can expect that transferred knowledge is not exploited by the partner (Kale et al. 2000, 222). Low competition, low intents to outlearn and high level of trust positively influence intended knowledge transfer and reduce the probability of exploitation of unintended knowledge transfer.

Compatibility. Differences between e.g., institutions, business practices and organizational culture cause *organizational distance*[251]. *Cultural distance*, i.e. cultural differences concerning language, cultural norms or practices, is particularly relevant for international alliances[252]. *Knowledge distance*, i.e. differences of the part-

247. Brandenburger/Nalebuff 1998, 11-39, Dowling/Lechner 1998.
248. Hamel 1991, 90f, Baughn et al. 1997, 106, Mohr/Sengupta 2002, 291ff.
249. Hamel et al. 1989, 134, Lei 1993, 36.
250. See section 6.4.2 - "Willingness to share knowledge" on page 223.
251. Simonin 1999, 603, Szulanski et al. 2003, 144f.

ners' knowledge bases influence expected success of knowledge transfer by hindering re-contextualization[253]. The more similar the partners, the easier knowledge can be transferred.

Infrastructure. *Physical closeness* of partners can be the result of e.g., geographical proximity of facilities, joint production or rotation of employees. This positively affects knowledge transfer by increasing probability of face-to-face meetings, observability and transparency[254]. *Collaborative use of information systems* can support intended knowledge transfer, but can also be accompanied by lack of access control and other security risks that increase the probability of unintended knowledge transfer (Schmaltz et al. 2004, 3f). Subject to defined security requirements, organizations can control risks e.g., by substituting systems or enhancing the security level of systems that do not comply with the requirements. The *number of channels for interaction* increases knowledge transfer, but reduces control and thus increases probability of unintended knowledge transfer (Hamel et al. 1989, 136). Finally, boundary objects, i.e. physical objects, technologies or techniques shared by communities, and *boundary spanners* as organizational roles can improve knowledge transfer by promoting development of shared understanding[255].

Protective measures. *Transfer policies* materialize intentions of organizations and determine which knowledge can be handed on to partners. For example, classification mitigates unintended knowledge transfer while over-classification hinders intended knowledge transfer[256]. This solves the problem that employees retain knowledge that should be transferred or transfer it too generously since they do not know whether knowledge may, should or even must be transferred or not. *Information security policies* determine what behavior is expected from employees when using enterprise assets and what unwanted effects noncompliance can cause (Peltier 2005, 39). *Inter-organizational agreements* determine e.g., in which areas knowledge is transferred and how transfer occurs (Loebbecke et al. 1999, 20). Such agreements can also regulate to what extent knowledge can be used beyond the alliance. The latter prevents the risk of knowledge spillovers since knowledge could be transferred by a multi-stage process to direct competitors (Erickson/Rothberg 2005, 11). *Gatekeepers* as organizational roles can control external knowledge transfer and reduce the probability of unintended knowledge transfer[257], but can also negatively affect intended knowledge transfer. Finally, *intellectual property rights* can limit use of transferred knowledge beyond the alliance, whereas these rights are still only fragmentary compared to property rights for tangible assets[258].

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252. Simonin 1999, 602, Lane et al. 2001, 1143f.
253. Hamel 1991, 91, Cummings/Teng 2003, 46f.
254. Loebbecke et al. 1999, 35ff, Cummings/Teng 2003, 46.
255. Awazu 2004, 18f.
256. Hamel et al. 1989, 138, Desouza/Vanapalli 2005, 80.
257. Hamel et al. 1989, 136, Awazu 2004, 19.

Table B-7 summarizes these influences. The symbol (+) means that the factor is positively correlated with probability of successful re-contextualization, frequency and mutuality of intended knowledge transfer or probability and frequency of unintended knowledge transfer respectively. The symbol (-) represents the opposite. The symbol (+/-) means that it is undetermined how the factors affect knowledge transfer. Each factor is assigned to one of four categories according to the directions of the influences. The last column shows implications for setting up governance rules for managing knowledge risks. The symbol (>) suggests to strengthen the corresponding factor whereas the symbol (<) suggests the opposite. In the case of the symbol (!) the factors require weighing and corrective measures must be taken because it is undetermined what consequences increasing or decreasing the factors would have.

The expected influences of the factors suggest varying strategies for setting governance rules for knowledge risks. However, rules that reduce risks of unintended knowledge transfer rarely simultaneously enhance intended knowledge transfer. Thus, organizations have to weigh potential gains of external knowledge transfer with potential losses and select their measures accordingly. Generally, organizations supposedly either risk low intended and unintended knowledge transfer by limiting transfer too much or risk depreciating knowledge assets by transferring too generously. In order to avoid erosion of the market position, knowledge assets have to be restricted in a balanced way.

Heuristics are needed concerning rules governing knowledge risks. While compiling this book, the author leads an empirical study described in the following section 5.3.5 on the basis of which an instrument can be developed that helps organizations to assess, weigh and prioritize factors influencing knowledge risks and select appropriate measures of governance.

5.3.5 Empirical study: KnowRisk

Due to the fact that the management of knowledge risks has not been widely recognized, the concept is currently empirically investigated. This section reports on the preliminary findings of the study[259]. Governance refers to processes of control or regulation in companies and can be interpreted as the implementation of an authority (Zyngier et al. 2006, 3). Governance of knowledge risks[260] is an emerging field of research that according to several discussions with managers of knowledge management or risk management units is institutionalized in organizations only weakly so far. Governance comprises organizational, technical and legal measures.

Organizational measures include e.g, designing physical access control, deploying policies for IT security, or limiting dependencies on key employees. Technical measures concern e.g., designing electronic access rights as well as their provision-

258. Teece 2002, 16ff, Lev 2005, 301.
259. The empirical study is part of a research project led by the author and supported by the German Research Foundation (DFG). First results have been published in Bayer/Maier 2006.
260. See also section 5.3.4 - “Management of knowledge risks” on page 140.

ing. Next to the use of intellectual property rights, legal measures comprise e.g., the use of non-disclosure or non-compete agreements in work contracts or the use of alliance agreements in inter-organizational arrangements.

Consequently, an explorative research design is used to analyze the relationships between governance of knowledge risks on the one hand and the concepts knowledge quality, knowledge transfer, knowledge diffusion and knowledge loss on the other hand. Based on the literature, the following hypotheses are investigated in the empirical study[261] (see Figure B-21).

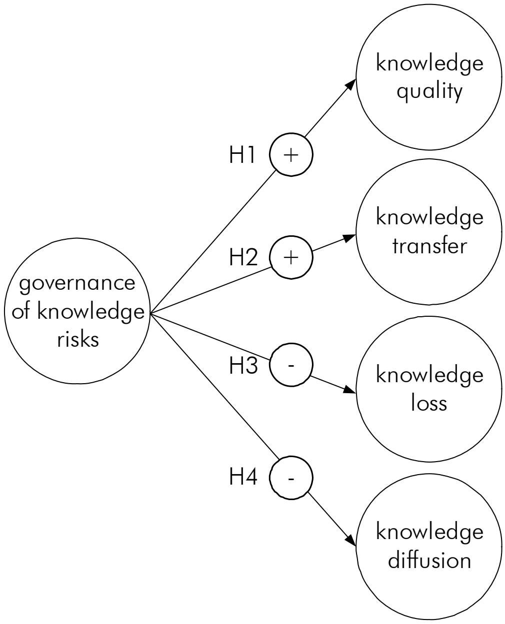

FIGURE B-21. Hypotheses for management of knowledge risks

Hypothesis H1. Governance of knowledge risks positively affects knowledge quality.

Knowledge quality is a broad concept that comprises (1) content, i.e. e.g., correctness or timeliness of knowledge, (2) community in which knowledge is created and used, (3) processes that provide knowledge as well as (4) IT infrastructures used to support access to documented knowledge or meta-knowledge about the knowledge sources[262]. In order to measure knowledge quality, exemplary variables

261. The empirical study extends beyond publication of this book and will be written up in a separate article. Interested readers should refer to http://iwi.uibk.ac.at/maier/kms/ about details on the publication. These hypotheses thus are not part of the original empirical study on KMS in the TOP 500 companies and TOP 50 banks and insurance companies in Germany that is reported in PART C - "State of Practice" on page 437.
262. See section 7.2.5 - "Quality of contents" on page 299, also Eppler 2003, 68.

such as accessibility of IT infrastructures, applicability or correctness of documented knowledge are included[263]. It is assumed that governance of knowledge risks positively affects knowledge quality, since companies are sensitized for the importance of knowledge assets and aim at reducing shortcomings concerning the various dimensions of knowledge quality by deploying appropriate measures.

Hypothesis H2. Governance of knowledge risks positively affects knowledge transfer.

In addition to motives such as economies of scale or access to markets, interorganizational cooperations, particularly knowledge cooperations[264], are means to get access to external knowledge that organizations can not create internally for reasons of time or cost[265]. Success of knowledge transfer can be determined e.g., by the extent to which the source's knowledge is recreated at the recipient's end (Cummings/Teng 2003, 41). Consequently, the concept of knowledge transfer is measured by variables such as contribution of transferred knowledge to other projects, tasks or processes, extension of the knowledge base or reduction of the dependency or reliance on partner knowledge[266]. It is assumed that companies without clear governance rules are rather restrictive concerning knowledge transfer. Employees might hold back knowledge, if they are in doubt whether it may, should, must or must not be transferred. Clear rules which are part of governance measures would increase certainty about which knowledge can be transferred and thus boost intended knowledge transfer while inhibiting knowledge diffusion[267].

Hypothesis H3. Governance of knowledge risks negatively affects knowledge loss.

Knowledge loss is non-recoverable and concerns knowledge assets that are bound to people or are incorporated in objects. Also, a lack of documenting knowledge may result in knowledge loss. The concept of knowledge loss can be measured by variables such as non-documentation of knowledge in day-to-day business or in projects as well as the degree of losses caused by job succession or substitution[268]. It is expected that governance measures negatively affect probability and exposure of knowledge losses by rules concerning e.g., email and document retention planning, documentation and reduction of dependencies.

Hypothesis H4. Governance of knowledge risks negatively affects knowledge diffusion.

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263. Kahn et al. 2002, 187, Eppler 2003, 74.
264. Also Badaracco 1991, Doz/Hamel 1998, Aulinger 1999, Moser 2002, Maier/Trögl 2005.
265. Baughn et al. 1997, 103, Teece 2000, 138.
266. Wathne et al. 1996, 75, Simonin 1999, 621.
267. See also section 5.3.4 - “Management of knowledge risks” on page 140, see “Hypothesis H4” on page 148.
268. van den Brink 2001, 66, Schindler/Eppler 2003, 221ff, Desouza/Vanapalli 2005, 84.

Knowledge diffusion means unintended access to sensitive knowledge by unauthorized persons. Unlike knowledge loss, diffused knowledge is still present, but not exclusively at the original organization. Knowledge diffusion reduces the value of the knowledge due to loosing its exclusivity. The concept of knowledge diffusion can be measured by variables such as access by unauthorized persons, unfavorable employee fluctuation or reverse engineering activities by competitors[269]. It is assumed that probability and exposure of knowledge diffusion is reduced by the deployment of governance measures such as access control, non-disclosure agreements or alliance agreements.

These hypotheses are subject to a broad explorative empirical study. Based on a population of 3.2 million German enterprises[270], the study targets about 130 German organizations that were selected on the basis of a stratified random sample. The stratification of the sample is based on the two criteria industry and number of employees. The study covered all industries because there has been no evidence of differences between industries in terms of management of knowledge risks prior to this empirical study[271]. The study targets organizations with more than 50 employees since relevance of knowledge risks assumedly increases with the number of employees. However, also some companies with fewer than 50 employees are included in this study in order to check this assumption.

Structured questionnaires were sent out to contact persons of the target group that were identified by telephone. The questionnaire should be filled out by chief executive officer, chief security officer, chief knowledge officer or the head of public relations. Based on the results of the broad study, ten companies will be contacted a second time for an in-depth study with personal face-to-face interviews and multiple feedback rounds. These attempt to identify which governance measures are most appropriate to govern what types of knowledge risks.

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269. Zander/Kogut 1995, 88f, Norman 2004, 612, Desouza/Vanapalli 2005, 81f.
270. According to the German Federal Bureau of Statistics (Statistisches Bundesamt), source: URL: http://www.destatis.de/.
271. Zack (2003) also backs this assumption of no influence between industry sector and importance of knowledge which is plausible due to the observation that knowledge assets are of increasing importance to all industries. However, one could also assume that high-tech industries are more aware of the competitive value of knowledge assets and thus are at the forefront of applying corresponding measures to manage knowledge risks. If this is the case, one should find correlations between the ordinal value of an industry along a scale from low tech to high tech on the one hand and the extent to which corresponding organizations employ measures to govern knowledge risks on the other hand. Concerning technology intensity, an index was developed by OECD. The index is based on R&D intensity measured by R&D expenditure in relation to output and indirect R&D expenditure that is caused by transfer of technology or R&D-intensive goods between industries. This conceptualization of R&D intensity is the basis for a classification of industries in high-tech, medium-high tech, medium-low tech and low-tech industries (Hatzichronoglou 1997).

5.4 Résumé

The state of the art of KM goals and strategies can be described as follows: there are already a large number of KM initiatives in organizations under way. There are quite a few authors who went to the trouble of distilling those KM activities which are used most frequently in organizations. As KM is a broadly defined concept, it is not surprising that many organizations combine projects with a more traditional focus, such as business process reengineering, quality management or customer relationship management and activities that in some way or the other have to do with the handling of knowledge and are supposed to deliver business value. KM in practice seems to be an effort that comprises a set of diverse activities, measures and technologies. Unfortunately, it seems that up to now organizations do not pay much attention to the strategic value of their initiatives. What is missing is a clear definition of generic KM strategies or, alternatively, dimensions of strategies (strategic options) that can be used to characterize one particular KM strategy.

Thus, one suggestion might be that organizations should aim at all KM goals at the same time and implement the strategic activities altogether. However, as a KM initiative will always face budget limitations, this potentially ideal situation might not be feasible. Moreover, even though most abstract KM activities[272] seem to complement each other, some instruments might also be conflicting. One example is a centralized approach with specialized knowledge brokers drawn together in competence centers in order to develop a central organizational knowledge base and a decentralized approach with emerging knowledge networks.

As a consequence, it seems that so far the relationships between KM goals and strategies[273] have not been well understood, neither in theory nor in practice. Thus, it is likely that organizations implement many KM activities at the same time hoping that some of them might trigger a substantial improvement of the way the organization handles knowledge. The following hypothesis can be formulated:

Hypothesis 7: The majority of organizations strongly aim at more than half of the KM goals (>7 goals) at the same time.

Organizations aiming at many goals at the same time would suggest a general KM strategy. The lack of emphasis could, however, limit the orientation provided for KM instruments leaving KM staff unsure what exactly the initiative should be about.

Due to time and space restrictions in the questionnaire, not every aspect of strategy could be questioned. Strategic KM goals and business goals were directly asked in the questionnaire. KM activities will be accounted for in the organization part (chapter 6) and the systems part (chapter 7). Due to the fact that KM strategies up to now have not been well defined neither in the literature nor in the empirical studies, it seems best to try to elicit different KM strategies by looking at scenarios of KMS implementations. This will require to consider a bundle of facts together,

272. See section 5.2.2.5 - "Strategic knowledge management activities" on page 125.
273. i.e., which relationships are complementary and which ones are rather conflicting.

such as goals, tasks, roles and processes, culture, contents and systems, and to take into account the results of the interviews and projects which will be done in part D.

One of the best known analysis of KM strategies suggests to distinguish between a personalization and codification strategy (Hansen et al. 1999). These two strategies were linked to the human-oriented and technology-oriented approach of KM and will be used later[274]. To sum up, the following dimensions will be directly measured in the empirical study:

Knowledge management goals. Respondents will be asked for their estimations to what extent their KM initiative aims at the following list of goals and to what extent these goals are actually achieved:

- transparency of knowledge,
- improve documentation of knowledge,
- change culture,
- improve communication and cooperation,
- turn implicit into explicit knowledge (externalization),
- improve education, training and networking of newly recruited employees,
- improve personnel development,
- improve retention of knowledge,
- improve access to existing knowledge,
- improve acquisition of external knowledge,
- improve distribution of knowledge,
- improve management of innovations,
- reduce costs,
- sell knowledge.

Business goals. This dimension assesses the contribution of the KM initiative to the achievement of business goals. Respondents will be asked to estimate the overall support of business goals as well as the support of the following list of business goals:

- reduce costs,
- improve productivity,
- improve speed of innovation,
- develop new business fields or topics,
- reduce business risks,
- improve employee satisfaction and motivation,
- improve growth of the organization,
- improve product quality,
- improve customer satisfaction and/or service quality,

274. See also chapter 9 - “Summary and Critical Reflection” on page 434.

- improve scheduling, reduce throughput/running time, improve meeting of deadlines.

Level of the management of knowledge management goals. The level of management of KM goals will be assessed with the help of two questions asking for the documentation of KM goals and for the methods applied to evaluate the achievement of KM goals.

Knowledge management strategies are implemented with the help of a combined set of organizational and ICT instruments. These will be described in the following two chapters.

6 Organization

As shown earlier, a KM strategy describing the strategic intent of a KM initiative has to be implemented with the help of organizational instruments. This section is devoted to the organizational design of a KM initiative. Figure B-22 proposes a model of the tasks and flows in knowledge management. The model builds on the concepts and theories depicted in section 4.1.1 - "From organizational learning to knowledge management" on page 22. In particular concepts and approaches from the following research fields were integrated within the model:

Organizational psychology and organizational sociology. These fields suggest that the group (in its general sense of a collective of people) is the single most important entity processing information in organizations (especially Hartwick et al. 1982, Wegner 1986). The idea of a transactive memory system (TMS, Wegner 1986) has found its way into the model in numerous respects. TMS are a brilliant way to explain the effect of inter-subjective knowledge, its linking and embedding on the information processing in a group as well as of each of the participating individuals.

Life cycle of information production. Levitan's (1982) life cycle of information production which was extended by Rehäuser/Krcmar (1996) as well as Matsuda's (1992, 1993) process of organizational intelligence was used to embed the organizational learning cycle in a bigger environment starting with the perception of information in an organization's environment until the communication and dissemination of new information resources.

Life cycle of knowledge tasks, functions or processes. A number of authors see KM as a life cycle or a set of knowledge tasks, functions or processes. Goal of knowledge management is to improve these knowledge tasks with the help of systematic interventions, instruments or measures[275]. However, most of these approaches only list the knowledge tasks, but do not describe how they are related to each other. This important aspect is covered in the model by the integration of concepts of organizational learning.

Organizational learning theories. Organizational learning is at the core of the model. Nonaka's (1994, 20) spiral model was integrated into the organizational learning cycle, which also reflects the organizational learning cycle found by Müller-Stewens/Pautzke (1991). The concepts used in Argyris/Schön's (1978) theory are assigned to the two fields *institutionalized knowledge* (espoused theories) and *knowledge-in-use* (theories-in-use). Research into organizational learning has made clear that only a small portion of the organizational learning processes can be formally organized (by some authors referred to as the "tip of the iceberg")

275. See also sections 4.1.4 - "Definition" on page 52 and 6.3.1 - "Knowledge management tasks" on page 207.

whereas a great portion of organizational learning is a rather informal process for which organizations can only create an environment conducive for this process.

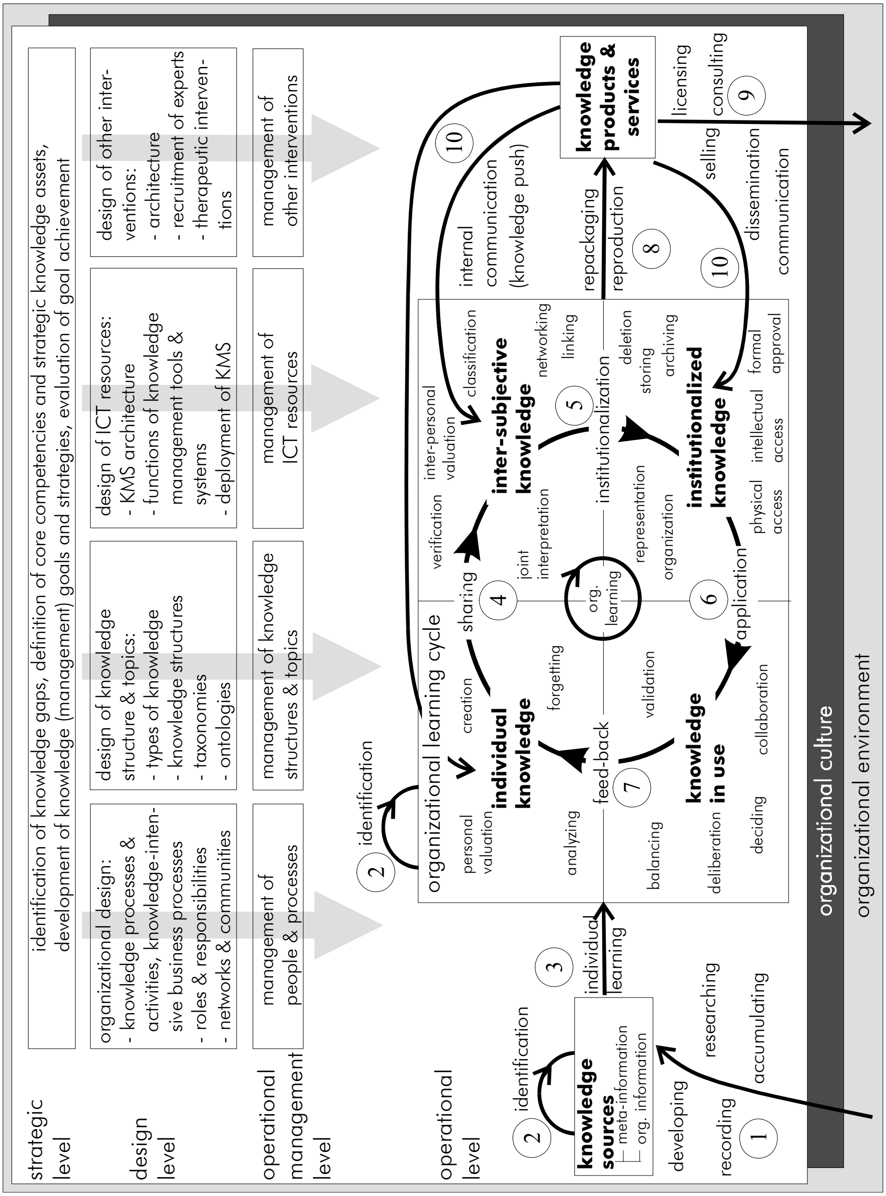

FIGURE B-22. Model of the tasks and flows in knowledge management

The organizational learning cycle consequently is not only used to classify and relate the knowledge tasks proposed in the various KM approaches. It is also used to show that, as opposed to *knowledge sources* and *knowledge products and services* (see Figure B-22), the organizational learning cycle cannot be systematically organized. However, an increased understanding of these processes might help organizations to create formal processes which help to speed up the "spinning of the organizational learning wheel" meaning that individual knowledge is applied, shared, institutionalized, reused and developed quicker and by a broader "knowledge community" than before.

Knowledge management systems. Last but not least, the market for KMS was studied in order to make sure that the model is complete with respect to the handling of KMS supporting knowledge tasks and processes[276].

Due to the variety of the fields that were integrated, the resulting model presented in Figure B-22 is highly complex. As shown in section 4.1 - "Knowledge management" on page 21, the research interests, objects and questions in the fields and disciplines that form the roots of KM are quite diverse. Thus, the model should be seen as a *boundary object* between the fields and disciplines guiding the discussion of the theoretical and empirical investigation (see also part C). In the following, the model will be described in detail, and is used as a guide for this chapter and also provides anchors to the other chapters of part B.

Generally, the model starts on the strategic level with a KM strategy. This strategy is in turn designed and implemented to create a supportive environment for the knowledge tasks and flows on the operational level.

Strategic level. Starting point is the identification of knowledge gaps or knowledge-related problems in an organization. A strategic KM initiative can also analyze the (core) competencies and strategic knowledge assets of an organization before strategic knowledge (management) goals are defined and corresponding knowledge (management) strategies are developed that aim at achieving these goals or at developing, improving or applying (core) competencies[277].

Design level. On the design level, interventions can be basically divided into four distinct areas: design and implementation of *(1) organizational and people-oriented instruments*[278], *(2) knowledge structure & topics*[279], *(3) ICT resources*[280] and *(4) other interventions*[281]. Generally, the design of a KM initiative can be supported by modeling methods and techniques[282]. The resulting models that describe the four groups of instruments form the *mediators* between knowledge goals on the

276. See Maier/Klosa 1999c and chapter 7 - "Systems" on page 273; see also e.g., Ruggles 1997, 5ff and 77ff, Borghoff/Pareschi 1998, especially 5ff.
277. See chapter 5 - "Strategy" on page 93.
278. See sections 6.1, 6.2 and 6.3.
279. See sections 7.2 - "Contents" on page 281 and 7.7 - "Semantic integration" on page 374.
280. See section 7 - "Systems" on page 273.
281. See section 6.5.
282. See section 6.6.

strategic level and knowledge tasks and flows on the operational level which are to a large part informal in nature. Whereas the instruments might closely influence the process of selecting, organizing and handling *knowledge sources* and especially *knowledge products and services*, the core process—the *organizational learning cycle*—as well as the underlying *organizational culture*[283] cannot be designed directly. The instruments rather foster an environment conducive to a more effective organizational learning cycle.

Operational management level. On the operational management level, the effects of the implementation of the four groups of instruments are constantly evaluated based on the operative knowledge goals derived from the strategic knowledge goals: (1) management of people and processes, (2) management of knowledge structures and topics, (3) management of the ICT resources and related services as well as (4) management of other interventions[284].

Operational level. Knowledge-related flows in an organization begin and end in the *environment of the organization*. New knowledge flows can be triggered from outside the organization as well as from inside, especially when an organization closely cooperates with its partners. Due to the manyfold collaboration and knowledge exchange that crosses the organizational boundaries, direct participation of non-members in the organizational learning cycle is the rule. Examples are virtual enterprises, temporal support by consultants, strategic alliances, joint ventures, share in R&D-intensive organizations, projects or other forms of collaboration or cooperation with customers, suppliers and even competitors such as joint R&D, distribution or marketing (Picot/Reichwald 1994, 559ff). These examples show only the officially accredited forms of collaboration that cross organizational boundaries. There are many more unofficial and informal networks of people that span organizations and even industries and impact or even drive the organizational learning cycle.

Thus, the model focuses on knowledge flows and collective learning processes from the perspective of one organization, even though these flows and processes clearly do not and should not stop at the organizational boundary (which in many cases is not clearly identifiable anyhow).

The model uses three concepts in order to describe different stages of a "knowledge life cycle" in an organization which is interwoven with the organizational learning cycle. All three concepts together represent the organizational memory or the organizational knowledge base. First, there are *knowledge sources* which represent selected external data and organization-internal data recorded within the organization. These knowledge sources are the "raw material for the *organizational learning cycle*. *Knowledge products and services* in turn are disseminated to the environment and communicated within the organization (knowledge push).

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283. See section 6.4.
284. See chapter 8 - "Economics" on page 396.

These three concepts are connected with one another via knowledge flows. The *organizational culture*[285] plays a special role, because it acts as the basis for knowledge tasks and flows within an organization. Thus, the whole set of knowledge tasks and flows is on the one hand embedded in the organizational culture. On the other hand, KM initiatives also change the organizational culture, hopefully into a more open one where willingness to share knowledge and willingness to reuse knowledge and to learn from others is increased.

In the following, the three main concepts on the operational level will be studied before KM-oriented structural and process organization will be discussed in detail. The numbers in Figure B-22 refer to the main knowledge processes within an organization.

Knowledge sources. The organizational knowledge processing starts with the establishment of data in the organization, which is perceived by organizational agents (human or computer agents) from outside the organization, called *knowledge acquisition* (1) or from within the organization which is called *knowledge identification* (2). Knowledge identification not only encompasses the organization's knowledge sources (e.g., documents, data bases and data warehouses, reports, books, magazines, links to Web sites and on-line data bases) but also the knowledge that is created within the organizational learning cycle. Two kinds of knowledge sources can be distinguished: the knowledge elements themselves and meta-knowledge, information about knowledge elements, which can be accessed, if required, in the environment and provides context about the knowledge elements.

Organizational learning cycle. Via *individual learning* (3) the knowledge sources become part of the organizational learning cycle in which knowledge creation takes place. The knowledge created can be distinguished according to its state in the cycle into *individual knowledge* which is accessible by the organization, *shared knowledge* and *institutionalized knowledge* (Pautzke 1989, 79). The individual knowledge is analyzed and its value is determined by the individual. It can be verified and linked to other individuals' knowledge by communicating it. The *knowledge is shared* (4) and *inter-subjective knowledge* is created. A special form of inter-subjective knowledge processing takes place in networks and communities. Communities are thought of as an instrument well suited for joint interpretation and inter-personal valuation of individual knowledge (section 6.1.3).

A portion of the inter-subjective knowledge directly influences the individual's information processing and learning, especially valuation, analyzing and linking. This effect can be described by the concept of the *transactive memory system (TMS)*. A TMS denotes the collaboration of a number of individual memory systems and the communication between these in so-called transactive processes (Wegner 1986, 191ff, also Maier/Kunz 1997, 11ff). The TMS is built up gradually

285. See section 6.4.

by the members of a group or team and influences the individuals' information processing not only within the group, but also outside.

To be fully accessible and independent of individuals, knowledge has to be *institutionalized* (5). The *institutionalized knowledge* which Argyris and Schön also called "espoused theories" represents proclaimed, officially accredited or agreed ways of reacting to certain situations as opposed to *knowledge in use* (6) which denotes the rules and hypotheses which are actually *applied* ("theories-in-use", Argyris/Schön 1978, 11). The knowledge in use may or may not be compatible with *institutionalized knowledge*. Furthermore, the individual using this knowledge may or may not be aware of the incompatibility of the two (Argyris/Schön 1978, 11). The results of actions finally give *feed-back* (7). New individual knowledge is created.

Knowledge products and services. The knowledge created, shared, institutionalized and applied within the organizational learning cycle can be *refined and repackaged* (8) and thus used to create knowledge products and services. On the one hand, these products and services can be *communicated*, *sold*, e.g., in the form of *licensing* and *consulting*, and *disseminated* to the environment (9). On the other hand, knowledge products can be *communicated internally* as some kind of "official statements", a form of *knowledge push* and knowledge services can be offered to the organization's knowledge workers (10). Especially in large organizations, knowledge might be distilled, packaged and then communicated to all project teams or work groups that are engaged in similar areas. For example the professional services company Ernst & Young calls this form of knowledge products *power packs* (Ezingeard et al. 2000).

The organizational design consists of *structural organization* (section 6.1), *instruments* for systematic interventions into the way an organization handles knowledge (section 6.2) and *process organization* (section 6.3). Instruments of the structural organization comprise the establishment of a *separate organizational unit responsible for knowledge management* (section 6.1.1), of *KM-specific roles and responsibilities* (section 6.1.2) as well as the design of collective structures, e.g., *groups, teams and communities* (section 6.1.3). KM instruments are defined (section 6.2.1) and classified into *product-oriented* (section 6.2.2) and *process-oriented instruments* (section 6.2.3). Process organization consists of the definition and implementation of *KM tasks* (section 6.3.1) and *KM processes* (section 6.3.2).

6.1 Structural organization

Generally, traditional design alternatives of the organizational structure, such as the hierarchy[286], have long been criticized for their rigidity (bureaucracy) and for

286. The hierarchy is also called the line organization, structuring the organization according to e.g., functions, regions, products or customers, with its extension to include line and staff positions, see Kieser/Kubicek 1992, 67ff.

requiring the design of extensive communication and coordination processes in order to guarantee the free flow of information and knowledge between organizational units, especially in a dynamic, unstable competitive environment[287]. Multi-dimensional organizational structures were proposed as a solution to this problem. This form of the organizational design is also called the matrix organization and structures the organization with respect to two or more dimensions at the same time. Examples are functions and projects or functions and regions[288]. Recently, there have been numerous approaches for alternatives to the traditional organizational design that pay attention to the management of knowledge. Examples are[289]:

Infinitely flat organization. Ideally, an infinite number of equally ranking organizational units is grouped around a center which coordinates the activities, serves as a knowledge source, develops specific competencies and transfers best practices. Examples are franchising companies.

Inverted organization. The inverted organization turns the traditional organizational pyramid upside down. Core competencies as well as knowledge about customers resides in the leaves of the tree, not at the center of the organization (management). Knowledge is exchanged primarily informally, horizontally between the experts who are in contact with customers as well as formally, vertically with the "lower levels of the hierarchy", i.e., with management in order to develop an organizational knowledge base. Management primarily provides a logistic and administrative infrastructure for the experts. Examples are hospitals or professional services companies.

Hypertext organization[290]. In this perspective, the well-known metaphor of a hypertext document[291] is used to denote the synthesis of the traditional hierarchical organizational structure with non-hierarchical, self-organizing structures in order to combine efficiency and stability of the hierarchy with dynamism and flexibility of cross-functional task forces. The design of these two systems of activities should enable the organization to shift efficiently and effectively between these two forms of knowledge creation. While the hierarchical organization primarily performs *combination* and *internalization* of knowledge, the self-organizing teams perform

287. For a brief summary see e.g., Frese 1992, 1681, also Rehäuser/Krcmar 1996, 26.
288. There is a lot of literature on the matrix organization. The approach was developed in the 70s and was a popular approach receiving a lot of attention in the organization science literature in the 80s and early 90s, see e.g., Galbraith 1971, Reber/Strehl 1988, Scholz 1992, Schreyögg 1999, 176ff.
289. See e.g., Quinn 1992, 113ff, Nonaka 1994, 32f, Rehäuser/Krcmar 1996, 26ff, North 1998, 79ff, Schreyögg 1999, 194ff and 254ff.
290. The idea of the hypertext organization was developed by Nonaka, Konno, Tokuoka, and Kawamura and presented in the journal *Diamond Harvard Business* in 1992 in Japanese (Nonaka 1994, 32ff).
291. A hypertext document is a text document that contains hyperlinks. Hyperlinks are connectors to other documents with the help of cross-references to their URL that can be activated by a mouse-click (Horn 1999, 380, also Mertens et al. 1997, 191f).

socialization and *externalization* (Nonaka 1994, 33). The hypertext organization consists of three layers: the *knowledge-base layer* (organizational culture, procedures, documents, data bases), the *business system layer* (performs routine operation by traditional hierarchy) and the *project-system layer* (multiple self-organizing project teams form a hyper network across business systems). Examples can be found in the Japanese industry.

Starburst organization. These organizations permanently "generate" new business units or found new companies which in turn follow the same model. Important and complex competencies are in both, the core as well as the spin-offs. The spin-offs operate quite independently whereas the core plays the role of a knowledge holding. Examples are film studios or software companies which develop different markets and niches on the basis of a common set of software applications or technologies.

Spider's web organization. The spider's web is a metaphor for an ideal network of highly specialized organizational units, e.g., competence centers, regional units, projects or experts between which primarily informal communication and cooperation take place. Ideally, there is no center and knowledge is exclusively exchanged between the various knots. In specific situations (e.g., a new order, a project), knowledge is mobilized and thus typically the knots cooperate temporarily. Examples are financial services networks (e.g., MLP AG).

All of these organizational forms aim at accelerating organizational learning and thus the development, combination and use of organizational competencies. Once again ICT plays the role of an *enabler*, a catalyst for these new, highly decentralized organizational forms (North 1998, 79). In the following, the discussion is limited to the implementation of a separate organizational unit responsible for (certain tasks) of knowledge management, to specific roles and their responsibilities with respect to KM and to concepts of work groups, teams and particularly communities as specific forms of knowledge networks that play an important role in KM.

6.1.1 Separate knowledge management unit

One alternative to formally implement KM in an organization is to establish a *separate organizational unit* responsible for KM. The management of knowledge, the coordination of knowledge-related tasks and instruments as well as the administration, maintenance and updating of a knowledge-related organizational and technological infrastructure can be considered permanent tasks. Thus, many organizations establish a position, a group or even a department coordinating corporate KM initiatives. Examples are the CKM – Corporate Knowledge Management office at Siemens that coordinates the over 130 KM projects worked on by over 350 KM specialists throughout Siemens (Klementz 2000, 2), the CBK – Center for Business Knowledge at Ernst & Young (Ezingeard et al. 2000), the sTM – sd&m Technology Management at the software house sd&m (Trittmann/Brössler 2000) or the

KTD – Knowledge Transfer Department at Buckman Laboratories (Pan/Scarbrough 1998, 59).

In many cases, the KM unit will be an extension of an already existing organizational unit, such as document management or technology management. One of the concepts preceding a formal KM unit best represented in the literature is the *competence center* or *think tank* (Probst et al. 1998, 204, 207ff, 358, Roehl 2000, 180f). These are units that systematically bundle capabilities (experts, networks, documents etc.) within a targeted domain. A think tank identifies, develops, refines and develops experiences (lessons learned, best practices) for a certain topic, regularly a cross-functional and cross-disciplinary topic, e.g., “Eastern Europe” or “Energy” at the professional services company McKinsey (Probst et al. 1998, 208).

Apart from the permanent institutionalization of KM in a separate organizational unit, many organizations start a KM initiative with the help of a project. *KM projects* are concerned with e.g., the assessment of potentials of KM for an organization, the development of a KM vision, mission and goals, the design and implementation of an organizational and especially technological KM infrastructure, the promotion of KM-specific instruments, the definition of decentral KM roles etc.

Another form of organizational design for KM that requires even less of a permanent commitment to this approach is the establishment of a *KM committee* or a *KM community*[292]. In this case, a group of employees, regularly from different organizational units, e.g., from strategic development, various functional departments and the department of IT/organization, together develop a KM vision and promote the effort.

In many organizations, the structural organization of KM has developed in certain stages. KM had started out as a group of interested employees that informally defined a KM initiative which later was turned into one or more KM project(s). In many organizations, especially in large organizations, either one KM project was later switched into a permanent organizational unit or one unit was established to coordinate all the KM projects and activities throughout the organization.

The structural organization of the KM function will be studied with the help of the following list of design alternatives ordered from a formal, lasting approach to an informal, temporary approach:

- *separate organizational unit*: as a functional or service unit,
- *project*,
- *no separate organizational unit*: as a community or a committee.

It is expected that those organizations that institutionalize a separate organizational unit staff it with more employees and also invest more in KM[293] than those organizations that set up a KM project or have an entirely decentralized, informal approach with no separate organizational unit. Therefore, the following hypothesis will be tested:

292. See also section 6.1.3.3 - “Communities” on page 180.
293. Investment is measured in terms of non-salary expenses; see also section 8.1 - “Expenses and funding” on page 397.

Hypothesis 8: The more formal the organizational design of a knowledge management initiative, the higher are the expenses for knowledge management

The reasoning behind this hypothesis is that organizations that already had established a functional unit responsible for certain KM-related tasks such as information brokering preceding the KM unit, have already assigned employees to a unit and a defined budget and, therefore do not have to assign new ones. Moreover, the installation of a separate organizational unit for KM shows that this organization regards KM as a permanent task rather than a temporary one as in a project. Additionally, employees assuming KM roles in organizations with a decentral approach might not work exclusively for KM, so that some of them might not be counted as KM staff at all.

6.1.2 Knowledge management roles

The term knowledge always implies a relation to its application, a pragmatic connotation[294]. Consequently, KM cannot be centralized in an organization e.g., in analogy to the management of capital. The role of a centralized unit is only a coordinating and administrating one. Generally, the most important KM-related instruments have to be applied as close to where the knowledge is needed as possible, which is directly in the functional departments or projects. Thus, many organizations, especially the professional services companies, have established KM-related roles which are distributed throughout the organization. Figure B-23 gives an overview of KM roles which have been either suggested in the literature[295] or mentioned in the interviews as part of the empirical study (see part C).

In the top area of the figure the CKO (Chief Knowledge Officer, knowledge manager) is responsible for knowledge management leadership. He or she might share responsibility with knowledge partners and/or stakeholders from the business units which knowledge management serves. In the upper middle part of the figure there are specific KM roles that can be assigned in order to guarantee the efficient and effective performing of important KM tasks and processes. The KM diamond in the center of the figure denotes those four KM roles that act as a kind of exchange platform for knowledge in an organization, a knowledge hub. The left hand side of the knowledge diamond reflects the human-oriented, personalization perspective of KM whereas the right hand side reflects the technology-oriented, codification perspective.

The basis of the model is formed by the knowledge workers which participate in the KM initiative. From an IT point of view, these are called participants rather than users in order to stress their active role with respect to the ICT systems in place. Knowledge workers are more or less enthusiastic about knowledge management putting them somewhere on the dimension between the two poles knowledge

294. See also section 4.2 - “Knowledge” on page 60.
295. Examples can be found in Baubin/Wirtz 1996, Probst et al. 1998, Earl/Scott 1999, Bach 1999, 67.

sponsor and knowledge skeptic. Knowledge workers are grouped in work groups, teams and communities which have been identified as the most important unit of analysis and intervention in KM initiatives. That is why the collectives form the basis of the KM roles on which the whole KM initiative is founded.

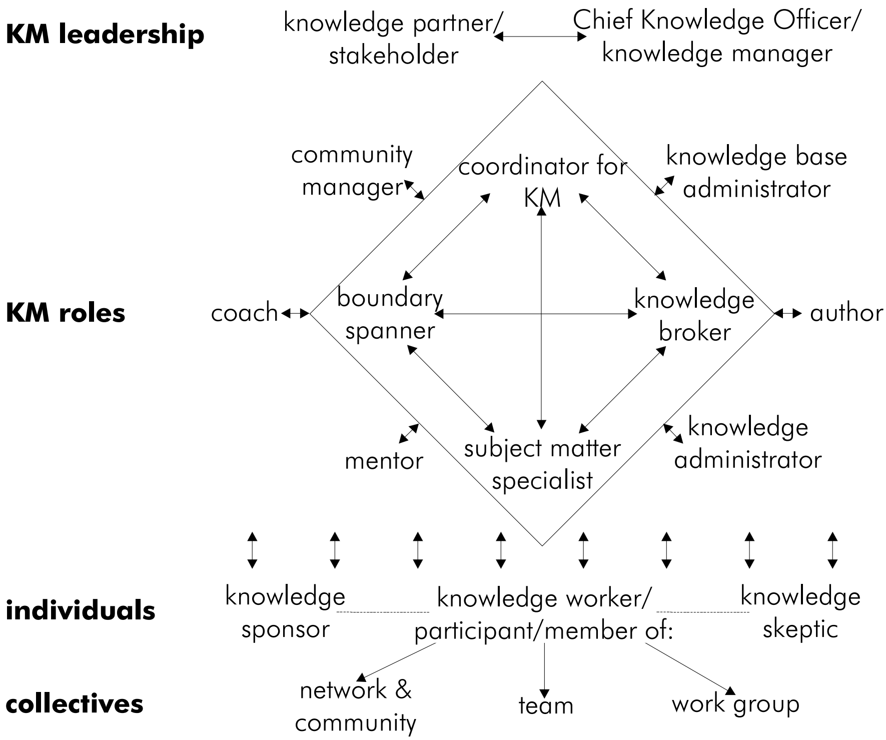

FIGURE B-23. Model of knowledge management roles and collectives

The KM roles depicted in Figure B-23 and the collectives are discussed in detail in the following.

6.1.2.1 Knowledge manager (CKO)

The highest ranked role in knowledge management is called the *chief knowledge officer* (CKO)[296], a term coined in analogy to other executive positions, such as the chief information officer (CIO). Other terms used to describe a similar role to the one held by a CKO are *knowledge manager* (McKeen/Staples 2003), *knowledge strategist* (Ruggles 1998, 86), *director intellectual capital* (e.g., Skandia), *director knowledge transfer* (e.g., Buckman Laboratories), *knowledge asset manager* or *intellectual asset manager* (e.g., Dow Chemical, Davenport/Prusak 1998, 224).

296. See e.g., Davenport/Prusak 1998, Guns 1998, Earl/Scott 1999, Bontis 2001.

The term CKO has been in use to denote the head of knowledge management for quite a while, even though in the beginning it was more connected to AI and expert systems and its relation to executives (Hertz 1988, 45ff). Today, in many organizations, the terms "CKO" and "knowledge manager" refer to the same position. However, especially in multinational professional services companies there are also examples where one CKO supervises several knowledge managers which are responsible for KM, e.g., in one particular business unit (e.g., Ezingeard et al. 2000, 811).

According to the interviews and the KM cases reported in the literature, the primary responsibilities of a Chief Knowledge Officer (CKO) are[297]:

- to build a knowledge culture, to raise awareness, to get commitment of business leaders and to motivate employees to share knowledge,
- to design a KM strategy aligned to the business strategy of the organization and to set the appropriate scope for knowledge initiatives,
- to launch knowledge-based products and services,
- to design, implement and oversee schemes and processes for knowledge codification and transfer,
- to lead a separate organizational unit which is designed to e.g., broker knowledge or to research and develop new knowledge,
- to establish new knowledge-related roles,
- to get a knowledge (best practice, experiences, skills) data base up and running,
- to oversee the concept, design, implementation and management of ICT supporting knowledge management, e.g., Intranet, knowledge repositories, data warehouses, Groupware etc.,
- to globalize knowledge management and thus coordinate several existing KM initiatives,
- to measure the value of intangible assets.

As an individual member of the organization, a CKO has to represent many of the positive connotations that KM approaches have. The CKO acts as a symbol and promoter for extensive knowledge sharing, a trustful organizational culture, the use of new methods in training and education for employees, teams, and communities, the application of KM-related ICT systems and last but not least the integration of KM-related measures into corporate accounting and leadership systems (see Bontis 2001, 31ff).

In practice, the CKO is often a highly educated, experienced organizational performer, previously mostly in managing line jobs, who has been with the current organization for quite some time and is attracted to the position because of its newness, the challenge, receiving intrinsic rewards and an understanding that knowledge management can make a visible change within the organization (McKeen/

297. See also Apostolou/Mentzas 1998, 13, Guns 1998, 316ff, Ezingeard et al. 2000, 811, Bontis 2001, 31ff, McKeen/Staples 2003, 32ff

Staples 2003, 38). The CKO role is somewhat unique in the executive board of an organization because the CKO directly reports to the CEO, but does not have budget, staff and entitlements that match his or her peers on the board, with no clear-cut description of the job, setting out to make a fundamental change to the organizational routines and culture with somewhat blurry mission, goals and evaluation criteria[298].

6.1.2.2 Subject matter specialist

A *subject matter specialist, subject matter expert, knowledge integrator* or *knowledge editor* or *person responsible for a field of competence* is an important role in knowledge management that is responsible for a multitude of tasks. Subject matter specialists have expertise in one particular area and serve as[299]:

- *gatekeeper of information and knowledge*: In this function, they formally approve contributions made by participants before they are entered into an organization's knowledge base.
- *quality assurer*: Subject matter specialists review documents, provide additional links, improve the document's quality in terms of readability, understandability, use of a common language etc.
- *expert in one or more topics*: In this function, a subject matter specialist might answer questions concerning his or her topic(s) if they remain unanswered within a certain amount of time.
- *linking pin to agencies and research institutions*: A subject matter specialist might be responsible for keeping track of new developments in his or her topic(s), periodically provide reports about the newest developments, etc.

6.1.2.3 Knowledge administrator

Knowledge administrators (e.g., Apostolou/Mentzas 1998, 13) are also called *knowledge engineers* or *knowledge editors*. As opposed to subject matter specialists who are responsible for one specific domain or topic, knowledge administrators are responsible to help authors capture, store and maintain knowledge independent of the domain in which they are working. If subject matter specialists are experts in the semantics and the contents, knowledge administrators are experts in the way knowledge elements have to be documented, linked, structured and organized. They help participants externalize and document their knowledge.

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298. These findings are based on an empirical study in which 41 knowledge managers were questioned mostly from the US and Canada (92%) representing a variety of sectors and industries. The majority of respondents were from organizations operating in the services sector (55%) or in both, the services and physical goods sectors (34%). With respect to industries, most respondents' organizations belonged to professional services (22%), financial services (19%), high technology/computers/telecommunications (19%), government (16%) and manufacturing (14%). About half of the organizations had more than 10,000 employees (48%), 21% had between 1,000 and 10,000 and 31% had up to 1,000 employees (McKeen/Staples 2003, 26f, 38).

299. See e.g., APQC 1996, 60f, Baubin/Wirtz 1996, 143, Probst et al. 1998, 362, Ruggles 1998, 86.

6.1.2.4 Knowledge base administrator

In analogy to data base administrators[300], knowledge base administrators are responsible for the development and maintenance of the technological infrastructure of KM, the knowledge management systems. At Accenture, there are three different roles responsible for the administration of their KMS Knowledge Xchange: knowledge base sponsors, knowledge base integrators and knowledge base developers (Baubin/Wirtz 1996, 143). The *knowledge base sponsor* develops policies, standards and procedures for the KMS and develops the KMS architecture. The *knowledge base integrator* provides overall coordination of structure and content for one knowledge base and ensures that security and ownership specifications are implemented. The *knowledge base developer* finally develops, supports and maintains the technical implementations of the knowledge base, ensures that it conforms with general IT standards (set forth by the CIO), executes and administers the security and ownership specifications and implements modifications to a knowledge base structure.

6.1.2.5 Knowledge broker

A *knowledge broker* is a person helping participants to locate the knowledge or experts needed (Ruggles 1998, 86). *Knowledge brokers* are also called *knowledge connectors*, *knowledge navigators*, *knowledge translators* and *knowledge stewards* (e.g., Skyrme/Amidon 1997, 33) or, in a more focused setting, *best practice sharing facilitators* (Klementz 2000, 2). Ernst & Young distinguishes between the following three levels of orders their knowledge brokers can get:

- *navigate*: to support people in navigating the organization-wide KMS,
- *research*: to collect documents and locate experts to a given topic by accessing the KMS,
- *analyze*: to create a formal report on a topic which includes valuing, summarizing and relating documents and experts found in the KMS.

The role of knowledge brokers might involve participation in several communities in order to broker knowledge from one community to another (Brown/Duguid 1998, 103). They argue that knowledge brokers work best in the context of overlapping communities. They call persons that "broker" knowledge between mutually exclusive communities "translators" (Brown/Duguid 1998, 103). A translator can frame the knowledge and interests of one community in terms of a different community's practice. In this respect, the knowledge broker also takes on the role of a *boundary spanner*[301]. Thus, knowledge broker is a key role in organizational knowledge management (see Delphi 1997, 22).

6.1.2.6 Boundary spanner

A *boundary spanner* has to network fields of competencies and broker contacts between experts in different fields needed to realize new business ideas (Probst et

300. See Maier et al. 2001 for a recent study on data management tasks.
301. See section 6.1.2.6 - "Boundary spanner" on page 166 below.

al. 1998, 363) or between communities (Schoen 2000, 118). This might involve e.g., the organization of theme-centered workshops the primary goal of which is networking experts from different fields of competencies, the identification, refinement and distribution of *boundary objects* between communities, expert networks and knowledge repositories. They are responsible for the development of an inter-functional and inter-disciplinary network of relationships and thus are contact persons for the brokering of contacts (Probst et al. 1998, 363) both, within and outside the organization.

6.1.2.7 Knowledge sponsor

Knowledge sponsors and *knowledge champions* are people who are excited about the idea of knowledge management, commit themselves to this effort and want to help to make the effort a success without taking on a formal role or responsibility as KM staff.

A *knowledge sponsor* is a senior executive of the organization implementing knowledge management who identifies with the KM concepts, publicly shows enthusiasm about the project and is likely to invest in or support knowledge management projects (Earl/Scott 1999, 31, Schoen 2000, 119). The knowledge sponsor secures the budget for KM initiatives, networks with other knowledge sponsors and might even encourage employees to take on formal KM roles, e.g., subject matter specialists or knowledge integrators (Baubin/Wirtz 1996, 143). In the same category fall so-called *network chairs*, senior managers who facilitate the KM process (Ezingeard et al. 2000, 811). The term network chair points to the support that is expected from the sponsor which is to help knowledge workers to network.

6.1.2.8 Community or network manager

There are a number of roles that have been suggested with respect to (virtual) communities or networks of experts in organizations[302]. Examples are (Pór 1997, 2, Wenger 2000, 220, Henschel 2001, 59f, Kim 2001, 177):

- *greeter*: welcomes new members and introduces them to the community,
- *host/facilitator*: encourages and moderates discussions,
- *editor/cybrarian*: is responsible for topics and contents,
- *cop*: enforces the community rules,
- *teacher*: educates the members of the community,
- *recognized expert*: also called thought leader upholds and dispenses the community's knowledge,
- *event-coordinator*: plans and organizes events,
- *supporter*: answers questions about the system(s),
- *boundary spanner*: connects the community to other communities and acts as broker and translator,

302. For a definition and discussion of the concept of communities see 6.1.3.3 - "Communities" on page 180.

- *keeper of organizational ties*: maintains links with other organizational units, in particular the official hierarchy,
- *care-taker*: cultivates social relationships,
- *system administrator*: is responsible for hardware, software and security of the community server,
- *account administrator*: administrates accounts, privileges and authentication of the members of the community,
- *architect*: starts social relationships, develops social networks and optimizes the community structure considering the feedback.

Although these roles might be assigned to a number of members, it is likely that a small core group of approximately two to six members who initiated the community take on all of these roles so that each of the members of the core group is responsible for a number of roles. There are also several roles responsible for the management of the community which are distinguished in analogy to the roles defined for the management of business processes (Neumann et al. 2000, 275ff, Schoen 2000, 117ff):

Community/network owner. A community owner is a senior manager or even a member of the board of directors who is responsible for the communities. As communities per definition are not (directly) goal-oriented collectives of people, the role of the community owner is to *sponsor* the community, provide budgets and support for time, travel and technologies (e.g., storage capacity for community homespaces) and promote the community topic (also Raab et al. 2000, 244).

Community/network manager. This is regularly a role that is attributed to the originator of a community, sometimes split to a small group of people who initiated the community. This person or this core group is responsible for the functioning of the community, has the "last word" in the set up of policies and norms, e.g., about participation in the community, its organization, about themes and topics, the discussion style etc. Sometimes the community manager is supported by one or more *community assistant(s)* who e.g., answer questions about the community, its topics or the ICT used to support the community. A community manager coordinates the activities in a community, however, he or she is not responsible for all types of leadership that are necessary in a community, such as networking, facilitation, documentation, retention of expertise, learning, inquiry, management of boundaries or organizational ties[303].

Community/network moderator. A moderator supports discussions in communities, e.g., provides summaries about threads of discussions, links and organizes contributions or encourages contributions from experts outside the community. Often, community moderators are responsible for many communities so that they

303. See Wenger 2000, 220; see also the community roles distinguished above.

can cross-post contributions from one community to another one that might stimulate discussions elsewhere.

Within the group of the members of the community or network, *experts, active or key members* on the one hand and (passive) *members* on the other hand can be distinguished (Schoen 2000, 118). The key members are the organization's experts in the community's topic and thus are responsible for answering the questions which are posed by the members of the community (Raab et al. 2000, 245). This distinction, however, introduces a quasi-hierarchy in the community which can be counter-productive to the free flow of ideas.

The formal definition of roles with respect to communities changes the informal nature of these collectives of people and sometimes turns communities into official networks of experts. These might even get tasks assigned which temporally changes them into a team. However, members of a team might stick together after the team assignment was finished as a community showing once again that the boundaries between teams and communities are vague.

6.1.2.9 Mentor

Mentors are persons responsible for the development of new talent and for instilling their own tacit knowledge in new employees through a kind of "informal apprenticeship" (Leonard/Sensiper 1998, 127). *Mentoring* is based on the Greek mythology (Kram 1988, 2) and can be defined as a deliberate pairing of a more skilled or experienced person with a lesser skilled or experienced one, with the agreed-upon goal of having the lesser skilled person grow and develop specific competencies (Murray/Owen 1991, xiv). Generally, relationships between younger and older adults that contribute to career development are also called *sponsor, patron* or *godfather* relationships (Kram 1988, 3). Mentoring can be an interesting addition to other human resource development programs and are valuable for both, the mentor and the mentee (Antal 1993, 453).

In Japan, this kind of relationship has got a long tradition as the *sempai-kohai principle* (e.g., Probst et al. 1998, 299). Every newly recruited employee in Japanese organizations, the younger so-called kohai, is assigned to a mentor, an older, teaching sempai. Many Western organizations (and also universities!) have taken over this principle that is used to reduce the time needed for the young recruited to take over all the tricks and know-how from the older employees (for case studies see e.g., Antal 1993). Mentoring functions can be divided into *career functions*, such as sponsorship, exposure, visibility, coaching, protection and challenging assignments, as well as *psychosocial functions*, such as role modeling, acceptance-and-confirmation, counseling and friendship, which enhance sense of competence, identity and effectiveness in a professional role (Kram 1988, 22ff).

Mentoring also faces major obstacles, e.g., due to an organizational culture that is not supportive, work design or incentive and reward systems (Kram 1988, 160ff). The complexity of cross-gender and/or cross-cultural mentoring relationships requires special attention (Kram 1988, 105ff, Murrell et al. 1999). International mentoring might play an active role in developing cross-cultural competencies in international networks, e.g., in multi-national organizations (Antal 1993, 453ff).

6.1.2.10 Coach

A different form of a paired relationship is *coaching*. The coach, an internal or external consultant specially trained in psychology, interacts with a member of the organization in order to improve the performance or motivation of the latter (Staehle 1991, 874f). Coaching is a form of consulting in between psychotherapy (therapeutic interventions) and training and often extends beyond work-related aspects to a more holistic "consulting for living" (e.g., Roehl 2000, 202f), but nevertheless can be a useful instrument to remove or at least make visible knowledge barriers that can be attributed to (negative relationships between) individual employees.

6.1.2.11 Knowledge skeptic

A knowledge skeptic is a person hostile to knowledge management in general and/or the implementation of a knowledge management effort in particular. As many knowledge management efforts need a "critical mass" of participants who buy in the idea and on the other hand knowledge skeptics might jeopardize the success of the efforts, it is important to identify doubters in order to convince them so that they participate in or at least do not oppose the effort.

6.1.2.12 Coordinator for knowledge management

Many organizations might employ their formal organizational structure and assign responsibility to their—line and project—managers or one particular employee within each organizational unit in order to roll out KM initiatives. Thus, a *coordinator for knowledge management* is assigned responsibility to coordinate the implementation of KM within one particular organizational unit. Typical responsibilities are:

- to ensure that knowledge processes are carried out within their area of responsibility and
- to oversee that the knowledge created within their unit is harnessed and spread across organizational units.

Typical organizational units that might be assigned responsibility for KM are a business or service process, a functional unit or a project. For example, Ernst & Young appoints one professional per larger assignment (= contract between Ernst & Young and a customer) as the assignment knowledge manager who is responsible for the knowledge process and the capturing of knowledge generated in the assignment (Ezingeard et al. 2000, 811).

6.1.2.13 Knowledge worker and participant

As mentioned before[304], *knowledge work* requires that knowledge is continuously revised, considered permanently improvable, not as truth, but as a resource (Willke

304. See chapter 1 - "Motivation" on page 1.

1998, 21). As opposed to traditional professional work, the expertise required for knowledge work is not basically acquired during one single and long-lasting learning period, but has to be constantly revised, extended, reflected and adapted. Knowledge workers require a distinctly different management style than more traditional professions: little direction and supervision, instead more protection and support by “covert leadership” (Mintzberg 1999). Knowledge workers are the primary target group for a KM initiative.

Generally, *participants* are all persons that are affected by KM initiatives. Participants are distinguished from *users* with respect to the application of KMS because of their active involvement into the functioning of KMS. Thus, participants actively play roles such as knowledge creators, developers, integrators, providers or authors, as active members of work groups, teams or communities, contributors in newsgroups, commentators, refiners and evaluators of organization-internal and -external knowledge elements, knowledge brokers and distributors etc.

Knowledge workers as well as participants can be classified according to their *level of expertise*. Many authors in the realm of knowledge management differentiate between *knowledge providers* and *knowledge seekers* or *knowers* and *not knowers*[305]. As most of them do not refer to a theoretical basis, it remains unclear according to what criteria a participant could be selected as “knowing” versus “not knowing”. It is also unclear to what extent the classification of “knowing” is topic- and context-dependent, especially concerning the granularity of such classifications. Moreover, a mere two-fold distinction seems to be too crude to guide KM activities.

Thus, in the following five levels of expertise are distinguished which are based on a model on the development of expertise well-received in the literature (Dreyfus/Dreyfus 1986, 16ff). The model describes the development of expertise as applied to unstructured situations for which there is no set of facts and factors which fully determine the problem, the possible actions and the goal of the activity (e.g., patient care, business forecasts, social interactions). It stresses the importance of implicit knowledge for expert problem solving. The central hypothesis is that in the step-wise course of becoming an expert thinking is reorganized qualitatively which means that expert knowledge is organized differently from explicit knowledge about facts and rules. Thus, teaching means to subsequently lead the learning person from an analytic via a planning to an intuitive way of problem solving. A central concept is “power of judgement” as a holistic way of pattern recognition which is highly adapted to contexts. Thus, the qualitative adaptation of the person’s organization of knowledge means a replacement of knowledge about facts and rules with a (large) number of practical cases which are used as patterns to intuitively judge the adequate actions required in a specific situation. The five steps are briefly described in the following (Dreyfus/Dreyfus 1986, 19ff):

305. See e.g., Glazer 1999, 177ff for a model to measure the knowing subject, the knower.

1. **Novice:**

   When novices observe an expert they are overwhelmed by the complexity of a situation so that they are not able to imitate an expert. In the first stage of learning, novices are provided with non-situational or context-free *attributes* and *rules*. These do not reflect the total situation, they ignore the total context and they do not require the novice to understand the total structure of the situation. The novice analyzes a situation by spotting single attributes and selects actions according to the rules remembered. The attributes are not implicitly integrated, but explicitly focused and summed up.

2. **Advanced beginner:**

   The advanced beginner has extensive practical experience in the domain. Thus, he or she can use more context-free attributes in his or her judgement of the situation and uses more complex rules to determine actions. The most important difference to the novice's problem solving is the use of so-called *aspects*. These are situational or context-specific attributes that the advanced beginner has encountered in a greater number of "similar" practical cases. The selection of actions is now not only based on context-free rules, but also on context-specific *guidelines*. However, the problem solving can still be characterized as not integrated as there is no conscious examination of configurations of attributes. The single attributes and aspects are considered as being of equal value and the advanced beginner should take into account as many attributes and aspects as possible. The number of attributes and aspects increase to a point where the learner is confronted with an overwhelming number of elements to be considered.

3. **Competent:**

   Central skill differentiating competent from the two levels before is the potential to analyze a situation with the help of a perspective. The person is able to plan consciously and thoughtfully. *Goals* and *plans* increase the complexity of the analysis, but reduce the complexity of the situation because not all attributes and aspects have to be considered anymore. Conscious, analytical problem solving is maximized on this level of expertise. Actions are selected with the help of a *perspective* which the actor decides on. As a consequence of the subjective selection of a plan, he or she will feel responsible for his or her actions (emotional involvement). This is different from the two levels before as actions were taken by strictly applying rules and guidelines and unwanted results could be attributed to inadequate rules or guidelines. Learning is supported by the analysis of situational case studies which require the selection of a perspective and the decisions derived by the application of the corresponding rules and guidelines.

4. **Skillful master:**

   The central new skill in this stage is the ability to perceive situations as a whole as opposed to observing single attributes and aspects of a situation. This means holistic recognition of similarities of current situations with situations the master encountered before. The master has a "mental library" of *typical situations* perceived using a specific perspective. New situations are perceived from a specific perspective without consciously selecting it. Relative importance of attributes and aspects in the problem domain is not analyzed consciously anymore. The situation rather presents itself accentuated to the master, he or she intuitively expects which situations could follow the current situation. Actions are still selected consciously on the basis of *maxims*. These maxims are heuristic principles that relate a certain action to a configuration of attributes and aspects. The master consciously selects those actions with a proven record of success in the type of situation. Summing up, the master perceives the problem character of a situation and the general direction in which he or she has to act without conscious efforts. The detailed planning of actions is still a conscious effort.

5. **Expert:**

At this stage, every specific situation that the expert encounters will automatically trigger the *intuitively appropriate action(s)*. Experts not only store perspective-based types of situations but associations of types of situations with corresponding actions. Situations are grouped in a way so that they require the same decisions and actions. They are stored in such a number that they cannot be verbally described. Thus, the expert does not process atomic facts logically, but perceives holistic similarities between the current situation and situations encountered before without having to take into account isolated single elements. Strategic planning does not occur anymore at stage 5. The expert can handle situation after situation without strategic planning in a way that can be described as "goal-oriented without conscious goal-setting". The experts' knowledge is best analyzed with the help of story-telling. The expert should report critical situations holistically together with the context in which they occurred, the subjective assessments of the situations and the actions taken.

Table B-8 shows the five levels of the model with those elements of problem-solving highlighted which determine the central shifts between the stages.

TABLE B-8. Model of the acquisition of expertise[a]

skill level	components	perspective	decision	commitment
1. novice	context-free	none	analytical	detached
2. advanced beginner	*context-free and situational*	none	analytical	detached
3. competent	context-free and situational	*chosen*	analytical	detached understanding and deciding; *involved in outcome*.
4. proficient/ skillful master	context-free and situational	*experienced*	analytical	*involved understanding*; detached deciding
5. expert	context-free and situational	experienced	*intuitive*	*involved*

a. According to Dreyfus/Dreyfus (1986, 50)

Experts differ from novices substantially with respect to problem-solving (Mietzel 2001, 277ff). Experts not only have more profound area-specific knowledge but also apply so-called schemes to analyze situations which allow them to consider more information about a problem quicker than novices. Experts are also quicker in deciding between relevant and irrelevant information than novices due to the automation of a large number of cognitive processes. This automation might also be disadvantageous, though, if experts experience difficulties to adapt to new problem settings or to accept new and revolutionary ideas or ways of problem solving. Experts spend more time to analyze the situation in difficult problem settings, are different from novices in their selection of problem solving strategies and are more able to control their cognitive processes than novices (Mietzel 2001, 278ff).

The application of this model and the consideration of the differences between experts and novices in particular has substantial consequences for the design of KMS. This is especially true for KMS functions such as *personalization*, system-supported *recommendations* and *collaboration*. Novices not only require a different presentation of knowledge elements than experts which means that personalization of KMS should not only reflect a participant's role, but also his or her skill level with respect to the topic (dynamic, context-dependent personalization).

The various skill levels also suggest that in some cases novices who search the KMS for information on whom they could ask personally for help might need support by intermediates—participants just one or two skill levels above their own, not experts who would require much more effort to reflect their decisions so that novices could learn from them. KMS in that case should present knowledge elements developed by intermediates as well as links to intermediates rather than experts.

Experts on the other hand might be best "teachers" for knowledge workers at the skill level *proficient* and possibly *competent*. Accordingly, tutorials and peer-to-peer learning deserves much more attention than the single-minded focus on experts teaching and answering questions of the rest of the employees. Also, communities might be designed with skill levels in mind. Some communities might intend to bring together people with skill levels not to far from each other so that perspective, decision and commitment are not too different. Other communities might intend to bridge the various skill levels and focus a topic independent of the experiences a person has made up to that point.

6.1.2.14 Knowledge partner and stakeholder

As knowledge management is a cross-functional effort, the KM team needs *partners* or allies in the implementation of such an effort. Earl and Scott identify HR professionals and IS executives as the main partners of CKOs in their survey of 20 CKOs in the US (Earl/Scott 1999, 32).

Stakeholders are those individuals, groups and networks of individuals in the environment of an organization who influence the organization's operations directly or might influence them in the future. In the ILOI study, 11% of the organizations reported to systematically manage relationships to stakeholders in order to improve the handling of knowledge (ILOI 1997, 25, 27). Examples for stakeholders of KM are:

Functional departments. Functional departments are the primary customers in many KM initiatives. Participation of representatives of functional departments in design and implementation of KMS is considered crucial as a positive attitude towards the KM initiative, a supportive organizational culture, is the most important success factor for KM[306].

Business partners. In a time when organizations more and more integrate their value chains with suppliers, wholesalers and retailers to provide better services to customers, these business partners supposedly hold extensive knowledge which is of interest to the organization. Thus, business partners may also become knowledge partners that jointly innovate and develop ideas for products and services.

Senior management. Senior management has to support the KM initiative not only with sufficient funding but also by giving a good example, by "living knowledge management" and by acting as knowledge champions coordinating KM-related issues throughout the organization and eventually by helping to reduce cross-functional KM barriers.

Human resource management. Personnel training and education remains an important promoter for organizational learning. Many authors suggest that an apprentice watching a skillful master is the best way to transfer implicit knowledge. However, only 45.5% of the organizations surveyed by the APQC considered themselves as effectively using apprenticing for knowledge sharing whereas 22.7% said they were ineffective in this respect. Apprenticing in fact was the least effective instrument for knowledge sharing as perceived by these organizations[307]. The more e-learning and KM grow together, the more learning will be decentralized and traditional personnel training and education will be integrated in the organization's KM initiative.

IT department. The organization's IT unit is responsible for the organization's ICT infrastructure and thus also for the implementation of ICT to support the KM initiative, the KM platforms and KMS. Even though KM units and the CKO are usually separated from the IT department, they have to work closely together in order to develop an integrated ICT solution that supports the intended organizational instruments to improve an organization's way of handling knowledge.

Data management. Data management handles a substantial portion of the infrastructure on which KMS are built. Data management is responsible for the quantitative portion of the enterprise knowledge base. Data-related tasks, such as data warehousing, data analysis, management of interfaces or data management for the

306. See section 5.3 - "Success factors, barriers and risks" on page 132.
307. See APQC 1996, 58; see also section 10.1.1 - "APQC" on page 439.

Web (Maier et al. 2001) are closely connected to the technical administration of KMS.

Public relations. This group handles the organization's official communication to stakeholders and the public, e.g., the organization's Web presence. Thus, the KMS appearance—and access to contents—has to be coordinated with the official communication (e.g., the organization's corporate identity). Public relations also often maintains a large network of experts in all kinds of fields potentially relevant for knowledge-related tasks.

Research and development. R&D as well as technology and innovation management are often the core groups in an organization that apply KM instruments and technologies first. They handle the bulk of organizational innovation. On the one hand, they are a major knowledge provider for the rest of the organization, but on the other hand they also need to be connected to the knowledge flows generated in the operative business processes. A KM initiative has to consider the R&D processes and KMS have to be integrated with the ICT systems that are used by this organizational unit.

Universities and research institutions. Universities and (partly state-funded) research institutions are important external sources for innovations, ideas, prototypes and concepts that might be turned into successful products and services, but also for new ground-breaking theories and approaches that might substantially influence organizations. Thus, universities can be important knowledge partners for organizations and many cooperations between universities and private organizations have already proven successful. However, in the Fraunhofer study cooperations with universities were ranked last of a list of instruments used for knowledge acquisition (Bullinger et al. 1997, 24). Thus, it seems that there is potential for universities to play significantly enhanced roles in knowledge management. Some examples are:

- *moderation of communities*: Universities might provide a platform for the exchange of ideas, moderate discussions and networking of experts in the field, periodically distill trend reports out of community interaction, evaluate and assess developments. Communities of innovation not necessarily have to be tied to traditional research disciplines. Interdisciplinary communities might be more successful in the assessment of trends and developments. As universities usually have a good network infrastructure, it might be a good idea for them to provide such services with the help of ICT systems supporting electronic communities,
- *incubator for start-ups*: Universities might act as an incubator for start-up organizations turning good ideas into products and services profiting from the geographical vicinity to research labs and students,
- *translation and explanation of new ideas:* Universities might install interdisciplinary groups or teams (e.g., linguists and natural scientists) that take on the linguistic re-formulation of ideas and concepts so that a broader community (e.g., of organizations, but also of customers) can understand them, provide

theme-oriented ontologies, structures and glossaries and visualize networks of terms, definitions and examples which could help organizations to organize their knowledge,

- *educating talent*. The education of talent not necessarily has to be restricted to students of more or less one age group. In a society postulating life-long learning, universities might also engage in executive education. Distance education and tele-learning might provide a technological basis on which such programs could be built without excessive costs.

This list of ideas is not complete. It is meant to indicate in what ways universities might apply KM instruments or KMS, so that they can continue to act as important knowledge partners for organizations.

Strategic alliances and relationships. In recent years, it has become popular for organizations in need of knowledge (about markets, technologies etc.) to look for strategic alliances and relationships or even to take over other organizations that promise to hold the competencies needed instead of developing them on their own. In the APQC study 68.2% of the organizations considered themselves to make effective use of strategic relationships in terms of knowledge sharing. Only 6.8% considered themselves ineffective in that respect[308].

This list shows that knowledge management is not only a true cross-functional initiative in an organization that has relations to many other organization-internal units, but is also an important initiative spanning the boundaries of organizations that has relations to organization-external units. As these units have their own initiatives to improve knowledge-related goals as well, coordination between all these initiatives is often quite a challenging task. Thus, it seems appropriate that in many organizations it is not an individual that is solely responsible for this coordination task (e.g., a knowledge manager), but a community of interested stakeholders from various organizational units who can act as linking pins. This eases the burden on the head of the KM initiative.

6.1.3 Groups, teams and communities

There are a number of terms used to describe organizational phenomena of people working together: work group, project team, virtual team or community among others. Groups can be characterized according to the amount of direct interaction between members of the groups (work groups, virtual groups), the size (small groups, dyads, big groups), the intimacy of interactions (primary groups, secondary groups), the relation to the individual membership (ingroups, outgroups), the relation to organizational tasks (instrumental groups, socio-emotional groups), the relation to the organizational structure (formal groups, informal groups) etc.[309]. Groups have long been recognized as the most important unit for the development

308. See APQC 1996, 58; see also section 10.1.1 - “APQC” on page 439.
309. See e.g., Staehle 1991, 242ff, Wiswede 1991, 166f, Wiswede 1992, 738.

and sharing of knowledge and numerous forms of group structures have been proposed in the literature that cover both, permanent group-oriented redesigns of the organizational structure (e.g., semi-autonomous work groups), additions to the organizational structure (e.g., committees) and temporary groups (e.g., the German concept Lernstatt which models learning in analogy to the shop floor called Werkstatt). Examples are:

- *semi-autonomous* or *self-managing work groups* (Bartölke 1992, Schreyögg 1999, 243ff),
- *multiple overlapping groups* (linking pins, cross-function and cross-linking groups, Likert 1961, Likert 1967, 50),
- *committees* (Mag 1992),
- *quality circles* and the German concept *"Lernstatt"*[310] (Deppe 1989, Zink 1992),
- *learning laboratories* (Leonard-Barton 1992b, Lehner 2000, 203ff),
- *learning networks* (Wilkesmann 1999, 217ff),
- *technology groups* (Rehäuser/Krcmar 1996, 31),
- *best practice teams* or *clubs* (North 1998, 39f).

In the following, the three concepts most widely used in KM, i.e. groups, teams and communities, will be discussed in detail and used to illustrate three different organizational entities. The organizational design of collectives is important as competencies are regarded as networked capabilities of individuals[311].

6.1.3.1 Work groups

In modern organization theory, there is a multitude of approaches that concentrate on the work group as the main unit of analysis and try to improve the employees' motivation and as a consequence efficiency and effectiveness of organizational work (e.g., Eppler/Sukowski 2000). For knowledge management, the work group is one of the most important units as most of the knowledge creation and sharing has its origin within a work group. In the following, one example for a modern organizational conceptualization of the work group will be discussed in order to give an indication of the manyfold ways of organizing work groups in organizations. Other examples for specific work-oriented organizational instruments supporting knowledge management are e.g., separate organizational units specialized for learning (learning laboratories), quality circles or learning journeys (e.g., Roehl 2000, 182f).

Under the concept *"semi-autonomous work group",* a bulk of literature has been produced that suggests to increase the autonomy and responsibility of work groups

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310. The term "Lernstatt" draws the two terms "Lernen" (learning) and "Werkstatt" (shop floor, factory) together. The "Lernstatt" concept is a model of work in small groups developed in German companies in the 70s (Deppe 1989, 82ff) and primarily aims at the training of social skills in small groups (Zink 1992, 2132).
311. See Probst/Raub 1998; see also section 5.1 - "Strategy and knowledge management" on page 93.

in order to overcome some of the problems of the traditional Tayloristic organization system[312]. The problems result from the dominance of hierarchical control mechanisms and the lack of autonomy. A semi-autonomous work group can be defined as a small group in the context of an organization which is responsible for related work packages that it has to fulfill and which holds decision and control privileges previously assigned to higher hierarchical levels (Bartölke 1992, 2385).

One of the most important lessons learned from the experiments with semi-autonomous work groups (e.g., at Volvo in the 80s) was that employees' motivation is coupled to the responsibility that is assigned to them as a group or as an individual. The consequence for knowledge management is that the handling of knowledge is a sensitive part of an employee's work environment. Thus, a KM initiative and also the design of KMS should take into account the individuals' responsibility for his or her own knowledge. On the group level, this might mean that work groups should be held responsible for their handling of knowledge. This argument is further developed in the scenarios in part D.

6.1.3.2 Project and virtual teams

The term "team" has been around for quite a while. Although there are many different views and definitions of this term, there is common agreement that team members have to trust each other, to coordinate work among themselves, to understand each other's importance for the task and to hold each other accountable. This is especially true for virtual teams (Jarvenpaa et al. 1998). Team members are therefore interdependent. (Potentials for) synergy is an important reason to create a team. Thus, due to the efforts required for coordination, a team cannot consist of too many members (some authors speak of up to 25, Katzenbach/Smith 1998, 45).

Goals must be the same for all members and should be clearly stated, measurable and understood by the team members. Members of a team have to commit substantial efforts to a team which limits the number of teams one individual can participate in. Teams are quite stable organizational entities with respect to their members, but they are temporary phenomena with a given task to fulfill. After completion of the task, team members split up, either return to their original work group, participate in a new team or the team as a whole takes on a new task.

To sum up, a team is a small group of individuals committed to common, clear, measurable, short-term goals. This requires their coordinated and interdependent effort for which they hold themselves mutually accountable. Teams get together for a finite amount of time (Ferrán-Urdaneta 1999, 129, Katzenbach/Smith 1998, 45ff). Teams play multiple roles with respect to knowledge management and can be responsible for a wide variety of tasks (Kleingarn 1997, 203ff):

- *top management teams*: are responsible for design and coordination of the learning organization,
- *process teams*: perform sub-processes of organizational learning,

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312. See Bartölke 1992, 2385ff and the literature cited there, other approaches are e.g., job enlargement, job rotation, job enrichment.

- *service teams*: support other teams,
- *problem solving teams*: are responsible for the development of solutions to complex problems,
- *coaching teams*: coordinate and optimize the communication between all the other teams.

In the ILOI study, multi-functional project teams and quality circles are suggested as an instrument for knowledge management (ILOI 1997, 22). In these teams, so the hypothesis, members with different perspectives, which are due to different functions, experiences and training, exchange ideas about problems and possible solutions of the daily work processes. 54% of the organizations responding to the ILOI study had multi-functional project teams and quality circles in place and 78% had this instrument or were planning to use it in the near future (ILOI 1997, 16, 22).

Teams, together with work groups, are the most commonly used setting for the exchange of experiences in organizations. In the ILOI study, 80% of the organizations used group and team work for the exchange of experiences and another 66% of the organizations reported to use groups to build experiences and exchange implicit knowledge (ILOI 1997, 33, 35). In the APQC study, 81.8% of the organizations said they were effectively using cross-functional teams for knowledge sharing (APQC 1996, 58). These examples show how multi-faceted group and team work can be resulting in different types of knowledge that is easily shared within such a setting. Consequently, ICT tools to support a "project memory" are needed (Weiser/Morrison 1998).

6.1.3.3 Communities

In recent years, the term community has been widely used and accepted to describe a form of organizational entity which is propagated as a premium instrument for knowledge sharing and management. The number of community-related terms in use shows the wide variety of forms and conceptualizations of communities that have been suggested in the literature or established in organizations recently. Examples are:

- *community of practice*[313],
- *community of interest*[314],
- *community of knowledge practice*[315],
- *(informal) networks*[316],
- *knowledge community*[317],

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313. Brown/Duguid 1991, Lave 1991, Lave/Wenger 1991, Wenger 1998a, McDermott 1999b, 1999c, Allee 2000, Nickols 2000, Storck/Hill 2000, Wenger/Snyder 2000, Henschel 2001, Lesser/Everest 2001.
314. Armstrong/Hagel 1995, 131.
315. Amidon 1998, 51ff, 1999, 83ff.
316. Charan 1991, Krackhardt/Hanson 1993, Rehäuser/Krcmar 1996, 27.
317. Borowsky 2000, Botkin 2000, 39ff and 93ff, North et al. 2000.

- *strategic community*[318],
- *communities in cyberspace*[319],
- *computer-supported social network*[320],
- *(geographically) distributed community of practice*[321],
- *electronic community of practice*[322],
- *on-line community*[323],
- *virtual community*[324],
- *virtual transaction community*[325].

Networks have always existed in organizations, e.g., as *advice* networks, *trust* networks, networks of *friends*, networks of *shared interests* and *communication* networks (also Krackhardt/Hanson 1993, 106f). Their systematic consideration has lead to the use of the term community.

The latter seven terms stress the important role of ICT to support interaction in communities that probably would not exist or stay alive without these technologies. On-line interaction supports a variety of social ties, not only within virtual communities, but also as an additional medium for "real-life" communities (Wellman/Gulia 1999, 181ff). Despite the limited social presence in on-line interactions, strong, supportive community ties (either initiated on-line or in real life) can be maintained and possibly the number and diversity of weak ties can be increased as well (Wellman/Gulia 1999, 185).

The term community has been in use as a central concept in sociology for a long time describing a major form for the organization of social life since nomadic groups ceased to wander and settled down (McKee 1969, 200), a "living organism" (Tönnies 1922, 5[326]) rooted in family relationships. The term has been used to describe other forms of collectives of people living together characterized by intimate, cooperative and personal relationships, for example villages, cities, guilds, religious communities and confessions (Tönnies 1922, 21ff).

As with most terms borrowed from everyday language, the term community as a sociological concept displays a number of facets and sociologists are not entirely consistent in their use of the term (Schnore 1967, 84). Some authors have questioned the utility of the term for sociological research due to its vagueness (Schnore

318. Storck/Hill 2000.
319. Kollock/Smith 1999.
320. Wellman/Gulia 1999, 169ff.
321. Hildreth et al. 2000, 31ff.
322. McLure Wasko/Faraj 2000.
323. Armstrong/Hagel 1996, Cothrel/Williams 1999, Kollock 1999, 220ff.
324. Rheingold 1994, Armstrong/Hagel 1995, Donath 1999, Wellman/Gulia 1999, Hummel/Lechner 2001; for an example of a virtual community that is well supported with ICT see Beinhauer et al. 1999.
325. Schubert 1999, 32ff.
326. Tönnies, a German sociologist, used the German word *Gemeinschaft* (community) in contrast to the word *Gesellschaft* (society) which denotes impersonal and independent relationships (Tönnies 1922).

1967, 87ff) and in newer textbooks on sociology the central importance of the term has faded (e.g., Wiswede 1991, 227, Turner 1994, 179ff, Tischler 1996, 537f).

From an organizational perspective, communities have been around for hundreds of years e.g., as networks of self-employed craftsmen fulfilling both a social and a business function (Wenger/Snyder 2000, 140). The term community denotes a large group of collocated people who satisfy the safety, economic and social needs of its members (e.g., Tönnies 1922, 23ff, Schnore 1967, 84ff, Smelser 1981, 144f, Ferrán-Urdaneta 1999, 129).

Over time, the term community has been used not only for geographical communities, but also for so-called social-psychological communities like the community of scientists or, more generally, *professional communities* in which case the term refers to shared interests or to the distinctive traits of a group of people (Schnore 1967, 91, McKee 1969, 200, Smelser 1981, 144) or the *community of interest* in which the psychological viewpoint of shared interests, characteristics, or association is stressed and the geographical viewpoint of a requirement of co-location of the community's members is neglected (e.g., Schnore 1967, 90ff).

What is new about communities as viewed here is that the term is now also applied for groups of people within an organizational setting (e.g., within companies), so they are different from the guilds in the Middle Ages or the professional communities (e.g., of scientists) in more recent days. In this new meaning the term *community of practice* was coined by Lave and Wenger in their studies about the relationships between masters and apprentices and the situated learning processes among apprentices (Lave/Wenger 1991, 91ff). Learning in this view took place as *legitimate peripheral participation* of novices in *communities of practice* of apprentices and masters.

This conceptualization views learning as situated activity. Learners inevitably participate in communities of practitioners in which mastery of knowledge and skill requires newcomers to move toward full participation in the sociocultural practices of a community (Lave/Wenger 1991, 29ff). The roles of teachers and learners are dynamic so that novices and especially apprentices who have participated in the community for a while also act as teachers for their peers. A community in this view is a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping communities (Lave/Wenger 1991, 98). Practice is the source of coherence of a community due to mutual engagement, a joint enterprise and shared repertoire (Wenger 1998a, 72ff). Shortly after, Brown and Duguid developed this concept further based on an ethnographic study of the workplace practices of service technicians extensively documented by Orr (Brown/Duguid 1991, 41ff). Box B-5 gives an exemplary definition of the term community.

This common core is shared by all communities, although actual communities differ widely and stretch from Lave and Wenger's face-to-face, highly interactive communities of practice of apprentices and masters within an organizational setting over electronic communities of transaction that share a buying or selling need to virtually all areas of social interaction, e.g., virtual communities of fantasy where people relate to each other in purely fictional settings (fantasy role play games, multi-user dungeons[327])[328].

> A community is a set of relations among persons, activity, and (social) world, a long lasting, informal group, composed of a number of people who join the community voluntarily with common interests, common work practice and/or common objectives that satisfy some of their individual needs, with low coordination but with many weak ties among members, where no member is critical for the survival of the group or the accomplishment of common objectives (Lave/Wenger 1991, 98, Ferrán-Urdaneta 1999, 130, Henschel 2001, 49). Communities in organizations are characterized by responsible, independent action, a relatively informal organizational entity in a usually fairly structured environment of defined roles and processes (Storck/Hill 2000, 64) and by self-management. Communities bring people informally together that share expertise and motivation for a joint enterprise (also Wenger/Snyder 2000, 139).

BOX B-5. **Definition of community**

Communities can be characterized by a number of *dimensions*. Table B-9 contains a list of dimensions and shows how diverse actual implementations of this concept can be[329]. The large number of dimensions used to characterize communities once again show the heterogeneity of this concept. In the following, the focus will be on communities within organizational settings. The two terms that come closest to this perspective are *communities of practice* in Lave and Wenger's or Brown and Duguid's view as well as the term *knowledge community* as used by Botkin to denote a group of people who share the interest to jointly develop, share and apply knowledge (Lave/Wenger 1991, Brown/Duguid 1991, Botkin 2000, 93ff). As opposed to Lave and Wenger, Botkin's knowledge communities can be founded or developed intentionally[330] and their existence is visible throughout the organization. This points to the dimension *degree of recognition by organization*.

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327. Multi-user dungeons or dimensions or domains (MUDs) are play and conversation spaces in the Internet that offer synchronous modes of communication and are based on fantasy role games, see Götzenbrucker/Löger 1999, 3.
328. See Lave/Wenger 1991, 91ff, Armstrong/Hagel 1995, 131. For a list of examples of virtual communities that gives an overview of the heterogeneity of this concept see Schubert 1999, 207ff.
329. Descriptions of the poles or several items on the dimensions are given where they are not self-explanatory.
330. Botkin suggests to view the development of knowledge communities as an entrepreneurial project (Botkin 2000, 93) and to view the whole organization as a portfolio of knowledge communities that act like small, dynamic firms (Botkin 2000, 110ff).

TABLE B-9. Dimensions of communities

dimension	**values**
size	*small*: fewer than 20 people *medium*: between 20 and 100 people *large*: more than 100 people
degree of activity	*active*: the community is perceived as a flourishing platform for interaction between its members, regular active (electronic) meetings take place, contributions are made etc. *inactive*: members' interests (temporarily) shift away from the community which might not serve well as a platform to satisfy its members' needs
degree of personal interaction	*small* amount of person-to-person communication *large* amount of person-to-person communication
equality of participation	*unequal*: a large number of passive members just listens to the communication in the community; a core group is clearly identifiable *equal*: small number of passive members; the level of activity is spread across the members; most members share about the same level of activity
cohesion	*strong ties*: members are highly emotionally involved and identify with the community and its goals; membership to the community is valued highly by its members *weak ties*: members are not highly involved in the community's activities; membership is not valued highly; most members do not identify with the community and its goals
focus on topic/theme	*focused* on topic *not focused* on topic
fragmentation	*no sub-communities,* activity solely on the community-level *sub-communities exist*, but activity primarily on the community-level *activity primarily in sub-communities* *activity solely in sub-communities*
language	*shared professional language*: members of the community share a professional background and language that provides context for the exchange of ideas and knowledge *no shared language*: no such shared context exists; this might be the starting point for cross-functional communities in organizations and for developing a common language
existence of an explicit agenda[a]	*explicit agenda* exists *no explicit agenda*

TABLE B-9. Dimensions of communities

dimension	**values**
degree of anonymity	*anonymous*: members do not know each other and do not disclose their identity *pseudonymous*: the members' identity is known to a community moderator or manager *identified*: members' identities are open to all members; every member has to disclose his/her identity when joining the community *varying*: it is up to the members whether they disclose their identity or not
openness	*open*: to all the members of the organization or even to the public *restricted*: to a selected group of people, e.g., with a certain background, history, role or position within an organization or in any organization (e.g., professional communities)
homogeneity of members' backgrounds	*unidisciplinary*: members have similar educational and/or professional background *multidisciplinary*: members stem from various disciplines, especially with respect to functional areas, e.g., engineers, salespeople *interdisciplinary*: members come from a wide variety of fields, e.g., business, engineering, biology, computer science and psychology for a bioinformatics community
degree of moderation/ management	*chaotic*: community develops entirely self-regulated; there are no explicit community rules and no member of the community is responsible or entitled to moderate the process *strongly moderated*: by a community manager who sets and/or executes rules about e.g., membership, behavior and contributions
reach/extension[b]	*local-interest* community *language-specific* community *multilingual, unbounded* community
degree of recognition by organization[c]	*unrecognized*: invisible to the organization and sometimes even to the members *bootlegged*: only visible informally to a circle of people *legitimized*: officially sanctioned as a valuable entity *strategic*: widely recognized as central to the organization's success *transformative*: capable of redefining its environment and the direction of the organization
stages of development of the community[d]	*potential*: people face similar situations without the benefit of a shared practice *coalescing*: members come together and recognize their potential *active*: members engage in developing a practice *dispersed*: members no longer engage intensely, but the community is still alive as a force and a center of knowledge *memorable*: the community is no longer central, but people still remember it as a significant part of their identities

TABLE B-9. Dimensions of communities

dimension	**values**
ICT support	*unsupported*: "real" community, members are collocated or meet regularly face-to-face *weakly supported*: the emphasis is on person-to-person meetings, but ICT is used to keep the relationships between the meetings. examples are mailing lists or listservers *strongly supported*: ICT support is an important aid and gains visibility; community has its own homespace, advanced communication tools, but occasionally meets person-to-person *virtual community*: the community exclusively relies on ICT support for the communication of its members who normally do not meet person-to-person at all
reference to organization/ company	*restricted to business unit*: members belong to the same business unit *across business units*: communities cut across business units, e.g., when cross-functional teams want to keep in touch with each other after a completed project *organization-centered*: the core group of the community consists of members of the organization, but externals are welcome, e.g., business partners, researchers etc. *unbound*: members of the community come from a variety of organizations, e.g., in professional communities
needs addressed[e]	*fantasy and entertainment* *relationship* *history and geography* *interest* *transaction*
profit orientation	*commercial*: either members of the community, e.g., to increase their bargaining power, or the community owner, e.g., through advertising, have commercial interests[f] *non-commercial*: the community serves the non-commercial needs and interests of its members (e.g., exchange of knowledge and experiences, social interests, entertainment)

a. See also Wenger/Snyder 2000.

b. Reach or extension restricts the group of potential members of the community besides the formal access restriction as discussed before, e.g., due to local interests or the use of a single language.

c. See Wenger 1998b, 3.

d. Stages of development characterize phases that differ by the number of members, by activities, form, intensity of interactions (Wenger 1998b, 2) and by opportunities for organizational support (Allee 2000, 9ff).

e. This classification applies especially to virtual communities (Armstrong/Hagel 1995, 130f, 1996, 135f, Hagel/Armstrong 1997, 18ff).

f. For business models of commercial virtual communities see Schubert 1999, 176ff.

However, whereas Lave and Wenger implicitly assume that communities are first founded and then might be positively sanctioned by the formal organization, it might also be the other way round. The foundation of communities might also be inspired by the formal organization. Intelligent tools might automatically recommend a number of employees with similar interest profiles and professional backgrounds into a community. No matter whether communities are viewed as an emergent phenomenon, whether they are fostered by the organization or their foundation is inspired by the organization, other characteristics of communities remain unchanged, for example the voluntary membership, longevity, common interests and relative informality. Communities are *different from teams* with respect to the following dimensions[331]:

Size. A community often consists of more members than a team, usually more than 25 members (Ferrán-Urdaneta 1999, 129f). Intensely collaborating communities rarely have more than 50 members (Brown/Gray 1995, 81). However, due to ICT support, e.g., in the form of newsgroups, forums, discussion lists or chat, there are also much larger, basically virtual communities such as ISWORLD with approximately 3,000 members. Often, there are a large number of passive members and a small number of active members. Even free riders are sometimes tolerated[332].

Goals and tasks. Communities aim at goals that are accepted by all members and are anchored in the satisfaction of (some of) the individual goals of its members. Thus, it is not an externally attributed task that is fulfilled by a community, but the sole reason for its existence is to create benefits for its members in their individual task fulfillment.

Form of membership. Members are often loosely integrated into the community and the community is self-organized in the sense that it defines its own work processes and decides on its own about accepting new members as opposed to teams for which the members are selected by managers. Individuals become members voluntarily, their involvement depends on their own initiative. Members of a community may not interact among one another or even know each other, but still they will recognize each other's membership to the community (Ferrán-Urdaneta 1999, 129). Members of a community should feel that they belong to the community, they should be committed which makes the community a (partial) kind of "home" or "social net" for its members. Still, as not all members have to be active participants, individuals can be members of many communities at the same time. Depending on the intensity of participation, the following forms of membership or levels of participation can be differentiated (Wenger 2000, 218f):

331. See e.g., Ferrán-Urdaneta 1999, 128 and the sociological theories as cited there; see also Smith/Kollock 1999, Wenger/Snyder 2000, 141ff.
332. See also Kollock 1999 for a more thorough discussion of the economics of virtual communities.

- *passive access*: persons external to the community who have access to institutionalized knowledge that the community publishes,
- *transactional participation*: occasionally persons contribute to the community or use services of the community without being a member,
- *peripheral participation*: members of the community who quite passively participate in the community e.g., because they are newcomers or because the topics discussed are not at the center of their interests and/or current work practices,
- *full membership*: participate in and contribute regularly to the community and are acknowledged as experts in the community,
- *core group*: a small group of people is at the heart of the community, works intensively for the community and takes on responsibility for the design of the community (e.g., rules, norms, organizational issues).

Relation to formal organization. Authority relationships are not organizationally determined, but evolve over time. "Knowledge leaders" (Storck/Hill 2000, 68) are identified to whom members of the community turn when they have a particular knowledge need. Interaction, coordination and the dependence of the community from single members is weaker than in the case of a team. Formal organization takes on the role of a sponsor of the community rather than integrating it into normal management processes (and reporting). Communities complement existing organizational structures rather than replacing them (Wenger/Snyder 2000, 139).

Lifetime. Usually, communities do not have a predefined lifetime, but are long-lasting organizational phenomena. Communities generally are not dependent on single members, they outlive individual members (Ferrán-Urdaneta 1999, 130). As it is passion, commitment, and identification with the members' expertise that holds a community together rather than project milestones and goals as in the case of a (project) team, communities last as long as there is interest (by the core group) to keep the community alive (Wenger/Snyder 2000, 142).

Table B-10 summarizes the most important differences between work groups, teams, communities and informal networks. The comparison shows that communities are most similar to informal networks with which they share many characteristics (goal/purpose, lifetime, size) and in fact formal networks might easily develop into communities if they open up for new members and gain more visibility in organizations.

In certain contexts, communities seem to produce considerable *benefits* for the organization. The following benefits result from several case studies on communities[333]:

333. See e.g., Allee 2000, 8, North et al. 2000, 52f, Storck/Hill 2000, Wenger/Snyder 2000, 140f, Lesser/Everest 2001, 38.

Efficient instrument for knowledge sharing. Within the community knowledge is shared efficiently, both, tacit knowledge as well as more tangible knowledge assets. This is partly due to the fact that communities are long-lasting organizational phenomena which helps and motivates members to develop mutual trust. Additional facilitating factors are diversity in membership, a limited requirement for formal reporting which creates a "secure space" for exchanging ideas and reflection processes that consolidate what was learned in e.g., a meeting or a trait in a newsgroup discussion. As communities are often cross-functional with members belonging to different business units, the knowledge shared between community members is also spread throughout a bigger circle and even organization-wide. Broad participation also supports that knowledge is transferred into business units and from business units back to the community (Storck/Hill 2000, 66, 70).

TABLE B-10. Communities compared to other forms of collective organization[a]

goal/purpose	membership	ties	lifetime	size
community				
serve needs of its members, e.g., develop capabilities, exchange knowledge	members select themselves	passion, commitment and identification with the group's expertise	as long as there is interest in maintaining the group	can be large or small; in large communities there are a large number of passive members
work group				
formal, organizational design goals: e.g., perform value adding activities, deliver a product or service	everyone who reports to the work group's manager	job requirements and common goals	until the next reorganization	tend to be small; all members actively contribute in the group
(project) team				
accomplish a specified task within a certain amount of time	employees assigned by (senior) management	the project's milestones and goals	until the project has been completed	can be large or small; contributions of members vary widely
informal network				
collect and pass on business information; build trust and social relationships	friends and business acquaintances	mutual needs	as long as people have a reason to connect	can be large or small; depending on individuals' needs

a. This table is based on Wenger/Snyder 2000, 142.

Communities are also important instruments to provide context for the sharing of explicit knowledge as can be found in knowledge repositories. This is especially true for practical skills the transfer of which requires interaction and a shared work practice (Henschel 2001, 282f). Communities might take on responsibility for a portion of the organization's knowledge repository and thus make sure that the contents documented actually serve the community's needs. As a consequence of the increased efficiency in knowledge sharing, the organization's reactions to customer needs could be quicker and more and better ideas for products and services could be generated (Lesser/Everest 2001, 38). In some cases, the effects might even lead to the start of new lines of business (Wenger/Snyder 2000, 140).

Driver for the implementation of a business strategy. If a community's agenda is aligned with an organization's strategy, it can be a useful instrument for the implementation of a strategy. Problems encountered can be resolved, different perspectives can be consolidated and the dynamic adaptation of a strategy to new (internal and external) developments (e.g., technological changes) can be supported. In this case, communities can act as change agents that create a drive that spreads throughout the organization (Wenger/Snyder 2000, 140 report two cases illustrating this potential).

Better motivation for learning and developing. Since communities are formed around individual needs and participation is voluntary, its members are usually highly motivated to learn from each other. Communities can create a distinctive culture conducive to innovation, individual learning and development of personal skills and knowledge which result in deeper internalization of learning. Learning as part of a group is considered more effective than learning alone as learning depends on the availability of peers and their willingness to act as mentors and coaches as much as it does on masters (Storck/Hill 2000, 70, Wenger/Snyder 2000, 141). The ability to learn of a community of practice is variable depending on the diversity, cohesion, the intensity of interaction and communication as well as the identity of a community (Henschel 2001, 278).

Improved development and exploitation of core competencies. Since communities are more visible than networks, it might be easier for the organization to identify core competencies and capabilities, to foster their development within communities, to diffuse practices more rapidly and thus to exploit competencies throughout the organization. Communities might also help to build a common language, methods and models around core competencies (Allee 2000, 8).

More influence on implementation of joint goals. Communities have more influence on decisions than a single individual. As the community exists in addition to the formal organizational structure, proposals of the community yield greater external validity than those of a single business unit. Since members often stem from different business units and conflicts are resolved effectively within the community, it is less likely that proposals are born out of particular interests of a single business unit with goals conflicting to other business units. Authority and influence of communities often extends beyond its boundaries and reduces additional review and decision making in the business units. Communities thus provide an instrument to share power and influence with formal organization (Allee 2000, 8).

Instrument to recruit and retain talent. Since a community can act as a virtual "home" for people who share interests, it can be an instrument to help organizations to recruit new people and to retain them (Wenger/Snyder 2000, 141). Thus, organization-internal communities can create a barrier to leave the organization. They can also create a motivational factor to entry if the community has an exclusive image and potential employees are promised that they can join such an exclusive "club". However, the opposite might be true if communities span organizations. In this case, communities serve as a "home" no matter on whose payroll its member is. In this case, it might even stimulate employees to join a different organization as the social network is easily transferable. Still, even in this case, the knowledge might as well stay with the company as it can be embedded in a larger group of people and thus retained in the community as no single individual is crucial to the survival of the community. Employees that left the organization might even still be willing to contribute towards the organizational goals in certain cases because the network is still alive.

Improved learning curve for new employees. Once recruited, employees have to quickly learn to use the methods, models and tools that have to be applied in the newcomer's position in the organization, get an overview about the knowledge network in an organization and thus links to experts and their competencies.

Provide homes for identities. As communities are not as temporary as teams and as communities are organized around topics or shared interests they can provide a platform, a social home for like-minded people in which they can develop their identities which have been found to be a crucial aspect in organizational learning (Wenger 1998b, 4, Allee 2000, 8).

Even though benefits can hardly be measured, there is broad agreement about the positive effects of this concept in organizations. The successful application of the community concept is dependent on a number of factors describing the concrete situation in an organization. A number of authors have tried to elicit *success factors* that positively influence the benefits of a community. Even though communities are essentially emergent and self-organizing organizational phenomena, the formal organization can be supportive of communities in order to profit from the concept. Examples for success factors are[334]:

Interaction format. Although face-to-face meetings are not a prerequisite for the functioning of a community, most communities work this way (Storck/Hill 2000, 68). Face-to-face networking builds trust which is necessary for efficient knowl-

334. See e.g., Storck/Hill 2000; for guidelines how to foster communities see also McDermott 1999b, 1999c, Cothrel/Williams 1999, 56ff.

edge sharing and subsequent use of electronic communication technologies. Within the community openness should be stimulated, e.g., by the establishment of a "zone of safety" that builds trust. Immediate feedback is considered important.

Common vocabulary. Communication between members of the community is facilitated if they already share a common vocabulary (e.g., through similar experiences from training and education in large organizations). Otherwise it is advisable to provide background context for people to understand each other.

Redundant media and channels. Communities need a variety of forums, multiple ways to connect and share knowledge, e.g., events and meetings, newsgroups, mailing lists, chat server, tele-conferencing, application sharing, on-line training, yellow pages or Web space (also Cothrel/Williams 1999, 59). ICT supports additional channels and can provide an important means of communication for the community, especially if members are geographically dispersed.

Reflection. Work processes should be defined which include reflection circles that review knowledge created and what was learned during community activities.

Pull versus push. Knowledge sharing in communities should react to concrete and current knowledge needs and thus respond to people pulling insights rather than pushing knowledge to people.

Sponsoring. Communities need a supportive environment in order to grow and be beneficial to an organization. A sponsor, usually a non-member who is a senior manager in the organization acts as a champion for the community, motivates employees to actively participate, helps with organizational and ICT issues (e.g., rooms for meetings, home space in an Intranet), convinces management about the importance of self-organization in a community and talks to supervisors who are not in favor of their subordinates joining the community etc.

Support and moderation. Most communities will never be entirely self-sustaining and just exist because of the contributions, motivation and commitment of its members. Communities require continuos support from both, formal and especially informal roles[335]. The time and effort invested required to maintain a community is even higher than the effort taken to build the community in the first place[336]. Support not necessarily is restricted to formal roles, but includes the systematic search for and support of members who could take on informal roles (Cothrel/Williams 1999, 59f).

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335. See also section 6.1.2.8 - "Community or network manager" on page 167.
336. In an empirical study of 15 on-line Intranet, Extranet and Internet communities, about two thirds of the respondents responsible for managing or coordinating the community believed that the ongoing effort to maintain the community had increased compared to the initial effort to set up the community (see Cothrel/Williams 1999, 58).

Trustful organizational culture. An organization's culture can either support or prevent informal networks, such as communities. A trustful organizational culture, a communication as well as a cooperation culture (Frey 2000, 81ff), is the basis for effective knowledge sharing in general and in communities in particular. The organizational culture can hardly be actively influenced, though, and thus can rather be viewed as a requirement than a success factor[337].

Relation to formal organization. Linkage to formal control structure should be minimized (Storck/Hill 2000, 72). The community should establish its own processes and rules which should be continuously improved. However, it would certainly help if the topics discussed in the community were of strategic importance to the organization (McDermott 1999b, 6f) and would be valued and supported by providing time, resources, encouragement, and guidance, e.g., by a community support team (McDermott 1999c, 6), and by connecting the community to people and other communities that might be beneficial and/or profit from the relationship (Wenger 1998b, 5).

As mentioned, communities vary considerably in terms of e.g., size, social structure (e.g., authority relations), interaction format, existence of an explicit agenda, relation to formal organizational structure or formality of the work processes it defines (see e.g., the cases illustrated in Wenger/Snyder 2000). What they do have in common is that its members share their knowledge in a way that is less rigid and formally structured than in traditional organizational units like work groups or teams. Usually, a core group provides intellectual and social leadership.

Given their informal nature, communities are not easily installed, managed nor integrated within an organization. Communities are considered "emergent" and thus cannot be "created" (Brown/Duguid 1991, 49). However informal this organizational entity is, it does benefit from cultivation (Wenger/Snyder 2000, 143). As their nature is different from traditional organizational units, *"management" of a community* is a matter of:

Helping to found a new community. The aim is to bring together the "right" people and generate enthusiasm for the community to be founded. Key task in the foundation phase of a community is to define its domain and its linkage to organizational goals.

Providing an infrastructure conducive to communities. This comprises both, an organizational and an ICT infrastructure. The ICT infrastructure consists primarily of communication systems that support collectives of people, such as listservers, mailing lists, multi-point video conferencing tools, and community home spaces. Home spaces serve as portals for communities and as an instrument to advertise the community, to help to show progress towards joint goals and to exchange documents. The organizational infrastructure covers official sponsoring, supporting the

337. See also section 6.4 - "Organizational culture" on page 221.

community financially (e.g., budgets for community events), facilitating (e.g., through a separate knowledge management unit), helping to overcome obstacles and linking the community to related organizational activities and to other communities etc. (see also Wenger/Snyder 2000 for examples of organizational infrastructure).

Measuring the value of a community. The value of a community is assessed differently from the value of traditional business units. The effects of community work are often delayed and also the results are generated within traditional organizational units (e.g., work groups, project teams) so that they can hardly be attributed to communities. Organizations overcome that problem by regularly interviewing community members and collecting success stories which often already illustrate higher benefits than efforts made for keeping up a community (e.g., Wenger/Snyder 2000, 145).

Wenger and Snyder report two cases of the successful implementation of communities which show different styles of formal commitment by senior managers. They hypothesize that different styles of formal commitment to communities can be effective when aligned with the organization's culture (Wenger/Snyder 2000, 145).

Ferrán-Urdaneta compares teams and communities in terms of their effectiveness to support KM activities. He hypothesizes that as teams are designed for highly interdependent tasks they should serve interdependent KM tasks such as knowledge creation better than communities that are looser forms of group work than teams (Ferrán-Urdaneta 1999, 131f).

Communities in turn should be more effective in supporting those KM tasks that require a large group of people, e.g., legitimizing or distributing knowledge (Ferrán-Urdaneta 1999, 132).

However, one can assume that these hypothesis are neither supported for all kinds of knowledge nor for all kinds of communities. Ferrán-Urdaneta shows for encultured knowledge that communities might more effectively create that kind of knowledge than teams (Ferrán-Urdaneta 1999, 132). Also, communities will be more effective in legitimizing knowledge if, and only if, there are experts in the community who (a) can and are willing to endorse this knowledge and (b) the reputation of whom is acknowledged by the whole (or a large part) of the community. In this case communities will need effective instruments to determine who is expert in what topics, otherwise "wrong" knowledge might be endorsed by the "wrong" people.

In the case of knowledge sharing, communities might be more suited than teams for that kind of knowledge the sharing of which does not profit from the interdependent nature of teams. In many cases, the sharing of knowledge cannot be fully separated from the creation of new knowledge. Thus, a concrete knowledge exchange might show elements of both, teams being more effective than communities in parts of the task and communities being more effective than teams in other parts.

To sum up, it will be necessary to categorize knowledge and its relation to the members of teams and communities in order to be able to determine which structure will be more effective. All three concepts discussed here in detail—work groups, teams and communities—as well as other forms of collective organization as mentioned in the beginning of this section are effective, complementary platforms for knowledge-related tasks (also Wenger/Snyder 2000, 142), although as shown here every concept has strengths in different areas. Collectives of people are the most important unit of analysis for research and practice of KM. Their design, support with organizational and ICT instruments, and fostering will determine success of a KM initiative to a large extent.

6.2 Instruments

As explained in the definition of KM[338], the implementation of knowledge strategies requires systematic interventions with the help of instruments, either person-oriented, product-oriented, organizational or ICT instruments. Section 6.2.1 reviews a number of case studies of KM measures to give examples of what actual KM initiatives in organizations aim at, gives a definition of the term KM instrument and classifies KM instruments. Sections 6.2.2 and 6.2.3 present three selected classes of KM instruments in more detail.

6.2.1 Definition

Even though the terms KM instrument, KM project, KM initiative and KM measure are widely used, there is hardly any concrete definition of any of these terms. A large number of measures has been proposed as part of case studies in KM which also comprise more traditional person-oriented measures well-known in HRM, e.g., programs for personnel development, content-oriented measures well-known in data base theory that revolve around the use of (simple) meta-data, organizational measures well-known in organization science, e.g., job rotation, job enrichment or ICT measures well-known in MIS, e.g., the use of data bases, email or Groupware. Several case studies deal with the introduction of KM in organizations and describe what instruments were used. Table B-11 lists some examples of case studies that have been found in the literature[339].

KM instruments target different goals and consist of several measures that have to be aligned and supplement each other. Most of the instruments described in Table B-11 comprise organizational as well as technological measures. Thus, it is useful to review a human-oriented and a technology-oriented perspective on KM instruments before aiming at a comprehensive definition of KM instrument.

338. See section 4.1 - “Knowledge management” on page 21.
339. See e.g., Chase 1997b, Güldenberg 1997, Davenport/Prusak 1998, Probst et al. 1998, Sveiby 1997, 1998, Bach et al. 1999, 267ff, McCampbell et al. 1999, 175ff, Antoni/Sommerlatte 2001, Eppler/Sukowski 2001, Mertins et al. 2001, Davenport/Probst 2002, Riempp 2004, 253ff, Jennex 2005, see also section 10.2 - “Case studies” on page 447.

Human-oriented definition. Instruments for knowledge organization are intervention tools that are describable, get deployed purposefully in a way that is traceable for an observer, have a clear knowledge orientation and are still relatively independent of the respectively organized knowledge (Roehl 2000). This definition has its roots in organizational psychology and sociology. The implementation of knowledge strategies is seen as a purposeful intervention into the way an organization handles knowledge. Having a clear knowledge orientation distinguishes KM instruments from other tools that help in an intervention into an organization, but remains unspecific about what exactly knowledge orientation is. In the case of ICT, knowledge orientation can be expressed by specific "intelligent" functions and specific content, with content being the most important part. Knowledge refers to contextualized information in an ICT context. Thus, KM instruments have to provide context in order to show knowledge orientation. Finally, a KM instrument in this view has to be general, spanning knowledge domains rather than being domain-specific.

TABLE B-11. Proposed instruments and supporting measures

instrument	measures
best practice sharing	a new organizational structure with several centers of excellence, an information system containing best practices and the adoption of benchmarking and models
case debriefings	several information systems including yellow pages and a case data base; new roles like knowledge stewards, coordinators and advocates and organizational rules
community of experts, interest, practice, purpose	establishing roles, e.g., moderator, subject matter expert, boundary spanner; foster networking between experts (community of experts), employees working on (community of practice) or interested in a topic (community of interest) or working towards a common goal (community of purpose)
competence management	definition of a skill tree and scales; establishing a procedure for assessing target and actual skills, rules for accessing skill profiles; implementation of a skill management system, expertise directory, yellow pages
content management (CM)	establishing a CM team consisting of roles responsible for design, structure, quality management and administration; definition of CM processes, implementation of a CMS
corporate and team culture management	corporate culture: off-shore meetings, expert meetings and debriefings; team culture: new team structures, informal interviews and an education program
documentation/ evaluation of customer feedback	establishing a new team and regular meetings; creating templates and organizational rules

TABLE B-11. Proposed instruments and supporting measures

instrument	**measures**
documenting tacit knowledge, identifying and integrating external knowledge	a new organizational unit; document management system, access to an online encyclopedia, lessons learned enforced through a workflow management system and "in-a-nutshell" learning videos
expert advice	a formal procedure installed in order to guarantee quick responses to (urgent) requests for knowledge which are given by (subject matter) experts within a defined time frame, supported by some form of forum or other content management system
externalization of knowledge	career plans, incentive systems, 360° evaluation, an electronic document management system and yellow pages, the introduction of so-called Intellectual Capital Teams that review new documents
idea and proposal management	is a formally defined procedure that targets all employees of an organization individually in order to get suggestions for improvements which are then selected, implemented and rewarded
knowledge maps	consistent access to customer, product and process knowledge with the help of organizational rules and visualization tools
lessons learned	establishing a lessons learned coach and a method for systematic harvesting of lessons learned in projects at defined project steps; consists of organizational rules, document templates and an IT system
technology-enhanced learning	also called e-learning, uses ICT in order to support learning processes. The emphasis is on organization-wide solutions including new roles, e.g., trainer, coach, tutor, learning processes that take pedagogical and didactical expertise into account and a learning infrastructure, e.g., consisting of an authoring tool and a learning content management system.
terminology management	establishing the role of a terminology manager, a process of meta-data and ontology management, a terminology management system for semantic integration of data sources

Technology-oriented definition. Knowledge management tools are technologies, broadly defined, which enhance and enable tasks along the knowledge life cycle, e.g., knowledge creation, codification and transfer. As with any tools, they are designed to ease the burden of work and to allow resources to be applied efficiently to those tasks for which they are most suited. It is important to note that not all knowledge tools are computer-based. Pulling these two perspectives together leads to the definition in Box B-6.

(1) Only parts of the valuable knowledge assets exist in explicit form as documented, electronically accessible knowledge. Therefore, KM instruments have to consider person-oriented measures. Organizational measures are implemented e.g., as rules, roles, procedures and newly or re-defined processes that describe how to deal with ICT systems. Last, but not least this book focusses those KM instruments that are enabled, fostered or substantially supported by ICT. (2) Clearly defined means that any proposed instrument has to clarify what measures and tools are involved so that it is possible to decide if an observed phenomenon in an organization matches this definition. (3) KM instruments have to be purposefully deployed within an organization, usually within the frame of a systematic intervention with the help of a KM initiative. That includes defining knowledge-related goals and respective measurement. Organizational knowledge base reflects people's skills, the contents as well as (ICT) tools and systems in an organization that support handling of knowledge.

A KM instrument is (1) a collection of organizational, human resources and ICT measures that are aligned, (2) clearly defined, (3) can be deployed purposefully in an intervention into an organizational knowledge base in order to achieve knowledge-related goals, (4) target contextualized information as object of intervention and (5) are independent of a particular knowledge domain.

BOX B-6. **Definition of knowledge management instrument**

(4) Knowledge orientation of the KM instrument can only be accomplished if the contents of the ICT systems are "knowledge-prone", thus being contextualized information instead of only data. An example is a data base containing experiences, lessons learned or best practices together with links to people who have made these experiences and/or experts in the domains that are described (knowledge) as opposed to a data base holding telephone numbers of employees (data). Embedding information into context is crucial[340]. In ICT systems, it can be achieved by assigning appropriate meta-data and systematic management of a taxonomy or ontology to help users to integrate information into their personal knowledge bases[341]. (5) Finally, a KM instrument should be independent of a specific knowledge domain and can be targeted at any topic or (core) competence of an organization.

Figure B-24 organizes some important KM instruments that have been proposed in the literature and are applied widely in organizations.

Even though KM instruments have been defined as comprising person-oriented, product-oriented, organizational and ICT measures, actual KM instruments usually target (1) either individuals (person) or collectives (organization) along the dimension organizational level and (2) knowledge as object, in the form of a product or

340. See also the characteristics of KMS stated in section 4.3.2 - "Definition" on page 86, especially the one discussed in the sub-heading "Context" on page 87.
341. See section 7.7 - "Semantic integration" on page 374.

knowledge in a process-oriented, encultured form, i.e. practices, processes or routines. All example KM instruments are supported by ICT.

Person. Person-oriented KM instruments primarily aim at knowledge that is provided by, managed by or bound to individuals, e.g., personal experiences or routines, ideas, proposals, self-managed ad-hoc learning processes or meta-knowledge about individual skills.

Organization. Organizational KM instruments target knowledge that is created together, shared, integrated, validated, legitimated or committed by many employees and thus is bound to social systems. Social systems in organizations are described with the help of the formal organization design, especially business and knowledge processes supported by good or best practices, knowledge maps, knowledge process reengineering and process warehouses, projects and work groups supported by case debriefings and lessons learned as well as the informal organization, reflected by communities and knowledge networks. Semantic content management provides the infrastructure for knowledge processes whereas learning processes are systematically supported by technology-enhanced learning.

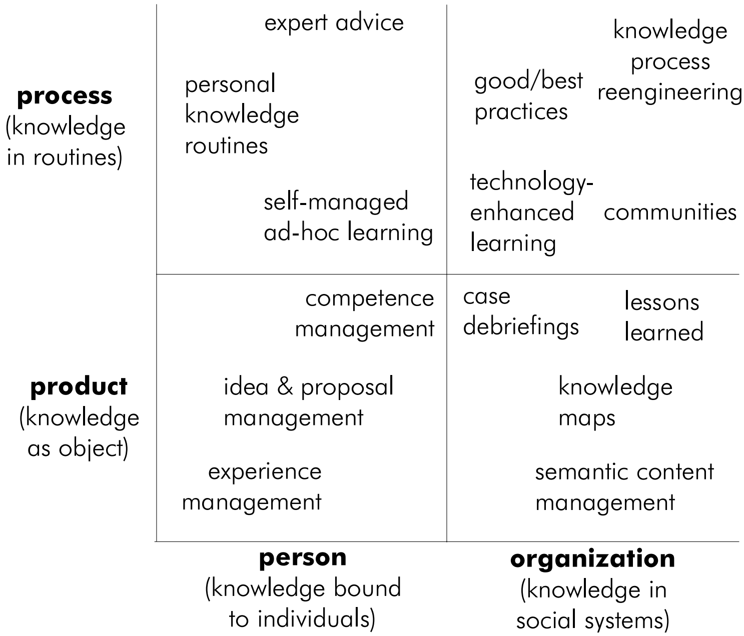

FIGURE B-24. Knowledge management instruments

KMS aim in general at providing a platform for KM and in particular foster the implementation of knowledge strategies with the help of a defined set of KM instruments. In the following, the identified instruments are described structured into KM instruments that target knowledge as a product (section 6.2.2) versus those that target knowledge as a process (section 6.2.3).

6.2.2 Product-oriented instruments

Documented knowledge certainly is of high importance with respect to the design of KMS. On the one hand, product-oriented KM instruments target personal knowledge, such as personal experiences, ideas and proposals or skills descriptions. On the other hand, documented knowledge can be spread across multiple sources and requires identification and visualization with the help of knowledge maps as well as integration which is supported by ontologies. Ontologies also aid the management of semantic content. While this instrument targets electronically available content as potential knowledge sources throughout the organization, there are two instruments that specifically establish the systematic handling of inter-subjective knowledge with commitment, i.e. case debriefings and lessons learned.

Personal experience management. The implementation of experience management systems eases documentation, sharing and application of personal experiences in organizations. These systems have to be integrated into the daily work practices of employees in order to be accepted. Several approaches exist that support capturing of experiences, e.g., information mapping, learning histories or microarticles (Willke 1998, 107ff) that help employees to document and structure experiences. On an organizational level, systematic management of personal experiences enables a company to solve recurring problems more effectively. However, there are some barriers which prevent the documentation of experiences or reuse of already documented experiences. Foremost, time required for documenting experiences is a critical factor because it imposes additional efforts on employees. Therefore, organizational measures are required that provide time tolerances and keep the effort as low as possible. Simultaneously, sufficient context of the experience has to be provided. ICT solutions help to automatically detect context. Personal barriers, e.g., insufficient willingness to share knowledge or to apply knowledge created by other employees (not-invented-here-syndrome) have to be considered by measures like trust management and incentive systems.

Idea and proposal management. Most organizations systematically collect ideas and proposals for improvements put forward by their employees. In Germany, such instruments are called *organizational proposal system* (Betriebliches Vorschlagswesen). These are formally defined processes that handle those ideas and proposals that have been submitted by individual employees. A group of experts reviews the proposals and evaluates them in a committee. If the idea or proposal is selected, it is then implemented and the employee is rewarded, mostly financially. A template can help employees to structure their ideas and proposals, an automated workflow can identify appropriate experts for reviewing the proposals. From an ICT perspective, a data base system as a minimal solution can be used to store the proposals. Semantic content management can help interpret the proposals, e.g., with a glossary for acronyms and special terms probably not known by reviewers of different areas of expertise.

Competence management. Competence management supports systematic analysis, visualization, evaluation, improvement and usage of competencies held by individuals in organizations. Competence management comprises expertise locators, yellow and blue pages as well as skill management systems, also called people-finder systems. Skill management comprises an information system that makes skill profiles accessible, learning paths that have to be defined for each employee and that have to be updated together with skill profiles. A central skill ontology, also called skill tree, has to be defined that provides context for all existing, required and wanted skills in the organization. Training measures have to be offered. Skill management systems are often not limited to information about skills, their holders and their skill levels, but also contain information about job positions, projects and training measures in which employees learned, used and improved their skills. Yellow and blue pages are directories of organization-internal and -external experts respectively. Profiles of the experts together with contact details are listed according to a number of knowledge domains for which they might be approached. Information about employees' skill levels and degrees of expertise can be used e.g., to connect people, to staff projects, to filter and personalize KMS contents and functions.

Semantic content management. Semantic content management refers to managing meaningfully organized content, i.e. documented knowledge embedded in a context. The term *semantic* in this case means that content is well-described with the help of meta-data that assigns meaning and structure to the content and that these descriptions are machine-interpretable and can be used for inferencing[342]. Semantic content management extends document management and enterprise content management into integrated document and content management. The instrument is certainly tightly related to an IT solution, but there have to be rules that guide definition and use of semantics, monitoring external knowledge sources for interesting content that should be integrated, developing an appropriate content structure as well as publishing of semantically enriched documents in the system. Semantic content management also allows for "smart" searching, collaborative filtering and can be integrated with competence management in order to handle interests used to connect people with the help of the joint analysis of semantic content and skills.

Knowledge maps. Different types of knowledge maps that can be used in order to aid access to knowledge, knowledge sources or to knowledgeable persons. Central goal in this instrument is the creation of corporate knowledge directories which visualize existing knowledge in organizations and support a more efficient access

342. See also sections 7.7.2 - "Meta-data management" on page 379and 7.7.3 - "Ontology management" on page 387.

to and handling of knowledge. The main objects of mapping are experts, project teams, networks, white papers or articles, patents, lessons learned, meeting protocols or generally document stores. In the following, the individual types of knowledge maps are discussed in detail.

Knowledge source maps visualize the location of knowledge, either people (sometimes also called knowledge carrier maps) or information systems and their relation to knowledge domains or topics. They can be further classified into knowledge topographies to identify gaps, competence maps to find experts and pointer systems that directly link from challenges within a process to a contact that can assist. *Knowledge asset maps* visualize also the amount and complexity of knowledge that a person or system holds.

Knowledge structure maps show the relationship between different knowledge domains or topics and should not only visualize that there is a relationship, but also explain the type of relationship. Formal definition of knowledge structures results in ontologies and is an important instrument for the integration of diverse knowledge sources[343].

Knowledge mapping can also be used in order to highlight knowledge processes, especially processes of knowledge development and application. These maps are combinations of process models and knowledge carrier maps. *Knowledge development maps* visualize processes or learning paths that can or have to be performed by individuals or teams in order to acquire certain skills. *Knowledge application maps* describe what process steps have to be performed in what situation at what step in a business process, e.g., who should be contacted for a second opinion.

Lessons learned. Lessons learned are the essence of experiences jointly made and systematically documented by members of the organization in e.g., projects or learning experiments. In a process of self-reflection, e.g., at the end of a project milestone, also called after-action reviews, or at the end of a project, also called project debriefings, the project members jointly review and document critical experiences made in this project (Probst et al. 1998, 209f). Lessons learned can also aid individual self-reflection about one's own experiences, but primarily aim at joint reflection that explicates know-how gathered in a team and learning from the experiences of others (also Haun 2002, 318). Lessons learned are thus the product of a formal process that involves a collective of project members who share, discuss, reflect, verify as well as integrate their experiences and finally commit to them. This process can be moderated by a lessons learned coach. Templates can be created that support a structured documentation of experiences and help the team to include important context information. An information system can aid this process and store and provide access to all documents containing lessons learned. A subject matter expert could review the documents and further enhance them by referencing other documents, projects or people. Rules support integration of the lessons

343. See sections 6.6.3 - "Knowledge modeling" on page 257 and 7.7.3 - "Ontology management" on page 387.

learned instrument into standard project processes and can also enforce that project managers study lessons learned documents before starting a new project.

Case debriefings. Whereas lessons learned aim at systematically eliciting experiences made by teams in projects, case debriefings target experiences documented by work groups in business processes. Generally, the term case can be applied to a wide variety of phenomena about which knowledge is documented. However, from a business process-oriented perspective, a case is an instance of a business process with an explicit connection to a customer. Thus, this instrument focuses knowledge that has been gained in specific, interesting cases encountered during operative work in business processes. In extension to business process definitions that abstract from the specifics of individual cases, case-oriented knowledge can enrich a process warehouse.

As the knowledge is assigned to specific business processes, templates and rules can be developed that structure the types of cases that can be encountered and helps to document case knowledge. As with lessons learned, coaches can help employees to document case knowledge and the experiences can be reflected in the work group that is responsible for the business process (commitment by work group) or by process managers (legitimation by supervisor). From an ICT perspective, several information systems, particularly a case data base system and, in formally structured environments, case-based reasoning systems aid retaining, searching and retrieving case knowledge.

6.2.3 Process-oriented instruments

Whereas product-oriented KM instruments target different types of documented knowledge in the sense of objects that can be accessed and reused not unlike information objects, another group of KM instruments aims at knowledge in a process-oriented form. This includes (1) retaining knowledge in a process-oriented form, e.g., personal knowledge routines, good or best practices, (2) directly targeting the design of knowledge and learning processes, e.g., expert advice, knowledge process reengineering or technology-enhanced learning or (3) informal organizational routines that aim at improving individual learning, e.g., self-managed ad-hoc learning or the sharing of knowledge in communities or knowledge networks. Even though some of these instruments also involve knowledge in an objectified form, e.g., communities might have a community home space, the primary focus is on supporting processes of handling knowledge, rather than documenting knowledge in a content or container fashion.

Personal knowledge routines. Even in knowledge work, certain knowledge-oriented activities can be partly routinized[344]. Knowledge routines thus comprise existing, allowed, recommended or prescribed partly routinized activities of

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344. The concept of routinization is based on activity theory (Engeström 1993) and is explained in section 6.6.2 - “Activity modeling” on page 250.

knowledge work. The routines can be structured and made available for reuse by e.g., knowledge brokers. Bundles of knowledge management services[345] might partly support routines. Knowledge routines can be structured according to Schultze's (2000) informing practices into routines for

- expressing knowledge, supported by templates, integration and contextualization activities,
- translating knowledge, acquiring knowledge from inside and outside the organization, integration, validation and activation activities for knowledge of diverse sources,
- monitoring, getting an update on and awareness for current activities in an organization with respect to a process, a project or a topic and
- networking, supported by collaboration technologies and by competence management[346].

Even though knowledge routines are personal in the sense that employees individually manage their own routines, the ICT infrastructure can support the individual reuse of routines. Organizational instruments can also aim at managing the transition process from personal knowledge routines to team, work group or unit best practices.

Self-managed ad-hoc learning. This KM instrument reflects a specific type of personal knowledge routine that is only stressed here because of the supposed tremendously increasing importance of individual, ad-hoc, self-managed learning processes, particularly the ones on the job, directly at the workplace. The instrument can provide systematic support for personal learning processes, e.g., with the help of structuring and offering learning objects, learning paths and reflecting on learning activities by peers and experts within the organization or even crossing these boundaries. It can thus be part of comprehensive technology-enhanced learning instruments that are implemented in an organization.

Expert advice. Expertise is often readily available, particularly in larger organizations, but meta-knowledge about who knows what is the bottleneck for an efficient and timely solution to knowledge problems. The instrument expert advice establishes a formal procedure that enables employees to pose requests for knowledge. A template structures questions and ICT, e.g., a forum, can provide support for quick accessibility to the unanswered questions. Semantic content management might even be used to scan open questions and draw the attention of appropriate experts to the questions. Standard operating procedures for expert advice might differentiate between ordinary requests which are answered as soon as possible and urgent requests for which handling is guaranteed within an agreed time frame, e.g.,

345. See sections 7.3.1 - "Knowledge management service" on page 302.
346. Integration, validation, contextualization and activation activities have been found in case studies by Eppler (2003, 82ff). Examples are listed in section 7.2.5 - "Quality of contents" on page 299.

24 hours. Responses are given by whoever believes to have a solution to the posed problem. In case of urgent requests and if no response is submitted within a certain time frame, the question is relayed to an identified (subject matter) expert. The instrument requires primarily organizational measures, but can also be supported by a forum or other content management system.

Technology-enhanced learning. Supporting or enhancing learning through ICT has a long tradition. The variety of approaches that has been developed is reflected by terms such as distance education, distance learning, tele-learning, programmed instruction, computer-based training, hypertext-, hypermedia- or Web-based training and blended learning. E-learning emerged at the end of the 1990s together with the wide-spread use of the Internet and other such terms like e-business or e-government. E-learning is ICT-supported learning with the help of multimedia or hypermedia contents that are online accessible for the learner backed by functions that enable communication between learners and teachers as well as among learners. This definition emphasizes that multimedia contents need to be provided online and together with functions that enable interaction, though e-learning is often used in a broader sense as comprising other forms of electronically supported learning. Technology-enhanced learning is a more recent term that emphasizes that learning is not automatized with the help of technologies, but that learning processes are supported and fostered by technologies. Newer approaches stress the importance of reusable learning material in the form of learning objects, the role of collaborative technology in interactive learning processes between teachers, coaches and learners as well as between learners themselves, adaptive, adaptable and personalizable learning solutions as well as a situation-oriented deployment of learning technology in on-demand, workplace or ambient learning solutions.

The instrument is traditionally not targeted as a KM instrument due to the fact that despite numerous attempts to bridge the gap between the two intuitively strongly related fields of e-learning and KM, they are still quite separated in research and practice (Le et al. 2006). Whereas e-learning as well as the related field of personnel development within human resource management have their foundations in (learning) psychology, (media) didactics and (learning) pedagogy and emphasize the importance of structural (by preparing learning material) or personal guidance, KM envisions an organizational memory or organizational knowledge base into which the individual's knowledge is supposed to be made explicit and which is the basis for (more or less unguided) knowledge transfer[347].

This separation is not only the case in the research environment, but also in business practice. In large organizations, e-learning and KM are institutionalized in different organizational units, information systems as well as attitudes towards handling knowledge. A more formal, elaborate and resource-intensive training approach with pre-defined courses contrasts a less formal, leaner approach, e.g., “harvesting” knowledge in projects and directly handing it on to an unspecified tar-

347. See section 7.2.1 - “Types of contents” on page 282, Maier/Schmidt 2007.

get group without much effort put into validating it, didactically refining it or examining success of the learning processes.

Due to the fact that both, KM and e-learning are approaches that intend to improve construction, preservation, integration, transfer and (re-) use of knowledge and competencies, the latter is integrated here as a KM instrument being well aware of the fact that one could elaborate much more on distinguishing a variety of different approaches within e-learning that might be considered as individual KM instruments in their own right[348].

Good/best practices. Lessons learned target project experiences and their reasons, but ideally make no statement about how processes should be adapted considering these experiences. The sharing of (good or) best practice is an approach to capture, create and share experiences in a process-oriented form as e.g., procedures, task flows or workflows. This term in a wide meaning denotes "any practice, knowledge, know-how or experience that has proven to be valuable or effective within one organization that may have applicability to other organizations" (O'Dell/Grayson 1998, 167). As managers might argue about what exactly is "best" in a practice, several organizations use different levels of best practice, e.g., (1) good (unproven) idea, (2) good practice, (3) local best practice, (4) company best practice, (5) industry best practice (O'Dell/Grayson 1998, 167). These categories reflect the scope in which the corresponding practice has proven to be valuable or has been selected as the best in a bunch of candidate practices. Thus, the categories might be structured along the structural organizational design into team/work group best practice, unit best practice, subsidiary best practice, company best practice, group[349] best practice or industry best practice.

So-called best practice teams are permanent institutions within an organization's networking infrastructure. They provide guidelines about what constitutes good or best practices and support identification, transfer, implementation, evaluation and improvement of practices (O'Dell/Grayson 1998, 161). Goal is continuous process improvement, so employees have to be encouraged to make suggestions for good practices. Best practices ultimately may lead to redesigned standard operating procedures, core and support business processes and knowledge processes.

Communities. Community management[350] targets creation and fostering of communities or knowledge networks. Communities differ from knowledge networks with respect to who initiated their foundation. Communities are founded by like-minded people (bottom-up) and can at most be fostered by the organization. Knowledge networks are established and legitimated by management (top-down). However, organizational and ICT measures to foster communities are the same as

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348. Examples are development of courses with certification, peer or informal learning or self-managed, ad-hoc learning.
349. In the sense of a group of companies belonging to the same concern, e.g., the BMW Group.
350. See also section 6.1.3 - "Groups, teams and communities" on page 177.

the ones used to support knowledge networks. Communities per definition can not be controlled or externally induced. However, organizations can provide employees with time and space to share thoughts, establish IT tools, e.g., community builder or home spaces, blackboards, Wikis or other forms of specifically designed content management system that support exchange of thoughts and create new roles like community managers that help keeping discussions going and look for important topics that should gain management attention.

Knowledge process reengineering. Knowledge process reengineering (KPR) aims at redesigning business processes from a knowledge perspective. The term references the field of business process reengineering (BPR) that aims at fundamental (process innovation) or evolutionary (process redesign) changes of business processes in organizations with the goal to increase organizational effectiveness. In addition to traditional BPR instruments, knowledge-intensive business processes are partially improved by KPR. The focus is on designing knowledge processes that connect business processes, defining cooperation scenarios, improving communication patterns between employees, as well as on "soft" skills or an organizational culture supportive of knowledge sharing (Davenport et al., 1996). Business processes are modeled with the help of modeling techniques. The models are stored in model bases. The model base can be expanded so that it handles not only knowledge about the process, but also knowledge created and applied in the process. This is termed process warehouse which can be used as a foundation for systematic knowledge process reengineering. Examples for contents in process warehouses are exceptional cases, case-based experiences, reasons for decisions, checklists, hints, frequently asked questions and answers, potential cooperation partners or suggestions for improvements.

6.3 Process organization

This section discusses knowledge management tasks (section 6.3.1) which can be combined in knowledge management processes (section 6.3.2).

6.3.1 Knowledge management tasks

Generally, there are a lot of approaches that view KM as a life cycle of knowledge tasks or a complex organizational "function" that designs, implements and evaluates a set of knowledge management tasks. Goal of knowledge management is to improve these tasks in the sense of organizational effectiveness and performance. The list of tasks provided in the literature comprises a large number of knowledge-related tasks. Examples are[351]:

- creation, building, anticipation or generation;
- acquisition, appropriation[352] or adoption;
- identification, capture, articulation or extraction;
- collection, gathering or accumulation;
- (legally) securing;

- evaluation or validation;
- conversion;
- organization, linking and embedding;
- formalization;
- storage;
- refinement or development;
- distribution, diffusion, transfer or sharing;
- presentation or formatting;
- application, deploying or exploiting;
- review, revision or evolution of knowledge.

In the following, a subset of these tasks will be described that deals with, involves or is supported by KMS and, at least at the current state of practice, is carried out by a person or a collective.

Knowledge identification. Main goal of knowledge identification is to make the organization's knowledge assets visible. These are for example the employee's skills, networks of experts, organizational competencies, but also the knowledge sources, such as data and document bases. Knowledge identification not necessarily stops at organizational boundaries and thus might also comprise the identification of industry best practices, competencies of experts and consultants outside the organization, on-line data bases as well as literature, such as books, magazines, studies and reports and thus provides the basis for *knowledge acquisition*. Once knowledge is identified, it can be organized, published and distributed in order to be applied wherever it is useful (reuse). Knowledge identification is a permanent task as skills and competencies evolve. A KM initiative might also start with an effort to identify the organization's core competencies and thus provide an initial knowledge structure that evolves as it is used to organize knowledge. Some authors use the term *capturing of knowledge* (e.g., Nissen et al. 2000, 25) which reflects knowledge identification as well as documentation (or codification) and storage. This task is basically supported by (knowledge) modeling and mapping technologies[353].

Knowledge acquisition. Knowledge is acquired from outside the organization. There are numerous alternatives for this task that mainly fall into three categories.

351. Wiig 1988, 104ff, Albrecht 1993, 86ff, Schüppel 1996, O'Dell/Grayson 1997, 11, Ruggles 1997, 5ff and 77ff, Allweyer 1998, 39f, Choo 1998, 18ff and 105ff, Davenport/Prusak 1998, 115ff, Mentzas/Apostolou 1998, 19.3, Probst et al. 1998, Rey et al. 1998, 31f, Tuomi 1999, 341ff, Bhatt 2000, 17ff, Nissen et al. 2000, Pawlowsky 2000, 115ff, Roehl 2000, 154ff, Alavi/Leidner 2001, 115ff, Bhatt 2001, 71ff, Mertins et al. 2001a, 3f; see also section 4.1.4 - "Definition" on page 52.
352. Tuomi uses the term appropriation to denote the generation of knowledge that is available within the society but which is new for the learner, in this case the organization (Tuomi 1999, 342).
353. Section 7.4.3 - "Discovery services" on page 322.

The first category contains the permanent or temporary *engagement of experts*, e.g., the hiring of talent and experts, the engagement of professional services companies, the development of joint ventures, strategic alliances, virtual organizations, the merger with or the acquisition of companies that hold competencies required.

The second category of alternatives is to gain *access to documented knowledge*, e.g., in the form of scientific and practitioner literature, e.g., patents, licenses, books, journals, reports, access to on-line data bases of professional information service organizations.

The third category is the *participation in knowledge-related events and processes*, e.g., conferences, workshops, meetings, fairs, exhibitions, research projects, benchmarking groups, industry organizations or industry best-practice groups, etc.

Whereas the first category is predominantly either a matter of strategy and corporate planning or a matter of HR management, the second and third categories are targeted and organized systematically by the KM initiative in many organizations.

Knowledge creation. Complementary to *knowledge acquisition* knowledge is created within the organization which provides e.g., new skills, ideas and improved organizational processes and competencies. Knowledge creation is also called *knowledge construction*. Knowledge is primarily created due to processes of individual and collective learning that cannot be "managed" but supported not only with the help of specialized R&D units and projects, but also with instruments that support creativity, e.g., by providing room for ideas and interaction and tolerate errors throughout the organization, and last but not least a creativity-supporting organizational culture. Examples for ICT supporting knowledge creation are creativity support functions provided in GSS and Groupware[354].

Knowledge organization. Once a knowledge element is created, it can be linked to other knowledge elements. Knowledge is valued by individuals or by collectives, e.g., communities and thus selected for documentation and storage. The main product is an organizational knowledge structure, an ontology, a knowledge map or a set of these instruments. After the initial set up of a knowledge structure which is part of a concerted effort of knowledge identification, it is updated or extended each time a new knowledge element requires an alteration of the structure. The knowledge structure is visualized with the help of knowledge mapping technologies[355]. Thus, knowledge elements can be classified and integrated into the existing knowledge structure, linked to other knowledge elements etc.

Knowledge publication. The process of publishing knowledge that can then be distributed to knowledge seekers using push and pull technologies is one of the most widely researched area of KM. Knowledge publication involves the *codification of knowledge*, i.e., in a general sense, putting knowledge in various forms that

354. See section 7.1 - "Technological roots" on page 273.
355. See section 7.4.3 - "Discovery services" on page 322 and section 7.4.4 - "Publication services" on page 326.

can be stored and thus retained, leveraged and transferred (Ruggles 1997, 6). In Nonaka's terms knowledge publication is a form of *articulation* or *externalization* (Nonaka 1991, 98f, Nonaka 1994, 18f) This can be documentation and formalization of knowledge using AI or more traditional technologies, but also structuring and organizing it. As with most tasks in knowledge management, knowledge can be published in various degrees of centralization such as entirely centrally e.g., by a KM department or a group of knowledge brokers or decentrally directly by the participants or both. In the latter case, the *release of knowledge elements*—the formal approval or institutionalization—is an important step in the publication process. In this case, knowledge documents are submitted to an expert or a group of experts in order to be reviewed so that quality and organization is maintained. Knowledge publication is supported e.g., by content management systems or Web publishing systems[356].

Knowledge distribution. Knowledge distribution is also called knowledge diffusion, dissemination or transfer. It comprises the systematic processes of bringing knowledge to the employees who need it (knowledge push) as opposed to knowledge search and retrieval that comprises knowledge being searched for by the employees (knowledge pull). Both knowledge tasks together primarily support *internalization* of knowledge (Nonaka 1991, 98f) at the receiving end of the push and pull processes. Another alternative forum for knowledge distribution applied widely by large organizations, such as Ernst & Young, Siemens and DaimlerChrysler, is a so-called organization-wide *knowledge fair* (Davenport/Prusak 1998, 190f). In this fair, all groups, teams and communities that work on KM-related projects can exhibit their work. All employees interested in KM can visit the fair, collect material, network, meet experts and thus knowledge is distributed. Technologically, knowledge distribution is not only supported by knowledge push technologies such as Listservers or information subscriptions, but also by the whole set of learning support technologies: e-learning platforms and learning management systems[357].

Knowledge search and retrieval. Search and retrieval is initiated by the participants (knowledge pull). The boundaries are not clear-cut, though, because it is also the participants' initiative that is required to start information subscriptions e.g., by providing an interest profile or sending an email to a listserver. In most cases, participants will search for knowledge on their own. However, there might also be roles (e.g., knowledge broker) that are specialized in professionally searching the organization's and external knowledge assets and thus provide a value-added search service. Knowledge search and retrieval can be supported by knowledge maps which are the results of the task *knowledge organization*, by recommendations and comments of other participants and experts (recommendation systems) and by search engines[358].

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356. See section 7.4.4 - "Publication services" on page 326.
357. See section 7.4.6 - "Learning services" on page 331.

Knowledge application. Application or usage of knowledge is the ultimate goal of knowledge management[359]. Knowledge that is created or acquired and then organized, published or otherwise distributed should be reused wherever it is useful. Knowledge is applied e.g., in projects or business processes. However, a number of *barriers* prevent participants from applying knowledge not created within their organizational unit, most of which are psychological factors, such as fear from lowered own status of expertise, resistance to change, cultural and language barriers (e.g., Probst et al. 1998, 269ff). Organizational instruments have to be applied in order to lower these barriers and create incentives for the reuse of knowledge not invented in the respective organizational unit. The application of knowledge also provides feedback for *knowledge evolution*. All KM technologies ultimately aim at a support of the application of knowledge, especially search and retrieval systems and all visualization systems that provide context for a translation of the knowledge into the current application situation.

Knowledge evolution. Knowledge evolution comprises all tasks that aim at an improvement of already existing knowledge. Participants might comment existing knowledge in order to assess its usefulness or in order to report experiences with its application. Subject matter specialists might refine knowledge, translate it, summarize it, provide additional context, explain terms and definitions or repackage it for the use by different groups of users, e.g., novices as opposed to experts or functional departments as opposed to IT. Also, knowledge decentrally published by participants might be evaluated by knowledge quality management that assures the quality of the content and the documentation. Another important task assures that the knowledge is timely, relevant and actualized. Knowledge evolution can be supported e.g., by workflow management functionality (quality management) and by automatic checks of links and document expiration dates.

Knowledge deletion & archiving. Irrelevant or outdated knowledge has to be systematically removed from the organization's active knowledge base, such as outdated reports, dead links or obsolete themes and topics. The selection of the knowledge to be deleted or archived is an important task as otherwise the organizational knowledge base is cluttered with outdated or even wrong documents, links or structures making it less efficient for employees to retrieve the knowledge needed. As deletion and archiving can be viewed as special forms of knowledge evolution, it can be supported by the same ICT technologies than mentioned before.

Knowledge selling. Knowledge selling is the counterpart of *knowledge acquisition*. In many organizations knowledge products and knowledge services can be offered on the market. Examples are patents, licensing, consulting services, reports and studies. More recently, especially professional services companies also demand fees for access to their KMS and knowledge bases (e.g., McKinsey & Co.,

358. See section 7.4.3 - "Discovery services" on page 322.
359. Application of knowledge sometimes might mean not to take any action.

Ernst & Young). The task knowledge selling comprises securing results of organizational R&D as well as the management of appropriability of profits which can be subject to bargaining, e.g., with business partners, such as customers, suppliers or distributors, and employees[360].

Collaboration. Collaboration aims at a transfer and joint application of knowledge by direct interaction within a collective of participants. It is closely related to *socialization* (Nonaka 1991, 98f). Collaboration is primarily supported by interactive KMS and maps of skills and experts, yellow pages, skills directories, expert finder, generally by synchronous communication and collaboration tools and Groupware[361].

Knowledge (management) processes in the sense of service processes for core business processes in a process-oriented organizational design require the combination of several of these KM tasks and their embedding in or connection to the organization's business processes (Remus 2002, 118ff).

6.3.2 Knowledge management processes

Generally, process management refers to the explicit design and management of business processes, an approach that has received wide attention since Hammer and Champy's best-seller on business process reengineering (Hammer/Champy 1993). In the course of the development of a variety of approaches to implement BPR concepts, a number of modeling methods and ICT tools have been developed. These methods and tools support the explicit design of business processes and of information and communication systems supporting these business processes (e.g., on the basis of workflow management systems)[362]. Recently, there have been a number of attempts to integrate process management and knowledge management reported in the literature[363]. The term *process* is used with respect to knowledge management in at least the following three connotations:

Knowledge-intensive (operative) business process. This term denotes a business process that relies substantially more on knowledge in order to perform the development or production of goods and services than a "traditional" business process (Allweyer 1998, 44). Knowledge-intensive business processes can either be core processes or service processes. Most process-oriented KM approaches propose to concentrate KM efforts, activities and instruments on the improvement of the (most) knowledge-intensive business processes (e.g., Remus 2002, 108). Depending on the individual organization's core competencies, every type of business pro-

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360. See section 5.1.1 - "From market-based to knowledge-based view" on page 94.
361. See section 7.4.5 - "Collaboration services" on page 327.
362. See section 6.6.1 - "Process modeling" on page 240.
363. Examples are Davenport et al. 1996, Allweyer 1998, Warnecke et al. 1998, Föcker et al. 1999, Schreiber et al. 1999, Warschat et al. 1999, Weggemann 1999, 223ff, Bach 2000, Merali 2000, Nissen et al. 2000, Hoffmann et al. 2001, Abecker et al. 2002, Dämmig et al. 2002, Remus 2002, Maier/Remus 2001, 2002, 2003, Strohmaier 2003.

cess is a potential candidate for a knowledge-intensive business process. An example of a typology of business processes distinguishes between operating processes and management & support processes[364]. Operating processes are (1) understand markets and customers, (2) develop vision and strategy, (3) design products and services, (4) market and sell, (5) produce and deliver products and services, (6) produce and deliver for service organizations and (7) invoice and service customers. Management & support processes are (8) develop and manage human resources, (9) manage information resources and technology, (10) manage financial and physical resources, (11) execute environmental, health and safety management program, (12) manage external relationships, (13) manage improvement and change. Determining the type of knowledge-intensive business process might be useful to decide what kind of KM instruments could be applied to improve the business process (Heisig 2002, 62).

There have been several approaches to operationalize knowledge intensity. Examples are vague goals and outputs that cannot be entirely planned, process complexity, i.e., many branches, parallel or iterative subprocesses, long duration, many variations and/or exceptions in the business process, weak structure, many qualitative decisions, many persons, experts, organizational units, disciplines involved, the need for highly valuable skills and competencies, complex relationships to other processes, the diversity and uncertainty of inputs and outputs, the share of data, information and knowledge-intensive products and services as part of inputs and outputs etc.[365].

Knowledge process. A knowledge process refers to a dedicated service or support process which supports the flow of knowledge within and between knowledge-intensive operative business processes, e.g., due to the systematic collection, refinement, storing and distribution of knowledge[366]. Examples for knowledge processes are:

- the *submission process* for new knowledge elements, also called the *knowledge asset creation process*, might start in a project, be evaluated by a community, reviewed, refined and linked by a subject matter specialist and finally several

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364. This typology is based on Porter's ideas of the value chain and was primarily developed by the American Productivity and Quality Center, URL: http://www.apqc.org/free/framework.cfm and http://globalbestpractices.com/ (see also Abecker et al. 2002, 8, Heisig 2002, 62).
365. .E.g., Eppler et al. 1999, Goesmann 2002, 61ff, Heisig 2002, 56, Nägele/Schreiner 2002, 29, Remus 2002, 108ff).
366. There is no agreement in the literature concerning the definition of knowledge process. For example, Allweyer (1998, 44) uses the term "knowledge process" to denote both, knowledge-intensive business processes as well as "specific" knowledge processes the main aim of which is to process knowledge. Bach (1999, 65) uses the term "knowledge management process" for separate processes to support knowledge management, e.g., knowledge distribution or development of knowledge. Many authors also do not distinguish between the terms knowledge process, knowledge task, knowledge function or knowledge activity (see also section 4.1.4 - "Definition" on page 52).

submissions might be turned into a new methodology by an expert team (e.g., Schubert 2000, 7),

- the *search process* identifies and connects several steps of a search for knowledge elements and/or experts,
- the *knowledge acquisition process* defines the acquisition and establishment of organization-external knowledge sources,
- the *knowledge push process* handles the creation of participant-specific interest profiles and the subsequent direction of news, new knowledge elements as well as links to events, meetings and/or experts that are potentially interesting for that participant,
- the *community management process* fosters the establishment and moderation of communities,
- the *maintenance process of the organizational knowledge base* deals with continuous improvement of the KMS, both, technically and organizationally, and also comprises the refinement, repackaging, replacement, deletion or archiving of knowledge elements.

Knowledge management process. The KM process can be viewed as a kind of "meta"-process (Hoffmann et al. 2001, Staab et al. 2001, 5) that is responsible for the implementation of the KM initiative, the design of organizational and ICT instruments as well as for knowledge controlling and knowledge process redesign. In other words, the knowledge management process administers and steers the knowledge cycle in an organization and comprises goal setting, implementation and evaluation of the organization's KM initiative (Probst et al. 1998, 54ff).

Figure B-25 shows an example of a typical knowledge process which can be formally defined in an organization as a service process.

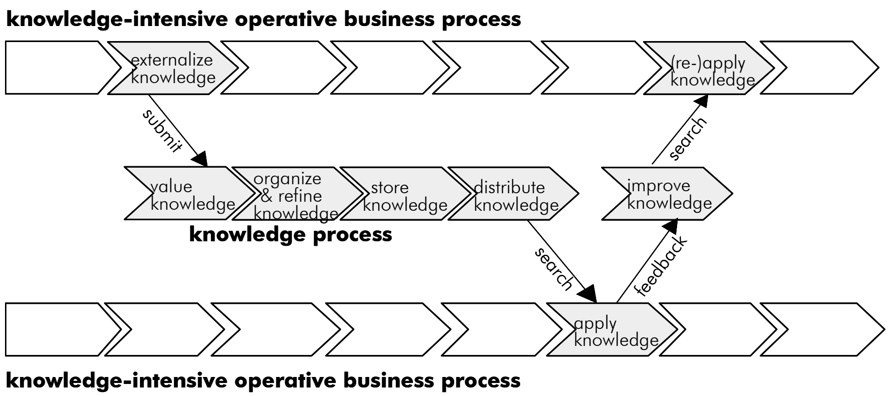

FIGURE B-25. Knowledge process and knowledge-intensive business process[367]

367. This figure is based on Remus 2002, 121.

The knowledge process starts with the creation of knowledge within a knowledge-intensive business process. The knowledge created is then first valued, e.g., by a subject matter specialist, a knowledge broker or a community. The subsequent step adds value to the knowledge in that it is e.g., classified, structured, formatted, linked to other knowledge elements or contextualized. Then, the knowledge might have to be stored, no matter whether the knowledge element is a document or a link to an expert. Then it is distributed to participants that are potentially interested (knowledge push) or it is retrieved in the course of a search initiated by participants (knowledge pull) before it can be applied either within the same business process or, as depicted in Figure B-25, in a different business process. The experiences made during the application of knowledge are then collected as feedback and used to improve the knowledge so that it is kept actual and relevant, links to participants who have recently applied the knowledge can be updated and the degree to which it has proven successful in application can be evaluated systematically. This cycle of search, application, feedback and improvement can be repeated and involve several business processes.

A comparison of the approaches to a process-oriented knowledge management provides the following levels of intervention which are targeted by these approaches (also Remus 2002):

- *goals and strategy*: KM goals, KM strategies, relations to business goals[368],
- *organization*: design of organizational structure, tasks, processes, roles, projects etc.,
- *culture*: organizational culture, group cultures, national cultures,
- *themes and topics*: taxonomies, knowledge structures, ontologies, types of knowledge, especially process-oriented knowledge,
- *participants and communities*: human resource management, community management, incentives and motivation, personalization,
- *instruments*: KMS, services, organizational and technological infrastructure,
- *environment*: markets, business models, business partners, business processes.

However, none of the approaches so far considers all of these levels[369]. There is still some way to go until the well-established methods and tools for business process reengineering in general and business process modeling in particular[370] can be applied with KM in mind.

Two typical situations for the implementation of process-oriented KM concepts can be distinguished (see Figure B-26)[371].

1. *Process management initiatives*: These are initiated by an organizational unit or project responsible for process management and expand their perspective

368. See also section 5.1.3 - “Process-oriented KM strategy” on page 108.
369. See the detailed comparison provided by Remus 2002.
370. A well known example for a method for process modeling frequently used especially in German organizations is the event-driven process chain supported by the ARIS toolset (see URL: http://www.ids-scheer.de/); see also section 6.6 - “Modeling” on page 237.
371. See Maier/Remus 2002, Remus 2002.

towards KM. Examples are modeling business processes to improve process visibility or analyzing business processes in terms of knowledge process reengineering (KPR) (Allweyer, 1999) The documentation, monitoring and controlling of business processes are often supported by a process management system and documented in a process warehouse. The process warehouse can be expanded with KMS functions in order to manage not only knowledge about the process, but also knowledge created and applied in the process. Process visibility is often the starting point for business process reengineering. In addition to more traditional BPR instruments, knowledge-intensive business processes are partially improved by methods such as KPR. KPR often focuses on the communication structure between employees, on “soft” skills or an organizational culture supportive of knowledge sharing (Davenport et al., 1996).

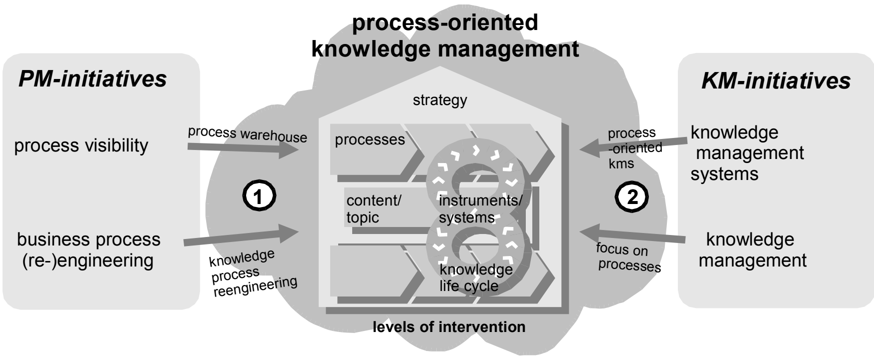

FIGURE B-26. Starting points for process-oriented knowledge management[372]

2. *KM initiatives*: The other situation is a KM project with a strong focus on (knowledge-intensive) business processes. One typical starting point would be the implementation of a KMS to support one or more business processes. An example is to customize commercial KMS (i.e. KM portals, KM suites) so that they support processes specific to the organization, e.g., the R&D process. Besides this technology-driven approach, a more comprehensive KM initiative sets a stronger focus on the organizational design, especially processes. It implements KM instruments, such as content management, lessons learned or employee yellow pages. In a process-oriented view, these KM instruments would be designed and implemented as knowledge processes or lead to a redesign of knowledge-intensive business processes.

Summing up, the integration of process orientation and knowledge management provides for a promising research direction for knowledge management. The implementation of process-oriented KM strategies can either start from a process management or from a knowledge management initiative and comprises the com-

372. Source: Remus 2002, 205.

bined assignment of instruments from both fields to knowledge and business processes on the levels of intervention strategy, (process) organization, contents, instruments and systems. Vendors of KMS will have to consider business and knowledge processes and their realization in e.g., process-oriented navigation structures, contextualization, profiling and filtering tools, and the implementation of knowledge processes with the help of workflow components of KMS. In the following, an example shows how process-oriented KM strategies can be implemented.

6.3.3 Example: Process-oriented KM

The following example reviews a project to implement KM for the transaction business of one of the five largest German universal banks[373]. Transaction banks offer services to handle the securities business and payment transactions. Traditionally, transaction banks were developed as organizational units of large universal banks in order to fulfil back office tasks. Generally, back office tasks have no direct interaction with customers. Recently, transaction banks have been outsourced so that they can offer their services independently on the market. Continuous quality management (QM) is required to handle operative risks and massive amounts of transactions. In this situation, a new project was set up that should extend QM in order to improve knowledge sharing within and between the core business processes of the organizational unit. The project was initiated on the basis of positive experiences gained in a QM project which used business process modeling techniques.

The project team consisted of members of quality management, process management and representatives of functional departments. Additionally, workshops and interviews brought in ideas from human resource management, experts in functional departments and representatives of the IT unit. These workshops and interviews were supported by one of the master students of the Dept. of Business Informatics III at the University of Regensburg for which the author worked during that time. The conceptualization was supported by the author and by Remus who also consulted the bank on a regular basis.

Firstly, some knowledge goals were defined. Besides typical knowledge goals, like *improve knowledge transparency*, *reduce knowledge losses* or *improve training of newly recruited employees*, the project also emphasized the strong link to business processes. Typical process-oriented goals were *improve knowledge flows within business processes*, *improve process visibility* or *document knowledge relevant for tasks in business processes*.

Some of the business processes involved in this project had already been modeled in the preceding QM project. After initial workshops to evaluate practical approaches to introduce KM, the project team decided to apply a process-oriented KM approach. One of the central ideas was to design a reference model which was used as a blueprint for the subsequent implementations of process-oriented KM in

373. A previous version of this section was presented in Maier/Remus 2003.

decentral units. The project team designed a landscape of reference processes and activities. Process owners could then adapt their business processes with the help of these reference processes. All relevant business processes will be "equipped" with KM activities. Currently, the design of reference processes has been completed and one business process has been selected as a pilot for the implementation. In the following, some of the main activities performed on the four levels of intervention strategy, contents, instruments/systems as well as organizational design will be discussed. Thus, the example gives a complete account of the implementation of a process-oriented KM.

Strategy. The transaction bank represents a strategic business unit of the universal bank. The critical success factor and also the core competence of this unit is to control operative risks. The business strategy of the transaction bank has been derived from the general business strategy of the universal bank. This strategy is primarily resource-oriented. Market-oriented factors will be considered because the transaction bank plans to extend its operations to include customers external to the universal bank. Until then, the resource-based view plays a crucial role in the definition of knowledge goals. There was no explicit KM strategy. Instead, the project was defined by the knowledge goals described above and approved by the business unit's executives. Project management was handled by an organizational unit called quality management.

Contents. The relevance of documenting process knowledge had already been realized during the QM project. In the KM project, process knowledge was not only seen as codified knowledge, embedded in documents like process models, but also embedded in the heads of employees working in these processes. Nevertheless, there was a strong focus on codification. Access to implicit knowledge was supported by expert directories. Neither communities nor networks of experts were supported. Consequently, knowledge about processes was identified, collected and explicated in the form of process models. Then, these process models guided the identification of knowledge created and applied within the processes which was also collected and explicated in a knowledge audit. Actual and planned supplies of knowledge were analyzed and assigned to the tasks in the process model. The knowledge structure was derived from the results of the knowledge audit. As mentioned before, processes can provide part of the context that is important for the interpretation and construction of process-relevant knowledge. This context was documented in two forms. Firstly, a topic tree was used to classify and structure knowledge elements relevant to the processes. Secondly, knowledge elements were linked to tasks in processes in the knowledge audit.

Instruments/systems. The project considered a number of typical KM instruments, in this case *skill management*, *content management*, *lessons learned*, *best practices* and *communities/knowledge networks*, as well as an instrument related to *process management* (see Figure B-27).

The continuous knowledge life cycle represented the most important guideline for the identification and design of KM activities and KM processes. KM activities and the instruments were assigned to each other and visualized in the form of an activity landscape. Figure B-27 shows a portion of the activity landscape. The arrows show the relationships between the activities and consequently between the instruments. For example, the KM activities *address knowledge* and *push knowledge* were assigned to the KM instrument *communities/knowledge networks*. With respect to the classification of instruments, there were human-oriented and technology-oriented instruments, but no instruments bridging the gap. The definition of processes integrated both types of instruments.

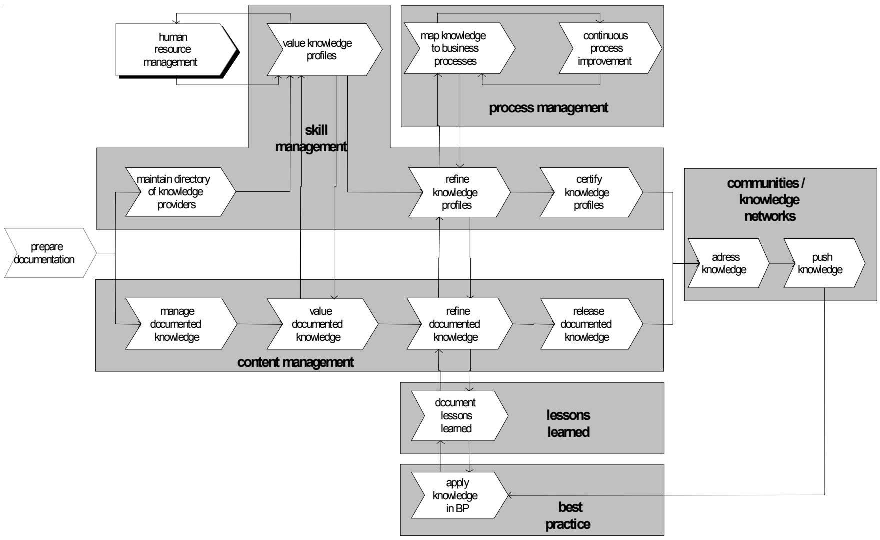

FIGURE B-27. Activity landscape with knowledge management instruments[374]

Organizational design. The structural organizational design in terms of new roles and responsibilities was quite lean due to resource restrictions. Organizationally, the integration between process and knowledge management was accomplished by holding process managers responsible for the operative business processes and at the same time for supervising KM activities in their processes. Also, the new role *knowledge broker* was introduced being responsible for the newly designed KM activities within the business processes. A role which supervises the connections between different business processes like a *network manager* who could link experts across process boundaries was planned, but not yet established. Knowledge processes were defined considering the following guidelines which was a new per-

374. Source: Maier/Remus 2003, 17

spective for the transaction bank: Knowledge had to be the primary process output. Specific KM roles were required for specific tasks in knowledge processes.

A knowledge audit was carried out for those business processes which were intended to be equipped with KM activities in order to identify process outputs and the knowledge requirements of the business processes. The results of the audit were used to define the interfaces between knowledge processes and business processes and/or to embed KM activities in business processes. The KM activities shown in Figure B-27 were combined to the four knowledge processes depicted in Figure B-28: (1) *document knowledge*, (2) *distribute knowledge*, (3) *improve knowledge usage* and (4) *apply knowledge*. The latter was embedded in the business processes.

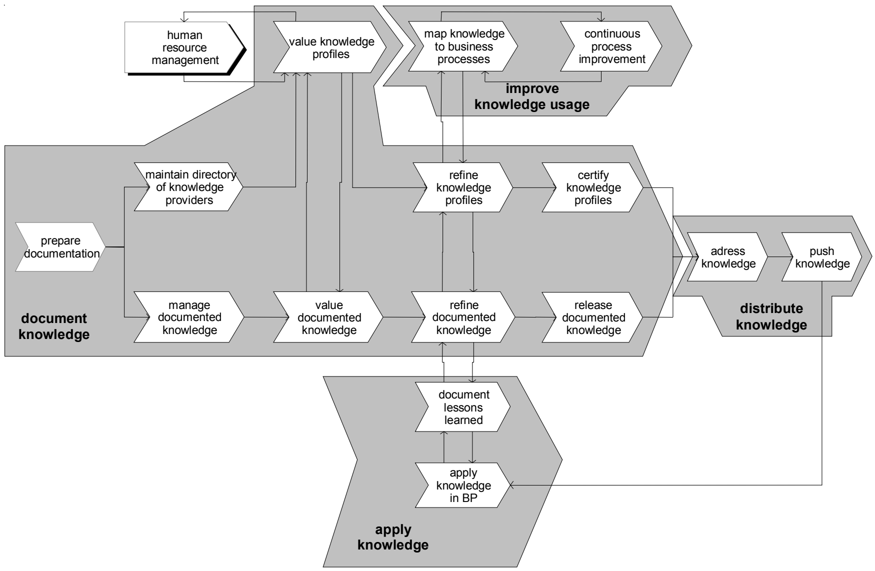

FIGURE B-28. Definition of knowledge processes[375]

The knowledge processes had to be defined on the basis of the assignment of KM activities and instruments (activity landscape). A typical example was the process *document knowledge* which combined the two instruments *content management* and *skill management*. This strong relationship is based on the thesis that content should not be disconnected from persons who create or apply it. In this case, skill profiles were used to filter contents in order to avoid information overload.

Figure B-28 presents only a portion of the entire process landscape of the transaction bank which also has interfaces to other processes, e.g., strategic manage-

375. Source: Maier/Remus 2003, 19

ment, human resource management, the operative business processes or innovation and technology management.

Lessons learned. The example represents a typical KM starter scenario[376] with a core group enthusiastic about the approach, with restricted resources, only a couple of KM roles and basic ICT infrastructure supporting KM. The implementation of a process-oriented KM approach profits from the successful preceding process management project because business processes had been modeled extensively before. Process owners were already used to adapt reference processes. The primary focus was at first on content management and an entirely centralistic approach. However, the implementation of the reference processes will be carried out decentrally.

The fact that the KM initiative started in a nucleus, a core group that designed the reference processes, positively contributed to the success of the initiative because quick wins could be shown in one selected knowledge-intensive business process and the measures taken were targeted at real business needs and not at abstract knowledge visions. Still, the transaction bank focuses too strongly on a codification strategy and neglects the potential benefits of integrating instruments of a personalization strategy, such as communities and networks. The project tried to avoid the creation of new KM positions and roles, e.g., a subject matter specialist or a network manager. These additional roles are deemed necessary for a comprehensive rollout of the KM approach. Also, the project will have to adapt the existing KMS infrastructure and extend the reference processes with KMS functions.

6.4 Organizational culture

In this section, first the term organizational culture is reviewed and problems of its measurement are discussed (section 6.4.1) before the focus is set on willingness to share knowledge, the dimension which will be investigated in the empirical study (section 6.4.2).

6.4.1 Definition

There is considerable discussion about the notion of organizational culture. For starters, there is no general agreement on what the term organizational culture describes (Drumm 1991, 164). The term is used in a variety of ways: as a *metaphor*, as an *objective entity* that refers to the organization as a whole or a *set of behavioral and/or cognitive characteristics*[377]. Organizational culture manifests e.g., in artifacts, language, symbols, norms of behavior, heroes, stories, myths, legends, beliefs, values and attitudes, ethical codes, basic assumptions or the organization's history.

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376. For a detailed description see section 17.1 - "Knowledge management starter" on page 599.
377. See Brown 1998, 7ff for an overview of definitions and a classification of approaches.

However diverse the approaches to organizational culture are, there is a certain common core that is connected with the term. The corresponding research is yet another interdisciplinary field, just like knowledge management (Schreyögg 1992, 1526). Organizational culture

- is an *implicit phenomenon*,
- is "lived" and thus *natural and obvious* to the members of the organization,
- comprises *collective orientations and values* that impact the individual's behavior,
- is the result of a *learning process* about how the organization has dealt with the internal and external environment,
- provides *patterns* for the selection and interpretation of behavior and thus provides orientation in a complex world,
- is handed on in a *social process* (socialization).

One exemplary *definition* of organizational culture is as follows: "organizational culture refers to the pattern of beliefs, values and learned ways of coping with experience that have developed during the course of an organization's history, and which tend to be manifested in its material arrangements and in the behaviors of its members" (Brown 1998, 9). Organizational culture thus is a pattern of basic assumptions that have worked well enough to be considered valid, and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to problems of external adaptation and internal integration (Schein 1984, 3).

Organizational culture in general greatly influences how an organization handles knowledge. These effects can be *functional*, e.g., reducing the need for rules and regulations, accelerating decision making and implementing or reducing the amount of work required for supervision, or *dysfunctional*, e.g., a tendency towards a "closed system" that locks off developments in the rest of the world, a lack of flexibility, emotional barriers, collective avoidance of new ideas (Schreyögg 1992, 1531f) as well as dysfunctional communication between and within groups (Frey 2000, 74ff).

A KM initiative therefore has to consider an organization's culture in the decision about the organizational instruments as well as the design and implementation of KMS. There is considerable debate in the literature about whether cultural change can be planned ("*cultural engineers*") or not ("*culturalists*") with yet another group in between that accepts the idea of a planned change in the sense of the initiation of a generally open process of change (Schreyögg 1992, 1534f). The perspective held by the team responsible for the design and implementation of a KM initiative can be anywhere along that dimension. This perspective or understanding of the role of the intervening team greatly influences the selection of the organizational, ICT and other instruments[378].

378. See also Roehl 2000, 253ff for a discussion of implicit assumptions of interventions into an organization's knowledge organization.

Cultural change might also be one of the goals of the KM initiative, e.g., to improve the openness towards new ideas which is often seen as a requirement for a successful management of knowledge (e.g., Rosenstiel 2000, 153f). Interventions as part of a KM initiative might have a profound impact on the organizational culture.

The assessment or *measurement* of organizational culture is a serious problem. In principle, the actual values and assumptions of people about other people, time, space and goals are a lot less observable than official statements about values and indicators, such as stories, symbols, language, clans (Schein 1984, Drumm 1991, 166). Thus, it is unavoidable to investigate the notion of organizational culture indirectly. In the following, the focus will be on one single dimension of organizational culture which is investigated as part of the empirical study presented in part C: willingness to share knowledge[379].

6.4.2 Willingness to share knowledge

Certain aspects of organizational culture can promote or hinder the handling of knowledge in an organization. Von Krogh introduces the concept of *care* which influences knowledge creation (von Krogh 1998). Care is conceptualized to include the following five dimensions (based on Mayeroff and Gaylin, cited from von Krogh 1998, 137f):

- *mutual trust*: Trust compensates for lack of knowledge about other people and is necessary in order to ensure that people can help each other – to give and to accept help.
- *active empathy*: Empathy means that a person can understand another person's situation, interests, skill level, history, opportunities and problems, "active" describes the situation when a person proactively seeks to understand another person.
- *access to help*: Having access to help means that a person needing help is able to find it directly.
- *leniency in judgment*: This dimension of care is especially needed when members of the organization experiment with new solutions and produce errors; leniency means that these errors are not judged harshly which would possibly prevent future experimentation.
- *courage*: Courage means that members of the organization voice their opinions and give (real) feedback as part of a process to help each other.

Von Krogh argues that the process of knowledge creation in an organization is heavily dependent on the level of care (von Krogh 1998, 143). A low level of care leads to individuals "capturing" their knowledge and "transacting" it with expected returns in mind. Thus, individuals gain only limited feedback from others as their

379. The interested reader will find a host of literature on organizational culture. Examples are Schein 1984, Hofstede et al. 1990, Drumm 1991, Sackmann 1992, Schreyögg 1992, Schein 1996, Brown 1998, Frey 2000, Rosenstiel 2000 and the literature cited there.

knowledge creation occurs in a rather isolated way and as they have no interest to share their knowledge. Knowledge sharing is based on expected returns as the members of the organization minimize the risk of sharing non-legitimate knowledge. The opposite – a high level of care – leads to “bestowing” and “indwelling” – individuals creating knowledge in a supportive environment with strong feedback from other individuals which in turn are integrated into “real” teams. Sharing is an accepted way of helping the team to grow.

Apart from a culture-oriented KM strategy focusing on improving care in an organizational context, the level of care has to be considered when designing a KM strategy. Additionally, care is thought of as a concept moderating the effects of a KM strategy on the handling of knowledge. Nonaka and Konno suggest the *concept of Ba* to enhance knowledge creation. They distinguish four types of Ba which reflect the four stages of knowledge conversion (Nonaka/Konno 1998, 45ff):

- *originating Ba*: This is the world where individuals share feelings, emotions, experiences, and mental models. It supports *socialization* and thus the sharing of tacit knowledge between individuals.
- *interacting Ba*: Interacting Ba means selecting people with the right mix of specific knowledge and capabilities for a project team, task force, cross-functional team. The individuals’ mental models and skills are converted into common terms and concepts through dialogue. Thus, interacting Ba reflects the *externalization* phase and thus turning implicit into explicit knowledge.
- *cyber Ba*: This type of Ba describes a virtual space of interaction, supported by ICT systems such as KMS, tele-conferencing or group support systems. It targets the *combination* phase, that is combining explicit with explicit knowledge.
- *exercising Ba*: Focused training with senior mentors and colleagues should support learning by continuous self-refinement. Thus, exercising Ba concentrates on the *internalization* phase that turns explicit to implicit knowledge.

The concept of Ba in general strongly aims at enhancing care in organizations and shows a way to operationalization for different settings of knowledge creation. However, there are still considerable challenges ahead concerning the measurability of such constructs and the effects of the application of organizational and especially ICT instruments on the level of care or the amount of *Ba* in an organization.

From the perspective of the socio-cultural rules employed to guide the sharing of knowledge in an organization *four types of environments for knowledge sharing* can be distinguished (Geißler 1999, 56f):

1. **Law-and-order model:**

   In the law-and-order model, power, rights and privileges determine the practice of sharing knowledge. The power system in an organization standardizes the distribution, sharing and handing-on of knowledge. There is a clear distinction between those who are informed and those who are not. As the power system is subject to organizational design, management prescribes the “ideal” form of the organizational knowledge base in the law-and-order-model. Power is used to enforce this ideal form.

2. **Family culture model:**
   In the family culture model, the sharing of knowledge is determined by interpersonal sympathy and antipathy as well as traditional, unwritten moral obligations. Solidarity ensures that all members of the "family" share the knowledge. As there is no standardization, a family member is at the mercy of the other family members to share in the family's knowledge. The consequence is that there are all kinds of group relations that lead to informal standardization of knowledge and the way of knowledge sharing specific to groups. This eases sharing within groups and hinders sharing between groups.
3. **Market model:**
   In this model, knowledge is considered a resource the value of which is determined based on supply and demand. As opposed to the law-and-order model, it is not the flows of knowledge that are designed with respect to their contents, but the framework in which the market transactions (here: the exchange of knowledge) take place has to be guaranteed. Thus, organizational "deregulation" replaces traditional principles of organization such as privileges and rewards. Deregulation means for example establishing property rights for knowledge, improving transparency through standardization of knowledge and enforcing standards for the quality of knowledge.
4. **Discourse model:**
   In the discourse model, the goal is to achieve "objective" truth, material, normative findings as well as to achieve consensus about the valuing of these findings. The process of the development of knowledge is based solely on the power of convincing arguments. A discursive standardization of the organizational knowledge base thus requires that the members of the organization make their usually divergent mental models explicit, share them and unify them in an ongoing process of exchanging arguments.

These four types reflect *social rules of give and take* and are the main basis for the cultural dimension of sharing knowledge.

Another important factor that has to be considered in KM activities is the *degree of sensitivity of interest* (Frese/Theuvsen 2000, 32ff). This factor is partly influenced by the organizational culture, especially the relationship between the executives and representatives of the employees or unions and the openness of the employees towards organizational change. It is also partly influenced by laws and regulations such as the German "Mitbestimmungspflicht". The two ends of the dimension degree of sensitivity of interest are (Frese/Theuvsen 2000, 33):

- *high degree of sensitivity of interest*: a proactive management of potential conflicts in the course of change is necessary,
- *low degree of sensitivity of interest*: there is no need for conflict management.

KM initiatives have to take into account the sensitivity as it will strongly affect the success of KM measures. In general, KMS and KM initiatives extend existing approaches to survey, supervise and investigate individual behavior which in Germany is regulated by data privacy law. Even in those cases in which regulations do not apply (e.g., the tracking of the headers of emails contributed to newsgroups) employees might be sensitive to the organizations' activities[380].

All of these concepts describe cultural phenomena and their effects on KM. Clearly, in order to improve an organization's level of willingness to share knowledge, a high level of care is desirable. It is not as easy to decide upon the effectiveness of the four types of KM environments. The degree of sensitivity of interest finally shows that KM initiatives have to be careful about the instruments they apply. Employees or representatives of employees should be contacted early on in order to avoid organized resistance to the initiative. Several *instruments* were suggested to make care widespread and sustainable in organizational relationships (von Krogh 1998, 143) or, in more general terms, to instill an open culture:

- incentive system rewarding cooperation or behavior that shows care;
- mentoring programs;
- knowledge sharing and caring behavior as part of employee assessments and career management;
- trust, openness and courage as explicitly stated values;
- training programs in care-based behavior;
- project debriefings and other forms of learning-oriented conversations;
- social events and meetings;
- private contents in KMS that provide context for trusted relationships.

Apart from these rather general statements and hypotheses about a positive influence of incentives and motivational aids on an organizational culture more supportive of KM, systematic studies about the effects of such systems are rare up to now[381].

Measuring organizational culture is a serious problem and has to be assessed indirectly[382]. In the empirical study, the single dimension measured reflecting organizational culture is *willingness to share knowledge*. However, even this portion of organizational culture remains vaguely defined and empirical assessments are rare so far. The approach taken here consequently shows a trade-off between the requirements of cultural investigations on the one hand and the limited amount of effort that organizations are willing to spend on empirical studies on the other hand. The problem is either (1) to perform a rigorous *cultural analysis* which would have required to question or interview a representative sample of employees *per organization* participating in the empirical study and thus would have limited the sample to a handful of organizations at best or (2) to completely leave the organizational culture out of consideration.

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380. See the abundant literature, e.g., published in the German journal "Datenschutz und Datensicherheit, see also the journal's comprehensive Web site on the topic: URL: http://www.dud.de/.
381. See also Döring-Katerkamp 2002 who performed an empirical study on the use of incentives to improve motivation to participate in KM.
382. See section 6.4.1 - "Definition" on page 221.

The compromise taken here was to ask the person completing the questionnaire to answer a set of questions for that portion of his or her organization that the KM initiative was responsible for. As the interviews have shown many of the KM initiatives have studied cultural issues in their organizations, e.g., with the help of employee surveys, interviews and workshops. As a consequence, the respondents might have had a reasonable feeling about the situation in their organizations.

Also, the questions posed in the empirical study used instruments that have been empirically tested before as much as possible. The items used to measure this construct were taken from other studies which dealt with constructs similar to the ones used here. In the following, these studies are briefly described:

Mutual trust, knowledge and influence between line and IS organizations. Nelson and Cooprider developed three constructs measuring shared knowledge, mutual trust and mutual influence between the line organization and the IS organization of companies which in turn are supposed to influence IS performance (Nelson/Cooprider 1996, 416). In their study, key informants were used to assess the level of shared knowledge (5 items), mutual trust (3 items) and mutual influence (6 items). Nelson and Cooprider found that the level of shared knowledge is dependent on both, the level of mutual trust and the level of mutual influence between these organizational units.

Organizational learning culture inventory. Goodman and Darr developed nine items describing what they call the organizational learning culture inventory (Goodman/Darr 1998, 435). The nine items are: sharing of best practices in my office is highly rewarded, sharing of best practices with other offices is highly rewarded, open communications in my office, my office is innovative, sharing of best practices is frequently discussed, sharing of best practices is a major way to solve problems, high communication with other offices, high cooperation in this office, high cooperation between offices. These items are supposed to moderate the effect of computer-aided systems for enhancing organizational learning in distributed environments (Goodman/Darr 1998, 417 and 435).

In the empirical study, the following amalgamated set of items will be used:

- *mutual understanding* of work groups: employees know about the work of other teams/work groups (e.g., about problems, tasks, roles), employees value the achievements of other teams/work groups,
- *mutual trust* of work groups: employees trust each other across teams and work groups,
- *mutual influence* of work groups: influence of teams/work groups on important decisions of other teams and work groups,
- *mutual support* of work groups: employees help each other between teams and work groups,
- *communication between work groups*,
- *help within work groups*: employees help each other within teams/work groups,

- *willingness to learn*,
- *communication within work groups*,
- existence of *incentive systems for knowledge sharing*: material incentives (money), career opportunities dependent on knowledge sharing,
- *approval/acknowledgement of cooperative behavior*,
- *informal exchange of ideas* (e.g., in breaks, at company events, private),
- *design of the decision process*[383].

All in all, 17 statements were used in order to determine these items describing the willingness to share knowledge in an organization. The following hypotheses concerning willingness to share knowledge will be tested in the empirical study:

Hypothesis 9: Employees are more willing to share knowledge within than outside their work environment (group or team)

The "Not invented here" syndrome was frequently reported in the literature, meaning that individuals often show a negative attitude towards experiences made by individuals not known to them. This might also be reflected by a higher willingness to share knowledge within a work group or team as employees know each other better than between groups and teams. Teams or work groups might also often compete with each other. Communities might help to reduce these barriers, though, as common interests and thus an "experienced similarity" between its members might also lead to a higher willingness to exchange knowledge.

Additionally, it is also plausible that members of the organization have more opportunities to share knowledge within their traditional work environment than outside, say, privately or at company events.

Hypothesis 10: The higher the share of newly recruited employees is, the more knowledge exchange is taking place outside traditional work environments

Newly recruited employees need to build social networks within the organization whereas employees who have been with the organization for longer already have had time to build enough social relationships. Thus, newly recruited employees might be able and willing to devote more leisure time to their job engagements and might be eager to build social networks privately with colleagues. This is especially probable if newly recruited employees had to move prior to their new job engagement and thus had to leave parts of their social relationships. Additionally, a "generation factor" might also have the effect that more exchange takes place outside traditional work environments. A large part of newly recruited employees might be within their first couple of years of work, young and childless which might once again positively affect motivation to meet with colleagues outside traditional work environments[384]. The opposite might be true for employees that have already been with the organization for a long time. They have already built up suf-

383. The design of the decision process supposedly varies greatly within and between departments. Thus, it could only be analyzed in personal interviews, not as part of the questionnaire.

ficient social relationships with many of their peers. Maintaining these networks does not require the devotion of as much private time than for newly recruited employees.

More generally, the "right" mixture of experienced knowledge workers who have been with an organization for an extended period of time and thus have built up social networks to a large extent and knowledge workers new to the organization might be a good combination for effective knowledge management. The experienced knowledge workers are networked well and thus take care for a quick dissemination of knowledge in the networks as well as prevent "re-inventing the wheel" and take over knowledge developed anywhere else within the network (exploitation). The knowledge workers new to the organization might help to overcome possible barriers between different networks and integrate knowledge from outside the organization (exploration). The average age of the employees, the average time that they have been with the same organization (and the same department!) and the percentage of new employees per organizational unit might thus be important KM measures that are well worth being paid attention to (see also Sveiby 1997, 263).

Hypothesis 11: A high share of employees leaving the organization negatively affects willingness to share knowledge between groups and teams

In organizations that lay off a large part of their employees, usually the atmosphere suffers. Those employees that have to leave might not be motivated to hand on their experiences. Those employees that remain in their jobs might fear that they can be replaced easily if they share their knowledge. They might think that "knowledge is power" and sharing of that knowledge means to give up power. It is expected that this behavior is most obvious between groups and teams where social relationships are traditionally lower than within groups and teams. Within groups, employees might still be willing to share knowledge because the work group or team may offer a "social home" in times of unpleasant changes.

Hypothesis 12: In organizations with systematic knowledge management, willingness to share knowledge is improved

One of the first activities in most KM initiatives is to raise awareness throughout the organization about the potentials and benefits of sharing knowledge, to build trust between employees and to stress the importance of every employee's knowledge. Thus, these activities might already trigger a change of employees' attitudes towards knowledge sharing because they feel taken seriously (Hawthorne effect, see e.g., Schreyögg 1999, 45f) and because they want to share in the benefits of KM. Moreover, concrete KM measures and instruments might improve an individuals' ability to share knowledge which in turn might positively influence his or her

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384. Recently, this effect has been repeatedly described in articles about start-up companies in the popular press (e.g. DER SPIEGEL). Start-up companies in many cases have been viewed by their employees (who are in their 20s and 30s) as a kind of "family" and boundaries between work and leisure time in many cases have become increasingly blurred.

motivation. Systematic KM can be measured in terms of KM expenses or the number of KM staff per participant as well as the share of employees with access to KM-related systems.

6.5 Other interventions

There are many other KM instruments which can be applied in order to improve the way an organization handles knowledge. Section 6.5.1 discusses some examples for interventions that do not directly involve design and implementation of a KMS, but are nevertheless interesting for enhancing the way of handling knowledge in an organization. Section 6.5.2 presents a the results of a project led by the author for an ICT professional services company which has changed office layouts and implemented an algorithmic solution to assign office space to consultants that takes KM issues explicitly into account.

6.5.1 Overview

The following examples show the wide variety of measures that can be taken as part of a KM initiative:

Architecture. Many positive examples of efficient knowledge sharing praise the kind of informal interaction of employees which takes place on the hallways, in the coffee kitchen, lounge or at lunch etc. An intelligent (physical) space management represents the knowledge flows and arranges the work spaces of those people close to each other who regularly work together (Probst et al. 1998, 226f). Space management can be highly effective and even prove more useful than the most advanced ICT system as good social relationships often are positively correlated with personal encounters. Examples for objects of space management are (North 1998, 264ff, Roehl 2000, 179): the size and sequence of offices, position of secretaries' offices, width and length of hallways, the design of office space and the arrangement of meeting space and meeting rooms. Recently, the virtualization of work spaces has changed requirements for architecture substantially as mobile knowledge workers demand to have a work environment as complete as possible wherever they are (e.g., Lippert 1997). These new requirements lead to new office forms such as nomadic offices, market offices, festival offices, just-in-time offices, non-territorial offices, project offices or so-called business clubs (Kern/Zinser 1997, 101f, Schnell 1997, 85f).

Personnel training and education. In the ILOI study, 83% of the organizations reported personnel training and education as the most important KM instrument for experiences (ILOI 1997, 35). In the Fraunhofer study training and education was also seen the most frequently used instrument for knowledge acquisition (Bullinger et al. 1997, 24).

Recruitment of experts. Organizations might also try to acquire knowledge from outside the organization on a permanent basis by recruiting experts in domains needed (see Hiltrop 1999 for an overview of recent developments in recruitment). However, there are some fundamental difficulties that might arise:

- difficult to find experts and to assess expertise,
- experts are scarce, so that it might be difficult to recruit and retain them,
- difficult to integrate experts into the organization's knowledge networks, culture and processes.

These might be some of the reasons why the organizations responding to the Fraunhofer study rarely used the recruitment of experts for knowledge management when compared to other instruments like cooperations with business partners or personnel training and education (Bullinger et al. 1997, 24). Thus, many organizations tend to hire experts only temporarily or rely on consultants. This approach on the one hand might prove successful in many situations as credibility is often higher for external experts and organizational experts might be more willing to accept and reuse ideas from outside the organization than from within (e.g., Bullinger et al. 1997, 34). On the other hand, it might worsen the difficulties to integrate the experts into the organization's networks, so that core competencies can be built up.

Therapeutic intervention. Some authors suggest that some of the most important barriers to effective knowledge sharing can only be overcome with the help of a targeted therapeutic intervention (e.g., supervision, e.g., Roehl 2000). However interesting this concept might be, the organizational practice in many cases seems to remain quite sceptic about this approach. In the ILOI study, no respondent indicated to use therapeutic interventions as a KM instrument within their organization (ILOI 1997, 35). Nevertheless, in cases in which important knowledge barriers are due to specific interpersonal situations, it might well be that a targeted therapeutic intervention improves the handling of knowledge much more than the best combination of organizational and ICT instruments. Therapeutic interventions are out of the focus of this book[385].

6.5.2 Example: FlexibleOffice

This section provides exemplary insights into the wide range of alternative approaches to other interventions into an organization's way of handling knowledge. The section reports goals, solution and results of an industry project about the implementation of a flexible office solution with knowledge management in mind[386].

The project FlexibleOffice was motivated by the following main observations:

385. The interested reader should consult literature in the realm of systemic organizational interventions. Examples are Königswieser/Exner 1999, for an overview of modern therapeutic methods to guide change processes in organizations e.g., Buchinger 1997, Scala/Grossmann 1997, for supervision, e.g., Pühl 1992, for the use of processes in large groups for organizational change processes, e.g., Königswieser/Keil 2000.

Mobility. Employees increasingly work outside their offices, e.g., at their customers' offices, on the road or at home. In the project, the average percentages of time spent outside the company were determined for all organizational units. It turned out that in one unit, employees spent on average almost 30% of their working time outside the company with a minimum of 14% and a maximum of 55%. This organizational unit was therefore chosen for the pilot study of the FlexibleOffice project. However, other organizational units also had average percentages of time spent outside the company between 14 and 18%, so that in a future step, it is planned to roll out the solution to other organizational units. Economically, the high portion of time spent outside the company leads to many empty offices and thus to inefficiencies in usage of office space. More efficient use of office space could allow for growth without the need to rent additional office space. From a KM perspective, distribution of employees over a number of offices inside and outside the company leads to inefficiencies in communication and knowledge sharing.

Project orientation. Office structures at the company reflect the traditional organizational structure and thus are arranged according to the organizational units built in the business system[387]. Typical for an IT company, projects play an important role and therefore the project system needs to be carefully considered. This company is characterized by a multitude of projects that span organizational units. Both, project managers and project team members suffer from the team being spread over a number of offices and would profit from the possibility to reserve a room for team members for a certain amount of time, e.g., for a project kick-off, for preparation of a milestone result or report, for finalizing a project or for documenting lessons learned.

Knowledge management. The increasing velocity with which new products and services are created, in this case standard software product and consulting services, leads to an also increasing importance of the knowledge base layer. This means that employees improve their competencies, are engaged in learning activities and co-develop themes that run across both, business system and project system, i.e. they span organizational units and also project teams. Flexible offices can systematically take into account the themes on which employees work that will hopefully be turned into successful projects in the future. As a consequence, workplace learning, knowledge transfer between employees working on the same theme as well as

386. This section reports the preliminary findings of a research project led by the author that was carried out together with the IT organization GISA, Halle (Saale) in the years 2005-2006. The project team comprised research assistants Florian Bayer and Stefan Thalmann as well as GISA representatives, particularly the CEO, Michael Krüger, as well as Hendrik Nitz, Michael Feustel and a large number of members of the organizational units who participated in the pilot study.

387. The denomination of organizational systems as business system, project system and knowledge base has been conceptualized as parts of the hypertext organization by Nonaka, Konno, Tokuoka, and Kawamura and presented in the journal *Diamond Harvard Business* in 1992 in Japanese (Nonaka 1994, 32ff), see also section 6.1 - "Structural organization" on page 158.

training of employees new to the job or the theme might be improved with such a solution.

Main goal of this project was to develop a hotelling software that considers mobility, project orientation and knowledge management. Specific characteristics of this software or differentials to standard hotelling software are that the assignment of a work place considers criteria such as project and theme overlappings between employees, preferences of employees and project managers. These criteria should lead to improved communication and coordination in projects, decreased search time, improved knowledge transfer, workplace learning and improved handover of projects between project teams and the organizational units responsible for operation and maintenance of the resulting application systems.

The project was carried out in two parts. The first part comprised the development of a feasibility study and a conceptual plan and the second part consisted of IT implementation and a pilot study to test the software.

In a first step, the situation at the partner company was studied in order to determine a sharing ratio, i.e. the number of employees divided by the number of work places. The investigation included

- literature analysis of relevant case studies[388],
- analysis of documents, e.g., floor plans, organizational structure diagrams, project management handbook,
- reports on times of absence, e.g., travel, holiday and home office days,
- self-reporting in a more detailed way with five employees compiling times being allocated to projects and customers, time spent on the work place, in other offices, meeting rooms, customers' offices etc. and
- personal interviews that helped to refine the information gathered above.

The collected data was used to determine the organizational unit that would be the first to profit from the flexible office (a unit with more than 80% project work), the sharing ratio (1.2[389]) as well as several rules, e.g., clean desk policy or limitations for booking a single work place.

Projects are the most important dimension in this organizational unit. They are prioritized which should also be considered in the assignment of employees to work places. Also, between 30 and 40 external persons are involved in many projects per year, who also need to be considered in the assignment of work places. For the theme dimension, existing skill directories oriented at customer demands as well as technologies by the primary IT partner organization could be reused. A communication analysis supported the importance of project (project system), team (business system) as well as theme (knowledge base layer) dimensions.

From a technical perspective, the flexible office required mobile phones, blackberries, UMTS network access for laptops as well as a remote access solution for

388. See the case studies reported in Zinser 2004.
389. This was the most popular sharing ratio that was found in the literature. This is due to the consideration that it is not cost savings, but KM-related goals that are of primary interest in this project.

home office and customer office access to company servers. The hotelling solution was integrated into the B2E (Business to Employee) information infrastructure on the basis of an employee portal.

The requirements and the conceptual plan developed in the first part of the project were then realized as a prototype software solution in the second part of the project. Seven projects, 35 team members and nine rooms were selected for the pilot study. These employees took over ownership of the FlexibleOffice project and closely and actively participated in the effort to refine both, the organizational and the technical part of the solution.

The prototype software solution consisted of

- input masks for project managers to reserve office space for their projects and for employees to submit their preferences, to apply for home office days and for fixed bookings of those work spaces that have not been assigned automatically,
- the core optimization component for the assignment of rooms,
- output components for visualizing the solution and for notifying employees of the booked rooms.

In the following, the core component is described in some detail. The booking process determines the optimal assignment of work spaces according to the predefined criteria for one work week. All reservations and preferences have to be submitted until Thursday evening in the week preceding the booking week. The results are forwarded to employees on Friday noon.

Criteria have been quantified and the optimization problem has been formalized with the help of standard methods of operations research. The utility function (score) that is optimized consists of a number of weighted factors:

Reservations by project managers. Project managers can reserve a room for one or more employees of a certain project. In case one employee is part of two projects for which managers have made a reservation, she will be assigned to the project with the higher priority. Due to hierarchical legitimation, reservations by project managers are treated separately as a kind of "K.O."-criterion.

Attractive rooms for important projects. Rooms are valued according to the attractiveness estimated by employees on a scale from one, i.e. very unattractive to ten, i.e. very attractive. A project score consists of a project category reflecting the importance of the project and its customer as well as a time-variant score dependent on the state of activity of the project, e.g., start, standard, near milestone, close to finish. These two parts give a project score between 1, i.e. less important project in standard mode, and 9, i.e. very important project in a "hot" phase. Multiplying room score by project score leads to results in which attractive rooms are assigned to important, currently highly active projects.

Project overlappings. This criterion values the relationships between employees with respect to their work in projects. Goal is to assign employees to a single room who share team membership in the same projects in as many cases as possible. Also, employees can submit a project preference stating that it is this project that they will be working on mostly in the booking time frame. This means, that overlappings are exclusively considered with respect to the preferred project. If there are no project preferences, the following formula calculates project overlappings *po* between project team members *a* and *b*:

$$po_{ab} = \left(\frac{\sum_{i \in P} ps_{ai \wedge bi}}{\sum_{i \in P} ps_{ai}} + \frac{\sum_{i \in P} ps_{ai \wedge bi}}{\sum_{i \in P} ps_{bi}} \right) / 2$$

ps_{ai} is 0 if employee *a* is not on project $_i$ and is the project's score if *a* is on project $_i$. $ps_{ai \wedge bi}$ is the project's score if employees *a* and *b* are on project $_i$ and 0 otherwise. Project overlappings are only considered if $po_{ab} > 0.6$ because they are only thought to be relevant if there are sufficient and sufficiently important projects that employees share.

Theme overlappings. Similar to project overlappings, theme overlappings also consider the relationship between two employees according to the themes that they are working on. The assumption behind this is that employees working on similar themes should be assigned to the same room in order to improve knowledge sharing. Again, an employee can submit a theme preference, which in this case means that they would like to sit in a room with a person that has a higher skill level with respect to the preferred theme. In this case, overlappings are exclusively considered with respect to the preferred theme. In all other cases, theme overlappings *to* between employees *a* and *b* are calculated according to the following formula:

$$to_{ab} = \left(\frac{\sum_{i \in P} th_{(a \wedge b)i}}{\sum_{i \in P} th_{ai}} + \frac{\sum_{i \in P} th_{(a \wedge b)i}}{\sum_{i \in P} th_{bi}} \right) / 2$$

th_{ai} is 0 if employee *a* does not work on theme $_i$ and is 1 if *a* works on theme $_i$. $th_{(a \wedge b)i}$ is 1 if employees *a* and *b* both work on theme $_i$ and 0 otherwise. Theme overlappings are only considered if employees have an equal skill level or if *a* has a lower and *b* a higher skill level, but not the other way round.

Group overlappings. Employees can submit a preference for a certain work group. This means that they wish to work with other members of the preferred work group. The corresponding score for work group overlappings *wgo* reflects the number of employees in the assigned room that belong to the preferred work group.

Moving costs. The selected employees showed a strong preference for stability if changes are not too significant. This is why fictive moving costs have been introduced, so that small differences between criteria do not result in a large number of moves between offices without much effect on the utility function. Moving costs also consider room preferences that employees have submitted. Employees can submit a preference for a type of room, e.g., a single office, a room with specific equipment, e.g., a beamer. If the new solution means a move into a room that the employee prefers, then there are no moving costs calculated. If the employee has to move out of a preferred room, moving costs are higher than in the standard case of no specific preferences for rooms.

The optimization problem is solved in two steps. In a first step, the following utility function is maximized in order to get a quick solution that considers the exclusive reservations by project managers. The mathematical problem can be solved with the simplex algorithm. The indices $_i$ and $_j$ in the two summarizing functions determine the matrix holding the decision variable X_{ij} meaning that x employees of project $_j$ are assigned to room $_i$. The only criteria that are considered in the utility function are the weighted multiplication of room attractiveness *ra* and project score *ps*, from which moving costs *mc* are subtracted. Thus, the utility function can be written as follows:

$$U = \sum_{(i \in R)} \sum_{(j \in P)} (X_{ij} \times (\alpha \times ra_i \times ps_j - \beta \times mc_{ij})) \rightarrow MAX$$

Constraints are as follows: elements of the decision variable have to be positive integers, each room has a limited capacity, no more than the number of employees that have been ordered by the project managers are assigned to rooms and projects requested as exclusive do not have to share rooms with other projects.

The second step considers all employees and rooms that have not been exclusively assigned in the first step. The weights of the criteria have been refined in a dozen rounds according to the preferences of the employees participating in the pilot study. The quadratic mathematical problem can be solved with a branch and bound algorithm. The utility function consists of two terms. The first term reflects a matrix of rooms and employees and the decision variable represents the boolean assignment of employee $_j$ to room $_i$ with 1 for assigned and 0 for not assigned. With this term, room attractiveness *ra* is maximized and moving costs *mc* are minimized. The second term reflects a three-dimensional matrix of rooms $_r$ and the relationships between employees $_a$ and $_b$. Thus, the decision variable is 1 if the corresponding two employees are assigned to the respective room and 0 otherwise. The term reflects the weighted[390] criteria project overlappings *po*, theme overlappings *to* and work group overlappings *wgo* which have been explained above. The utility function can be written as follows:

$$U = \sum_{(i \in R)} \sum_{(j \in E)} (X_{ij} \times (\alpha \times ra_i - \beta \times mc_{ij})) +$$
$$\sum_{(r \in R)} \sum_{(a \in E)} \sum_{(b \in E)} (X_{ra} \times X_{rb} \times (\gamma \times po_{ab} + \delta \times to_{ab} + \varepsilon \times wgo_{ab})) \rightarrow MAX$$

Constraints are as follows: elements of the decision variable have to be boolean, each employee is only assigned to one room and each room has a limited capacity.

390. Weights are written in Greek letters.

During the pilot study, all participating employees were asked to fill out short online questionnaires and project managers were interviewed on a regular basis. The results of this study show a typical u-shaped curve concerning user satisfaction with the solution. It started out with high hopes, then some problems with the prototype and also the criteria that had not yet been sufficiently refined led to a decline in satisfaction. However, in the last three weeks of the pilot study, the curves reflecting usability, improvements in communication, efficiency, learning and knowledge transfer all showed a positive tendency. One has to be careful in interpreting these results, though. On the one hand, some participants feared that a flexible office would mean a loss of their personal work space and of their relationships with colleagues. On the other hand, more and more employees in the IT company claimed their interest in participating in flexible office because of the supposed benefits that this would have on their personal productivity and development. Longitudinal studies are required to see whether these personal opinions can really amount to measurable improvements in the dependent variables of this study, namely communication, search efficiency, knowledge transfer, learning and, finally, organizational success.

6.6 Modeling

Models are representations of a selected portion of the perceived reality of an individual or a group of observers. Central to models are their structural, functional or behavioral similarities to the perceived reality (Lehner et al. 1995, 26f). Modeling is one of the key tasks that helps on the one hand to understand, analyze and improve business processes (business process reengineering), organizational structures in general and structures and processes of KM initiatives in particular. On the other hand, modeling supports the design, implementation and management of information systems, in this case of knowledge management systems.

Based on the model of tasks and flows in knowledge management[391], the design of KM initiatives requires the modeling of concepts for

1. *instruments*[392] that have been selected in order to implement the KM strategy and aim at the desired outcome,
2. *processes*[393], the organizational design in which those instruments are deployed, i.e. knowledge tasks and processes, the relationship to business processes, roles and responsibilities,
3. *persons*[394], capturing facts about people as the target group of the instruments, i.e. their profiles, skills, communication and cooperation in organizational units, project teams, networks and communities,

391. See Figure B-25, “Knowledge process and knowledge-intensive business process,” on page 214.
392. See section 6.2 - “Instruments” on page 195.
393. See section 6.3 - “Process organization” on page 207.
394. See section 6.1 - “Structural organization” on page 158.

4. *products*[395], knowledge as object in the sense of themes, the type of knowledge, meta-data, structures, taxonomies and ontologies,
5. *ICT*[396] tools and systems in support of KM, i.e. the KMS architecture that integrates interacting basic services that are composed into advanced KM services.

Figure B-29 shows the most important KM modeling concepts structured according to these four categories and their relationships. The importance of the three main modelling perspectives person, process and product is stressed in Figure B-29 by the shaded triangle that visualizes them as being connected in the middle layer. The strategy-oriented selection of KM instruments on the top determines the modelling efforts in the middle layer whereas the subsequent implementation of ICT forms the ultimate modeling goal and thus limits and streamlines the modeling effort. The five perspectives are connected by a number of concepts.

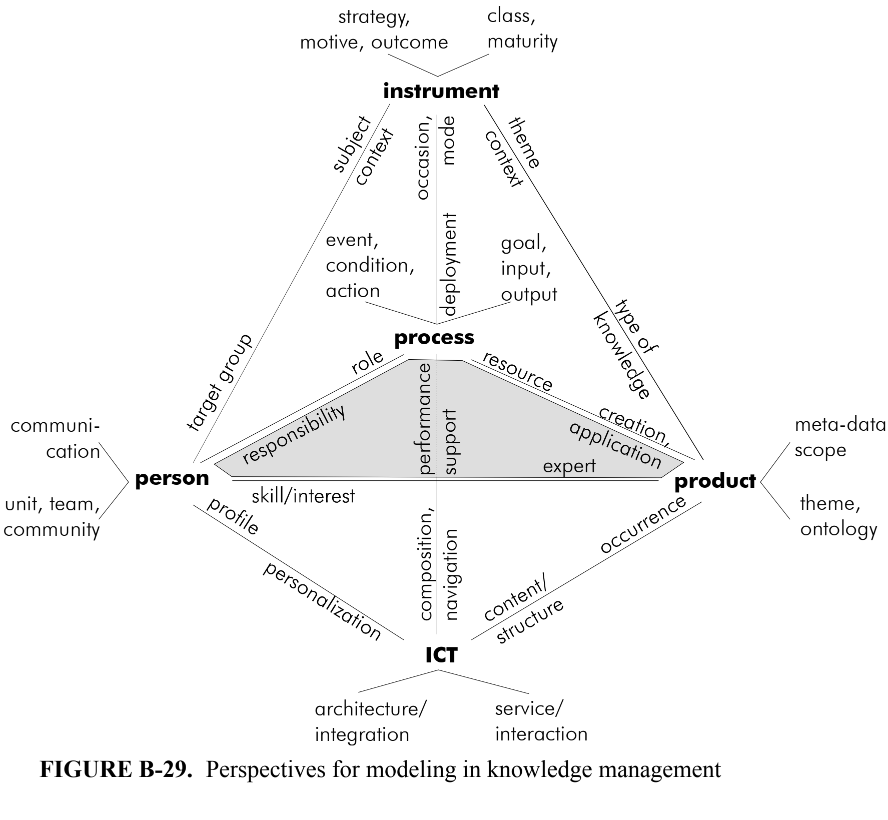

FIGURE B-29. Perspectives for modeling in knowledge management

KM instruments determine the target group in the person perspective and the type of knowledge focused in the product dimension. Processes on the one hand

395. See section 7.2 - “Contents” on page 281.
396. See section 7.3 - “Architectures and services” on page 302.

provide occasions for knowledge-oriented tasks and on the other hand are a primary vehicle for the implementation and deployment of KM instruments. In this view, person and product form subject and theme context for triggering KM instruments in the respective business and knowledge processes.

Persons are involved in processes by responsibilities for tasks and processes and roles that are assigned to tasks. Business and knowledge processes are supported by ICT tools and systems, especially KMS, in order to improve organizational performance. Also, processes can be used to guide composition of services and to aid navigation in ICT resources. Themes and topics in the product perspective are mapped to occurrences, e.g., documents or other resources that are stored in ICT systems. Structures, taxonomies and ontologies can be used as the primary structure of contents of ICT systems. Persons hold skills that are structured as topics and have interest in topics. Experts take care of certain topics in organizations, e.g., subject matter specialists. Processes and topics are connected by the knowledge resources, both in the form of skills and in the form of documents, that are required in business and knowledge processes and by the process context of knowledge, i.e. in which processes knowledge is created and applied, sometimes also called flow of knowledge. Identity management with the help of profiles and personalization techniques are used to support access of contents and services in ICT resources.

In a concrete KM initiative, modeling can be focused according to the two main directions of KM research, human orientation and technology orientation, and Hansen et al.'s (1999) distinction of KM strategies into a personalization versus a codification strategy[397].

In a human-oriented KM initiative, or a personalization strategy respectively, modeling focusses on the perspective person and its links to the product and process perspectives. Skills, interests, experts, roles, responsibilities, communication and social network analysis will be of interest to these KM initiatives.

In a technology-oriented KM initiative, or a codification strategy, modeling primarily is concerned with the product perspective and its relationships to ICT and process. The modelers model meta-data as well as ontologies and design architectures, services, contents and structures of KMS. Services are composed so that they can be deployed with the help of KM instruments to support performance in processes.

In a KM initiative aimed at bridging the gap between human orientation and technology orientation or between personalization and codification respectively, the process perspective is emphasized together with its relationships to the person, product and ICT resources perspectives. The design of knowledge processes and knowledge-intensive business processes with their roles and responsibilities, the types of knowledge created and applied as well as their support by ICT resources is as important as the design of the relationship between persons and ICT resources that supports profiling and personalization of ICT systems for KM.

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397. See also sections 4.1.4 - "Definition" on page 52 and 5.2.3 - "Generic knowledge management strategies" on page 129.

A large number of modeling approaches, methods and techniques have been developed in the literature. Examples are business process modeling, communication modeling, data modeling, data flow modeling, knowledge modeling or object-oriented modeling. Detailed descriptions of these and more modeling methods and techniques can be found in the literature[398]. This section reviews some of the modeling perspectives that have been proposed for KM and discusses their applicability for the design of KM initiatives that use KMS. These are process modeling and its extensions to cover aspects of KM (section 6.6.1), activity modeling, an approach to model ill-structured knowledge activities based on the activity theory (section 6.6.2), knowledge modeling (section 6.6.3) as well as person modeling, including user and role modeling, communication modeling and social network analysis (section 6.6.4). ICT are considered as resources that support or automate activities in process modeling methods, e.g., the execution of workflow definitions, as occurrences and media holding knowledge in knowledge modeling and as tools and systems that allow for profiling and personalization in person modeling. However, there is no specific section on the modeling of ICT resources in this book as existing methods, tools and techniques can be used for modeling this perspective, e.g., object-oriented modeling with UML.

6.6.1 Process modeling

Many organizations have applied concepts of business process reengineering (e.g., Davenport 1993, Hammer/Champy 1993) and a number of methods and techniques to support business process modeling have been proposed in the literature. There are a number of methods and techniques to support business process modeling discussed in the literature. As process modeling is a complex task that requires computer support in order to be an economically feasible approach, most methods are applied with the help of a corresponding tool. Examples are ADONIS (Junginger et al. 2000), the architecture of integrated information systems - ARIS (Scheer 1998, 2001), integrated enterprise modeling - IEM (Spur et al. 1996, Heisig 2002, 49ff), multi-perspective enterprise modeling - MEMO (Frank 1994, 2002), PROMET for process development (PROMET BPR) and for the process-oriented introduction of standard software (PROMET SSW, Österle 1995, 31ff), semantic object modeling - SOM (Ferstl/Sinz 1990, 1994, 1995) or business process modeling methods on the basis of the unified modeling language UML[399] (e.g., Oesterreich et al. 2003). These modeling methods are also called enterprise modeling methods because they integrate a number of perspectives on an organization, e.g., the data, function, organizational structure and the process perspective. Moreover, there is a number of frameworks and reference models for the definition of workflows that imple-

398. A good overview of techniques and modeling methods developed and applied in software engineering can be found in Balzert 2001.
399. UML, the unified modeling language, is a notation and semantics for the visualization, construction and documentation of models for object-oriented software development that has been standardized by the Object Management Group (OMG), URL: http://www.omg.org/.

ment business processes (see e.g., Kumar/Zhao 1999, WfMC 2007). The methods differ in formality, semantic richness and understandability. Basically, the modeling methods fall into two categories:

- methods that primarily aim at the design of organizational structures and processes with the resulting models being a tool for business process reengineering and improvement (e.g., ARIS) and
- methods that primarily aim at the design of information and communication systems, mostly on the basis of workflow management systems and using concepts of object-orientation in a process-oriented view of the organization (e.g., ADONIS or the modeling methods on the basis of UML).

The main challenge in the selection of a method for business process modeling is to balance understandability and ease of use on the one hand and preciseness and formality on the other hand. This is due to the fact that business process modeling is mostly used to design organizational structures and processes on an abstract level or to customize standard software, such as enterprise resource planning software, e.g., SAP R/3, basically by selecting the functions that have to be supported by the software. However, business processes can also be technically supported by workflow management systems which require a much more detailed description of business processes.

Recently, a number of authors have proposed extensions to business process modeling methods, notations or semantics that model (some of the) specifics of KM. Examples are:

ARIS-KM[400]. The architecture of integrated information systems was proposed by Scheer (1992) as a framework for the design and analysis of business processes and the design of information and communication systems in support of these processes. The extensions proposed to ARIS (Allweyer 1998) basically comprise the addition of (1) the object types *knowledge category* and *documented knowledge* and their relationships to activities, persons and organizational units, and (2) the model perspectives *knowledge structure diagram* that shows the relationships of knowledge categories and documented knowledge elements, *knowledge map* that maps knowledge elements to people and organizational units and *communication diagram* that shows which organizational units communicate with each other.

Business knowledge management. The business knowledge management framework, proposed by Bach and Österle (1999, 26), consists of the three layers (1) *business processes*, (2) *knowledge base*, that comprises KM roles, documents, systems and specific KM processes in the sense of service processes to business pro-

400. The ARIS method and toolset is widely used for business process management in the German-speaking countries. The extensions of ARIS for knowledge management are straightforward and pragmatic and yet can be regarded as being representative for many approaches to connect business process management and knowledge management. Therefore, the extensions to ARIS will be discussed in more detail below (see “Example ARIS for knowledge management” on page 245).

cesses, and (3) *knowledge structure*, i.e. the topics and categories of knowledge and their relationships. Topics are created and used in business processes, conceptualized as knowledge flows between business processes, stored in documents and systems, managed by KM roles, refined and distributed by KM processes, and thus mediate between the layers business processes and knowledge base.

The corresponding modeling method, PROMET®I-NET, is based on PROMET and aims at the design of an Intranet-based KM solution, mainly (1) the selection of business processes that use a substantial amount of (semi-) structured knowledge and/or involve a large number of locations which requires coordination and sharing of information, (2) the design of an information architecture which corresponds to the knowledge structure in the business knowledge management framework, (3) the design of an Intranet system architecture consisting of the tools and systems that provide the required functionality, e.g., for classification and structuring of information and knowledge objects, and personalization, and (4) the design of processes that manage the information and knowledge objects in the Intranet (Kaiser/Vogler 1999).

GPO-WM. This method extends the integrated enterprise modeling method and is called the business process-oriented knowledge management method[401]. GPO-WM consists of a procedure model, a model-oriented audit instrument that helps to determine strengths and weaknesses of the current handling of knowledge in the business processes as well as knowledge-oriented criteria and heuristics, all aiming at the design of a process-oriented KM initiative. From a modeling perspective, the extensions comprise (1) new types of resources used in tasks within business processes, i.e. *explicit* (documents, data bases) and *implicit* (persons) *knowledge*, structured in *knowledge domains*, (2) the so-called *basic KM tasks*, i.e. create, store, distribute and apply knowledge, which are identified and analyzed for each activity in the business processes, and (3) *best practices* as elements of construction for a process-oriented KM initiative, e.g., yellow pages, communities-of-practice, customer voice or process-rally, that are linked to activities in business processes.

KMDL. The knowledge modeler description language KMDL is based on the communication structure analysis (KSA)[402] (Gronau 2003). The basic object types in KSA are *task*, *position*, *information* and *information flow*. These basic object types are extended in KMDL in order to cover knowledge-related aspects of knowledge-intensive business processes. The extensions build upon the distinction between explicit knowledge (in documents or data bases) and implicit knowledge (in people's heads) and Nonaka's processes of knowledge conversion, i.e. internal-

401. In German: "Methode des Geschäftsprozessorientierten Wissensmanagements" (GPO-WM, Heisig 2002)
402. Kommunikationsstrukturanalyse, KSA, developed by Hoyer 1988 (cited from Gronau 2003, 11f) in order to analyze information-intensive processes of office information and communication systems.

ization, externalization, combination and socialization (Nonaka 1991, 98f). Consequently, KSA was extended by the additional object types (1) *knowledge object* that covers implicit knowledge in addition to information objects covering explicit knowledge, (2) *person* as an individual that provides and/or seeks knowledge objects and (3) *requirement of a position* that comprises a knowledge object that a position or, more precisely, an owner of a position, must have in order to accomplish the task(s) that are assigned to the position. The four processes of knowledge conversion link information objects and demand and supply of knowledge objects. A consequent application of KMDL is only feasible at a rough level of detail due to the substantial complexity that a detailed study of the processes of knowledge conversion on the level of individual employees would bring. Additionally, KMDL proposes a procedure model that consists of the five activities (1) identification of processes, (2) detailed study with interviews and checklists, (3) modeling, (4) feedback from interview partners as well as (5) analysis of strengths and weaknesses and reporting. This procedure model and the modeling work with KMDL is supported by the tool K-Modeler (Gronau 2003, 23ff).

PROMOTE. The PROMOTE framework, i.e. process-oriented methods and tools for knowledge management, builds on the business process management systems (BPMS) paradigm (Hinkelmann et al. 2002, Karagiannis/Woitsch 2002). The PROMOTE framework consists of a procedure model, a method to design process-oriented KM instruments and a tool that aids the modeling process and is based on the ADONIS toolset. The BPMS procedure model that already covers business processes and process knowledge is extended by functional knowledge and its context. More specifically, the extensions to the BPMS method and ADONIS toolset comprise (1) additional steps in the procedure model, especially the *identification of knowledge flows* which consists of knowledge-oriented modeling of business processes, the description of *knowledge-intensive tasks* including the persons and the organizational memory[403] that provide the knowledge and the determination of *types of knowledge* required in these activities, e.g., functional, rule, experience or case-based knowledge, and the modeling of *specific knowledge processes* that are then linked to knowledge-intensive tasks in the business processes, (2) the new model types *knowledge process*, *skill model* and *topic map* and (3) a PROMOTE engine that executes the knowledge processes. Compared to methods that primarily aim at the design of organizational structures and processes, PROMOTE targets a finer level of detail with the analysis of knowledge-intensive tasks instead of whole processes and primarily aims at the design of KMS, specifically of workflow management solutions that are extended to cover knowledge processes. Consequently, knowledge processes are quite pragmatic and are limited to basic knowledge-related tasks, such as define search context, search for authors or combine results, which can be supported by KMS. PROMOTE provides contextual meta-data that

403. The term organizational memory is used here in the sense of organizational memory information system to cover all explicit knowledge that is accessible with the help of an information and communication system (Hinkelmann et al. 2002, 67).

describes knowledge elements according to the topics the knowledge element describes (link to topic map), the knowledge-intensive tasks in business processes in which the knowledge element is created or required (link to business process model) and the persons that hold the knowledge element (link to skill model and organizational structure).

Knowledge-MEMO. The Knowledge-MEMO framework builds on the multi-perspective enterprise modeling framework (MEMO) proposed by Frank (1994, 2002). MEMO offers a generic conceptual framework to capture common abstractions of organizations. MEMO consists of the three perspectives (1) strategy, (2) organization and (3) information system. Each of these perspectives is structured by the five aspects (1) structure, (2) process, (3) resources, (4) goals and (5) environment (Frank 2002, 3). Thus, MEMO provides 15 foci of organizational modeling. A single modeling language supports one or more of these foci, e.g., the structure aspect of the information system perspective corresponds to an IS architecture, a data model or an object model. Knowledge-MEMO uses MEMO‘s foci and extends the modeling concepts and languages considered in MEMO. Examples for extensions are intangible assets, core competencies or topics in the strategy perspective, abilities and skills in the organization perspective and explicit knowledge in the information system perspective (Schauer 2004). One of the focal points in Knowledge-MEMO is the organizational design of a secondary organizational structure, e.g., projects or communities-of-interest, their link to business strategy and their support by information systems[404]. Knowledge-MEMO also contains an evolution model that is used to classify organizations according to their achieved level of KM. The model represents the starting point for procedure models that aim at improving an organizational KM initiative and set the focus on certain perspectives and aspects in Knowledge-MEMO. With respect to other process modeling methods or frameworks, MEMO can be characterized as a meta-framework to which other modeling languages can be mapped.

These are only some examples of approaches to extend business process modeling methods to cover aspects of knowledge management. Further efforts have been made, e.g.,

- by vendors of business process management tools. Besides ARIS, there are a number of business process management tools that recently have extended the object types and model types used in their modeling suites as well as the integration of business process models into KM-oriented ICT solutions, e.g., enterprise portals. One example is the INCOME suite (Get-Process AG) that combines the INCOME process designer tool with a navigation tool called INCOME knowl-

404. The concepts of Knowledge-MEMO are still under construction and will be presented in Schauer 2004. However, some preliminary results target e.g., the integration of project management and business planning (Fraunholz/Schauer 2003), an object-oriented meta-model for KMS architectures (Frank 1999) or, more specific, enterprise-wide project memory and management systems (Frank et al. 2001).

edge browser. The process designer tool extends the multi-dimensional models used in business process design, e.g., goal hierarchies and critical success factors, process model, organization model, data model, resource model, product catalogue, by knowledge structures, skill maps and knowledge maps that assign knowledge topics with roles and resources. The knowledge browser then integrates the models developed in the process designer in a portal environment and uses them to access the organizational knowledge base[405],

- by researchers in the area of workflow management systems who propose to use the knowledge externalized during build-time and run-time of workflow management systems and to extend the workflow definitions by knowledge objects that are provided and searched for in the course of knowledge-intensive tasks. Examples are KnowMore, WorkBrain, Workware and the Workflow Memory Information System (WoMIS) that explicitly aims at modeling and implementing context in the sense of an organizational memory information system (OMIS) with the components of a traditional workflow management system[406].

The reasoning behind all these extensions is that many organizations went to the trouble of a detailed analysis and modeling of their business processes, e.g., in the course of a major reorganization, quality management programs or the introduction of the standard software SAP R/3. Consequently, business process models already exist and simply have to be extended by concepts such as knowledge structures, required and provided skills or knowledge maps so that the extended models can serve as a basis for KM-specific analysis and design tasks.

A detailed discussion of the numerous approaches and methods for business process modeling in general and their extensions to cover aspects of KM in particular can not be given in this book[407]. Instead, according to the goals of this book, the ARIS method is described with respect to its applicability for KM as an example for a widely used business process modeling method.

Example ARIS for knowledge management. ARIS, the architecture of information systems, can be viewed as a framework consisting of the five perspectives (1) data, (2) function, (3) organization, (4) control and (5) output. Within each of these perspectives, a number of object types can be combined with the help of a number of modeling notations. An example is the entity-relationship model that comprises entities and relationships as object types in the data perspective that model events, messages and data objects in the ARIS meta-model. The perspectives overlap so

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405. The INCOME suite was originally developed by Promatis, Germany, URL: http://www.promatis.de/english/products/income_suite/index.htm/. Since February 2003, the Swiss company Get-Process AG is owner of the copyright for the INCOME suite and responsible for maintenance and development of the software, URL: http://www.get-process.com/.
406. See Wargitsch 1998 for the system WorkBrain, Goesmann 2002, 43ff and the literature cited there, see also Goesmann 2002, 166ff for the system WoMIS.
407. See e.g., Abecker et al. 2002, Goesmann 2002, 39ff, Remus 2002, 36ff and 216ff for a more detailed account of some of the approaches and modeling methods mentioned here.

that some of the object types can be used to join two or more perspectives. The ARIS framework integrates the five perspectives into one multi-perspective enterprise model and also offers a toolset that supports the design and navigation of ARIS models. So-called event-driven process chains are at the core of the integration in ARIS and bring activities, tasks or functions in a timely order, a chain of activities that are linked by events. Figure B-30 shows the ARIS meta-model with the five perspectives and the most important object types used to describe each of the perspectives. It also shows that the control perspective integrates all object types in an extended event-driven process chain[408].

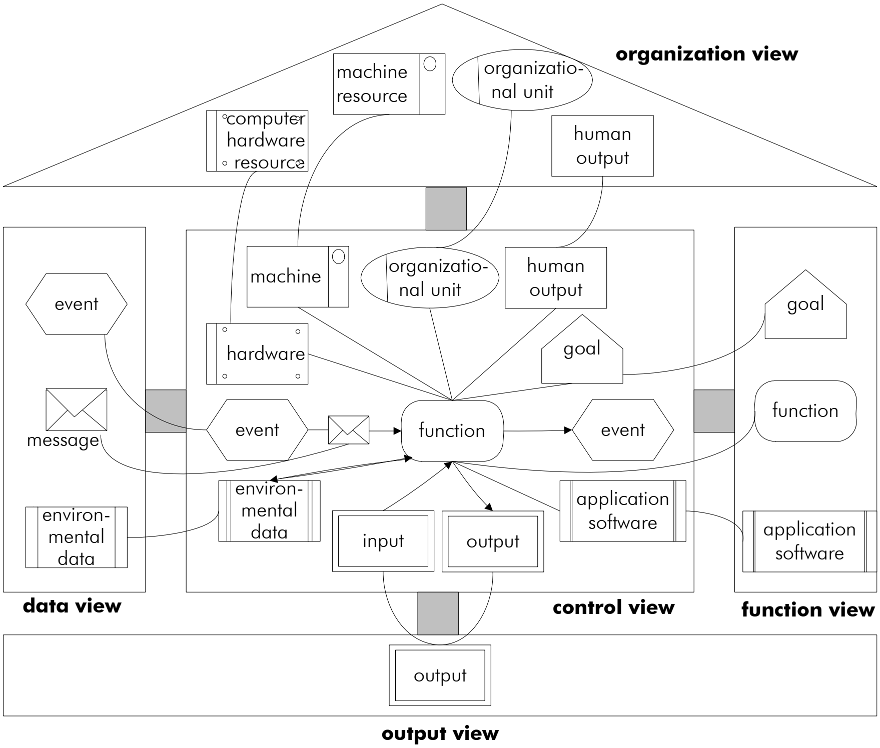

FIGURE B-30. ARIS meta model and perspectives[409]

The extensions to ARIS are relatively straightforward. The modeling method is extended by two additional object types, the object types *knowledge category* and *documented knowledge*. Knowledge categories as well as documented knowledge are treated like data objects and can thus be assigned to tasks in event-driven process chains. Figure B-31 shows an extended event-driven process chain that mod-

408. For a detailed description of ARIS see Scheer 2001.
409. Source: Scheer 1992, 22, Scheer 1998, 37.

els a portion of the core process of a typical small or medium-sized enterprise that makes dies and moulds[410].

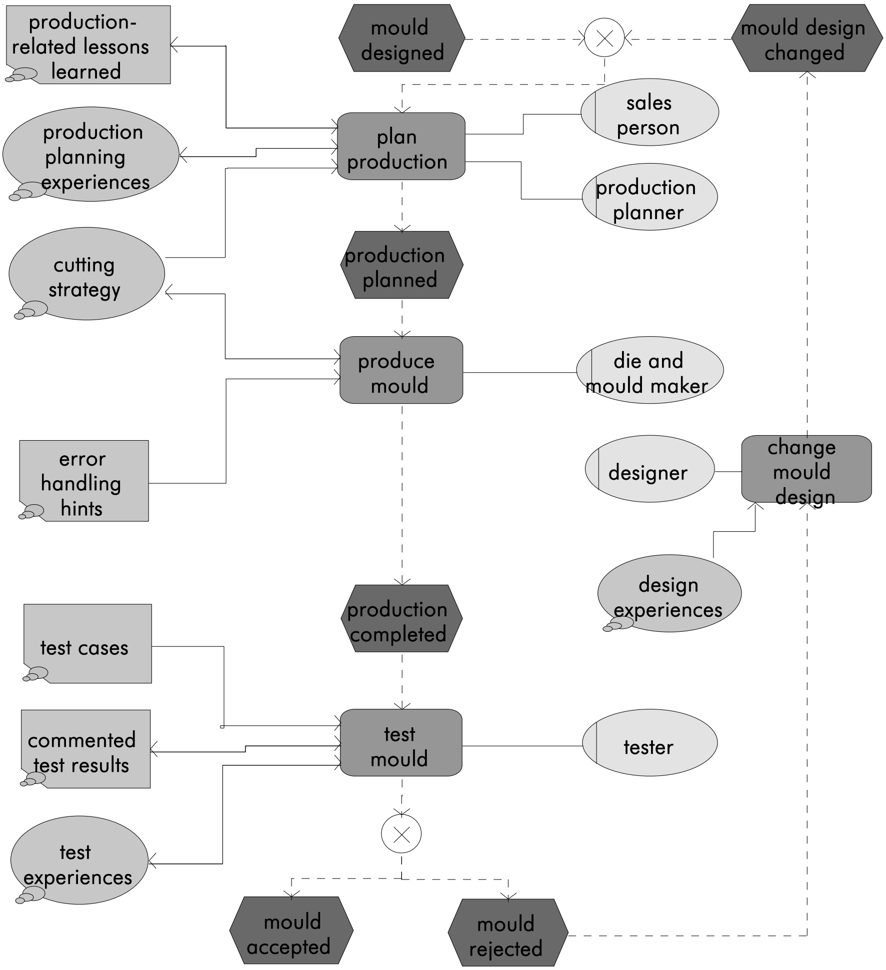

FIGURE B-31. Extended event-driven process chain with KM elements

The event-driven process chain is extended by a number of knowledge categories and documented knowledge. Also, ARIS is extended by additional model types within the existing perspectives, the model types (1) *knowledge structure diagram* in the data perspective, (2) the model type *communication diagram* in the

410. Figure B-31 to Figure B-33 show simplified portions of the models that were developed in the course of the EU project "KnowCom - Knowledge and Co-operation-Based Engineering for Die and Mould Making Small and Medium Enterprises" (KnowCom 2003).

organization perspective and (3) the model type *knowledge map* in the control perspective and (see Allweyer 1998).

ARIS knowledge structure diagram. Knowledge structure diagrams show the relationships (a) between knowledge categories and (b) between knowledge categories and documented knowledge. The diagram can be characterized as a simple form of knowledge modeling (see section 6.6.3). Thus, knowledge structure diagrams contain the object types *knowledge category*, *documented knowledge* as well as the object type *document* that visualize specific documents, e.g., text documents (see Figure B-32).

Additionally, knowledge structure diagrams assign documented knowledge to media and/or systems, e.g., to text documents that are stored in file systems or specific document, content or knowledge management systems[411].

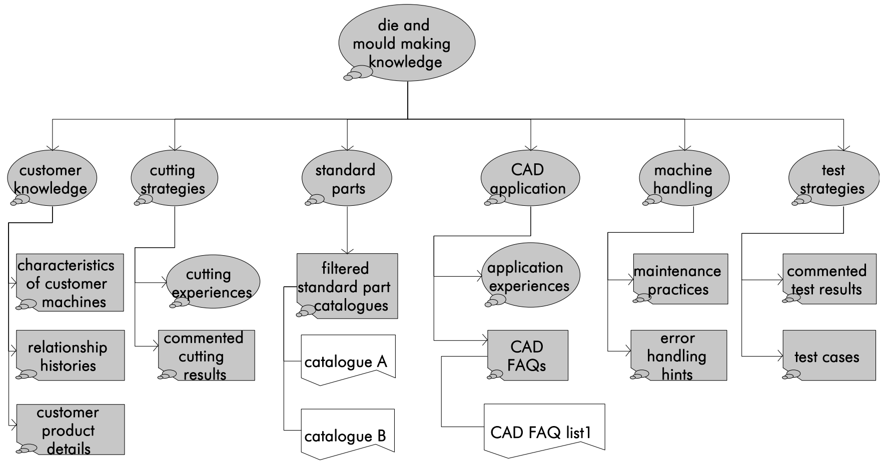

FIGURE B-32. Example for knowledge structure diagram in ARIS

ARIS communication diagram. Communication diagrams in ARIS visualize the communication links between organizational units and comprise the object type *organizational unit* and the object type *communication* (see Figure B-33).

The object type *communication* is labelled with the type of communication that characterizes the communication link. Organizational units are connected to communication with the help of a relationship *communicates with* that shows the direction of the communication. The relationship can be detailed according to what business processes a certain organizational unit communicates with another organizational unit.

411. The ARIS module "ARIS for Hyperwave" uses the knowledge structure diagrams and the assignments for the implementation of enterprise knowledge portals, e.g., by a translation into a description of folder structures and meta-data for the knowledge management system Hyperwave (URL: http://www.ids-scheer.com/).

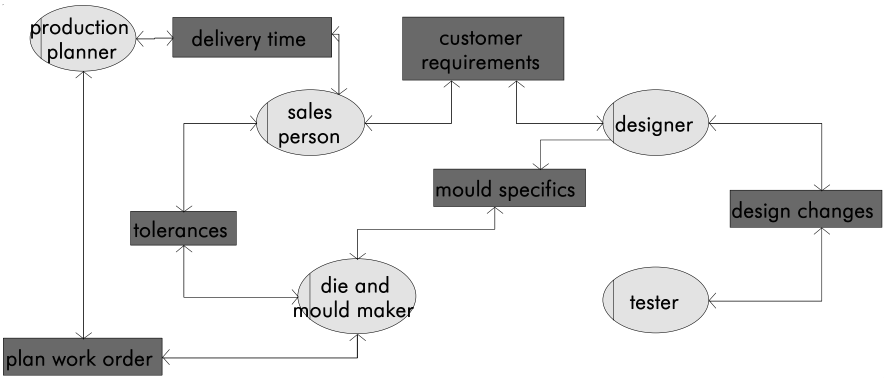

FIGURE B-33. Example for a communication diagram in ARIS

ARIS knowledge map. Knowledge maps in ARIS show which employees or organizational units hold what knowledge categories to what extent (see Figure B-34).

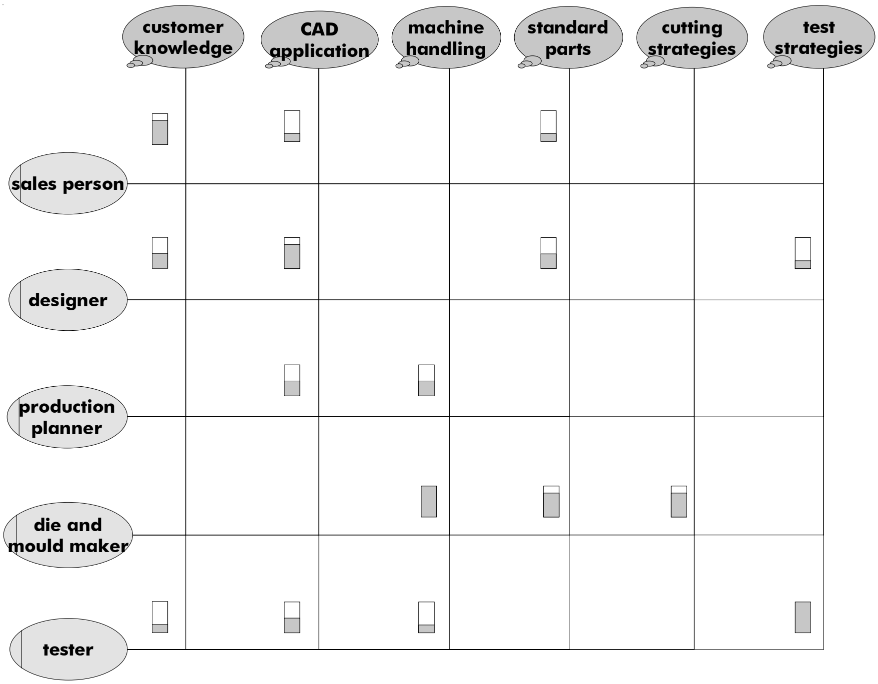

FIGURE B-34. Example for knowledge map in ARIS

ARIS knowledge maps therefore are a form of user/role modeling (see section 6.6.4). They take the form of a matrix that consists of the object types *person* and *knowledge category.* The relationships between persons and the knowledge categories they hold are visualized by bars that show to what extent a person holds a certain knowledge category. Compared to communication diagrams, knowledge maps represent a finer level of analysis. Whereas ARIS communication diagrams are restricted to the level of organizational units and thus naturally a high level of aggregation, knowledge maps show the relationships between individual persons and knowledge categories.

6.6.2 Activity modeling

Knowledge always undergoes construction and transformation when it is used. The acquisition of knowledge in modern learning theories is not a simple matter of taking in knowledge, but a complex cultural or social phenomenon. Thus, some authors suggest not to model knowledge as an object with its connotations of abstraction, progress, permanency and mentalism, but of the processes of knowing and doing which take place in a *(socially-distributed) activity system*[412].

Figure B-35 shows the elements of a socially-distributed activity system[413]. These systems provide a new unit for the analysis of the dynamic relationships among individuals (called agents or actors), their communities and the conception(s) they have of their activities (the inner triangle in Figure B-35). These relationships are mediated by instruments and concepts (e.g., language, technologies) used by the agents, implicit or explicit social rules that link them to their communities and the role system and division of labor adopted by their community (the outer triangle in Figure B-35, Blackler 1995, 1036ff).

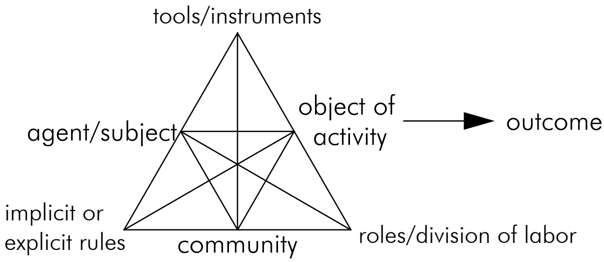

FIGURE B-35. Model of the socially-distributed activity system[414]

Table B-12 describes each of the elements used in the activity theory and gives some examples that help to understand the concepts.

Activities have a hierarchical structure (see Figure B-36): They are driven by common motives which reflect collective needs (Engeström 1999). They are accomplished by actions directed to goals coupled to the motives. There is a many-

412. Blackler 1995, Spender 1996a.
413. For a recent overview of activity theory e.g., Chaiklin et al. 1999.
414. The figure is based on Engeström 1987, Engeström 1993, 68, Blackler 1995, 1037, Engeström et al. 1999.

to-many relationship between activities and actions: an action could belong to multiple activities and the object of an activity could be reached by multiple alternative actions (Engeström 1999). Actions in turn consist of orientation and execution phase. The first comprises planning for action, the latter execution of the action by a chain of operations (Kuutti 1997). The better the model upon which planning is based fits the conditions, the more successful the action will be. Actions can collapse into operations, if the model is sufficiently accurate, so that no planning is necessary. Operations are executed under certain conditions and are the most structured part that is easiest to automate.

TABLE B-12. Elements of the activity theory[a]

element	**description**	**example**
object of activity	purpose and motives that define the reason why the activity exists and/or why the subjects participate in the activity	to learn how to write a scientific paper
agent/ subject	person(s) that perform(s) or participate(s) in an activity	Ph.D. student
outcome	intended and unintended results of the transformation process(es) performed in the activity	contributions to workshops and conferences, conference presentations, journal papers, contacts with colleagues
community	the collective of persons that are involved in the transformation process(es)	Ph.D. students, faculty, community of researchers in the discipline or area of research
tool/ instrument	material and immaterial instruments that are used in the activity	ISWORLD Web site, text processor, endnote tool, information systems, language, artifacts
role/division of labor	explicit and implicit organization of the relationships in the community	author, co-author, peer reviewer, referee, program committee, editor, publisher
rule	formal and informal norms, laws, regulations and principles that govern conduct, action and procedure in the activity and are imposed on the subject by the community	citation rules, conference/journal ranking, submission procedure, publication policy, ethics concerning plagiarism or double submissions

a. see also Engeström 1987, 1993, Engeström et al. 1999, Hasan/Gould 2003, 110.

An important feature of activity theory is the dynamic relationship between the three levels. Operations can again unfold into actions, e.g., if conditions change, as well as actions can become activities. Elements of higher levels collapse to constructs of lower levels if learning takes place. They unfold to higher levels if changes occur and learning is necessary.

Activity theory and process modeling have concepts in common, e.g., persons, resources, goals, but target different types of work practices. In the following, activity modeling and business process modeling are contrasted.

$$\begin{array}{ccc} \text{activity} & \text{—} & \text{motive} \\ \downarrow\uparrow & & \downarrow\uparrow \\ \text{action} & \text{—} & \text{goal} \\ \downarrow\uparrow & & \downarrow\uparrow \\ \text{operation} & & \text{conditions} \end{array}$$

FIGURE B-36. Hierarchical structure of an activity[415]

Process modeling describes routine work solving structured problems that primarily aim at the exploration or application of knowledge. However, knowledge work does not fall into this category. Consequently, an alternative concept is needed to describe knowledge work. Still, processes describe the details of an organizational value chain that provides the main concept to ensure that activities in the organization are targeted towards creating customer value.

The concepts provided by activity theory are well suited to analyze the creative, unstructured and learning-oriented practices of knowledge work. However, although activity theory comprises motives and objects, they lack integration with the value chain, i.e., transformation processes in business settings. It is not ensured that activities are oriented towards creating customer value. Also, activity theory does not study the contributions of actions to the creation of customer value. Therefore, concepts of process orientation and of activity theory have to be combined in order to get a more comprehensive picture of knowledge work in a business context.

Nonaka's concept of the hypertext organization[416] can be used to describe this picture. It consists of the three layers (1) business system layer, (2) project system layer and (3) knowledge base layer and describes how employees can switch between different (hyper-)linked settings of an organization depending on their actual work practices. The business system layer might be described by concepts of process orientation and the knowledge base layer might be described by concepts of the activity theory. The project system layer connects these two layers. Projects can either target structured or unstructured problems and thus be studied by process models or activity models. It remains unclear how the relationship between these two layers can be modeled. In a first step, Figure B-37 maps business processes and activities on three levels and contrasts refinement in business process modeling and routinization in activity modeling.

415. Source: Kuutti 1997.
416. See section "Hypertext organization." on page 159; see also Nonaka 1994, 32ff.

Business processes aim at improving work processes that can be characterized as routine, well structured or at least semi-structured processes that solve structured problems. Strategically, business processes primarily are the operational counterpart to exploitation as strategic focus for a certain competence and thus aim at the application of knowledge. Hierarchization in process modeling can be characterized as a refinement relationship consisting of the following three levels:

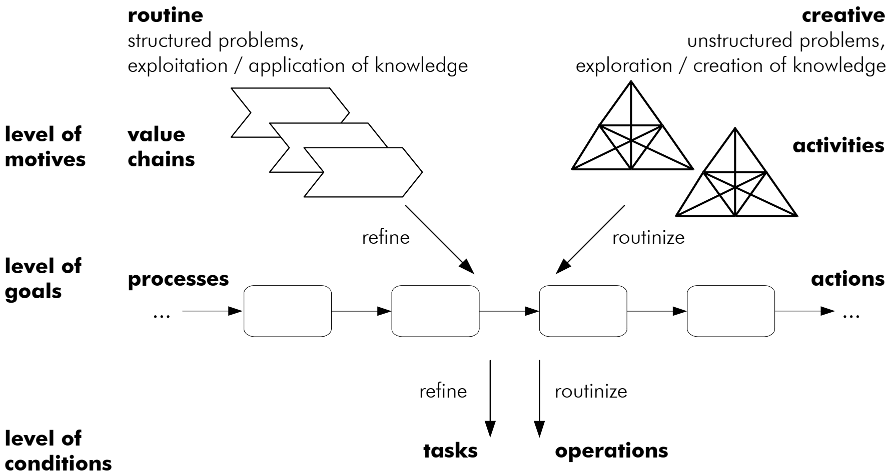

FIGURE B-37. Process modeling and activity modeling compared

- *value chains*: value chains are modeled by core and service processes relevant for an organization that can be visualized in a process landscape,
- *processes*: each of the processes in a process landscape can be detailed or disaggregated as a business process that consists of a sequence of events and functions, i.e. event-driven process chains[417],
- *tasks*: each function can be modeled in detail as a number of tasks that have to be fulfilled in order to accomplish a function's goals.

Activities model the organizational context of creative, often less foreseeable and ill-structured "processes" that focus unstructured problems. Strategically, activities in the sense of the activity theory primarily operationalize exploration as strategic focus. They aim at the joint creation of knowledge that is then applied in business processes. Hierarchization in activity modeling does not mean aggregation and disaggregation as in the case of business processes, but routinization of activities, and consists of the following three levels:

- *activities*: the term denotes the set of activities in an organization that is defined with respect to the strategic core competencies that have been identified in a process of strategy development[418],

417. See section 6.6.1 - "Process modeling" on page 240.

- *actions*: what has been learned by a person or a group of persons can then be used as a (routinized) skill or competence in a (series of) actions within a business process,
- *operations*: further routinization of actions yields operations, i.e. a detailed description of how to fulfill a task that is subject to automation or at least heavy support of ICT.

The three levels contrasted here can be characterized as level of *motives*, level of *goals* and level of *conditions*. Motives specified in a business strategy lead to the definition of a process landscape and of activities. Processes and actions both are performed in order to achieve certain goals that are determined considering the motives during process design and analysis of activities. On the finest level finally, conditions trigger tasks and operations. Value chain orientation and activity orientation could be integrated on the level of goals. On this level, actions could be connected to event-driven process chains. Concepts of process modeling and of activity theory provide two different perspectives on work practices in business organizations. The process-oriented perspective focuses implementation, exploitation, and accumulation of knowledge in the context of business processes. Some knowledge-related tasks may be described by knowledge processes and knowledge flows, i.e. by extended process modeling techniques. The activity-oriented perspective focuses creative, dynamic, and communication-intensive tasks, unstructured problems, membership in communities, self-organizing teams and demand for learning. A concept is needed that connects these two perspectives which is termed knowledge stance (see Box B-7, Hädrich/Maier 2004).

> A knowledge stance is a class of recurring situations in knowledge-intensive business processes defined by occasion and context, in which a person can, should or must switch from a business-oriented function to a knowledge-oriented action.

BOX B-7. **Definition of knowledge stance**

Both perspectives and the concept of knowledge stance are shown in Figure B-38. In a process-oriented perspective, an employee accomplishes functions on the level of goals that belong to business processes by fulfilling a sequence of tasks on the level of conditions. Simultaneously, she can be involved in one or more activities framing knowledge-oriented actions necessary to complete the functions.

An activity can be focused on the business process or a more general activity pursuing a motive not related to the business process, e.g., an effort to build competencies related to other topics or business processes. In contrast to the clearly

418. See also the framework for the definition of a process-oriented KM strategy presented in section 5.1.3 - "Process-oriented KM strategy" on page 108. Core competencies and strategic knowledge assets guide the design of activities which are routinized in actions as part of knowledge processes and knowledge-intensive business processes.

defined sequence of events and functions, there is no predetermined flow of actions. Activities, corresponding actions and operations can (a) be focused on the business process or (b) pursue a motive not related to the business process, e.g., an effort to build competencies, and thus may make a direct or a more indirect contribution to the process goal.

A business process offers several occasions to learn, to create or integrate knowledge related to core competencies of the organization. Occasions trigger knowledge stances and are associated with the functions of which the business process is composed. Occasions offer the opportunity or create the need for knowledge-related actions. A knowledge stance is not limited to creation of knowledge, but may also include translation and application of knowledge created outside the knowledge stance which in turn offers the possibility to create knowledge. Examples for occasions are treatment of exceptions, reflection in order to build knowledge with respect to core competencies of the organization.

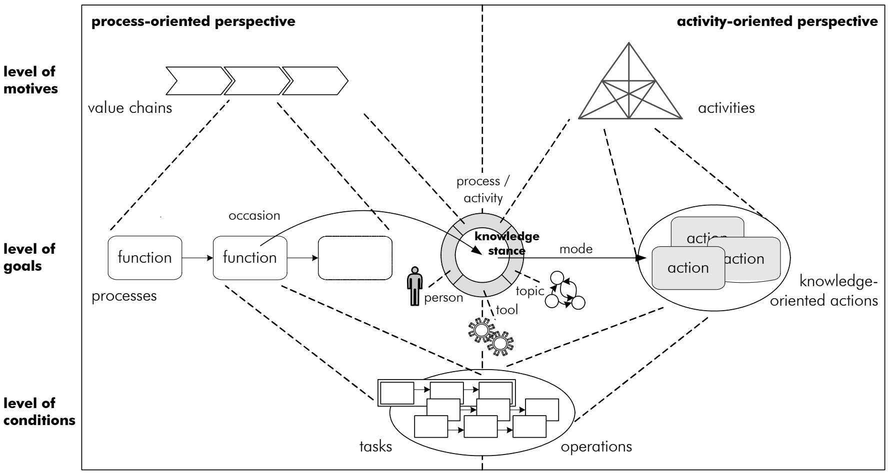

FIGURE B-38. Concept of knowledge stance

Context. This concept comprises all relevant dimensions suitable to describe the actual situation of the worker. Context is classified in process- and activity-oriented perspective on two levels of granularity, i.e. individual function/action or entire process/activity, as well as in type and instance level (based on Goesmann 2002). Instance level means in this case that context is restricted to the work order or action actually processed. Context on the type level refers to all work orders or actions of the same type.

Examples for relevant dimensions are elements of the related activity and the process, e.g., artifacts like software tools, diagrams, knowledge maps, other subjects involved, desired outcomes, relevant roles, rules, e.g., user rights, members of the community important for the user, e.g., with whom she communicates regularly, as well as other process steps connected by knowledge flows. The two dimensions location and time should also be included as they are important parts of the context.

In order to support knowledge stances with ICT, context should be derived automatically as far as possible by the KMS or the workspace in use on the basis of usage history or information about the participant. The currently best way to represent context and relations between context elements seems to be with the help of an ontology[419].

Mode. Mode classifies actions, or knowledge routines, that can be performed and refers to four informing practices (see Schultze 2000, 2003): (a) ex-pressing is the practice of self-reflexive conversion of individual knowledge and subjective insights into informational objects that are independent of the person, (b) monitoring describes continuous non-focused scanning of the environment and gathering of useful just in case-information, (c) translating involves creation of information by ferrying it across different contexts until a coherent meaning emerges, and (d) networking is the practice of building and maintaining relationships with people inside and outside the organization.

Actions. Context, mode and occasion are means to specify the set of available, allowed, recommended or required partly routinized activities which can be supported by arrangements of knowledge management services[420]. A straightforward approach to support knowledge actions is to automate corresponding operations that accomplish the action. They are highly dependent on the stance and thus must obtain information from context variables as well as mode and occasion of the knowledge stance. This could be accomplished e.g., by offering workflows to automate actions or to guide the user by wizards known from office applications. Examples are actions to integrate, validate, distribute or annotate knowledge elements.

From the perspective of designing KMS, those knowledge stances are of primary interest that can be supported by ICT. Depending on occasion, context and mode, it can be decided which parts of the KMS, i.e. contents and services, are suited to support the selected knowledge-oriented action. With respect to the characteristics of KMS[421], knowledge stances represent situations in which an arrangement or a bundle of knowledge management services can be suggested to complete knowledge-oriented actions. In some cases, flexible knowledge processes can be offered. Due to activities framing the social system in which knowledge is handled, the specifics of knowledge are considered when designing a comprehensive platform for supporting occasions to explore or exploit knowledge in business processes. Knowledge stances also provide a concept to connect KM instruments to business processes. For example, in a certain knowledge stance, a KMS could sug-

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419. See sections 6.6.3 - “Knowledge modeling” on page 257 and 7.7 - “Semantic integration” on page 374.
420. See also section 7.3.1 - “Knowledge management service” on page 302.
421. See section 4.3.2 - “Definition” on page 86.

gest to document a personal experience or to start a lessons learned process depending on the activity context and the activities other members of the community are currently engaged in.

Context should be derived with as little user effort as possible. Currently opened documents on the desktop, emails in the mailbox or the history of the Web browser could be used to determine parts of context information. This could be enriched by data about the current function in the business process the user performs and data about actions that other users took in similar situations. Furthermore, awareness services could monitor current activities of other employees relevant in the knowledge stance and thus be helpful in analyzing which cooperation partners are currently available or even engaged in similar business-oriented functions or knowledge-oriented actions respectively. Context elements and their relation can be represented by a standardized or shared ontology. Thus, inference techniques can be applied and context can be communicated to and translated for other applications.

6.6.3 Knowledge modeling

Knowledge modeling aims at a formal description of (documented) organizational knowledge that can be processed by computers and at a visualization of the topics that are of interest in a KM initiative and/or that are supported by the contents of a KMS and their relationships. There are relationships (1) between topics and persons, knowledge maps (see section 6.6.4), (2) between topics and ICT systems, especially which documents and other resources contain information on a certain topic and how they are related to each other as well as (3) relationships between topics themselves. The extensions of process modeling methods to capture knowledge structures have already shown the importance of explicitly modeling topics and structures in an organization's knowledge base.

Knowledge modeling techniques and methods differ with respect to the degree of formality that they focus. On the one hand, methods and techniques from the field of artificial intelligence and knowledge-based systems are highly formal and represent knowledge in the form of rules, frames, semantic nets, with the help of a variety of logic languages (e.g., Prolog)[422]. In the field of KM, particularly knowledge representation with the help of ontologies or domain models that can be processed by computers has gained widespread attention and use in practical example cases. On the other hand, knowledge mapping techniques often primarily serve as a tool for human beings to better understand the (highly aggregated) structure of important areas of knowledge or competence and their relationships to, e.g., the persons, groups or other organizational units that create, hold, seek, distribute or apply the knowledge[423].

Explicit modeling of computer-understandable knowledge that is similar to knowledge-based systems has been an important stream within knowledge man-

422. See textbooks on knowledge-based systems or logic, with an emphasis on knowledge management e.g., Karagiannis/Telesko 2001, 53ff).
423. See e.g., Eppler 2003a.

agement. Several groups of authors have recently extended methods, techniques and tools that were originally developed to model knowledge used in knowledge-based systems to cover aspects of KM. Examples are the CommonKADS method (Schreiber et al. 1999) or the many applications of ontologies in KM that have been shown by the Institute AIFB of the University of Karlsruhe and the company Ontoprise that develops the ontology modeling and brokering tools OntoStudio and OntoBroker[424].

The two terms *ontology* and *taxonomy* are used widely for the results of modeling efforts. Depending on the semantic richness of the constructs that can be used to formalize topics, knowledge objects and their relationships, some authors distinguish between (simpler) taxonomies and (more powerful) ontologies. In the following, these two terms and their usage in KM(S) are briefly reviewed.

Taxonomy. The term taxonomy denotes the classification of information entities in the form of a hierarchy, according to the presumed relationships of the real-world entities that they represent (Daconta et al. 2003, 146). A taxonomy can contain definitions and explanations, synonyms, homonyms and antonyms, as in a thesaurus. A taxonomy is often modeled as a hierarchy of terms and can be used as the semantic basis for searching and visualizing a domain, e.g., a collection of documents. Figure B-39 gives an example of a well-known taxonomy developed in the discipline of biology. There is only one type of hierarchical relationship between concepts in a taxonomy, in this case the *belongs_to* or *subset_of*-relationship.

- Kingdom: Animalia
  - Phylum: Chordata
    - Subphylum: Vertebrata
      - Class: Mammalia
        - Subclass: Theria
          - Infraclass: Eutheria
            - Order: Primates
              - Suborder: Anthropoidae
                - Superfamily: Hominoidae
                  - Family: Hominidae
                    - Genus: Homo
                      - Species: Homo Sapiens

FIGURE B-39. Example taxonomy[425]

Ontology. “An ontology is a (1) formal, (2) explicit specification of a (3) shared (4) conceptualization” (Gruber 1993, 199). More specifically, an ontology “defines the basic terms and relations comprising the vocabulary of a topic area as well as the rules for combining terms and relations to define extensions to the vocabulary“[426]. (1) An ontology has to be formal which requires that the ontology is

424. See URL: http://www.ontoprise.de/, Staab et al. 2001, Staab 2002.
425. Daconta et al. 2003, 148.

machine-readable. However, there are different degrees of formality of ontologies, from a thesaurus like WordNet to ontologies capturing formal theories for common-sense knowledge like Cyc. (2) Explicit specification means that the concepts and relationships as well as constraints on the use of concepts are defined openly and not left to the interpretation of the ontology's users. (3) Shared refers to the requirement that the conceptualizations made in an ontology have to be agreed upon by a group of people that intend to use the ontology for knowledge exchange. (4) Finally, conceptualization is an abstract model, a representation of a domain or phenomenon which investigates the concepts of that domain or phenomenon that are relevant to the ontology's users.

Ontologies generally can be used for (1) communication between computational systems, between humans and between humans and computational systems, (2) computational inference, for internally representing and manipulating plans and planning information and for analyzing the internal structures, algorithms, inputs and outputs of implemented systems in theoretical and conceptual terms, (3) reuse (and organization) of knowledge, for structuring or organizing libraries or repositories of plans and planning and domain information (Gruninger/Lee 2002, 40).

Typical uses of ontologies in KM fall into the first category. Ontologies here are formal models providing a shared and/or common understanding of an application domain communicable between people and application systems that help to define, retain, exchange and share knowledge with the help of ICT systems and thus facilitate representation, storage, communication and search of knowledge (O'Leary 1998, 58, Davies et al. 2003a, 4f). Ontologies are therefore developed to provide machine-processable semantics of data and knowledge sources that are accepted by a group of users and facilitate semantic integration, knowledge sharing and reuse[427]. Ontologies are not static, but evolve over time. An ontology not only defines basic terms and relations comprising the vocabulary of a topic area, but also comprises rules for combining terms and relations to define extensions to the vocabulary. Ontologies model (1) objects in domains, (2) relationships among those objects, (3) properties, functions and processes involving the objects and (4) constraints on and rules about objects (Daconta et al. 2003, 190). Thus, ontologies support clear-cut, concise, semantically rich and unambiguous communication between persons aided by KMS and/or between different KMS.

Compared to the term taxonomy, the term ontology is usually used not only to describe definitions of terms, basic properties and relationships between terms, e.g., *is_a*-relationship, but also to support an extended set and a variety of types of relationships, e.g., symmetric, transitive or inverse relationships, and rules that allow for reasoning about concepts and instances defined in the ontologies. Figure B-40 illustrates a portion of an ontology with definitions of concepts, relations and instances as part of an ontology assigned to the URI "http://onto.org". In the example, employees are defined as persons including the transitive relationship

426. Neches et al. 1991, 40, cited from Zelewski 2002, 6.
427. See section 7.7 - "Semantic integration" on page 374.

of the reporting hierarchy. Themes are defined as related to each other in a symmetric relationship and treated on events and in publications, defined in the inverse relationship `deals_with` and `is_about`. The concepts are illustrated with the help of several instances. `Book` as sub-concept of `Publication` "inherits" the relation `is_dealt_with` and thus can also be assigned to `Theme`.

The concept of rule is used e.g., to check not only syntactic, but also semantic validity of a statement or that is used to derive new properties of terms and relationships between terms from existing ones. Semantic rules, e.g., in the form of inference rules, describe how knowledge can be gained from existing statements (Zelewski 2002, 7).

```
  << Concepts >>
#Person@"http://onto.org".
#Employee::#Person.
#Theme@"http://onto.org".
#Event@"http://onto.org".
#Publication@"http://onto.org".
#Book::#Publication.
  << Relations >>
#Employee[#reports_to=>>#Employee@"http://onto.org".
#Theme[#has_expert=>>#Person@"http://onto.org".
#Theme[#has_related_theme=>>#Theme@"http://onto.org".
#Theme[#is_dealt_with=>>#Event@"http://onto.org".
#Theme[#is_dealt_with=>>#Publication@"http://onto.org".
#Event[#is_about=>>#Theme@"http://onto.org".
#Publication[#is_about=>>#Theme@"http://onto.org".
relation_property_(#Theme, #has_related_theme, symmetric)@
     "http://onto.org".
relation_property_(#Employee, #reports_to, transitive)@
     "http://onto.org".
inverse_relations_(#Theme, #is_dealt_with,#Event,
     #is_about)@"http://onto.org".
  << Instances >>
#"Alice Aberdeen":Employee@"http://onto.org".
#"Knowledge Management":Theme@"http://onto.org".
#"Knowledge Management Systems":Book@"http://onto.org".
#"IKNOW":Event@"http://onto.org".
#"Knowledge Management"[#is_dealt_with->>#"IKNOW"]@
     "http://onto.org".
#"Knowledge_Management"[#is_dealt_with->>#"Knowledge
     Management Systems"]@"http://onto.org".
```

FIGURE B-40. Example definitions of concepts, instances and relations

An example is: if two companies operate in the same industry and the same geographic region, then they are competitors (Figure B-41). The definition of the term ontology is broad enough to cover different types of ontologies that play a number of roles in developing KMS (Fensel 2004, 5f):

- *domain* ontologies capture knowledge of a particular type of domain and are thus restricted to the context of this domain,
- *meta-data* ontologies provide a vocabulary used to describe contents in an EKI, e.g., the Dublin Core meta-data standard,
- *common-sense* ontologies capture basic notions and concepts for e.g., time, space, state, event and relationship that are valid across several domains,
- *representational* ontologies comprise definitions of ways to represent knowledge and are not restricted to particular domains, e.g., frame ontology defining concepts such as frame, slot, slot constraint that can be used to explicate knowledge in frames,
- *method and task* ontologies provide concepts specific to particular problem-solving methods, e.g., the concept correct state in a propose-and-revise method ontology, or concepts specific for particular tasks, e.g., the concept hypothesis in a diagnosis task ontology.

```
FORALL company1, region1, sector1, company2
  company1[#is_competitor->>company2]@"http://onto.org" <-
  company1[#operates_in->>region1]@"http://onto.org" AND
  company1[#operates_in->>sector1]@"http://onto.org" AND
  company2[#operates_in->>region1]@"http://onto.org" AND
  company2[#operates_in->>sector1]@"http://onto.org".
```

FIGURE B-41. Example rule

Ontologies can be formalized with the help of a number of languages, e.g., F-Logic as depicted in Figure B-41, that are in turn supported by tools, e.g., Ontobroker[428]. However, the term ontology is sometimes used to describe conceptualizations on a spectrum that extends from weak to strong semantics starting from *taxonomy*, via *thesaurus* and *conceptual model* to *logical theories* that describe semantically rich, complex, consistent and meaningful knowledge (Daconta et al. 2003, 156ff).

Most organizations that are about to implement or have implemented a KMS have also created at least a minimal taxonomy or ontology (O'Leary 1998, 58). However, development and continuous maintenance of an ontology requires a substantial amount of effort. Also, ontologies developed individually in organizations are likely to be incompatible and thus cannot be used to share knowledge across organizational boundaries. Consequently, there is a need for standardization, both in the language used to develop an ontology and also with respect to the content of ontologies.

428. URL: http://www.ontoprise.de/.

An example for a standardization effort aimed at the description of documents with the help of meta-data is the Dublin Core structure[429]. Other examples for semantically richer standardization efforts are discussed in the field of the Semantic Web such as RDF, RDF Schema, DAML+OIL and OWL[430]. There has been put a lot of effort into semantic integration, namely meta-data standards and the standardization of languages that can be used to describe semi-structured data, such as documents, and their handling with the XML standards family which will be described in section 7.7 - "Semantic integration" on page 374.

6.6.4 Person modeling

Person modeling captures that portion of the context of KM initiatives that refers to people. The explicit or implicit modeling of user profiles has had a long tradition in human-computer interaction. User models are required for ICT systems to better adapt to the needs of human beings (e.g., Mertens/Griese 2002, 27ff). In KM, the adaptation of ICT systems to the needs of knowledge workers plays an important role that has been termed personalization. Figure B-42 shows the process of profiling and the subsequent application of the collected and analyzed profiles to personalize KMS. The grey arrows visualize the data flow between knowledge workers, the steps and the data base holding the user profiles. The black arrows visualize the process of the steps.

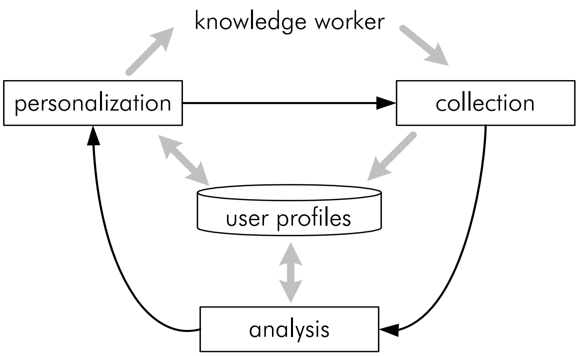

FIGURE B-42. The process of profiling and personalization[431]

The *collection* of information can be:

- explicit with the help of a number of questions that the user answers,

429. URL: http://www.dublincore.org/; see also section 7.7.2 - "Meta-data management" on page 379.
430. RDF stands for Resource Description Framework, DAML stands for DARPA (Defense Advanced Research Program) Agent Markup Language, OIL stands for Ontology Inference Layer; OWL stands for the Web Ontology Language; see section 7.7.1 - "Semantic Web" on page 375.
431. The figure is based on Frielitz et al. 2002, 545.

- implicit by observing user behavior, e.g., user tracking or click stream analysis,
- based on a combination of data collected from other systems, e.g., enterprise resource planning systems or human resource management systems.

Analysis of the collected information requires:

- data mining, e.g., the selection, cleansing, transformation and analysis of relational data, e.g., skill or interest profiles, in analogy to data warehouses and customer relationship management systems,
- text mining, e.g., the analysis of submitted documents or of contributions in newsgroups,
- Web content, structure and usage mining, e.g., the analysis of log files of an Intranet platform or a knowledge management system.

Finally, *personalization* can be:

- user-initiated by explicit user statements,
- KM-initiated, e.g., by predefined “if-then” rules, e.g., data, role, event or time-driven triggers,
- automated content-based filtering, e.g., by comparing user profiles with the contents of the knowledge base,
- automated collaborative filtering, e.g., “communities of preference”, active recommendations by other users, automated or hidden recommendations.

Moreover, person modeling in KM covers the following three aspects:

- *formal organization*: person modeling considers the formal organizational structure with e.g., roles, positions, work groups and organizational units.
- *informal organization*: on the other hand, knowledge management is particularly interested in the informal relationships between members of the organization, their communication, social networks as well as communities of practice or communities of interest.
- *skill management*: a third part of person modeling assigns actual employees, not roles or positions, to the skills they hold.

Formal organization and communication modeling in connection with process modeling have already been described in the course of process modeling[432]. In the following, methods and techniques of knowledge mapping and of social network analysis are discussed with respect to their contribution to skill management and the analysis of the informal organization.

Knowledge maps. Eppler (1997, 2003a) distinguishes several types of knowledge maps depending on what kind of elements are mapped to the knowledge domain or topic. He explicitly mentions three groups of elements:

- experts, project teams, or communities,
- white papers or articles, patents, lessons learned, or meeting protocols,

432. See the organization view and the communication diagram of the ARIS meta-model in section 6.6.1 - “Process modeling” on page 240.

- data bases or similar applications, such as expert systems or simulations.

This leads to the following types of knowledge maps (Eppler 2003a, 192f):

- *knowledge source maps* help to visualize the location of knowledge, either people (sometimes also called knowledge carrier maps) or information systems and their relation to knowledge domains or topics. They can be further classified into knowledge topographies to identify gaps, competence maps to find experts and pointer systems that directly link from challenges within a process to a contact that can assist. Knowledge source maps are used if not only people with knowledge in the desired domain are listed, but also all forms of codified knowledge (see above) that are relevant,
- *knowledge asset maps* is a further enhancement of the knowledge source map as it visualizes not only that there is knowledge in a document or person, but also the amount and complexity,
- *knowledge structure maps* show the relationship between different knowledge domains or topics and should not only visualize that there is a relationship, but also explain the type of relationship (belongs to, how it is related, etc.),
- *knowledge application maps* are a combination of process models and knowledge carrier maps as they describe who should be contacted for help at what step in the process,
- *knowledge development maps* visualize the learning paths that are required to acquire a certain skill as an individual or a certain competence as a team or other organizational unit.

The procedure to create knowledge maps is a five step process that can briefly be described as follows (Eppler 2003a, 202):

- identify knowledge-intensive processes or issues,
- deduce relevant knowledge sources, assets or elements,
- codify these elements, build categories of expertise,
- integrate codified reference information on expertise or documents in a navigation and/or search system that is connected to the work environment of the target group,
- provide means of updating the knowledge map, especially enabling decentralized update mechanisms so that every employee can (re-)position himself continuously within a knowledge map.

There is no standard that describes how knowledge maps should be visualized. Thus, the development of knowledge maps provides a great deal of freedom for both the determination of what elements and relationships should be part of the models and how they should be visualized.

Figure B-43, Figure B-44 and Figure B-45 give examples of knowledge maps and show the variety of approaches to their design (further examples can be found e.g., in Eppler 2003a).

Figure B-43 maps central areas of competence in an IT consulting organization and employees according to their expertise. The bars indicate whether an employee holds basic knowledge, expert knowledge or is a leader in the corresponding area of competence. The map shows the importance of Mr. Tinner and Mr. Ehrler for the organization because they seem to be competent in (almost) all relevant areas of competence.

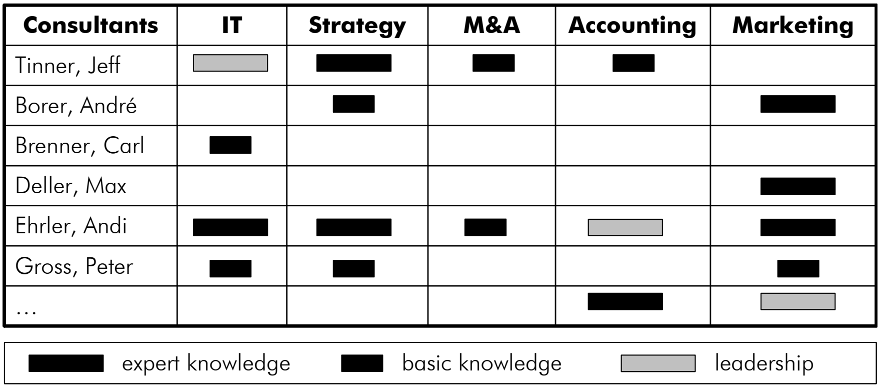

FIGURE B-43. Example for a knowledge asset map[433]

Figure B-44 shows a portion of the knowledge source map of a multimedia company that develops Web sites, CD ROMs and stand-alone multimedia terminals.

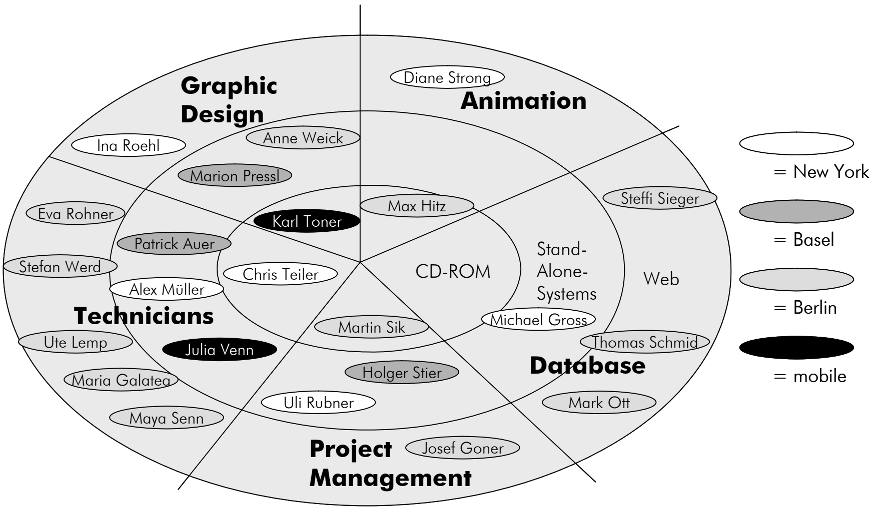

FIGURE B-44. Example for a knowledge source map[434]

433. Source: Eppler 2003a, 196

The map supports staffing of multimedia projects. The map visualizes what experts are available for the company's five areas of competence animation, data base, graphic design, project management and technology know-how and the three product lines Web systems, stand-alone systems, CD-ROMs, at the company's three main locations Basel, Berlin and New York. Additionally, two employees are not located in a single office, but float between the three locations.

Figure B-45 shows a portion of the main knowledge structure used by the author's work group as the central access structure to a knowledge workspace implemented in the knowledge management system Open Text Livelink[435].

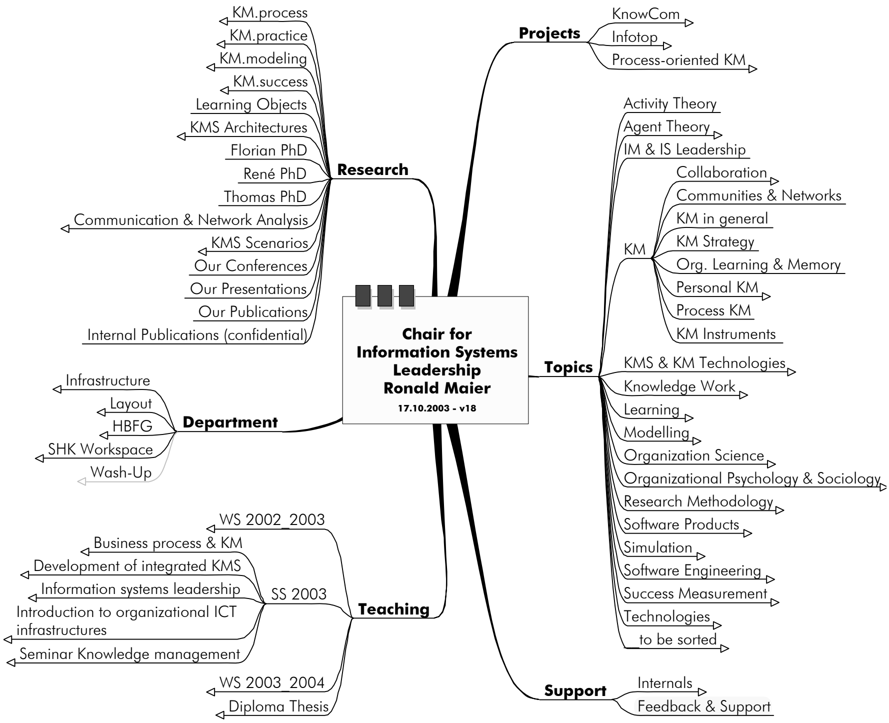

FIGURE B-45. Knowledge map of the structure of a knowledge workspace

The first level of the knowledge structure consists of the terms department, projects, research, support, teaching and topics. Thus, it reflects the two core processes of a university department, research and teaching. In the research branch, there are a number of workspaces to support specific research streams that the work group is engaged in. This includes the Ph.D. workspaces of the research assistants. Teaching contains workspaces for each individual course or seminar.

434. Source: Eppler 2003a, 195
435. See also section 7.4.9 - "Example: Open Text Livelink" on page 336.

Students have access to a portion of the material in the workspaces of the courses that they are enrolled in. Moreover, they can contribute to the workspaces and share knowledge with their colleagues. Projects represent units of funded thematic research. and of cooperations with other institutions. Topics are the primary structure to organize e.g., electronic research articles, news, contributions to newsgroups or empirical data that has been collected by the members of the work group. Department reflects internal projects and collaboration workspaces for the work group's teaching assistants. Support is a category in which the work with the KMS is supported and reflected. Arrowheads at the end of the branches represent collapsed hierarchies that are not visualized in the map.

The map can be automatically generated by a script that exports Livelink's structure, imports it into MindManager[436] and serves as an alternate way to access the knowledge elements stored in Livelink. Each branch in the map contains a hyperlink that directly links to the corresponding object in Livelink.

Knowledge structure maps differ widely between organizations. The maps usually represent the primary instrument to structure the organization's knowledge objects and thus are an important navigation aids.

Analysis of social networks. As stated before, knowledge management is concerned with both types of knowledge: knowledge as an object or product and knowledge as a process. The latter on the one hand concentrates on the flows of knowledge between individuals and on the other hand on processes of jointly creating and retrieving knowledge in a collective of individuals which is conceptualized for example by the transactive memory system approach (Wegner 1986).

How can these processes be described? What kinds of relationships between individuals are needed in order to encourage these knowledge processes or make them possible? How can hidden social structures in organizations be detected which could be supported by organizational measures and instruments (e.g., the selection of members for projects and work groups, the adaptation of roles, the building of communities, the organization of meetings to name a few)? In the following, the main forms and application areas of network analysis are reviewed in order to judge the possible contributions of this instrument to answer these questions (for a detailed analysis see Pappi 1987a).

Network analysis as applied in social sciences is based on two research traditions: sociometrics (e.g., Moreno 1967, cf. Pappi 1987a, 11) and social anthropology (e.g., Mitchell 1969, cf. Pappi 1987a, 11). It can be used in general to study both, micro and macro structures of social networks and to analyze relationships e.g., between individuals, positions, groups, communities or organizations. A social network is defined as a set of social entities (such as individuals, groups, organizations) which are connected by a set of relationships of a certain type.

Sociologists distinguish between *partial networks* – in which only relationships of a certain type are considered, and *total networks* – all kinds of relationships are

436. http://www.mindjet.de

considered. They also differentiate *wholesome networks* in which a multitude of social entities and their relationships are considered and so-called *ego-centric networks* in which one social entity with its relationships to other entities is focused.

The combination of wholesome and partial network analysis seems to be the most promising area to be applied in the field of KM. This is due to the idea that (a) only those relationships have to be considered which support knowledge processes (therefore partial network) and (b) the unit of analysis (= the social entities) could either be (a group of) individuals, groups, communities or other organizational units, such as departments. In either case, it is the "general picture" of the relationships between these entities that is of interest to KM, not only those of one single entity (therefore wholesome network). Network analysis can be used to study the following three perspectives of phenomena of grouping (Pappi 1987a, 15):

Structured order. This perspective is used to interpret the individual behavior as an action appropriate for the position the individual holds. In KM, this perspective stands for the formal structural organization (e.g., hierarchy, positions, ranks).

Categorical order. This perspective is used to interpret the intended behavior as a social stereotype of class, race, ethnic group etc. Also, this perspective could be used to study the effects of different "business-specific stereotypes", such as roles (e.g., technical experts and salespeople, novices and experts) in KM.

Personal order. This perspective is used to interpret the individual behavior as depending on personal relationships to other individuals and, moreover, on the "transitive" relationships which these "other individuals" have in turn. This can directly be applied to knowledge management.

Formally, social networks are represented by graphs. The knots represent the social entities and the edges represent the relationships. Formal characteristics of relationships are:

- *reflexivity:* determines whether or not a social entity chose itself ("self choice"),
- *symmetry:* determines whether a relationship is reciprocal (ego chooses alter and alter chooses ego),
- *transitivity:* determines whether a relationship from a to b and one from b to c imply a relationship from a to c,
- *valued graphs:* are graphs the relationships of which carry values such as intensity, number and duration of relationships.

With respect to the content, the following types of relationships have been investigated so far (Knoke/Kuklinski 1982, cf. Pappi 1987a, 16): transactions in which goods or services are exchanged; communication; boundary penetrating relations, e.g., between organizations; instrumental relationships: development of contacts to achieve goals; emotional relationships (e.g., the so-called socio-metric choice); authority or power relationships; family relationships.

Pappi suggests the following classification of relationships (Pappi 1987a, 17f):

1. **Potential for interactions:**
   - *objective*: opportunities for interaction, e.g., membership in groups, communities, supervisory boards; dependencies: if one social entity is interested in something another social entity controls; measurable in number of opportunities, intensity of dependencies,
   - *subjective*: socio-metric choices, normative expectations; measurable in intensity of choice,
2. **Actual interactions:** (measurable in number)
   - communication; measurable in number,
   - transaction: exchange of goods and services,
   - influential interactions,
   - other interactions: private contacts, etc.
3. **Permanent social relationships:** (measurable in durability)
   - friendship relationships,
   - role structures.

Figure B-46 shows a number of instruments and methods for network analysis classified according to the type of relationships and the unit of analysis.

relation		unit of analysis: one social entity	unit of analysis: partial net	unit of analysis: all social entities
one net	direct relation	popularity	neighbourhood	dense census of triads
one net	connected relation	prestige	clique	connection
one net / many nets	pattern of direct relation	social distance	position	picture structure
many nets	linked relation	multiplexity of local roles	aggregated local roles	role structure

FIGURE B-46. Typology of methods of network analysis interesting for KM[437]

Social network analysis has been repeatedly proposed as an instrument for KM (e.g., Zack 2000) and is definitely a promising direction on an agenda for future KM research and practice. Network analysis can for example be used to identify informal networks which then can be aligned in order to better support business or, in this case, KM goals (e.g., Krackhardt/Hanson 1993). Making informal networks visible can help to found communities which are open to be joined by new members and thus avoid a number of problems that informal, unidentified networks often have, e.g., holes in the network, fragile structures, so-called “bow ties” where the network is dependent on a single employee (Krackhardt/Hanson 1993, 110f).

437. This figure is based on Pappi 1987a, 26. Areas interesting for knowledge management are highlighted.

The following examples show in which KM-related scenarios network analysis has already been successfully applied (Krackhardt/Hanson 1993, 106):

Advice networks. An advice network reveals the experts in an organization as it asks whom employees contact when they need help or advice. These maps seem to be useful when a company considers routine changes.

Trust networks. This type of networks shows the strong tie relationships in an organization as it asks whom employees would reveal their concerns about work issues to. These maps seem to help when implementing a major change or experiencing a crisis.

Communication networks. A communication network simply analyzes whom employees frequently talk to and can reveal gaps and inefficiencies in the information flow. These maps should be considered when productivity is low.

These examples show the variety of application scenarios thinkable for network analysis to help identify networks that can be fostered and better aligned with the organization's knowledge strategy.

6.7 Résumé

This chapter discussed the multi-faceted organizational design of a KM initiative. Generally, the organizational design of a KM initiative and the organizational instruments used to implement it rely on the solid, mature and extensive foundation of the literature on organization science. A complete review seemed impossible because of the enormous number of approaches. Thus, the focus was on selected aspects that seemed to matter most for a KM initiative.

The chapter started with a comprehensive *model of the tasks and flows of knowledge management* which gave an overview of the target system for organizational instruments and measures and connects this chapter with other interventions[438] and the development of a KM strategy[439].

Then, the *structural organization* of a KM initiative was reviewed. The institutionalization of a separate organizational unit responsible for KM was discussed. New roles and collectives of employees were reviewed that have mushroomed with the advent of KM in the organizations. As the interviews preceding the empirical study have shown, so far most of the organizations have not implemented all or even a substantial part of these KM roles. In order to get comparable results across the organizations and not to confuse the respondents with the minor differences between several of these roles, the following three roles will be used in the empirical study:

- *knowledge manager* (CKO) or knowledge integrator,

438. e.g., ICT instruments, see chapter 7 - "Systems" on page 273.
439. See chapter 5 - "Strategy" on page 93.

- *subject matter specialist*,
- *participant/author*.

After definition, classification and detailed description of the most widely discussed *instruments* applied in KM initiatives, the next section was focused on the *process organization* of knowledge management and reviewed selected KM tasks that deal with, involve or are supported by KMS. This restriction was again due to the abundance of knowledge-related tasks that are described in the literature. The KM tasks that will be used in the empirical study had to be reworded and selected due to the results of several pretests with knowledge managers:

- knowledge identification,
- acquisition of external knowledge,
- release of knowledge elements (formal approval of institutionalization),
- storing of knowledge elements,
- integration of knowledge into existing structure (knowledge classification),
- updating/extending of existing knowledge structure (ontology),
- knowledge distribution,
- knowledge quality management,
- refinement, repackaging of knowledge,
- knowledge deletion, archiving,
- knowledge selling.

Also, process-oriented knowledge management was discussed and the differences between knowledge-intensive business processes, knowledge processes and knowledge management processes were shown. Process orientation will be included into the empirical study with the help of one question about the scope of the organization's KM initiative. Respondents will be asked to report the number of business processes their KM initiative targets. Apart from this basic question, the pretests and also the interviews have shown that most of the organizations so far do not integrate KM related tasks, roles and instruments with business process management in their KM initiative. The relationships between these two concepts will be analyzed in detail as part of a subsequent study on the basis of interviews with selected respondents and will not be reported in this book.

Also, the notion of organizational culture was analyzed. On the one hand, the organizational culture has to be considered in the design of a KM initiative, on the other hand to change the organizational culture might be a goal of a KM initiative in its own right. The focus was set on the dimension *willingness to share knowledge* which will be investigated with the help of a set of statements describing:

- mutual understanding of work groups,
- mutual trust of work groups,
- mutual influence of work groups,
- mutual support of work groups,
- communication between work groups,

- help within work groups,
- willingness to learn,
- communication within work groups,
- existence of incentive systems for knowledge sharing,
- approval/acknowledgement of cooperative behavior,
- informal exchange of ideas (e.g., in breaks, at company events, private).

The selection of aspects of the organizational design of a KM initiative left out a number of other possible interventions into an organization's way of handling knowledge. Some of these other interventions were briefly sketched out, e.g., the architecture of office space, recruitment of experts or therapeutic interventions.

Finally, the specifics of *modeling* as part of KM initiatives were discussed. The four perspectives process, person, topic and ICT resources were distinguished. A large number of modeling techniques and methods already exists for each of these perspectives. Selected process modeling, activity modeling, knowledge modeling and person modeling techniques and methods were discussed with respect to their potentials for KM. Their combination is still a challenge for KM initiatives. Whereas KM initiatives with a focus on codification concentrate on the ICT resources and the topic perspectives, personalization efforts rather model person and topic. However, in order to ripe the potentials of KM, processes, persons, ICT resources and topics have to be jointly considered before KMS are implemented. The investigation now turns to KMS, their roots, contents, functions and architectures.

7 Systems

KMS were defined in section 4.3 - "Knowledge management systems" on page 82. In the following, first the technological roots of KMS are reviewed (section 7.1). Then, the contents of KMS are analyzed along with their structure, the types of media used, a maturity model for knowledge elements and some aspects of quality of contents (section 7.2). The definition of KMS is detailed with the help of a review of KMS architectures that have been proposed in the literature or have been implemented as standard KMS platforms. Based on this analysis, an amalgamated architecture for a centralized KMS is presented. The architecture is discussed in detail with the help of a structured list of KMS functions that will be used in the empirical study (section 7.4). As an alternative to this ideal architecture for a centralized KMS, an architecture for a distributed or peer-to-peer KMS is presented (section 7.5). The development of tools and systems will be discussed in a structured way leading to a classification of KMS (section 7.6). Finally, the important integration layer is discussed in more detail, reflecting on meta-data and ontology management as well as the Semantic Web (section 7.7).

7.1 Technological roots

Figure B-47 uses the metaphor of a magnetic field produced by a coil to show the technological roots and influences that impact design and implementation of KMS. The term KMS plays the role of the coil, the magnetic center. Theoretical approaches that support deployment of KMS and related terms that show a different perspective on ICT support of an organization's way of handling knowledge are shown to the right of the magnetic center. The main differences between KMS and their predecessors guiding the design of KMS are shown on the left side[440]. Both influences together provide the energy to integrate, (re-) interpret, (re-)arrange and (re-) combine ICT technologies that are the roots of KMS into a set of KMS-specific services that in turn are integrated into application systems, tools and platforms with a clear focus on the support of KM concepts and instruments.

The strong metaphor of a KMS, a system aiding the handling of knowledge in an organization, influences other ICT-related initiatives that can benefit from the ideas integrated with the help of KMS. Examples are the overall handling of electronic assets in an enterprise-wide content management, the integration of intelligent services for strategic enterprise management, the provision of access from any location in mobile information management, the specialized management of knowledge about employees, customers, projects, processes and products, the support of training and education by e-learning as well as the personal knowledge management of networked knowledge workers.

440. For an explanation see section 4.3.2 - "Definition" on page 86.

In the following, the most important ICT will be reviewed that form the technological roots of KMS[441]. Comprehensive KMS combine and integrate the functionality of several, if not all of these predecessors:

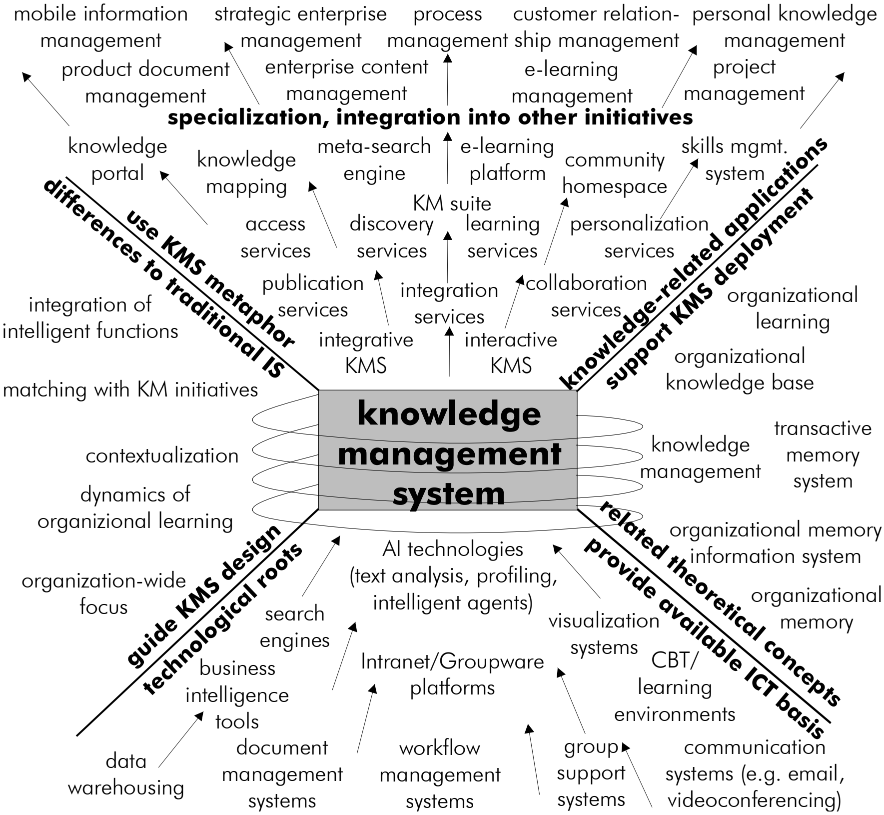

FIGURE B-47. Technological roots and influences of KMS

Document and content management. The term document management denotes the automated control of electronic documents, both individual and compound documents, through their entire life cycle within an organization, from initial creation to final archiving (Turban et al. 1999, 433f), i.e., creation, storage, organization, transmission, retrieval, manipulation, update and eventual disposition of documents (Sprague 1995, 32). A document management system (DMS) provides functions to store and archive documents, navigate and search documents, for versioning and to control access to documents. Additionally, many DMS support the pro-

441. See chapter 7 - "Systems" on page 273 for a detailed discussion of the various services, applications and specializations of KMS.

cess of imaging which turns paper-based documents into electronic ones and the classification of documents (Mertens et al. 1997, 128f, Thiesse/Bach 1999, 100ff).

A content management system (CMS) supports the organization of information and contents and the publication on the Web. Like DMS in the non-Web environment, CMS manage the whole Web publishing process, offer mechanisms for releasing new contents, support HTML generation with the help of templates, standard input and output screens and the separation of content and layout which provides for a standardized look & feel of the Web pages (Horn 1999, 165). As a consequence, participants who are not familiar with HTML can publish Web documents that fit into an organization's corporate (Web) identity. So-called Wikis and Weblogs are purpose-oriented CMS that are pre-structured, offer a subset of easy-to-use CMS functions and allow for simple (joint) editing, updating and linking of content within and between sites[442].

Workflow management. A workflow is the operative, technological counter-part of a business process and consists of activities related to one another which are triggered by external events and carried out by persons using resources such as documents, application software and data (Galler 1997, 7f). A workflow management system (WFMS) "defines, creates and manages the execution of workflows through the use of software, running on one or more workflow engines, which is able to interpret the process definition, interact with workflow participants and, where required, invoke the use of IT tools and applications" (WfMC 1999, 9, for examples for WFMS see Koch/Zielke 1996, 162ff). Most WFMS primarily support well-structured organizational processes. More recently, some WFMS also focus flexible workflows, so-called ad-hoc workflows (Galler 1997, 16f). An ad-hoc workflow is a sequence of tasks that cannot be standardized, but has to be designed spontaneously by participants (Koch/Zielke 1996, 30). WFMS functionality can be used in knowledge management, e.g., to support processes such as the publication or distribution of knowledge elements. Several KMS contain flexible functions for workflow management (e.g., Open Text Livelink).

Intranet. The term Intranet denotes an organization-internal ICT platform based on Internet technologies[443]. An Intranet consists of a bundle of applications and data bases. Access to the Intranet is restricted to a limited group of users (also

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442. Weblogs and Wikis have become popular in the Internet (Wikipedia, Blogosphere). However, many organizations attempt to profit from the benefits of easy content handling also for professional use within the organizational boundaries. Some authors even consider Weblogs and Wikis as (simple) tools for knowledge management (e.g., Efimova 2004, Röll 2006).

443. For an overview of Internet technologies see Röckelein (1999, 22ff). Röckelein uses a model with three layers to describe (1) base technologies, (2) net technologies as well as (3) information services that can be found in public electronic networks such as the Internet. Additionally, he gives a short overview of support technologies and presents numerous examples for the use of Internet technologies for organizations' market communications (Röckelein 1999, 7ff and 109ff respectively). For potentials of an Intranet for businesses see Jaros-Sturhahn/Hießl 1998.

Thiesse/Bach 1999, 105ff). In 1997, one in four German organizations were considered pioneers in the application of Intranets (Jestczemsky 1997, 24). 78% of these pioneers used their Intranet to provide access to data bases, 78% to exchange data and documents, 65% for email, 65% for access to on-line services, 52% for training and education, and 26% for access to financial data, stored e.g., in ERP systems (Jestczemsky 1997, 25).

Groupware. Groupware is a category of software for the support of work groups and teams. Examples for Groupware applications are (Watson 1999, 441f): electronic discussion groups, electronic meeting support, group support systems[444], conferencing software, shared screen systems, group calendars, workflow automation, image management or desktop video conferencing. Groupware is usually classified according to a matrix of group interaction with the two dimensions *time* and *place*: same time vs. different time as well as same place versus different place. Groupware tools can further be classified into (1) communication systems, e.g., email, audio/video systems, chat systems, (2) information sharing systems, e.g., message boards, tele-consultation systems, co-browser, (3) cooperation systems, e.g., co-authoring, shared CAD, whiteboard, word processor, spreadsheet, group decision support systems, (4) co-ordination systems, e.g., group calendar, shared planning, notification systems and (5) social encounter systems, e.g., media spaces, virtual reality (Andriessen 2003, 12). A *Groupware platform* provides general support for collecting, organizing and sharing information within (distributed) collectives of people, such as work groups and project teams over corporate networks as well as the Internet. The best known Groupware platform is Lotus Notes which combines data base, group calendar, email and workflow automation functionality (Watson 1999, 442ff). Other examples are BSCW[445] that is freely available over the Internet and Groove[446], a recent example for a Groupware platform that uses the peer-to-peer metaphor instead of the client-server paradigm.

Data warehousing. A data warehouse is a subject-oriented, integrated, non-volatile, time-variant collection of data in support of management decision processes (Inmon 1992). It is implicitly assumed that a data warehouse is physically separated from operational systems (transaction processing systems, TPS). TPS and also organization-external data bases are the sources from where data are regularly loaded into the data warehouse. Data are organized by how users refer to it. Inconsistencies are removed and data are cleaned (errors, misinterpretations), converted (e.g., measures, currencies) and sometimes summarized and denormalized before they are integrated into the data warehouse (Gray/Watson 1998, 8ff, Muksch/Behme 1998a, 40ff). The data in the data warehouse is usually optimized for the

444. See “Group support systems (GSS).” on page 277.
445. Basic Support for Cooperative Work, offered by the GMD (Gesellschaft für Mathematik und Datenverarbeitung), URL: http://bscw.gmd.de/
446. URL: http://www.groove.net/

use with business intelligence tools (e.g., star and snowflake data model, multidimensional data bases, Gray/Watson 1998, 66ff, Holthuis 1998, 148ff).

Business intelligence. Business intelligence denotes the analytic process which transforms fragmented organizational and competitive data into goal-oriented "knowledge" about competencies, positions, actions and goals of the internal and external actors and processes considered (Grothe/Gentsch 2000, 19). The analytic process requires an integrated data basis that is usually provided by a data warehouse. There are a number of technologies that support this process[447]. Examples are decision support system (DSS) technologies, multidimensional analysis (online analytical processing, OLAP), data mining, text mining and Web mining technologies, the balanced scorecard, business simulation techniques, and also artificial intelligence technologies, such as case based-reasoning or issue management[448],

Group support systems (GSS). GSS are also called group decision support system (GDSS). A GSS is an interactive system that combines communication, computer, and decision technologies to support the formulation and solution of unstructured problems in group meetings[449]. GSS integrate technologies to support the communication in groups, the structuring of processes by which groups interact (e.g., agenda setting, facilitation) and information processing (e.g., aggregating, evaluating or structuring information, Zigurs/Buckland 1998, 319). GSS can be classified according to the level of support in *level 1 GSS* which remove communication barriers, *level 2* GSS which provide decision modeling and group decision techniques and *level 3* GSS which provide expert advice in the selecting and arranging of rules in a meeting and thus lead to machine-induced group communication patterns (DeSanctis/Gallupe 1987, 593ff). One of the best known GSS well received in the literature is GroupSystems (e.g., Valacich et al. 1991, Dennis 1996).

Visualization of structure. Visualization is used in a multitude of tools and systems. Most visualization systems are based on graph theory. In addition to two-dimensional graphs representing elements and relationships, recently a number of tools also provide three-dimensional visualization techniques[450]. Examples are tools for data, function, organization, process or object-oriented modeling or tools that provide mapping techniques which have a long tradition in psychology, sociology and pedagogy, such as mind mapping[451].

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447. E.g., Gray/Watson 1998, 123ff, Chamoni/Gluchowski 1998, Bissantz et al. 1998, Watson 1999, 469ff, Grothe/Gentsch 2000, 21.
448. See "AI technologies." on page 279.
449. DeSanctis/Gallupe 1987, 589, Turban et al. 1996, 501, see also Zigurs/Buckland 1998, 320 for an overview of classifications of GSS technologies.
450. So-called hyperbolic browsers, see also section 7.4.5 - "Collaboration services" on page 327.
451. See e.g., Mandl/Fischer 2000 for an overview of mapping techniques which can be applied in knowledge management.

Search engines. A search engine is a program that can be used to find Web sites, documents or images, either in an organization's Intranet or in the WWW. Search engines apply programs that permanently trace the Web or an Intranet for new Web pages, so-called spiders or robots (Horn 1999, 57, Brenner et al. 1998, 197ff). A new found Web page is scanned for possible keywords which then are stored together with the URL of the Web page in the search engine's data base. At the time when a user submits a search term to the search engine, only this data base is searched and intelligent algorithms are applied in order to retrieve those Web pages that fit most to what the user has searched for. One of the best known search engines that is used in a number of KMS is Verity's K2 Enterprise or Developer search engine[452]. So-called meta- or multi-search engines (Horn 1999, 59) forward search strings including boolean operators to various search services, collect and filter the results (e.g., for redundancies) and present them accordingly. One of the best known meta-search engines on the Internet is Meta-Crawler[453]. Both, search engines and meta-search engines can be further distinguished with respect to the search domain which they support, such as organization-internal and/or organization-external systems.

Computer based training (CBT) tools and learning environments.
Learning environments are application systems that offer specified learning content to the learner in an interactive way and thus support the teaching and/or learning process (Behrendt 1998, 220, Schäfer 2000, 36). CBT, also called *computer-assisted* or *aided instruction* (CAI) or *computer supported learning* (CSL)[454], has its historical roots in *programmed instruction* or *learning* in the late 1950s and 1960s which was based on the concept of *operant conditioning* developed by Skinner (Hilgard/Bower 1975, 610ff, Möhrle 1996, 76ff). Both, psychological and pedagogical as well as technological advancements have led to a wide variety of CBT systems and learning environments which reflect how diverse learning can be[455]. Examples are[456]: drill & practice systems, (intelligent) tutoring systems, active assistance systems, microworlds, simulation systems, experimental game systems, hypertext-/hypermedia learning systems as well as more recent developments in the field of computer-supported learning, such as Web based training (WBT), multimedia learning environments, tele-teaching, distance learning, tele-tutoring and computer supported collaborative learning. Recently, these diverse CBT concepts

452. See URL: http://www.verity.com/; see also the support Web site for this book http://iwi.uibk.ac.at/maier/kms/.
453. URL: http://www.metacrawler.com.
454. There are many more terms in use that denote the application of software for teaching and/or learning purposes (e.g., Bodendorf 1990, 37f) which reflects the vivid interest in this field, especially since the 80s and the wide-spread use of the PC.
455. For examples see Schanda 1995, 21ff, Ballin/Brater 1996, 41ff, Möhrle 1996, 24f, Schulmeister 1997.
456. See also Möhrle 1996, 32ff, Mertens et al. 1997, 46, Behrendt 1998, Kerres 1998, Schreiber 1998, 11ff, 16f, Lehner/Klosa 2000, Schäfer 2000, 38ff, Lehner 2001, Nikolaus 2002, 22ff.

have found their way into integrated learning management systems or e-learning suites which overlap with KMS[457].

Communication systems. Communication systems are electronic systems that support both asynchronous and synchronous communication between individuals (point-to-point communication systems) and collectives (multi-point communication systems). Examples for synchronous communication systems are tele-conferencing systems such as text conferencing (chat), instant messaging, audio and video conferencing systems. Examples for asynchronous communication systems are email, listserver or newsgroups[458].

AI technologies. There are a large number of specific technologies that is discussed as supporting knowledge management. Most of these technologies have their roots in the field of artificial intelligence. Results from AI research play a crucial role in the development of KMS and provide intelligent functions for KM. Examples for AI-based tools for KM are[459]:

- *experience and know-how data base systems* are ordered collections of application solutions, i.e., specialized data base systems that store e.g., experiences, lessons learned, best practices as well as technical solutions (Mertens et al. 1997, 227f, Roithmayr/Fink 1997, 503). Experience data bases technologically typically rely on conventional information retrieval and document management technology, augmented with business process models and ontologies about the application domain as well as additional meta-data categories for describing knowledge documents (Kühn/Abecker 1997, 932, Staab et al. 2001). The term experience data base aims more at management, organizational and technical experiences (e.g., customer relations, business processes, projects) whereas the term know-how data base aims more at technical problems and solutions (Wargitsch 1998, 25f);
- *case-based reasoning (CBR) systems* provide an approach to solve problems with the help of known solutions for similar problems that has its roots in AI research. CBR comprises the four steps (1) retrieve cases from the system's case base which are similar to the problem presented by the user, (2) reuse solved cases, (3) revise the selected case and confirm the solution and (4) retain the learned case if it is an interesting extension of the case base (Aamodt/Plaza 1994[460]);

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457. See section 4.3.1 - "Overview and related concepts" on page 82.
458. See also section 7.4.5 - "Collaboration services" on page 327.
459. See also Kühn/Abecker 1997, 931ff, Mertens et al. 1997, Probst et al. 1998, Wargitsch 1998, 23ff, Krallmann et al. 2000, 234ff, Lehner 2000, 330ff, Mertens/Griese 2002, 49ff.
460. For an extensive analysis and discussion of the potentials of CBR see also Althoff/Aamodt 1996, Mertens et al. 1997, 74f, the special issues on case-based reasoning of the journal WIRTSCHAFTSINFORMATIK, Ehrenberg 1996 or the journal KI, Bartsch-Spörl/Wess 1996; examples of CBR tools are listed on the support Web site for this book http://iwi.uibk.ac.at/maier/kms/; see also the overview of CBR tools and applications, URL: http://www.cbr-web.org/.

- *recommender systems* extend systems that support information retrieval and give recommendations based on techniques such as test of context correspondence, frequency analysis and agent technologies (e.g., Wargitsch 1998, 29). Some authors also use the term *collaborative filtering* (Goldberg et al. 1992) to denote the social process of recommending. The systems collect and aggregate recommendations of a multitude of people and make good matches between the recommenders and those who seek recommendations (Resnick/Varian 1997, 56). In order to accomplish this, recommender systems have to model the users' characteristics, interests and/or behavior: *user modeling* (Bodendorf 1992, Mertens/Höhl 1999), also called *profiling* (Brenner et al. 1998, 132ff, Applehans et al. 1999, 37ff) or *personalization* (Zarnekow 1999, 132f). Profiles are a requirement for the application of many intelligent technologies, especially intelligent software agents (see next paragraph). Systems using *content-based filtering* recommend items similar to those a given user has liked in the past (Balabanovic/Shoham 1997, 66). Recently, AI techniques as part of recommender systems have been applied widely in commercial Web sites, e.g., to recommend music, videos or books (e.g., URL: http://www.amazon.com/[461]).
- *intelligent software agents* are autonomous units of software that execute actions for a user (Mertens et al. 1997, 6). Intelligent software agents use their intelligence to perform *parts of its tasks* autonomously and to interact with its environment in a useful manner (Brenner et al. 1998, 21). Software agents thus differ from more traditional software programs with respect to their autonomy, ability to communicate and cooperate, mobility, reactive and proactive behavior, reasoning, adaptive behavior and last but not least some agents even might show human characteristics (Zarnekow 1999, 16ff). The roots of the agent technology can be traced back to approaches of *distributed artificial intelligence* where agents deconstruct tasks into sub-tasks, distribute the sub-tasks and combine their results (Mertens et al. 1997, 7) and to developments in the area of networks and communication systems which form the underlying technological basis (Brenner et al. 1998, 41f). Intelligent or semi-intelligent agents can be classified according to their main area of application as information agents, cooperation agents and transaction agents (Brenner et al. 1998, 19) and are applied in a multitude of settings. Prominent examples for agents can be found in electronic market processes. Agents provide value-added services for the identification phase, the information phase, the negotiation and buying phase (in a narrow sense) as well as the application and service phase of a buying process (Zarnekow 1999, 118ff). In knowledge management, agents can be used e.g., to scan emails, newsgroups, chats etc., to group and automatically update user-specific messages and information items in the Internet (newswatchers), to analyze

461. For a more detailed discussion and examples of recommender systems see Konstan et al. 1997 (GroupLens; for netnews articles), Kautz et al. 1997 (ReferralWeb; for people), Terveen et al. 1997 (PHOAKS; for URLs) and Rucker/Polanco 1997 (Imana's CommonQuest; for URLs).

and classify documents, to search, integrate, evaluate and visualize information from a multitude of sources, to intelligently handle information subscriptions, to identify and network experts, to visualize knowledge networks and to recommend participants, experts, communities and documents[462].

- *issue-based information systems* are systems to visualize argumentation that build structured networks of arguments consisting of e.g., questions, opinions, pro and counter-arguments or examples recorded in group decision processes (Buckingham Shum 1998, 903ff, Wargitsch 1998, 29). One of the best known examples is the system gIBIS which is marketed as CM/1 or QuestMap respectively (Conklin/Begeman 1988, Stein/Zwass 1995, 93, Buckingham Shum 1988, 906ff).

7.2 Contents

The content of an organizational memory—the organization's knowledge—can be located[463]:

- in *peoples' minds*,
- in *artifacts*, such as the physical organization, e.g., the architecture, the use of office space; printed media, audiovisual media and multimedia instruments etc.,
- in *ICT systems*, particularly in KMS, e.g., routines, procedures, models, (hypertext) documents, multimedia files, user profiles, learning (CBT) modules, knowledge bases or links to experts.

These three locations, or media, are related to each other and complexly interwoven into knowledge networks. Networks of knowledge consist of a number of people with their external memories, e.g., documents, office space and ICT systems. These networks of knowledge have been termed organizational competencies which in turn create competitive advantages[464]. Consequently, KM has to handle and improve these complex relationships and networks rather than individual knowledge elements or just one location, e.g., a knowledge base. The transactive memory system concept (Wegner 1986) has been suggested to analyze these complex relationships and provides a great metaphor for the implementation of KMS and especially for structuring the contents.

Due to the complexity of this topic and the focus of this book the following discussion of contents will concentrate on KMS[465]. Generally, both, normative sug-

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462. For examples of actual implementations of some of these technologies see Brenner et al. 1998, 189ff, Zarnekow 1999, 163ff and the list of KMS provided on the support Web site for this book http://iwi.uibk.ac.at/maier/kms/.

463. See also Watson 1999, 15 who concentrates on people and electronic organizational memories and Amelingmeyer 2000, 51ff who distinguishes between persons, material media and collective media as locations for knowledge. The idea of a collective or organizational memory is discussed in section 4.1.1 - "From organizational learning to knowledge management" on page 22; different types of knowledge including collective knowledge are investigated in section 4.2.2 - "Types and classes of knowledge" on page 66.

464. See section 5.1 - "Strategy and knowledge management" on page 93.

gestions for KMS and actual implementations of KMS, vary considerably in terms of the content to be managed. According to the interviews with knowledge managers, many companies seem to be driven by a pragmatic approach which puts those parts of the organizational knowledge at the center of consideration the management of which promises the most direct positive effects. Typically, the organization's knowledge structure is determined in a workshop and reflects sources that already exist in the organization, at best in electronic form, but are handled by a number of incompatible ICT systems. Examples are customer-related data, patents, skills data bases (yellow pages), lessons learned, best practices, descriptions of products, business processes, the structural organization or projects, external online data bases, presentations, reports and market studies. In many cases, explicit knowledge is predominant. It is also a lot harder to describe implicit knowledge that is an equally important part of knowledge to be handled in organizations.

Section 7.2.1 discusses examples for *types of contents* that can be found in KMS. Section 7.2.2 defines the concept of a knowledge element and discusses some aspects of maturity of knowledge. Section 7.2.3 investigates what *media formats* are supposedly used to encode knowledge elements and how to determine the size of organizational knowledge bases. Finally, section 7.2.4 discusses the two predominant ways to *organize knowledge elements*, the hierarchical and the network structure.

7.2.1 Types of contents

A classification of types of contents of KMS can be built on the abundance of classifications and distinctions of types of knowledge as presented in section 4.2.2 - "Types and classes of knowledge" on page 66. Some pragmatic distinctions which can be studied rather easily are:

- *organization-internal*, that is knowledge created inside the organization, e.g., internal analysis, versus *organization-external knowledge*, e.g., market reports,
- *formal knowledge*, that is knowledge already approved by some institution and officially released, e.g., descriptions of organization and processes, versus *informal knowledge*, e.g., ideas, questions and answers,
- *secured knowledge*, that is knowledge protected by intellectual property right or some other form of legal contracts, e.g., patents, versus *securable knowledge*, e.g., a part of proposals or best practices, versus *knowledge not securable*, e.g., external patents, common industry knowledge,
- *historic knowledge*, that is knowledge that relates to past events, experiences or has been used in a certain application context, e.g., lessons learned, versus *knowledge relating to the future*, that have not been used in the past, but have a prescriptive or normative character, e.g., proposals, ideas.

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465. Research about knowledge processing and representation in people's heads has a long tradition in the field of cognitive psychology (see also section 4.1.1 - "From organizational learning to knowledge management" on page 22). Architecture has been briefly touched in section 6.5 - "Other interventions" on page 230.

- *classification according to the topic*, e.g., knowledge about participants, customers, business partners, stakeholders, competitors, products, methods, instruments or procedures[466].

In order to get a more detailed picture, a list of sixteen items will be used that represent typical contents of KMS in the empirical study. The list was pragmatically developed on the basis of the literature and several interviews with knowledge managers. There are two different theoretical streams that were used for the classification of the type of contents of KMS. These are the distinctions between:

Integrative and interactive KMS[467]. It is supposed that the predominant knowledge managed in *integrative KMS* currently will be *method, product and process knowledge* whereas in *interactive KMS* the main knowledge used will be *person-oriented knowledge*.

Novices and experts. The classification distinguishes between knowledge adequately presented for *novices*, i.e. facts and rules, and knowledge better suited for the perception by *experts*, i.e. case-oriented knowledge, or at least competent[468]. This is a differentiation well-suited to detail both, method, product and process knowledge as well as person-oriented knowledge.

Table B-13 shows some examples for each type of knowledge which will be described in the following[469].

Knowledge about organization and processes. Descriptions of the organization (structure and processes) are typically managed by the IT/organization, HRM departments or by process owners and managers. Examples are organizational charts, event-driven process chains to describe business processes, descriptions of organizational positions, projects, roles or personnel handbooks.

Product knowledge. This type of knowledge represents descriptions related to the organizations' products and/or services, such as marketing presentations, technical papers, CAD models or white papers.

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466. For an extensive list of dimensions of types of knowledge see section 5.2.2 - "Strategic options" on page 120.
467. See section 7.6.1 - "Knowledge Tools" on page 361.
468. See section 6.1.2 - "Knowledge management roles" on page 162 for a discussion of novices versus experts.
469. Several types of knowledge described in the following are specifically targeted by a corresponding KM instrument, e.g., lessons learned, good or best practices etc. which have been described in section 6.2 - "Instruments" on page 195. The number of types of knowledge does not amount to sixteen as some types have been split in the table, i.e. studies and business partners, as well as combined in the following descriptions, but treated separately in the empirical study, e.g., patents and studies. The latter thus amount to fifteen types of knowledge to which private contents are added so that there are sixteen types of knowledge that have been tested in the empirical study in 14.2.1 - "Types of contents" on page 532.

Internal/external patents. Patents are legally secured innovations. There will be a distinction between patents held by the organization and organization-external patents. External patents can be found e.g., in so-called patent data bases such as the World Patent Index (WPI, operated by Derwent, Mertens/Griese 2002, 22).

TABLE B-13. Classification of knowledge with respect to type and target group

	method, product and process knowledge	**person-oriented knowledge**
facts and rules (novice)	• knowledge about organization and processes • internal and external patents • product knowledge • fact knowledge in internal/ external studies and analyses	• employee yellow pages • fact knowledge about business partners
cases (expert)	• lessons learned • best practices • ideas, proposals • cases in internal/external studies and analyses	• cases about business partners • directory of communities • employee communication • questions, answers (frequently asked questions, FAQ)

Internal/external studies/analyses. Reports document the results of an organization-internal study or analysis related to a specific topic or a study or analysis performed by an organization-external institution, e.g., universities, research institutions, professional services companies or benchmarking groups.

Lessons learned. Lessons learned are the systematically documented essence of experiences made by members of the organization in e.g., projects or learning experiments. They thus are authored by a collective of project members that commit to the critical experiences made in the project and documented for future reuse in the same or in other projects.

Best practices. This term in a wide meaning denotes knowledge in a process-oriented form that describes task or workflows that have proven to be valuable or effective within one organization or organizational unit and may have applicability to other organizations (also O'Dell/Grayson 1998, 167). Regularly, best practice management distinguishes various categories of quality that relate to the scope in which the corresponding practice is considered "best", e.g., team, subsidiary, company; group[470] or industry best practice (O'Dell/Grayson 1998, 167).

Ideas, proposals. These can be informal or formal documents submitted to an established proposal system. So-called *microarticles* are a structured approach to

470. In the sense of a group of companies belonging to the same concern, e.g., the BMW Group.

organize individual learning experiences and help knowledge workers to externalize and share their knowledge (Willke 1998, 107ff).

Questions, answers (FAQ). Frequently asked questions (FAQ) are a popular instrument to store questions that might be of interest to many participants together with answers, mostly given by experts (e.g., Mertens/Griese 2002, 52). Examples are the manyfold public FAQ lists that can be found in newsgroups or the WWW.

Employee yellow pages. Expert yellow pages and skills directories support the transparency of expertise in an organization. Employees can provide their skill or competence profile which can be accessed by all employees who look for an expert on a certain topic or for an expert who can provide a solution to a given problem.

Knowledge about business partners. This topic-specific type of knowledge has been gained from interactions with customers and suppliers, e.g., through personal or computer-supported interaction between business partners and members of the organization, customer relationship management, supply chain management programs and surveys.

Directory of communities. In analogy to skills directories, this is a list of communities that are established within or accessible through the organization and a short description of themes, members and contact data. The directory might also offer some examples for discussions that are mediated or for documents that are shared with the help of community home spaces.

Internal communication. This term denotes the organization-internal equivalent to public relations and describes the part of corporate communication that is targeted to the organization's employees: official organization-wide communication, e.g., business TV, corporate newsletters, corporate electronic magazines, announcements etc.[471].

External on-line journals. The electronic equivalent to paper-based journals can be directly accessed through the Web[472]. Due to the fact that on-line journals can hold both types of knowledge as well as fact knowledge and cases, they cannot be classified according to the dimensions in Table B-13 on page 284.

Organizations with a systematic KM initiative supposedly handle different types of knowledge when compared to organizations without such an initiative. The list of items describing the contents of KMS contains several items which require special attention in order to be systematically handled in the organizations' electronic knowledge bases. These are best practices, lessons learned and employee yellow

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471. See Will/Porak 2000, 195f for an extensive model of corporate communication that covers internal and external communication.
472. For example the Knowledge Management Magazine, URL: http://www.kmmagazine.com/.

pages. Moreover, at many KM conferences organizations that handle knowledge that is legally secured (patents) were on the forefront of applying KM (e.g., chemical or pharmaceutical organizations). Again, this points to the direction that organizations with systematic KM differ from other organizations with respect to contents handled in their KMS. The following hypothesis will be tested:

Hypothesis 13: Organizations with systematic knowledge management target different contents than organizations without such an initiative

In addition to the 15 items describing the contents of KMS, *private contents* were included as it is hypothesized that this in turn has significant effects on the way an organization handles knowledge. By allowing employees to publish private contents or to present themselves, organizations can show that they respect the individuals' off-the-job interests and networking needs. If organizations take these needs and interests seriously, it might in turn have a positive influence on the building of trust and as a consequence the willingness to share knowledge of their employees.

Hypothesis 14: If an organization allows private contents as part of their knowledge management systems, willingness to share knowledge is higher

7.2.2 Maturity of knowledge elements

The term content and its treatment with the help of ICT takes an objectified perspective on knowledge[473]. A knowledge unit or *knowledge element*, sometimes also called knowledge chunk, denotes the smallest unit of explicit, documented knowledge. It has been termed "a formally defined, atomic packet of knowledge content that can be labeled, indexed, stored, retrieved, and manipulated. The format, size and content of knowledge units may vary, depending on the type of explicit knowledge being stored and the context of its use" (Zack 1999a, 48). Examples for knowledge elements are (Zack 1999a, 49):

- concepts, categories and definitions (declarative knowledge),
- processes, actions and sequences of events (procedural knowledge),
- rationale for actions or conclusions (causal knowledge),
- circumstances and intentions of knowledge development and application (specific contextual knowledge).

However, these are still conceptual categories. From an ICT perspective, examples for knowledge elements are:

- a document, email message, instant message, video file, audio file, slide show or picture displaying an idea, proposal, recommendation, an expert's opinion, a description of or solution to a specified problem[474],
- a personal note with a write-up of a personal experience,

473. See section 4.2 - "Knowledge" on page 60, particularly the discussion related to the description of Figure B-8, "The term knowledge and its application in KM," on page 78.

- a contribution to a forum, newsgroup, Wiki, Weblog or other form of CMS,
- an entry in a list of frequently asked questions (FAQs) and the answer to the question,
- an element in an experience data base,
- a document with e.g., a product presentation, lesson learned, good or best practice, story, study, write-up of an experiment, whitepaper, patent or report, e.g., about the results of a project milestone,
- a prototype,
- a model of e.g., a (business or knowledge) process, class, data, knowledge structure or other enterprise model,
- a learning object in a learning repository, e.g., definition, explanation, formula, example, case, demonstration, exercise, exam question, test or master solution,
- a skill description in a skill data base,
- an entry in a yellow page system or expertise locator describing available expertise on a specified topic,
- knowledge elements that connect some of the above elements to persons, groups, teams or organizational units, e.g., the description of skills of a particular employee or organizational unit,
- an evaluation of or a comment to one of these knowledge elements etc.

The types of data underlying these knowledge elements have been extended from structured data as can be found in data base systems to (semi-)structured data typically found in e.g., DMS, file servers, CMS or email servers. As compared to structured data, semi-structured data has not been managed equally well in most organizations. A large number of terms have been coined for semi-structured data, e.g., content, (digital) asset or, most importantly for the handling of knowledge elements, the term document.

A document is a legally sanctioned record or a transitory record of a business transaction, decision or some form of externalization of knowledge that can be viewed as a single organized unit both from a business or knowledge perspective and from a technical perspective. It is composed of a grouping of formatted information objects which cannot be separated without substantial loss of meaning, possibly together with meta-data[475].

The term record denotes that the document's context relates to some kind of business transaction or decision or, in the case of knowledge elements, some form of externalization of knowledge, which the document represents. Examples for legally sanctioned records are purchase orders or patents. Examples for transitory

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474. The stress is here on the representation of a solution to a specified problem. This is not necessarily a document, a video file or an audio file etc., but can also be a selected portion, e.g., a document fragment, a video sequence or an audio theme.
475. See also Kampffmeyer/Merkel 1997, 1999, Karakas 2003, Götzer et al. 2004, Maier et al. 2005, 247ff, Maier/Trögl 2006.

records are meeting notes or ad-hoc solutions to problems. There are legal requirements and retention plans regulating the handling of many types of documents in organizations, e.g., access restrictions or time period required for archival. The term transitory reflects the fact that not all documents are archived, but some are developed step-by-step with increasing levels of maturity which calls for versioning. Documents are collections of information objects bound by the document's purpose. These information objects are often formatted, so that in some cases, e.g., certain contracts or annotated maps, the original form of the entire document has to be conserved. Documents can be regarded as containers of content which cannot be split without loosing their original meaning and, in the case of knowledge elements, without loosing context and thus hindering reconstruction of knowledge. Annotations with meta-data ease transfer, distribution, retrieval and understanding of documents[476]. Documents are accessed as a whole because they group related information with respect to the expected or most common user needs.

Documents can be *elementary*, e.g., a text file or a fax message, *compound*, e.g., a text file with embedded graphs, tables or pictures or *container*, e.g., a collection of elementary or complex documents organized around a workflow in a folder or zip file (Kampffmeyer/Merkel 1997, 12). Documents have business value and thus can be considered as (digital) assets. Document types can be distinguished using a number of characteristics, for example:

- physical characteristics, primarily with respect to non-electronic documents,
- formal characteristics, e.g., file types and formats,
- structure, e.g., functional grouping of objects, sequence,
- type of content, e.g., type of knowledge element,
- layout, e.g., arrangement, design,
- coding, coded or non-coded information,
- time characteristics, e.g., date of creation, last modification, last access, version,
- control and security characteristics, e.g., encryption, confidentiality, privileges to search, access, print, change, create, delete or administer documents,
- legal characteristics, e.g., requirements for retention, modifiability, digital rights management.

Taking into account the definition of document, Box B-8 defines the term knowledge element. The considerable variety of (1) types of knowledge elements, of (2) organizational units responsible for a systematic management of the processes in which these knowledge elements are involved as well as of (3) systems supporting these knowledge elements leads to an often fragmented landscape of numerous media and locations to preserve as well as channels to transfer knowledge of varying degrees of maturity which employees, teams, work groups and communities can select from in order to retain or transfer knowledge elements for further development and application by other employees, teams, work groups or

476. See section 7.7.2 - "Meta-data management" on page 379.

communities. The choice is often difficult, leading to inadequate supply of information and knowledge in organizations and thus can be improved.

A knowledge element is the smallest unit of atomic, explicit, formally defined knowledge content, a record of some form of externalization viewed as a single organized unit both from a conceptual and from a technical perspective. It is composed of a grouping of formatted information objects which cannot be separated without substantial loss of meaning together with meta-data describing the element.

BOX B-8. **Definition of knowledge element**

Examples for types of knowledge elements have been given in section 7.2.1 - "Types of contents" on page 282. Organizational units, such as innovation management, project management, quality management or units dealing with e-learning, all intend concurrently to improve construction, preservation, integration, transfer and (re-) use of knowledge and competencies. Additionally, programs of personnel development as part of HRM support training into the job, on the job, near the job, off the job and out of the job (Scholz 2000). But despite increased interest in bringing them together, particularly as part of KM initiatives, there are still huge conceptual differences. Whereas e-learning and personnel development have their foundations in (learning) psychology, (media) didactics and (learning) pedagogy and emphasize the importance of structural guidance by preparing learning material or personal guidance, there are also more document-oriented units, such as project and quality management that rather envision an organizational knowledge base into which the individual's knowledge is supposed to be made explicit and which is the basis for more or less unguided knowledge transfer.

From an ICT perspective, numerous systems aim at improving knowledge and learning processes as well as organizational competency development which are typically designed and managed according to the specific needs of the respective organizational units. Employees thus use a fragmented systems landscape in which each system supports a certain part of knowledge and learning processes. There are substantial conceptual challenges of designing learning and knowledge processes that bring together the separated organizational support infrastructures fostered by the different organizational units. Therefore both, organizational units and corresponding application systems typically target knowledge of different degrees of maturity.

Pruning the tree of types of knowledge elements and guiding employees on how to use the channels of knowledge transfer is thus a pivotal task in any KM initiative. In the following, the knowledge maturing process is described in order to provide a framework for the design of the required integrating types of knowledge elements, knowledge processes and channels in KM.

In a first step of structuring this process, Figure B-48 shows the five phases that have been identified after analyzing some practical cases[477]. The phases are described in the following.

- *expressing ideas*: New ideas are developed by individuals in highly informal discussions. The knowledge is subjective and deeply embedded in the context of the originator. The vocabulary used for communication is vague and often restricted to the person expressing the idea.
- *distributing in communities*: This phase accomplishes an important maturing step, i.e. the development of common terminology shared among community members, e.g., in discussion forum entries or Blog postings.
- *formalizing*: Artefacts created in the preceding two phases are inherently unstructured and still highly subjective and embedded in the context of the community. In this phase, purpose-driven structured documents are created, e.g., project reports or design documents in which knowledge is desubjectified and the context is made explicit.
- *ad-hoc learning*: Documents produced in the preceding phase are not well suited as learning materials because no didactical considerations were taken into account. Now the topic is refined to improve comprehensibilty in order to ease its consumption or re-use. The material is ideally prepared in a pedagogically sound way, enabling broader dissemination.
- *formal training*: The ultimate maturity phase puts together individual learning objects to cover a broader subject area. As a consequence, this subject area becomes teachable to novices. Tests and certificates confirm that participants of formal training have achieved a certain degree of proficiency.

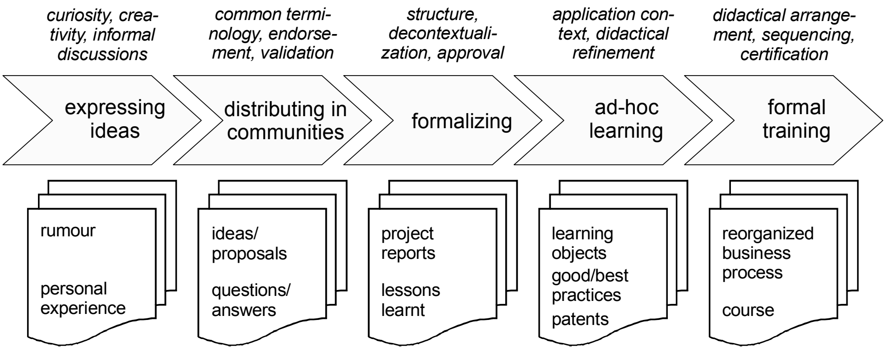

FIGURE B-48. Knowledge maturing process[478]

477. See Schmidt 2005, Maier/Schmidt 2007 who considered project experiences as reported in Bayer et al. 2005, Schmidt/Braun 2006 as well as metaphors of organizational knowledge and learning discussed in chapter 6 - “Organization” on page 153 and also the empirical results on types of contents presented in section 14.2.1 - “Types of contents” on page 532.

Knowledge thus can be classified according to its level of maturity. The class then suggests the appropriate form of learning and technical support systems. The following criteria have been identified as useful to define classes of knowledge:

Validity. Certainly, the most obvious categorization refers to a validation process of knowledge and could distinguish in a first step between unproven and proven[479] knowledge. In a more refined version that considers the specifics of organizational knowledge, validation could take into account the number of successful uses of knowledge, systematic tests or, finally, (mathematical) proves for its working.

Hardness. In analogy to mineralogy, this criterion describes the (alleged) validity and reliability of information or knowledge. According to Watson (1999), a possible scale runs from unidentified sources of rumors up to stock exchange data (see Table B-14).

TABLE B-14. Scale for information hardness[a]

degree	description	degree	description
1	unidentified source; rumors, gossip and hearsay	6	budgets, formal plans
2	identified non-expert source; opinions, feelings, ideas	7	news reports, non-financial data, industry statistics, survey data
3	identified expert source; predictions, speculations, forecasts, estimates	8	unaudited financial statements, government statistics
4	unsworn testimony; explanations, justifications, assessments, interpretations	9	audited financial statements, government statistics
5	sworn testimony; explanations, justifications, assessments, interpretations	10	stock exchange and commodity market data

a. Source: Watson 1999.

478. After: Maier/Schmidt 2007. When comparing this basic model with the model of organizational information processing (see Figure B-22 on page 154), all processes in the basic model are also part of the model of information processing. The emergence of ideas corresponds to the process of individual learning, distribution in communities corresponds to sharing, formalization is reflected in institutionalization, ad-hoc training in feedback and formal training in the refining and repackaging processes. The basic model sets the focus on a pragmatic chain of knowledge development tasks that can be designed so that formal, mature knowledge products are the outcome of the respective knowledge maturing process.

479. In a critical-rationalist perspective, “proven” could be replaced by repeatedly not falsified. It is noted that validation or “truth” of knowledge is a category that gives rise to age-old philosophical debates which this book will refrain from; for a small account see section 4.2 - “Knowledge” on page 60.

Context. With deepened understanding, connections to other topics become visible. This must not be confused with inherent contextualization of knowledge which decreases in the knowledge maturing process and refers to the degree of implicit linkage to the creation context, so that it cannot be used outside the original context. Inherent contextualization and inter-connectedness are inverse properties.

Commitment/legitimation. Knowledge can be structured according to the amount of support it gets. Support can be in the form of commitment by members of groups, teams, communities or other organizational units. Another form of support can be authorization to use knowledge by supervisors, executives or committees as well as legalization and standardization, forms of legitimation (Figure B-49).

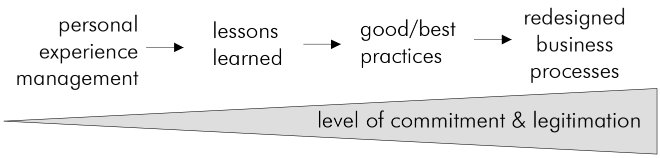

FIGURE B-49. Portion of the knowledge life cycle

The knowledge life cycle starts with individual experiences which have the least level of organizational commitment. Individual experiences are discussed, filtered and further explored in a team. If the team commits to certain experiences, they are called lessons learned. This process can be aided by a lessons learned coach that helps the team to structure the process of group reflection on team experiences. Further commitment and legitimation is needed in order to turn lessons learned into good practices. Practices can be seen as guidelines how to act in certain situations. Sharing good practices throughout the organization and agreeing that this is the best way to deal with a specific situation turns them into (organizational or local) best practices. Knowledge process reengineering is finally one method for redesigning business processes taking good and best practices into account. Knowledge bound to an individual is disseminated in the form of knowledge products that ultimately reside in social systems, changed business practices and processes.

Form of learning. As knowledge maturing is basically interconnection of individual learning processes where knowledge is taught and learnt, an important criterion is its teachability. Whereas immature knowledge is hard to teach (even to experts), formal training allows by definition for wide-range dissemination.

Table B-15 gives an impression of what a checklist for the classification of knowledge elements according to the criteria for maturity of knowledge discussed above could look like. This exemplary list differentiates between the four maturity levels initial, advanced, consolidated and mature. The last three rows give examples for types of knowledge and learning objects as well as channels that could be institutionalized to capture knowledge of varying degrees of maturity. The checklist should help organizations to design supporting infrastructures for maturing knowledge. These infrastructures are thought of as both, organizational and technical infrastructures. These help to (semi-)automatically identify knowledge that is ready to be brought to the next level of maturity. The knowledge is visualized together with its context in the same maturity level as well as the context of knowledge elements in the next maturity level. Then, the infrastructure could recommend specific actions on the knowledge elements, e.g., selection of certain parts, summaries, tagging, merging or other foms of enrichment and integration.

TABLE B-15. Exemplary categories for maturity of knowledge

criterion	**initial**	**advanced**	**consolidated**	**mature**
validation	unproven	successfully used	systematically tested	proven
hardness	proposed	supported	approved	audited
context	isolated	filed	annotated/ tagged	linked/ networked
commitment	opinions in community	convergence of discussions	consensus	commitment
legitimation of knowledge	ad-hoc order	guideline	standard operating procedure	compliance to standard
legitimation of learning content	case write-up	peer-reviewed article	textbook by field expert	standard textbook
legitimation of personal advice	peer advice	community advice	company expert advice	field expert advice
teachability	no special attention	explication of learning goals	sequencing	personalization
knowledge type	idea	lesson learned	good practice	patent/process
learning resources	learning material	learning object	course	certified/ personalized course
channel	individual communication	emerging social network	community of practice/interest	centre of competence

Table B-16 gives an overview of the phases of the knowledge maturing process with an examplary list of characteristic types of knowledge and their values according to the criteria discussed in this section. The degree of hardness of types of knowledge is not a direct translation of the scale of information hardness, but attempts to match it as closely as possible. Information hardness only considers individuals and institutions as sources of information, but does not consider teams and communities. In the latter cases, the degree of hardness is thought of as being in between individuals (information hardness 1-5) and institutions (information hardness 6-10). In the case of reorganized business processes, those compliant to laws, regulations and standards are considered of higher hardness. The same applies to courses when they are certified by some external authority.

TABLE B-16. Types of knowledge in phases of knowledge maturing process

phase	knowledge type	hard-ness	medium/context	commitment/ legitimation	form of learning/ technology
expressing ideas	rumors	1	human, highly contextualized	none	informal, direct communication by phone, instant messaging, email
	personal experiences	2	human, personal notes, highly contextualized	commitment by individuals, confirmation by colleagues	direct/computer-mediated communication, exchange of personal artefacts, collaboration systems, Weblogs
distributing in communities	ideas and proposals	2	forum entry, suggestion form, explicit use context	commitment by individuals, confirmation by colleagues	committee selection, validation, organizational proposal system, forum, community workspace
	questions/ answers	3	FAQ, forum entry, explicit problem context	legitimation by experts	self-managed, on-demand search, FAQ data base, forum, Wikis
formalizing	project results	3	project/milestone report, explicit project context	legitimation by project manager	on-demand search, project & document management system
	lessons learned (LL)	4	LL document, explicit project context	legitimation by project team	case-based, self-managed learning, LL data base, Wikis, Weblogs
ad-hoc learning	learning objects	5	well-defined digital resource, formal meta-data	legitimation by experts	self-managed ad-hoc learning, composition from learning object repository
	good/best practices (BP)	5	BP document, process description, explicit creation context	commitment of team, unit, company, group, industry	case-based, self-managed ad-hoc training, continuous process improvement, BP data base
	patents	9	patent application, explicit potential use context	legitimation by patent office	specialized information seeking, patent data bases
formal training	reorganized business process (compliant)	6 (7)	process models and descriptions	legitimation by process owner	standard training of standard operating procedures, courses, process warehouse
	courses (certified)	6 (7)	composed learning objects, curriculum, certificates	legitimation by course owner	standardized training, WBT authoring, learning content management system

Figure B-50 reviews the diagram classifying KM instruments presented in Figure B-24 on page 199. The arrows connecting KM instruments represent some examples for maturity paths between KM instruments that could be systematically designed and encouraged in organizations. The Latin numbers (I-III) show the two major directions in which maturity paths can be organized in organizations:

- from personal-product knowledge via personal-process to organizational process knowledge and
- from personal-product knowledge via organizational-product to organizational process knowledge.

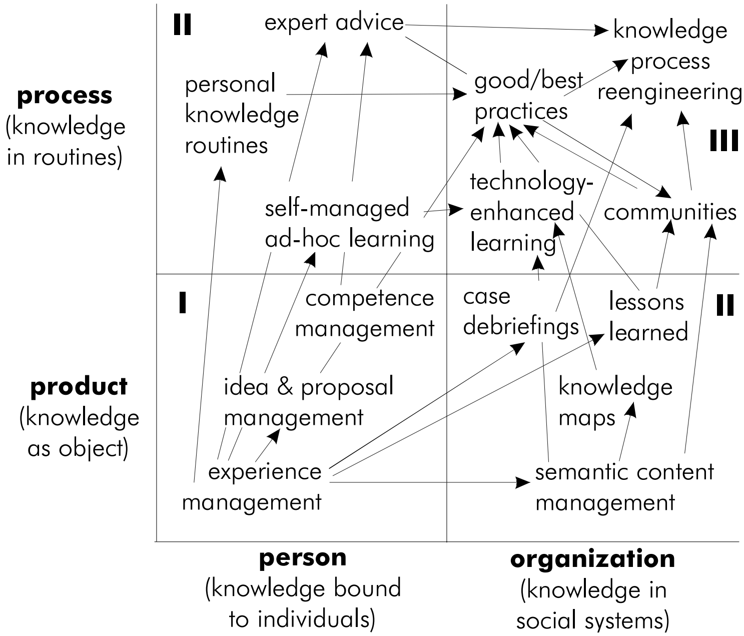

FIGURE B-50. Exemplary maturity paths between KM instruments[480]

However, the maturity path between *idea and proposal management* and *good/best practices* shows that there are also paths that directly relate personal-product with organizational process knowledge. Other paths are thinkable, but have been omitted for reasons of readability. The model can be used by organizations (1) for checking what processes, procedures, roles and system services they have established in each of the categories, (2) for connecting these with the help of explicitly designed transitions along the maturity paths and (3) for selecting KM instruments for those categories that have been neglected so far or (4) for selecting KM instruments that specifically target knowledge in incomplete maturity chains.

480. See also Figure B-24 on page 199.

Starting point for the maturity paths is person-product knowledge in the lower left corner of the classification diagram (I). The most important role is played by personal experience management which targets a particular type of knowledge of the least degree of maturity and thus is the starting point for a number of maturity paths. Knowledge systematically handled by individuals finds its way both into individual knowledge in routines (upper left corner, II) as well as into knowledge objects embedded in social systems (lower right corner, II). From there, knowledge finally enters the upper right corner (III) which contains those KM instruments that target comparably matured knowledge in organizations.

7.2.3 Size and media used

As opposed to e.g., relational data base systems, it is quite difficult to measure the size of the contents of KMS. In the case of relational data base systems, size is quite easily measured as the number of rows of a table times the number of bytes in every row. The sum total of all tables is the total size of a data base system. However, a "knowledge base" in most cases consists of a large number of knowledge elements, i.e. semi-structured files that are dispersed over a number of servers which not only contain files that are part of the KMS, but also more traditional documents which might also be managed with the help of a KMS.

Knowledge elements vary greatly in terms of *size* and in terms of *ICT used*, with respect to the type of ICT that is used to handle the knowledge elements, e.g., (relational) data base systems, word processing software, office information systems, file server, data warehouses, archiving systems, DMS, forums, Weblogs, Wikis or other CMS, Web server, video server, learning management systems, mailboxes or news server. Knowledge elements can also be organized in a variety of ways[481].

The *size of the knowledge base* is assessed using the following measures:

- the number of knowledge elements,
- the amount of storage capacity used (in MB).

The average size of knowledge elements will be calculated in order to get a more detailed picture about what an organization terms a knowledge element.

It is hypothesized that organizations with a systematic KM initiative store greater volumes of knowledge elements than organizations without one. In several related empirical studies, identification, providing access to and/or documentation of existing knowledge turned out to be among the first activities of KM projects[482]. The result of these activities should lead to more knowledge elements. These organizations should therefore use increased amounts of storage capacity for knowledge elements:

Hypothesis 15: Organizations with systematic KM handle a larger knowledge base than organizations without such an initiative

481. See section 7.2.4 - "Structuring of contents" on page 298.
482. See chapter 10 - "Related Empirical Studies" on page 439.

Also, organizations with KM initiatives are expected to handle a large amount of electronic resources that could be considered as knowledge elements with heterogeneous formats and types of media. The file format is not sufficient to determine the content or purpose of a knowledge element, e.g., an XML file can be technically a text processor document, a spreadsheet, or a scalable vector graphic (SVG), conceptually an idea, a lesson learned, a good practice or a skill description. KMS primarily deal with semi-structured, compound documents containing coded information for different purposes. However, the type of media has great impact on the requirements for meta-data management, e.g., a full text search may lead to a feasible result for a text document, but not for an image. The following *types of media* can be used in organizations[483]:

(Hyper-)text documents. Documents are stored in varying formats, e.g.:

- *document exchange formats:* such as the document exchange format rich text format and the formats developed by Adobe Systems postscript or the portable document format,
- *text document formats:* as part of office application suites, such as the Adobe Framemaker format, the Microsoft Word format or the Star/OpenOffice format,
- *hypertext documents:* e.g., Web pages, written in Hypertext Markup Language (HTML) or written in eXtensible Markup Language (XML). The latter can be characterized as a meta language which is used to integrate documents, data base outputs and various types of multimedia elements in a flexible way.

Multimedia contents. Multimedia contents could also be part of hypertext documents[484]:

- *audio files:* coded in formats, such as MPEG–Motion Picture Expert Group's MPEG Audio Layer III and the MP3 compression format, Dolby Laboratories Inc.'s format AC-3, Sun's Audio File format or Microsoft's WAVE format,
- *video files:* coded in different formats, such as the MPEG's format family of the same name, Real Network's RealMedia format or Microsoft's Audio-Video-Interleaved format,
- *vector graphs:* coded in formats like Computer Graphics Metafile CGM, Initial Graphics Exchange Standard IGES, AutoCAD's Drawing Exchange Format DWF/DXF or 3D-graphs, written in Virtual Reality Markup Language VRML,
- *pictures:* coded in formats such as the Bitmap format commonly known in the Windows world, the Graphics Interchange Format, the Tagged Image File Format TIFF, the UNIX graphic data format XPM and the compression format of the joint photographers expert group JPEG.

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483. For a good overview of multimedia and electronic publishing formats see Steinmetz/Nahrstedt 1995, Henning 2000.

484. In the category (hyper-)text documents the focus is still on the text component whereas in multimedia contents the focus shifts to audio or video files, graphs or pictures. In the following, formats can be codecs, file layouts or both; see also Henning 2000 for details.

Contributions to newsgroups. These are regularly email (text) messages with or without attachments that are sent to discussion lists.

Data base elements. This type of media represents the traditional, structured form of data storage in hierarchical, network, object-oriented, multi-dimensional or, most commonly, relational data bases and data warehouses (for an overview of data base theory, development and systems see e.g., Elmasri/Navathe 1994, Inmon/Hackathorn 1994, Atzeni et al. 1999, Watson 1999). Data base elements still might be considered as part of a KMS's storage system, especially when connected to richer media like documents, multimedia contents and the interactive side of a KMS like contributions to newsgroups or email messages.

Organizations with a systematic KM initiative might also include more differing types of media in their knowledge bases than organizations without one. This should be especially true for multimedia elements, contributions to newsgroups and data base elements, whereas traditional documents could represent a smaller share of the knowledge base. Again, the activities identification, providing access to and/or documentation of existing knowledge should lead to a greater variety of types of media used to represent knowledge elements. Therefore, these organizations should use more variety in the types of media used:

Hypothesis 16: Organizations with systematic KM handle a higher share of multimedia elements, contributions to newsgroups and data base elements in their KMS than organizations without such an initiative

7.2.4 Structuring of contents

In addition to type of contents, the size and the media used in KMS, structuring and organizing the contents is supposed to be one of the key tasks in knowledge management. There have been many approaches suggested to organize knowledge in organizations that basically fall into two groups. On the one hand, AI methods are suggested to support the development of ontologies in organizations (e.g., Staab et al. 2001). On the other hand, business processes models are used as a starting point to identify the most critical business knowledge in organizations (e.g., Remus 2002). However, the interviews showed that in the organizations so far mostly pragmatic approaches are applied. In most cases, the knowledge structure is determined by a committee in a workshop without much methodical support and then evolves with new additions to the knowledge base. The investigation of knowledge structure will therefore be limited to a set of basic criteria to study to what extent organizations structure and organize their knowledge bases[485].

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485. The interested reader will find a host of literature in the AI field that has a long tradition in dealing with structuring expert systems and knowledge bases and recently has been applied to broader domains, such as organizational document bases or Intranets (for links to literature on AI see also section 4.1.1 - "From organizational learning to knowledge management" on page 22).

The structure and organization of knowledge elements supposedly strongly influences the usefulness of a KMS. Structure not only determines how quick a participant can navigate to the knowledge elements needed, but also supposedly influences participants' mental models of the organizational knowledge base. Thus, structure and organization has a descriptive and a normative component influencing the way of thinking of the members of the organization. Structuring of contents will be assessed using the following two criteria:

- the number of knowledge clusters and the ratio between the number of knowledge clusters and the size of the knowledge base,
- the way of structuring: hierarchy, network or both.

According to the interviews, the hypertext is the single most important metaphor for organizing documents in an organizational Intranet or KMS. Navigation of hyperlinked documents has become a basic standard. The next step would then be to use the hypertext or network metaphor not only for navigation within documents, but also for the overall organization of knowledge areas. Thus, the network is supposedly the predominant principle of structuring knowledge areas when compared to the hierarchy.

Hypothesis 17: There are more organizations which apply a network structure to their knowledge areas than organizations with a hierarchical structure of knowledge areas

The interviews showed that organizations differ with respect to centralization of their KM tasks. It seems that organizations are facing a *trade off* between actuality/flexibility and understandability/simplicity of knowledge structure and contents. Actuality and flexibility of contents on the one hand require a decentralization of the corresponding KM tasks, e.g., storing of new knowledge, integration of knowledge in existing structure and especially update of structure. On the other hand, the more decentralized these tasks are, the more complex the contents might be due to the agglomeration of the variety of mental models held by the members of the organization that is not integrated.

However, as mentioned above it is a challenging task even for knowledge managers to determine the size and structuring of an organization's KMS. As a consequence, in the empirical study there will probably not be enough data on each of these measures to test correlations between complexity of contents and, say, a form of organizational design of the KM initiative or types of Groupware platforms and KMS used.

7.2.5 Quality of contents

The quality of contents is a key factor that determines the usability of a knowledge management system. Research on data and information quality has a long tradition in MIS and has been influenced strongly by quality management as well as knowledge management literature[486]. A large number of quality criteria have been sug-

486. Eppler 2003, 23, 41ff and the literature cited there.

gested that can be applied to measure or estimate the quality of contents of a KMS (Eppler 2003, 63).

Many authors have compiled lists of criteria to assess the quality of data[487]. Table B-17 shows a list of criteria that are widely used in the literature and in practice together with their description. However, the criteria for data quality are focussed on (raw) data, rather than on their interpretation by users and their combination, integration and contextualization. In order to be applicable for knowledge management, the criteria have to be extended and structured.

Eppler (2003) suggests a list of criteria for information quality together with their opposites (Table B-18).The criteria are structured according to the "level" of information quality and can be interpreted with respect to their application to content of KMS as follows:

- *infrastructure*: the infrastructure level deals with the quality of the knowledge management system that conveys the content.
- *process*: criteria on the process level help to evaluate knowledge processes and (parts of) knowledge-intensive business processes.
- *product*: the product level covers aspects of the resulting knowledge elements, i.e. the contents in a narrow understanding.
- *community*: finally, the community level deals with the knowledge receivers and covers the reconstruction process and the application of knowledge in the receivers' application domain and situation.

TABLE B-17. Criteria for data quality[a]

criterion	description
accuracy	data are precise enough for certain application areas
availability	data are available with respect to time and location of their user
completeness	all data are available that are needed for certain application areas
consistency	data correspond to the description in a repository; data are compatible with other data in the data base
correctness	data correspond to the portion of reality they describe
credibility	data can be traced back to a trusted source and transformations can be explained
relevance	data carry meaning for certain application areas
understandability	data are presented in a comprehensible form

a. Based on Schwinn et al. 1998, 210f.

These criteria are particularly important for documented knowledge elements stored in a KMS that are to be reused effectively and especially efficiently. Specific

487. For example Schwinn et al. 1998, 210f

functions and layers of KMS[488] contribute towards fulfilment of these criteria. Thus, the criteria for information quality can also be assigned to the layers of a KMS architecture so that each layer can be evaluated according to a number of specific criteria[489].

Eppler identified 28 "activities"[490] in a number of case studies that might increase the quality of contents (Eppler 2003, 82ff):

- *integration activities*: visualize concepts, list sources, summarize, personalize, prioritize contents, highlight aspects, give an overview, elicit patterns,
- *validation activities*: evaluate source, indicate level of certitude/reliability, describe rationale, compare sources, examine hidden interests/background, check consistency,
- *contextualization activities*: link content, state target groups, show purpose, describe background, relate to prior information, add meta-information, state limitations,
- *activation activities*: notify and alert, demonstrate steps, ask questions, use mnemonics, metaphors and storytelling, stress consequences, provide examples, offer interaction.

TABLE B-18. Criteria for information quality[a]

level	criterion	opposite
infrastructure level	accessibility	inaccessibility
	maintainability	neglect
	security	exposure
	speed	slowness
process level	convenience	inconvenience
	interactivity	rigidity
	timeliness	lateness
	traceability	indeterminacy
product level (soundness)	conciseness	polixity
	consistency	inconsistency
	correctness	falsity
	currency	obsolescence

488. See section 7.3.3 - "Integrating architectures for KMS" on page 311.
489. See section 7.8 - "Résumé" on page 390, particularly Table B-21, "Assignment of quality criteria to levels of KMS architecture," on page 391.
490. In the terminology of the activity theory, these "activities" might be considered as actions, i.e. routinized activities; see section 6.6.2 - "Activity modeling" on page 250.

TABLE B-18. Criteria for information quality[a]

level	criterion	opposite
community level (relevance)	accuracy	inaccuracy
	applicability	uselessness
	clarity	obscurity
	comprehensiveness	incompleteness

a. Source: Eppler 2003, 68.

These activities can be institutionalized in the form of e.g., the role of a subject matter specialist and the establishment of knowledge processes that are specifically designed to improve the quality of documented knowledge.

7.3 Architectures and services

Architectures in general play an important role in MIS as blueprints or reference models for corresponding implementations of information systems. The term architecture as used in MIS origins in the scientific discipline architecture and is used in a variety of ways, e.g., application architecture, system architecture, information system architecture and especially software architecture[491]. The prevalent architectural design recently has been impacted profoundly by the ideas marketed under the term service-oriented architecture (SOA). The primary concept of this architectural paradigm is discussed from the perspective of KM in section 7.3.1. Section 7.3.2 then reflects on some issues involved when designing a KM service infrastructure. Finally, section 7.3.3 reviews a number of theory-driven, vendor-specific and market-driven architectures of KMS and discusses their advantages and shortcomings.

7.3.1 Knowledge management service

Generally, a service is an abstract resource that represents a capability of performing tasks that form a coherent functionality from the point of view of providers entities and requesters entities (W3C 2004a, b). It consists of a contract, interfaces as well as implementation and has a distinctive functional meaning typically reflecting some high-level business concept covering data and business logic (Krafzig et al. 2005, 57-59). The service concept has gained much popularity with the advent of a set of standards that allow for open interaction between software applications using Web services[492]. A Web service is a software system, identified by a URI, whose public interfaces and bindings are defined and described using XML. Its definition can be discovered by other software systems. These systems may then interact with the Web service in a manner prescribed by its definition, using XML-based messages conveyed by Internet-based protocols (W3C 2004a),

491. See Lehner et al. 1995, 58ff for a definition and overview of the term.

see also (Alonso 2004, 124). Web services are one way of implementing business and technical services in a service-oriented architecture. A service-oriented architecture is based on the concepts of an application frontend, services, service repository and service bus (Krafzig et al., 2005, 57) which together make business and technical functions available as independent services that can be accessed without any information about their implementation.

The service concept has had a profound impact on enterprise application integration, on business-to-business applications and generally on the way information and communication infrastructures are designed and managed from a technical perspective (e.g., Cox/Kreger 2005). In addition to this technical impact, "SOA-enabled" businesses and organizations are sometimes called agile, on-demand or service-oriented enterprises, metaphors that attempt to carry over SOA semantics to organizational design (Bieberstein et al. 2005) which has connotations for changes in IT's general role in business (transforming business models), value creation (value networks), business processes (dynamically designed, net-like with emphasis on parallel processing) as well as organizational structure (service consumer-provider relationship complementing or even replacing traditional hierarchies; Cherbakov et al. 2005, 659). In the following, this section will concentrate on the specifics of the service concept applied to KMS (see also Maier/Remus 2007).

KM services are a subset of services offered in an organization, both basic and composed, whose functionality supports high-level KM instruments as part of on-demand KM initiatives. Examples for these services are *find expert*, *submit experience*, *publish skill profile*, *revisit learning resource* or *join community-of-interest*. Services are offered by service providers that procure the service implementations, supply their service descriptions, and provide the necessary support. Often, KM services cater to the special needs of one or a small number of organizational units, e.g., a process, a work group, a department, a subsidiary, a factory or an outlet in order to provide a solution to a defined business problem. KM services describe individual aspects of KM instruments implemented in heterogeneous application systems that can be combined into an enterprise knowledge infrastructure.

492. In distributed systems, service-oriented architectures can be seen as successors of component architectures. The underlying conceptual change could also trigger a paradigm shift from a primarily production-oriented view, not only of software production, to a view that takes into account the specifics of the service sector which has experienced growth during the last decades as opposed to the production sector which has declined. There is currently an initiative led by IBM and Oracle, but also involving institutions such as the European Commission, that aim at defining a research agenda for so-called services sciences. This agenda should bring the vision of a service-led economy to the focus of a number of scientific disciplines. Thus, the service concept transcends the scientific disciplines of computer science and information systems and also involves disciplines such as management, economics or service engineering.

7.3.2 Service infrastructure

Basic services can be composed into new composite services enabling larger integrated KM services. In addition, service descriptions have to be published in order to provide information about service capability, interface, behavior, and quality (Papazoglou/Georgakopoulos 2003). Figure B-51 shows the main layers of a KM service infrastructure.

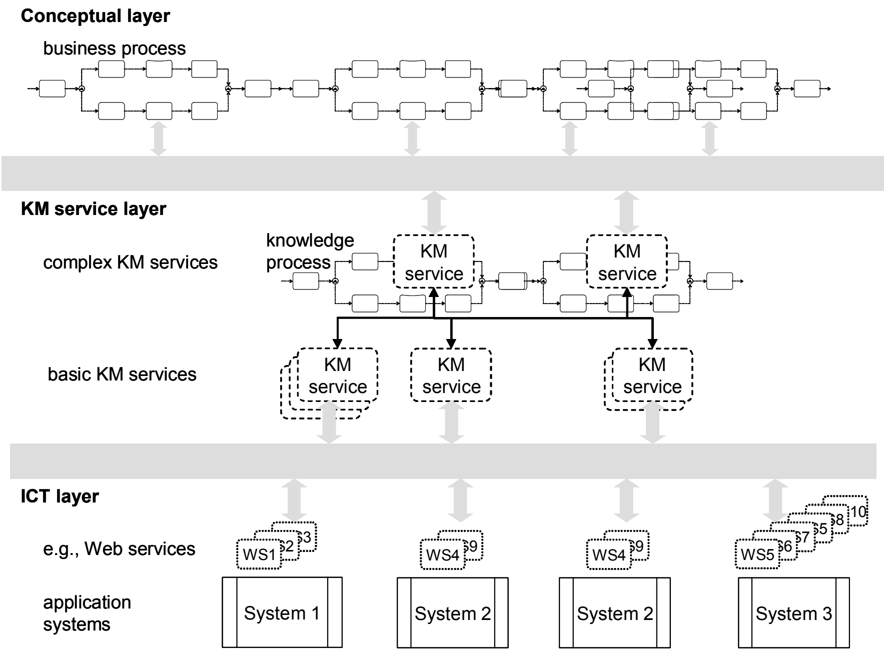

FIGURE B-51. KM service infrastructure[493]

Conceptual layer. Based on process descriptions, the conceptual layer defines which services are required in which core business processes, which services are offered by what service processes, who is responsible for them and what resources are allocated to fulfil them. Especially concepts of process-oriented KM can help to analyze, understand and design business and knowledge processes with regard to a knowledge-oriented and at the same time a strategic perspective on KM services in business processes.

ICT layer. Services are described, discovered and invoked with the help of negotiated or standardized sets of technologies, e.g., in the case of Web services WSDL, UDDI and SOAP. These technologies support the integration on different levels, i.e. human-to-machine, machine-to-machine and inter-organizational integration

493. Source: Maier/Remus 2007, 10

(Puschmann/Alt 2005). The ICT layer comprises infrastructure, integration, knowledge, personalization and access services dispersed over a variety of heterogeneous application systems that cover structured as well as semi- or unstructured data sources.

KM service layer. The main task is to bridge the gap between the conceptual and the ICT layer. KM services have to be composed using services offered by heterogeneous application systems from the ICT layer. In addition, discovery, call and provision of KM services from different activities of business processes have to be supported.

In the following, the conceptual layer is briefly reviewed[494]. Then, the primary function of the KM service layer is outlined with the help of an example. Finally, section 7.4 - "Centralized architecture" on page 318 presents the most important services that are required in order to implement a comprehensive KMS. These services, however, do not necessarily have to be implemented as one centralistic system, but can be accessed from different application systems using the service infrastructure described here.

Conceptual layer. The idea of a KM service infrastructure is demonstrated using a real-life example of a knowledge process and its composition by KM services. Identification, separation and description of relevant processes are important prerequisites. Models that support the conceptual layer were developed as part of a process-oriented KM modelling project[495]. In this project, a complex process landscape consisting of several knowledge processes was defined and modelled (Maier/Remus 2003). In extension to this project, the conceptual layer of a KM service infrastructure requires different levels of abstraction.

The highest level displays the activity and process landscape that shows the definition of processes as well as the assignment of KM instruments to KM activities. The second level refines the delineation of the processes that are shown in the first level e.g., by using event-driven process chains (Scheer 2001). The third level details these processes with the help of action charts linking single activities to knowledge structures. These models can be the first step towards the description of KM services together with their triggering events, inputs, outputs of activities and corresponding ICT systems and tools. In this project, modeling techniques provided by the ARIS (architecture of integrated information systems) method and toolset (Scheer 2001) were used. However, the development of a KM service infrastructure is not tied to a specific modeling technique as long as other methods provide techniques for modeling business processes on different levels of abstraction and a model type corresponding to action charts in ARIS[496].

494. For a detailed description see section 6.3 - "Process organization" on page 207.
495. The project is described in section 6.3.3 - "Example: Process-oriented KM" on page 217.
496. Examples for other relevant modeling approaches are mentioned in section 6.6.1 - "Process modeling" on page 240.

Action charts illustrate which service objects are consumed, produced and transformed. Here, these service objects are typically knowledge elements.

In general, service descriptions have to provide information about (Papazoglou/Georgakopoulos 2003):

- *service capability* states the conceptual purpose and expected result of the service by the description of output objects,
- *service interface* publishes the service's signature (input/output/error parameters and message types),
- *service behavior* can be described as detailed workflow invoking other services,
- *quality of service* publishes functional and non-functional quality attributes (e.g., service metering, costs, performance metrics, security attributes).

Figure B-52 shows the example knowledge process *knowledge documentation*, consisting of the two parallel sub-processes *content* and *skill management* with its main activities and triggering events. Processes were modelled as event-driven process chains (Scheer 2001).

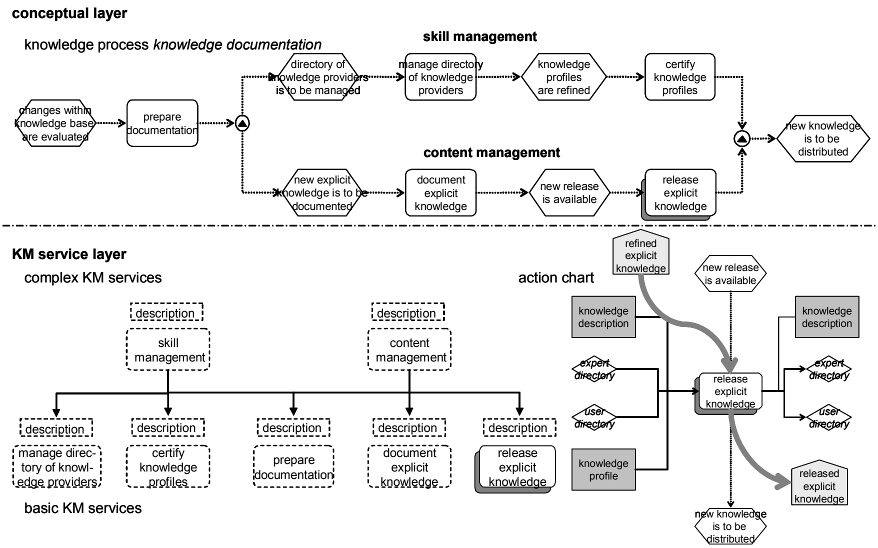

FIGURE B-52. KM services of the knowledge documentation process[497]

Every event-driven process chain is represented as a diagram. The recommended direction of reading is from left to right. Functions represent tasks or activities performed as part of the interactions from one or more objects. They are displayed as a rectangle with rounded corners. Functions produce events or states which in turn can cause a change of states of these objects or the execution of other

497. Source: Maier/Remus 2007, 12

functions. Events specify relevant states for objects that must be satisfied before functions can be executed and are displayed as hexagons. To display possible alternatives of similar business processes in one diagram, the event-driven process chain contains logical operators (OR, XOR, AND) that are used to describe the control flow between sequences of actions.

Experiences (i.e. lessons learned) that have been documented during the execution of business processes have to be managed regularly by initiating the process *knowledge documentation*. In order to avoid information overload and to guarantee a high quality standard of the knowledge base, changes within the knowledge base have to be evaluated. Therefore, appropriate measures to value, refine, certify and release knowledge have to be carried out (link to the process *enhancement of the knowledge base*). It is important to distinguish between explicit and implicit knowledge, since both types need different measures handling them. Explicit knowledge can be documented directly whereas implicit knowledge can be addressed by developing and maintaining an expert and user directory in which knowledge profiles are provided and linked to content in the knowledge base.

The result is an updated knowledge base with knowledge that can be used within business processes. It contains updated knowledge profiles of employees together with documented knowledge. Both are linked to functions in the business processes with the help of the process-oriented knowledge structure. A subject matter specialist can then release parts of the updated knowledge base for distribution. In addition, refined and updated knowledge profiles have to be certified, e.g., by discussions between supervisors or project managers and group or team members[498].

The next step is to determine which services are required to fulfil the process. At one extreme, the process can be viewed as one single, but complex service; at the other extreme, service granularity could be so fine that each function in the process can be constructed from multiple services. Similar to concepts in SOA, the choice is made by balancing quality of service characteristics (QoS), ubiquitous service reuse, and reduction of complexity for service composition (Crawford et al. 2005).

KM services can be viewed as encapsulated KM activities, accessible by an interface and described by action charts (providing an initial service description). The composition of KM services is presented in Figure B-52, together with one detailed service description (as action chart) for the KM service *release explicit knowledge* in the process *knowledge documentation*. This KM service approves content and makes it accessible to the employees of the organization. It releases knowledge descriptions, user and expert dictionaries, and assigns appropriate user privileges for the envisioned target group. It is based on the input *refined explicit knowledge* and produces the output *released explicit knowledge*.

ICT Layer. The ICT layer describes the services offered by heterogeneous application systems that have to be selected, called and combined in order to provide basic KM services. A comprehensive platform-type solution for these services has

498. See also section 6.2.2 - “Product-oriented instruments” on page 200.

been termed an enterprise knowledge infrastructure (Maier et al. 2005). From an ICT perspective, services can be structured into the following categories: (1) infrastructure services, (2) integration services, (3) knowledge services, (4) personalization services and (5) access services[499]. These categories help to structure existing services offered by different application systems. Next to semantic integration[500] between these services, process integration is required in the form of KM service composition which is explained in the following section.

KM Service layer. Regardless of the implementation, it is important to understand the steps required to decompose a process into a series of complex and basic services and operational characteristics (Crawford et al. 2005). Composing KM services means specifying how these services have to be discovered and selected (discovery), how they have to be accessed from different activities of business processes (call) and finally how these services are provided by the service infrastructure accessing heterogeneous application systems from the ICT layer (binding, provision). Modeling techniques help defining the composition of services (Crawford et al. 2005). Figure B-53 shows the interplay between conceptual and ICT layers by the example of invoking the complex KM service *search for experts* from the business process layer.

On the conceptual layer, this KM service has to be described using knowledge process descriptions and action charts specifying basic input and output parameters. Area of expertise is required as the minimum input parameter. Further input parameters can be specified that describe the context of the situation in which the service is invoked. Examples for context parameters are (1) process, i.e. the business process or task that the person is currently engaged in, (2) person, i.e. the profile of the person invoking the service, e.g., areas of expertise or skill levels, (3) preferences, e.g., for synchronous versus asynchronous communication channels, (4) products, i.e. electronic resources concerning the area of expertise that have been collected and/or analyzed by the person, e.g., learning resources, handbooks, reports or lessons learned, (5) applications and appliances, e.g., a Web browser on a desktop PC or a mobile application on a smartphone, (6) location, e.g., GPS coordinates or the connection, e.g., wired LAN, wireless LAN or UMTS connection, (7) date and time, normalized according to the time zone, which might help to determine the appropriate way of contacting experts and (8) urgency of the need for an expert. Execution of the service results in a list of experts, brief descriptions, contact history and information about the (social) relationship to the searcher, e.g., common business acquaintances, and contact and availability details, ordered according to the preferences of the experts together with links to further KM services that can be invoked in order to establish a connection to the selected expert.

The middle layer in Figure B-53 shows the composition of a number of basic KM services into one complex KM service and maps the required basic KM ser-

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499. See section 7.4 - “Centralized architecture” on page 318.
500. See section 7.7 - “Semantic integration” on page 374.

vices to actual, "real" services offered by diverse application systems that are part of the ICT layer. It is a structural abstraction of the composition process, while the interplay between the basic services can be described e.g., with UML activity diagrams or state-charts or with BPEL-oriented notations such as BPMN[501].

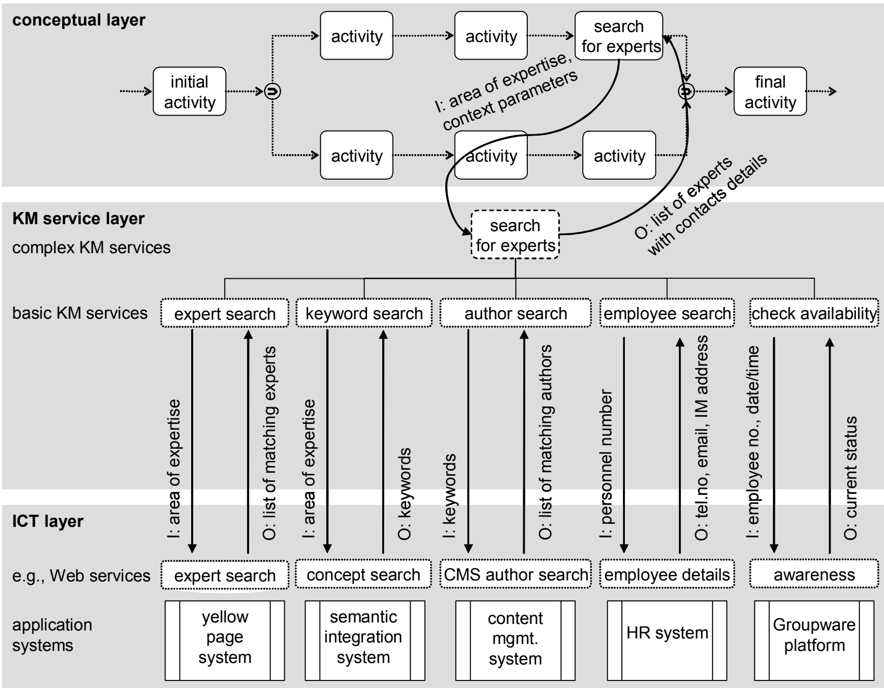

FIGURE B-53. KM service invocation

The complex KM service *search for experts* is composed of the basic KM services (1) *expert search*, (2) *keyword search*, (3) *author search*, (4) *employee search* and (5) *check availability*. The *expert search* service delivers a list of IDs (e.g., personnel numbers) for experts matching the input parameter of an area of expertise. The *author search* service requires a list of keywords describing the area of expertise. Thus, the complex KM service *search for experts* also comprises an integration function or invokes an integration service for the task of finding keywords that describe the area of expertise, here called *keyword search*. The keywords are assigned to areas of expertise either in a simple data base solution or in a more advanced semantic integration system based on an ontology. With the help of an inference engine, these relationships together with rules in the ontology can be used to determine a list of keywords[502]. The *author search* service then returns a

501. See http://www.BPMI.org for a description of the BPMI stack for the composition of Web services.

list of IDs of matching authors or active contributors to the CMS respectively. An *employee search* service takes the personnel numbers found in the *expert search* and the *author search* and returns contact details, e.g., telephone number, email address, instant messaging address. Finally, the *check availability* service delivers the current status of the experts and a decision on their availability.

The ICT layer binds the basic KM services of the conceptual layer to application systems in the current work environment of the searcher that can deliver these services. In the case example, there might be a yellow page system, a semantic integration system, two content management systems, an HR system, a Groupware platform and an instant messaging system that offer Web services fitting to the descriptions of the basic KM services on the conceptual layer. Depending on which systems are accessible to the calling complex KM service, the actual implementation could consist e.g., of basic services (1) and (4), of (3) and (4), of (1), (4) and (5), of (1), (2), (3) and (4) or of all services respectively. Consequently, the description of the complex KM service needs to include some specification of what basic KM services are mandatory and of what combinations of basic KM services are allowed. Figure B-53 shows the three layers and an example of calls of KM services from activities in business processes and their binding to the corresponding Web services on the ICT layer.

The KM service infrastructure supports service-oriented, agile or on-demand KM approaches in organizations that take into account decentral developments of KM initiatives. Thus, KM technologies have to operate increasingly on infrastructures that support the rapid deployment of relevant tools and systems for ad-hoc, intensive and inter-organizational collaborations (Tsui 2005). Recently, these dynamic approaches of bringing the right knowledge rapidly to the point where it is needed have been called just-in-time KM (Davenport/Glaser 2002), workplace learning (Ellström 2002, Illeris 2003) or on-demand KM (Sampson et al. 2002).

When designing and implementing KM infrastructures, KM initiatives can introduce service-orientation as additional guideline. The three-layered KM service infrastructure composes services from heterogeneous applications into specific KM services and supports their discovery, call and provision from activities within business processes. This infrastructure aims at solving the following challenges:

Strategy. Strategic alignment is realized by connecting KM services to the materialization of strategic decisions (e.g., customer orientation) in the form of business processes and corresponding application systems on the ICT level. The deployment of KM services in organizations might profit substantially from both, the integration and the corresponding alignment with strategic goals.

Processes. Process orientation is realized by not only focussing on business processes as main drivers for calling KM services, but also on knowledge processes

502. See section 7.7 - “Semantic integration” on page 374.

which comprise a procedural view of a bundle of KM instruments implemented by KM services that are in turn described with the help of action charts.

Instruments. The numerous KM measures, procedures, instruments or tools applied in isolation from each other are integrated by bundling KM instruments to provide complex KM services. Business processes determine which KM services are required in which core business processes, are offered by what service processes, who is responsible for them and what resources are allocated to fulfil them.

Architecture. A concise KM architecture consisting of a KM service infrastructure on different levels helps reducing complexity and improving flexibility of KM initiatives. One of the major advantages of a KM service infrastructure is the ability to build it once and reuse it frequently. However, the efforts to implement a KM service infrastructure should not be underestimated. Already established KM services have to be identified and made available. New KM services have to be implemented. KM services have to be composed and decomposed finding the appropriate level of detail. The quality of KM services has to be assessed and documented in order to provide a constant level of quality throughout the knowledge life cycle.

The KM service infrastructure can be considered as an approach of a strategy-based integration of KM services which provides a blueprint, i.e. a framework and platform for dispersed KM services defined in heterogeneous KM initiatives. In the following, the services required for comprehensive KM initiatives are structured according to an ideal architecture and then described in detail[503]. This can serve as a framework guiding the design of a KM service infrastructure and the integration of application systems towards a transparent, centralistic KMS solution.

7.3.3 Integrating architectures for KMS

There are basically three main sources for architectures describing the structure of knowledge management systems: theory-driven, vendor-specific and market-driven architectures which will be discussed in the following.

Theory-driven architectures. The first group of KMS architectures is the result of theoretic investigations which represent a theory-driven decomposition of an organizational knowledge base or organizational memory and derive ideal groups of functions or components of a corresponding ICT system respectively[504].

Core functions of KMS can be viewed and categorized on different levels and from different perspectives. Classifications of functions as found in the literature fall roughly into one of the following classes[505]:

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503. See section 7.4 - “Centralized architecture” on page 318.
504. See for example Stein/Zwass 1995, 98; see also section 4.3 - “Knowledge management systems” on page 82.
505. For classifications of KMS see section 7.6.2 - “Classes” on page 369.

- **categorization on the technical level:**

  These are specific system functions, like workflow management functions, document management functions, communication functions etc.
- **system-centered categorization:**

  An example for a system-centered categorization is the distinction between integrative and interactive KMS. This perspective bundles functions into function areas which give an indication of the primary direction of the use of such systems. They are usually a combination of functions on the technical level.
- **categorization according to knowledge (management) tasks:**

  This can either be concrete phases of a knowledge life cycle like knowledge identification, acquisition, storing, distribution etc. or abstract "processes" such as externalization, internalization, combination and socialization (Nonaka 1991, 98f, Nonaka 1994, 18f).

A classification of KMS functions can focus on the system-centered categorization which is more abstract than the list of functions on the technical level and more specific to KMS than the classifications with respect to KM theory. The following list of function areas was derived (a) from an extensive survey of existing KMS (Maier/Klosa 1999c), (b) from a set of empirical studies on KM[506] and (c) from several approaches to classify functions of KMS in the literature[507]:

- knowledge search,
- knowledge presentation,
- knowledge publication, structuring and linking,
- knowledge acquisition,
- knowledge communication and cooperation,
- computer-based training and tele-learning,
- administration of KMS.

The function areas can be further aggregated. *Knowledge search* and *presentation* are both discovery-oriented groups of functions of KMS. Thus, they are two sides of the same coin and can be drawn together. *Knowledge publication, structuring and linking* as well as *knowledge acquisition* are oriented towards (structured) publication of knowledge elements and thus can be combined as well. An architecture for a KMS has to show how these function areas are realized.

Zack classifies KM tools and systems into one of the following two segments: KMS with an integrative versus an interactive architecture (Zack 1999a, 50). This classification corresponds to the two main directions of KM research, human orientation and technology orientation, and Hansen et al.'s (1999) distinction of KM strategies into a personalization versus a codification strategy[508]:

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506. See chapter 10 - "Related Empirical Studies" on page 439.
507. Ruggles 1997a, 5ff, Angus/Patel 1998, Apostolou/Mentzas 1998, 3.3ff, Borghoff/Pareschi 1998a, 5ff, Warschat et al. 1999, 56f, Krallmann et al. 2000, 233f, Seifried/Eppler 2000, 29.

- **integrative knowledge management architecture:**

  Integrative KM applications focus a repository and the explicit knowledge it contains as the primary medium for knowledge exchange. Integrative knowledge management applications can be further segmented according to the extent to which knowledge producers and consumers come from the same knowledge community. On the one extreme (called *electronic publishing*), there is neither direct interaction nor a shared context (in terms of e.g., belonging to the same community of practice) between producers and consumers of knowledge. Consumers do not give feedback and do not modify the knowledge in the repository. On the other extreme (called *integrated knowledge base*), producers and consumers share context intensively (e.g., they belong to the same organizational unit or community of practice).
- **interactive knowledge management architecture:**

  Interactive KM applications primarily facilitate the exchange of tacit knowledge among people. If there is a repository, it is seen more as a by-product the content of which changes dynamically. Interactive KM applications can be further segmented according to the expertise level of producers and consumers and the degree of formalization imposed on the interaction. On the one extreme, there is a formal, well defined knowledge transfer between "knowers" and "not knowers" (called *distributed learning*). On the other extreme, there is ad-hoc or emergent interaction more like an electronic discussion space (called *forum*).

Holistic KMS implementations aim at bridging the gap between these two architectures, at their combination and integration into a single KMS architecture. As mentioned by Zack, context plays the key role in bringing these two architectures together. Apitz et al. (2002, 33) present a KMS architecture that emphasizes contextualization as an important cornerstone in KM (see Figure B-54). Context management handles the context of topics or themes, and the context of tasks and processes and is used (1) to support workflows, (2) to describe information sources and organizational knowledge, (3) to acquire information and (4) to refine information that is pushed to or pulled by the knowledge worker. Also, the architecture stresses the importance of an integration of an intelligent handling of information technologies (information sources) on the one hand and of knowledge-based technologies (knowledge base) on the other hand. In this architecture, "intelligent" means the consideration of the types of context for both, information sources and the knowledge base. However, the proposed theory-driven architectures are limited to the conceptual level and do not indulge into the depths of concrete ICT components, tools or systems.

508. See also sections 4.1.4 - "Definition" on page 52 and 5.2.3 - "Generic knowledge management strategies" on page 129.

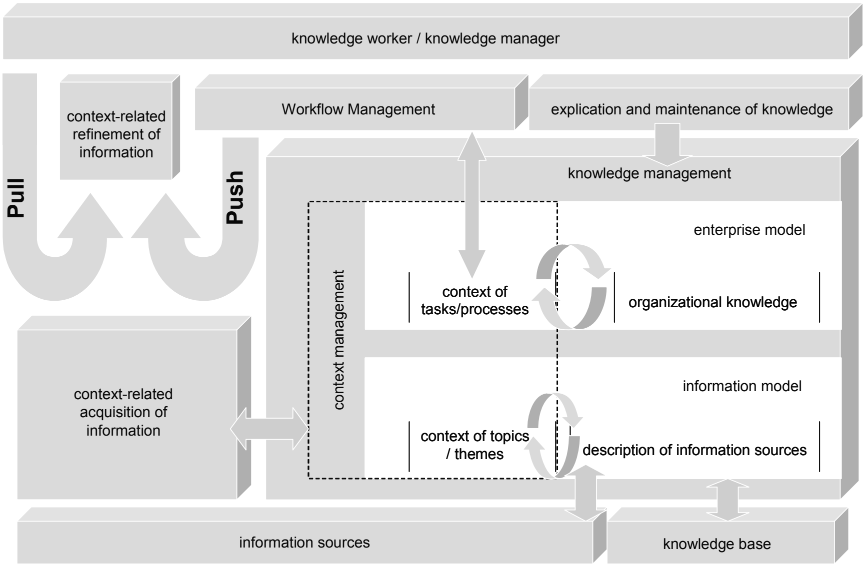

FIGURE B-54. Task-oriented architecture for KMS[509]

Vendor-specific architectures. Vendors of KMS publish white papers describing their perspective on knowledge management and place their tools in a KM architecture that regularly pays attention to the ICT infrastructure already available in the organizations[510].

Figure B-55 shows the simplest form of such an architecture. The KMS is just moved in between a standard Web browser and relevant data and document sources that exist in an organization. This approach is the traditional middleware approach that can be found in many KMS implementations.

Comprehensive KM suites comprise an often large number of modules offering functions such as text mining, tools for semantic integration of meta-data on data and documents, a search engine, visualization, administration of users and privileges, publishing and reporting.

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509. Source: Apitz et al. 2002, 33.
510. See e.g., Baubin/Wirtz 1996, 139 for Accenture's Knowledge XChange, see Sippach et al. 1999, 65f for Multimedia Software GmbH's Intranet Knowledge Management System; see also the white papers on the homepages of KMS vendors: e.g., of the Empolis Knowledge Management Suite (Empolis), Hummingbird KM suite (Hummingbird, now Open Text), Hyperwave Information Server (Hyperwave), Intraspect 4 (Intraspect) or Livelink (Open Text). More recently, vendors modularize their offerings and package these modules according to application scenarios or concrete business needs for which the platform is used. Knowledge management is one of those application scenarios. For a more detailed analysis of Open Text Livelink see section 7.4.9 - "Example: Open Text Livelink" on page 336.

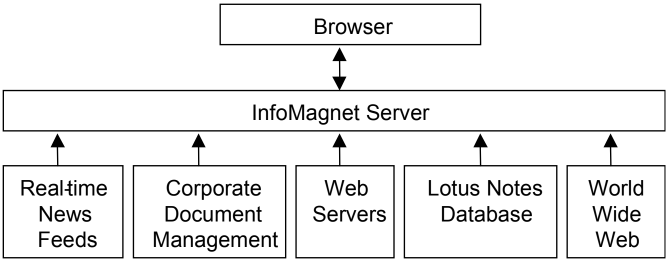

FIGURE B-55. Simple architecture for KMS[511]

Market-driven architectures. A third group of authors applies a more pragmatic approach and empirically distills the most important components of an organizational knowledge management environment which is integrated with more traditional data and document management systems as well as communication systems[512]. The authors mostly rely on the offers of (a number of) vendors of standard software tools, platforms and systems to support KM or analyze the individual KM environments of organizations that are regarded as KM pioneers and develop their own KMS solutions. These architectures are mostly layer models. The number, naming and inclusion criteria of the layers differ from author to author. Examples for layered KMS architectures are:

- OVUM, also a vendor of KMS tools, developed a simple architecture for KMS based on an empirical study on ICT demands and supplies for KM (Versteegen 1999). The architecture supports the four KM core processes capture, classification, sharing and understanding of knowledge and consists of six layers: (1) information and knowledge sources, e.g., texts, DBMS, email directories, WWW and the knowledge workers themselves, (2) infrastructure, i.e. email, file server and Intranet-/Internet-services, (3) information and process management that is located in a knowledge repository, (4) a shared taxonomy, a knowledge map, (5) knowledge management services for discovery and collaboration and (6) a user interface that consists of a knowledge portal.
- The architecture presented by Applehans et al. (1999) is quite similar to the OVUM architecture and also comprises six layers (see Figure B-56): (1) information and knowledge sources, called repositories, (2) transport layer, which corresponds to an Intranet infrastructure, extended by collaboration and stream-

511. Source: CompassWare 1998.
512. See e.g., Applehans et al. 1999, 87ff for a layered knowledge architecture, Bach 1999, 69 who proposes a tool architecture for business knowledge management, CZ 1999, 13 for the comprehensive KM architecture proposed by the Meta Group, Versteegen 1999, 118 who describes OVUM's six-layer KMS architecture, Seifried/Eppler 2000, 31ff who suggest a structured set of functionality expected from knowledge management suites and Vieser 2000 who presents the Siemens three-layered architecture for ICT tools, services and KM applications.

ing media tools, (3) application layer, with the examples calendar, yellow pages and analysis tools, (4) intelligence layer which consists of search, personalization and agent technologies, (5) access layer that stresses security technologies and (6) user interface, here as in most KMS architectures mainly a Web browser.

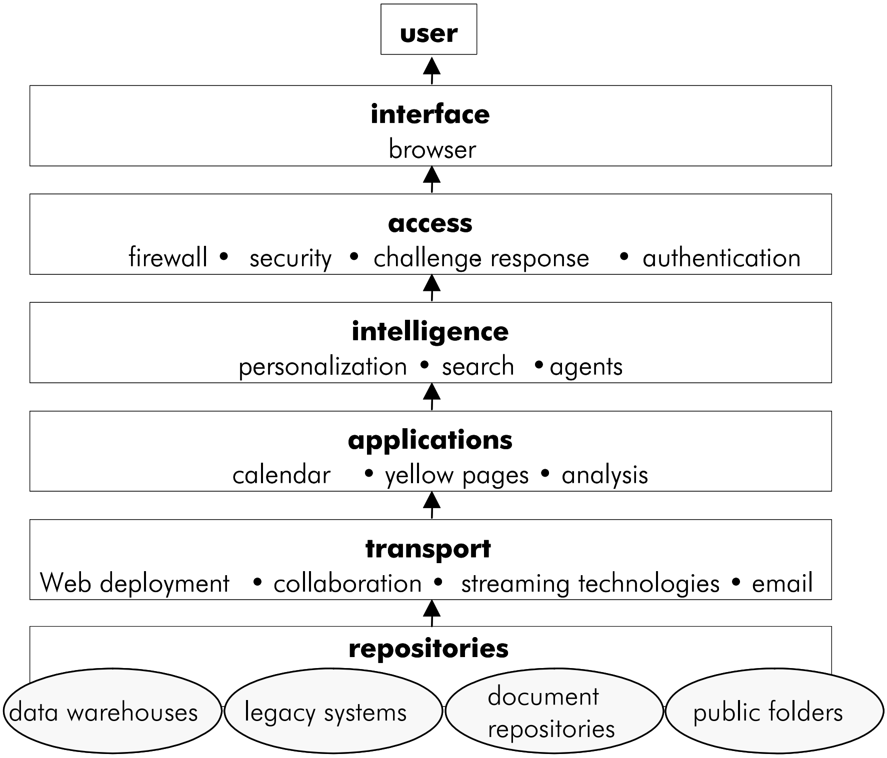

FIGURE B-56. Layered architecture for KMS[513]

- Bach's (1999, 69) architecture stresses the importance of supporting individual knowledge workers with an integrated electronic work place on the basis of a process-oriented knowledge management architecture (see Figure B-57). The architecture consists of the five layers (1) *Intranet infrastructure*, (2) a wide array of *information sources* that also contain transaction processing systems, data bases and external sources, (3) *integration services*, that contain a search engine, a data warehouse, a directory and a viewer for heterogeneous types of documents, (4) *information services*, that provide support for publishing, workflows, a library, an employee directory and collaboration tools and (5) the *integrated work place*. Bach's aim of integrating process-orientation into KMS

513. Source: Applehans et al. 1999.

architectures manifests on all layers except the integration layer. Task flows in the integrated work place are supported by workflows as part of information services. Transaction systems execute processes in the layer of information sources.

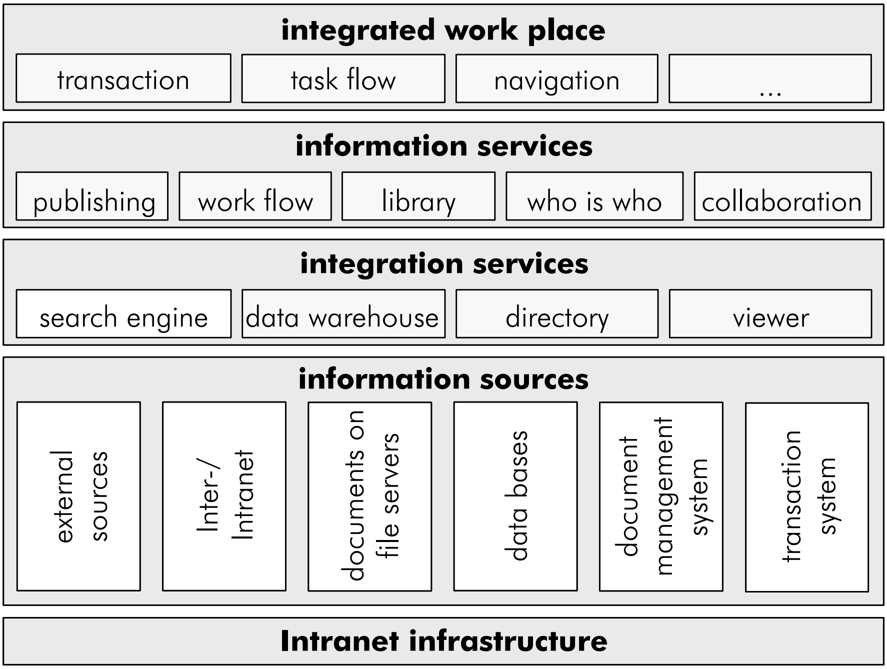

FIGURE B-57. Integrated, layered architecture for KMS[514]

- Becker et al. (2002, 24) present an architecture that views KMS from the perspective of meta-data (see Figure B-58). The starting point for this architecture is the observation that in most organizations there are already a number of application systems installed that provide a substantial portion of the functions that are required for KM. Becker et al. conclude that the KMS additions are basically restricted to the integration of these application systems with the help of a defined set of meta-data and a knowledge portal. Examples for application systems that provide KM functionality are content management systems, data warehouses, enterprise resource planning systems and workflow management systems. Each of these systems handles its own meta-data. Consequently, a KMS needs to align the meta-data of these systems. A knowledge management portal accesses the contents of these application systems on the basis of a separate data base with integrated meta-data drawn from these systems.

514. Source: Bach 1999, 69.

The comparison of these architectures reveals that each architecture suggests the establishment of a number of components organized on a number of layers, but none of the architectures comprises all the layers.

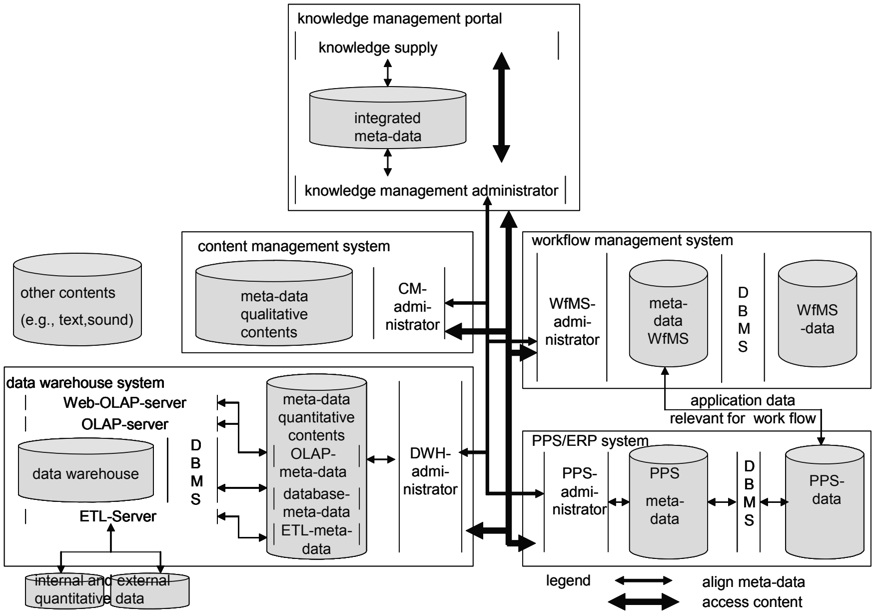

FIGURE B-58. Meta-data-oriented architecture for KMS[515]

For example, the OVUM architecture lacks a security layer, Applehans et al.'s architecture has no integration layer with a shared taxonomy and a repository. Bach's architecture provides the important layer of an integrated knowledge work place. However, the underlying layers lack detailing. Becker et al. finally introduce the aspect of a meta-data-based integration of legacy systems into a useful KMS. However, the role of KMS in this architecture is reduced to a portal. It lacks the intelligent functions that all other architectures stress as being one of the key components that distinguish KMS from traditional approaches.

7.4 Centralized architecture

The architectures described in the last section are now integrated into an ideal architecture for centralized KMS. Section 7.4.1 gives an overview of this architecture which comprises infrastructure, integration, discovery, publication, collaboration, learning, personalization and access services. In the sections 7.4.2 to 7.4.8, a comprehensive list of individual KMS functions are discussed structured according

515. Source: Becker et al. 2002, 24.

to the services organized in the architecture. Finally, section 7.4.9 discusses the components of Open Text Livelink according to the ideal architecture presented in section 7.4.1 as an example for a typical centralized KMS that is one of the best known and most widely used standard KMS in the market.

7.4.1 Overview

Figure B-59 shows an ideal layered architecture for centralized KMS that represents an amalgamation of the theory-driven, market-oriented and several vendor-specific architectures and integrates their components and layers.

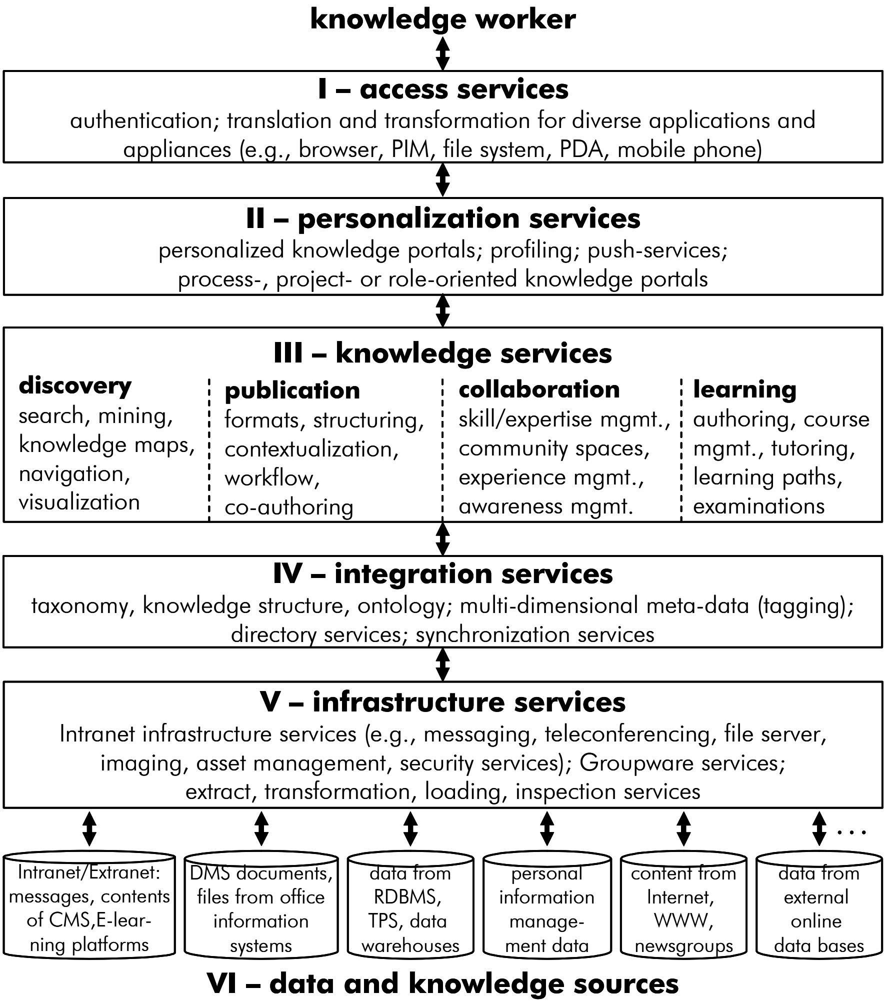

FIGURE B-59. Architecture for centralized KMS

As in the majority of architectural approaches in the literature, the ideal architecture is oriented towards the metaphor of a central KM server that manages all shared knowledge and can be accessed by knowledge workers, the clients.

Access services. The participant or knowledge worker accesses the organization's KMS with the help of a variety of access services, that translate and transform the contents and communication to and from the KMS to heterogeneous applications and appliances. Synchronization between these different applications and appliances including an integrated management of meta-data is provided by an integrated knowledge workspace. The KMS has to be protected against eavesdropping and unauthorized use by tools for authentication, authorization and encryption.

Personalization services. Main aim of the personalization services is to provide a more effective access to the large amounts of knowledge elements and thus to avoid information overload (Eppler/Mengis 2003). On the one hand, subject matter specialists or managers of knowledge processes can organize a portion of the KMS contents and services for specific roles or develop role-oriented push services. In this case, the knowledge services are accessed by the knowledge workers through an enterprise, a work group, a project or a role-specific knowledge portal respectively. On the other hand, both, the portal and the services can be personalized with the help of e.g., interest profiles, personal category nets and personalizable portals. Automated profiling can aid personalization of functions, contents and services.

Knowledge services. The core knowledge processes—search and retrieval, publication, collaboration and learning—are supported by *knowledge services.* These are key components of the KMS architecture and provide intelligent functions for:

publication: is the joint authoring, structuring, contextualization and release of knowledge elements supported by workflows,

discovery: means search, retrieval and presentation of knowledge elements and experts with the help of e.g., search, mining, visualization, mapping and navigation tools,

collaboration: supports the joint creation, sharing and application of knowledge of knowledge providers and seekers with the help of e.g., contextualized communication and coordination tools, location and awareness management tools, community homespaces and experience management tools and

learning: is supported e.g., by authoring tools and tools managing courses, tutoring, learning paths and examinations.

Integration services. Knowledge services work on the basis of integration services, e.g., a knowledge repository which handles the organization's meta-knowledge describing knowledge elements that come from a variety of sources with the help of meta-data for a number of dimensions, e.g., person, time, topic, location, process, type[516]. A taxonomy, a knowledge structure or an ontology help to meaningfully organize and link the knowledge elements and are used to analyze the semantics of the organizational knowledge base. Moreover, integration services are needed to manage meta-data about the knowledge workers that work with the KMS, e.g., in directory services. Finally, synchronization services export a portion of the knowledge workspace for work offline and (re-)integrate the work on knowledge elements that has been done offline.

Infrastructure services. The personalization, knowledge and integration services layers together can be viewed as a KMS in a narrow sense[517]. These layers are based on an *Intranet infrastructure* which provides basic functionality for synchronous and asynchronous communication, the sharing of data and documents as well as the management of electronic assets in general and of Web content in particular. In analogy to data warehousing, extract, transformation and loading tools provide access to the data and knowledge sources[518]. Furthermore, inspection services (viewer) are required for heterogeneous data and document formats. Inspection services support viewing of documents without the corresponding application, e.g., a text document without the text processing software that created the document.

Data and knowledge sources. The data and knowledge source layer gives some examples of the wide variety of electronic sources for data and knowledge which have to be integrated into the KMS or at least accessed through the KMS. In addition to *organization-internal sources*, such as the organization's transaction processing systems, data base systems, data warehouses, document management systems, content management systems, messaging systems and personal (or group) information management systems, many organizations need to include *organization-external sources* into their KMS. There is a huge and growing market for external (on-line) data bases. They can be classified e.g., into *fact data bases* that contain large collections of data and *reference data bases* which collect literature and/or references to literature. Examples for some well-known data supply companies that operate hundreds of data bases are (Mertens/Griese 2002, 20ff): DIALOG Information Services, Lockheed Information System, Predicasts, Reuters, or the Statistisches Bundesamt in Germany. Last but not least, the Internet, especially the WWW and newsgroups, provide abundant material that has to be considered in a KMS architecture.

In the following, the functions of a KMS that are required to perform these services are discussed according to the layers shown in Figure B-59. The layers comprising KMS in a narrow sense - personalization, knowledge services and integration, are discussed in detail. Due to their importance as key components of KMS, the four bundles discovery, publication, collaboration and learning that together provide the knowledge services are discussed separately.

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516. For a description of these dimensions see section 7.5.3 - "Example: Infotop" on page 349.
517. See section 4.3.2 - "Definition" on page 86.
518. The input part of a data warehouse architecture has been called data acquisition layer, Gray/Watson 1998, 17 or input layer, Muksch/Behme 1998a, 45.

7.4.2 Infrastructure and integration services

In addition to the publication of knowledge elements by participants, KMS should provide functions to transfer knowledge elements from sources external to the KMS into the system. The functions can support both, the manual and the automatic integration of knowledge elements from organization-internal and organization-external sources. Knowledge acquisition also comprises the value-added process of deriving knowledge (in the sense of interesting relationships, patterns) from large collections of data (data bases, data warehouses)[519].

- *manual integration of external knowledge elements:* this function supports the integration of e.g., documents, bookmarks, links, multimedia and hypermedia elements such as video files, audio files, graphics, pictures or integrated video, audio and text files into the KMS,
- *automatic integration of knowledge elements from external sources*: the KMS automatically searches a predefined domain of organization-external knowledge sources (e.g., with the help of intelligent agents, crawler) and integrates new or updated knowledge elements,
- *generation of knowledge elements from internal data sources*: this function generates reports from organization-internal data bases (e.g., production, sales or financial data) through a value-added process (i.e., advanced reporting functions),
- *statistical data analysis*: comprises techniques and functions that have been developed under the label *business intelligence* to help managers and analysts to discover relationships in large collections of data, e.g., data mining, knowledge discovery in data bases, on-line analytical processing, decision support systems as well as statistics software packages such as SAS or SPSS.

7.4.3 Discovery services

Functions for knowledge search provide together with functions for knowledge presentation the output-oriented part of a KMS and can be divided into pull-functions and push-functions (Horstmann/Timm 1998, 242f). “Pull” means that the participant (inter-)actively uses search (support) functions, such as keyword search, a thesaurus or navigation tools to retrieve knowledge elements. Push-functions are activated once as an information subscription, the start of an intelligent agent or an email to a listserver[520] and then deliver knowledge elements automatically when the function detects new and/or interesting knowledge elements within a certain period of time.

1. Primary search functions:

- *keyword search*: a widely used function with which keywords belonging to certain categories (e.g., author, title, year) are used to search for e.g., docu-

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519. This process requires intelligent knowledge services that can also be applied to discover relationships between knowledge elements of the KMS’ own organizational knowledge base.

520. See also section 7.4.5 - “Collaboration services” on page 327.

ments or persons. The keywords can be combined using logical operators (Boole's algebra, e.g., AND, OR, NOT),

- *meta-search system*: is also called a multi-search system (Horn 1999, 59) and provides functions supporting the (user-friendly) access to multiple knowledge sources. The term "meta" denotes here that the meta-search system accesses several individual search systems and "forwards" the search term in order to provide search results that span several data or document bases. Meta-search systems are further distinguished with respect to the search domain which they support, such as organization-internal and/or organization-external systems and with respect to the formats which they can search[521]. Meta-search engines offered on the WWW (e.g., MetaGer, MetaCrawler, ProFusion) so far are limited to HTML pages[522],
- *user-initiated filters*: allow to restrict the search to e.g., certain knowledge sources, topics, time, formats to avoid or at least decrease irrelevant search results,
- *navigation*: instead of directly typing in keywords to search for knowledge elements, participants can navigate through the knowledge structure to find their way to knowledge elements. The knowledge structure can be presented using two- and three-dimensional (e.g., hyperbolic) visualization of categories (category browsing) as well as sitemaps to avoid the "lost-in-cyberspace" phenomenon. Navigation also comprises e.g., Web browser functions, such as going back, history or hyperlinks to related hypertexts[523].

2. **Search support functions:**

   Search support functions are not search functions on their own, but can be applied so that the quality of search results is improved:

   - *thesaurus/synonyms*: a thesaurus is an alphabetically or otherwise systematically organized directory of words which displays the terminological relationships between the words (e.g., homonyms, synonyms) within a certain domain (Mertens et al. 1997, 408f) A thesaurus can either be used intentionally or automatically by the KMS to improve participants' search terms,
   - *presentation of new/unread documents*: knowledge elements which have been added to the KMS that is searched (unspecific novelty) and/or which have not been accessed by the participant (participant-specific novelty) are marked, e.g., by a symbol or by using a specific color,
   - *search assistants/search support*: aid the participants during the search, e.g., on-line help, tips, context-specific help, e.g., help in narrowing or extending a search term,

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521. Examples are documents, hypertext, relational data bases, data warehouses and the like; see also section 7.2 - "Contents" on page 281.
522. See also section 7.1 - "Technological roots" on page 273.
523. See also section 3. - "Presentation of relationships between knowledge elements before search:" on page 324.

- *display of access statistics for knowledge elements*: the KMS displays the numbers of accesses to certain knowledge elements and/or knowledge areas. The participant can use this information, e.g., to get a feeling of how many other participants have been interested in a topic or to detect trends.

After searching and navigating the knowledge space, knowledge presentation comprises functions that support the presentation of search results and that visualize the organization of knowledge elements, their structure and the relationships between knowledge elements.

3. Presentation of relationships between knowledge elements before search:

- *three-dimensional visualization*: this function uses three-dimensional models to represent the organization of knowledge elements and their relationships. *Hyperbolic browsers* use mathematical models to visualize three-dimensional hierarchic structures on a two-dimensional medium (screen, paper). Examples are the tools PersonalBrain (TheBrain Technologies) and InXight SmartDiscovery (InXight) which help the participant to navigate through complex knowledge structures and also handle the links from the leaves of the hyperbolic tree to the actual knowledge elements,
- *integrated presentation of knowledge elements in knowledge maps*: knowledge maps are graphical representations of knowledge and its relation to organizational concepts. Examples are maps about knowledge holders, knowledge sources, knowledge structures, knowledge stocks, knowledge flows, knowledge processes, knowledge application or competence cards. They are used to visualize relationships between knowledge elements and their providers in an organization (e.g., Eppler 1997, Probst et al. 1998, 107ff, Vogt 1998). With this function, knowledge maps are integrated into the KMS and can be used in the search for knowledge elements,
- *presentation of semantic closeness between knowledge elements (semantic net)*: a number of tools use advanced text mining technology to analyze documents and visualize the semantic relationships between the documents. An example is the tool ThemeScape (Cartia) that clusters documents with similar contents together with the distance between two documents visualizing their semantic closeness. Themes are represented as “mountains” of documents,
- *presentation of access paths to knowledge elements/knowledge clusters*: the tool Answer Garden analyzes the paths (e.g., links in an Intranet’s web of hypertext documents) which participants use to access knowledge elements. These access paths are displayed as trails to knowledge elements. The more participants have used a certain access paths, the more pronounced is the visualization of the corresponding trail (“beaten tracks”),

4. Presentation of knowledge elements after the search (=search results):

- *ranking of knowledge elements*: search results are presented in an order which reflects either how closely they match the participant’s search term or the “importance” of the knowledge element which might be calculated using criteria such as publication date, number of links to this knowledge element (citation score), or criteria known from collaborative filtering, such as number of accesses by different groups of participants (e.g., experts), subjective evaluations by e.g., subject matter specialists or by participants with a similar profile and the like (e.g., Autonomy KM Toolsuite),

- *presentation of full texts*: search results regularly consist of a list of titles of matching knowledge elements, sometimes including the first paragraph of the description of the knowledge element (e.g., Hyperwave Information Server) or a short summary describing the knowledge element (e.g., Open Text Livelink). In case of documents this function allows that documents of varying formats can directly be viewed within the KMS (e.g., with so-called viewers),
- *presentation of related knowledge elements*: this is again a function of collaborative filtering. The KMS compares participants' profiles and suggests knowledge elements which the participant had not searched for, but which other participants who have a similar profile and who previously had got the same results had also searched for ("Who searches for X, searches also for Y"). An example for this function is Amazon.com's service that suggests a list of "related books" which builds on customers' profiles derived from their shopping history and other customer data,
- *navigation from knowledge elements to authors, experts or communities*: this function supports the interactive use of KMS. The participant can directly contact the author of a knowledge element, experts in the domain, subject matter specialists or knowledge brokers responsible for the corresponding topic or communities that discuss related issues e.g., by email or videoconferencing.

Finally, discovery services also comprise reporting about the state of the knowledge base, its use and users.

5. Reporting:

- *reports concerning knowledge elements*: can provide measures such as the number of accesses to each knowledge element, the number of searches with a certain term, the number of search results to specific search terms etc. In the case of no or a small number of search results to a popular search term, or a low ratio of organization-internal to organizational-external search results, these measures might suggest that knowledge in that area has to be developed[524],
- *reports concerning participants*: these functions monitor the patterns of usage of KMS by participants or collectives of participants. Examples for measures are the number of contributions in newsgroups, the number of knowledge elements published and the number of information subscriptions. These mea-

524. One interviewee reported that the monitoring of their KMS usage had revealed that the search term "Linux" had been searched more and more frequently by the participants. The organization decided on the basis of this information to offer Linux courses to a large number of employees.

sures can be used for motivation instruments such as a ranking of best knowledge providers in an organization or incentive systems, e.g., to reward the best contributors to every topic considered important for the organization. However, the design of incentive systems for knowledge management is a challenging task and experiences with simple measures such as the number of contributions to lessons learned data bases are not encouraging[525].

7.4.4 Publication services

This group represents *input-oriented functions of KMS*. Apart from a decentral publication of knowledge elements by the participants without support by technical staff, this group provides important functions for the organization of knowledge. Knowledge elements have to be linked with other knowledge elements as well as within the knowledge structure (ontology) of the organization. The quality of these functions has substantial influence on the quality of retrieved search results as knowledge elements that are not linked appropriately (i.e., corresponding to the collective mental models of the participants) are hard to find.

1. Knowledge publication:

- *publication of pre-structured contents by participants*: forms and templates provide guidance for the documentation of knowledge,
- *publication of not pre-structured contents by participants*: participants can store documents of all kinds of formats and structures in the KMS,
- *indexing/integration of published contents*: indexing helps the participant to provide a list of keywords to the published contents. The function integration of published contents is used to link a knowledge element to the organization's knowledge structure,
- *feedback from participants to authors of knowledge elements*: participants can provide structured or unstructured feedback to the author(s) of knowledge elements,
- *comments to knowledge elements*: participants can publish comments to knowledge elements ("post-it" function) which in turn can be used by other participants to cooperatively evaluate knowledge elements.
- *automatic notification of potentially interested*: once a new knowledge element is published, the KMS automatically selects and notifies participants who are potentially interested in the newly published knowledge. The selection of potentially interested participants might be based on information subscriptions, memberships in communities, organizational roles, an analysis of profiles or on the access history of participants,

525. The interviewee at Ernst & Young reported that his organization abandoned this practice years ago after their experience data bases were flooded with documents of questionable quality greatly reducing the signal to noise ratio. However, recently several organizations have started more sophisticated incentive programs for knowledge sharing, e.g., Siemens and Hoffmann La Roche.

2. Knowledge organization:

- *development and management of knowledge maps*: knowledge maps are not developed separately from the KMS, but the KMS provides functions that help the knowledge manager to semi-automatically derive maps from the contents of the KMS. Examples are InXight Smart Discovery (InXight), SemioMap (Semio Corp.), ThemeScape (Cartia) and AnswerGarden2[526],
- *knowledge repository*: a repository is a system used to store meta-data about objects of information systems such as data, functions, application systems, hardware, users or organizational units (Mertens et al. 1997, 345f). Knowledge repositories support the management of meta-information for knowledge elements (e.g., documents, authors, experts, communities),
- *automatic indexing of full texts*: documents are scanned with text mining techniques that suggest a list of keywords for the texts which is compatible to the organization's knowledge structure (Grothe/Gentsch 2000, 212ff),
- *automatic integration/classification/linking of knowledge elements*: again, text mining techniques are applied in order to e.g., discover interesting relationships between documents, classify documents, integrate them with the knowledge structure or cluster documents that cannot be integrated into the organization's knowledge structure. Thus, text mining provides techniques for a bottom-up document-driven categorization of knowledge elements which can be combined with a top-down categorization developed in e.g., an expert workshop (Grothe/Gentsch 2000, 217),
- *semantic analysis of knowledge elements*: the KMS discovers relationships within and between knowledge elements. On the basis of techniques such as language analysis, semantic nets of terms are developed that describe a collection of knowledge elements,
- *(hyper-)linking of published contents* (within documents): traditional documents (e.g., developed with text processing software such as MS Word) are transformed into hypertext documents in which hyperlinks are used to directly navigate within the documents, e.g., between sections of the documents or to cross-references,
- *structuring and management of knowledge clusters*: the KMS provides functions to support the development and management of theme-specific knowledge areas or clusters containing knowledge elements to a specific topic.

7.4.5 Collaboration services

Apart from the advanced management of knowledge elements as described in the groups of services above[527], communication and cooperation is the second impor-

526. See also the function *integrated presentation of knowledge elements in knowledge maps* in section 7.4.3 - "Discovery services" on page 322.
527. See sections 7.4.3 - "Discovery services" on page 322 until 7.4.4 - "Publication services" on page 326.

tant part of a corporate KMS. Advanced support for organizational communication and cooperation regularly builds on a corporate Intranet and/or Groupware platform that supports basic functionality such as email or discussion lists[528]. Functions for knowledge communication and cooperation can be classified like general Groupware tools and systems according to time, location and flexibility of communication and cooperation (Koch/Zielke 1996, 70ff). In the following, time is used as criterion for the classification and distinguishes synchronous (all participants are on-line at the same time) from asynchronous communication and cooperation (simultaneous presence of communication partners is not necessary).

1. **Asynchronous communication and cooperation:**
   - *email*: is the electronic pendant to traditional mail. Basically, ASCII text messages and so-called attachments (binary files) or MIME messages (Multi-Purpose Internet Mail Extensions) can be sent easily and quickly between email clients using the Internet or an organization's Intranet with the help of specific protocols, such as SMTP, the Simple Mail Transfer Protocol, POP3, the Post Office Protocol in version 3 or IMAP4, the Internet Message Access Protocol in version 4 (e.g., Höller et al. 1998, 10ff, Horn 1999, 42ff, Röckelein 1999, 40f),
   - *email distribution lists*: are lists of email addresses maintained by the participants used to broadcast emails to multiple receivers.
   - *listserver*: is a software tool that automates the management of mailing lists. The listserver can handle many mailing lists at the same time. Participants who want to join a mailing list simply send a message to the listserver (e.g.: subscribe list_name first_name last_name). The listserver then sends a request to the list's manager whether the participant should be added to the list. Every member of a list can send messages to the listserver which in turn are forwarded to all the members of the list either immediately or as a digested set of messages in defined time intervals, e.g., daily. Examples for listserver software are ListProc, Listserv (L-Soft) or Majordomo (Vaughan-Nichols1997, 162ff).
   - *ad-hoc workflow management system*: workflow management systems primarily support well-structured organizational processes[529], but lack support for ad-hoc workflows (Koch/Zielke 1996, 158). Groupware platforms (e.g., Lotus Notes) and knowledge management systems (e.g., Open Text Livelink) offer this kind of flexible functionality.
   - *newsgroups*: a newsgroup is a discussion list on a certain topic, a forum for exchanging ideas. NetNews is a public collection of newsgroups (more than 25,000) which are hierarchically organized according to themes (top-level themes are e.g., .comp for computer-related topics, .rec for recreational topics, .sci for scientific topics). Participants can subscribe to a selection of these

528. See also section 7.6 - “Classification” on page 361.
529. See section 4.3 - “Knowledge management systems” on page 82.

newsgroups[530] which might contain valuable information for certain groups of participants (e.g., system administrators, programmers). Additionally, organization-specific discussion lists can be set up with the help of tools which are part of Groupware platforms or Intranet solutions (Horn 1999, 46ff and 274ff, Grothe/Gentsch 2000, 78ff),

- *co-authoring functions*: support an asynchronous joint development of knowledge elements (e.g., documents) by multiple dislocated authors (Zwass 1992, 641). Examples for functions are version management, check-in, check-out of parts of (distributed) documents, highlighting updates attributed to a certain author, management of comments, accept/deny proposals for changes and the like. Examples for tools that provide co-authoring functions are document management systems such as Documentum 4i (Documentum) or Panagon (FileNET),
- *administration of group profiles and privileges*: this functionality supports in analogy to the definition of roles for participants and profiling for participants the definition of privileges and profiles for collectives of participants, such as work groups, teams and communities. The functions for administration of collectives of participants greatly support interaction within groups, collaboration, e.g., collaborative filtering and the transactive memory as groups can be connected to information flows in the same way as described for individual participants above. These advanced administration functions together with intelligent agent technology that uses participants' individual profiles as well as group profiles can provide the basis for an *intelligent community portal* (Grothe/Gentsch 2000, 267ff).

2. **Synchronous communication and cooperation:**
   - *point-to-point video conference*: also sometimes called "simple video conferencing" connects two participants and transmits motion pictures usually captured by a small video camera which is mounted on the participants' monitors as well as audio recorded by microphones between them via the Internet, ISDN (Integrated Services Digital Network) or the analogous telephone network, sometimes also referred to as POTS (Plain Old Telephone System, Horn 1999, 18ff, 227ff). Examples for video conferencing software are CU-SeeMe (White Pine) or NetMeeting (Microsoft) which offer a lot of additional functionality, such as whiteboard, application sharing, text chat and multi-point video conferencing,
   - *multi-point video conference*: in addition to point-to-point video conferencing a multi-point video conference involves more than two participants and thus requires a multicast capable network infrastructure (see Wittmann/Zitterbart 1999) or a multi-point control unit or service (Horn 1999, 231). Examples are the Polycom video conferencing tools (Polycom).

530. The organization can preselect those newsgroups it wishes to offer to its employees.

- *networked group video conferencing rooms*: in the beginning of tele-conferencing, many multinational organizations (e.g., IBM, Siemens) or telecommunication companies (e.g., Deutsche Telekom) installed the expensive video conferencing equipment in a separate room, a video conferencing studio (Hansen 2001, 431). The immobile installation of professional video equipment provides high quality pictures and sound. With the advent of cheap and powerful desktop video conferencing systems, the use of video conferencing studios is limited, e.g., for electronic group meetings of managers or of two and more geographically dispersed work groups or project teams,
- *audio conference*: is the electronic equivalent to the telephone. Two or more participants communicate via electronic networks. If the Internet is used as the communication medium, audio conferencing is also sometimes called Internet-telephony (Vaughan-Nichols 1997, 204ff, Horn 1999, 223ff). Examples for audio conferencing tools are Surf&Call (VocalTec) or the audio part of NetMeeting (Microsoft),
- *group conference management*: functions for a management of tele-conferences support a person to moderate a group discussion. A dedicated moderator can for example restrict access to certain participants, ban unwanted contributions or participants, thread contributions, administer votings and the like. Examples for software tools supporting the moderation of text chats are the moderation module of SpinChat (Spin) or the MBone moderation tools (Malpani/Rowe 1997, Perry 1997, 13ff),
- *instant messaging*: is the synchronous form of email. A participant can send a text message to a person (or a group of persons) that is delivered immediately. The best known systems supporting this function are ICQ–"I seek you"[531], the AOL Instant Messenger[532] (see Horn 1999, 49) or the Microsoft Messenger[533],
- *chat*: is a form of text-based tele-conferencing. A chat is a synchronous forum for discussions which displays all contributions immediately after they have been typed by the participants. Internet-based public chat server, so-called IRC (Internet Relay Chat), offer thousands of theme-specific channels, so-called conference rooms, and are visited by many thousand people daily. Web portals such as YAHOO! (URL: http://www.yahoo.com/) or web.de (URL: http://chat.web.de/) offer overviews over chat offerings (Horn 1999, 48ff). Apart from these public on-line discussion groups many organizations internally use chat software to support text-based conferences about certain topics or as a brainstorming tool. One example for commercial chat software applied in organizations is SpinChat (Spin).
- *electronic whiteboard*: is part of a tele-conferencing system. It offers functionality similar to a simple paint software (e.g., Windows Paint) that can be

531. See URL: http://www.icq.com/
532. See URL: http://www.aol.com/
533. See URL: http://messenger.msn.com/

used simultaneously by multiple dislocated participants of a tele-conference to share information, import and jointly work on documents, drawings or images and the like (e.g., the whiteboard in Microsoft NetMeeting, Horn 1999, 233),

- *application sharing*: is a form of tele-conferencing where several dislocated participants jointly use an application and simultaneously work on e.g., CAD designs, spreadsheets, graphs or text documents (Hansen 2001, 431f). One popular example is the application sharing functionality offered by Microsoft NetMeeting in connection with Microsoft's Office applications (e.g., Excel, Powerpoint, Word and Access, Horn 1999, 233f),
- *electronic brainstorming*: is a specific function that is often part of Groupware tools. Brainstorming tools usually support generation and organization of ideas. The software enables participants to submit ideas to a topic and immediately presents these ideas to other participants. One example for brainstorming software is GroupSystems (Valacich et al. 1991),
- *list of participants currently on-line*: are also called "Buddy lists" and an instrument to increase awareness of what is going on in a KMS. Tele-conferencing, no matter whether text-based, audio or video conferencing, requires that participants are on-line. In order to support the initiation of tele-conferences, participants need to know who else in an organization is on-line and on which computer they are. Due to data privacy laws, access to a list of participants currently on-line is regularly restricted. Additionally, in large organizations the participant might need additional information about the other participants in addition to a person's login (e.g., name, location, position, roles, memberships, competencies etc.) and navigation help (e.g., find all participants on-line worldwide who work for a specific business process),

7.4.6 Learning services

As mentioned before, the market for KMS in general develops from advanced document management systems and thus a focus on explicit, codified knowledge to the integration of collaboration and e-learning functionality and thus a focus on implicit, personalized knowledge (see also the empirical results in part C). E-learning suites provide a basis for an organization-wide integrated management of CBT and WBT modules and also for computer-supported cooperative learning (CSCL) or distributed collaborative learning (Möhrle 1996). Examples for elements of an e-learning suite such as Lotus's LearningSpace are: administration of course materials and (hyper-) media, e.g., documents, audio and video files, links etc.; a schedule that provides an overview of programs, courses, times etc.; a so-called course room for on-line exchange of ideas and discussions between students and teachers; profiles of participants and administration of exams (e.g., Lehner 2000, 389f, Seifried/Eppler 2000, 33).

1. Asynchronous CBT and tele-learning:

- *computer based training*: this function supports the integrated and context-dependent access to CBT modules within KMS. Examples for software that specifically focuses on tele-teaching and tele-learning in organization's Intranets are so-called e-learning suites such as LearningSpace (Lotus) and the Hyperwave E-Learning suite (Hyperwave),

- *video server*: is in analogy to a data base server a computer system that stores and handles accesses to video files. Video server have been heavily discussed in connection with *video-on-demand* (e.g., Röckelein 1997, 56f, Hansen 2001, 114). Video server provide functionality so that participants can access any video file (e.g., a lecture, a product presentation, a penal discussion) at any time. Video streaming server allow that the user does not have to wait until the entire file is loaded, but can already watch the video while the file is loaded,

2. Synchronous CBT and tele-learning:

- *live broadcasting of videos*: this functionality is the synchronous equivalent of video servers. It supports the broadcasting of e.g., lectures, presentations or the CEO's weekly talks to participants who have to be on-line and "tuned in" at the time of the broadcasting. Video broadcasting is applied in tele-teaching (e.g., at the two-campus University of Erlangen-Nürnberg) and in business TV (Lehner 2000a, Weidler 2000). Recent implementations regularly include functionality to support interaction between the receivers of the broadcast and the sender (feedback channels for text, audio or video). Examples for software tools supporting video broadcast are the MBone tools and IntraTV (Siemens Business Services, Lehner 2000a, 15f).

Generally, it is supposed that organizations with a KMS solution (no matter whether bought on the market or developed internally) have implemented a larger number of KMS functions than organizations without a dedicated KMS solution. This should be especially true for the more advanced KMS functions which are not available as part of a basic Intranet or Groupware platform. Consequently, the following hypothesis will be tested:

Hypothesis 18: Organizations with KMS have a larger number of KMS functions than organizations without KMS

KMS architectures also strongly aim at an integration of existing data and knowledge sources as well as existing knowledge-related services (e.g., documentation, visualization, search and retrieval as well as collaboration). Thus, there should also be a positive correlation between the existence of a KMS in an organization and the integration of KMS functions. This should be especially true for KMS bought on the market, because according to interviews with vendors of KM suites as well as knowledge managers applying such systems, integration across platforms and formats is the single most important reason why organizations invest in KMS available on the market. This leads to the following hypothesis:

Hypothesis 19: KMS functions in organizations with KMS bought on the market are more integrated than KMS functions in organizations without KMS

7.4.7 Personalization services

Subject matter specialists and knowledge brokers are responsible for e.g., the refinement of knowledge, the distribution of knowledge to potentially interested members, for the identification of trends in the use of KMS, for the acquisition of external knowledge about topics that are needed or for the motivation of participants to contribute[534]. The functionality within the group administration of KMS supports these specific roles in their tasks, but also individual participants and groups, teams and communities in the personalization of interfaces and knowledge managers in monitoring the system usage as measures of success[535].

Knowledge push functions can generally be initiated either decentrally by the participants or centrally e.g., by subject matter specialists or knowledge brokers who can therefore easily distribute information to interested groups of participants:

- *profiling*: participant profiles contain general information about a participant such as job description, roles, privileges, interest profiles or the level of experience which are used to narrow the search domain and improve the relevance of search results. Consequently, KMS have to extensively apply complex user models in order to provide this kind of support (Mertens et al. 1997, 53f, Mertens/Höhl 1999). Profiles can either be administered by the participants themselves or centrally by knowledge managers, subject matter specialists or knowledge brokers,
- *information subscriptions for interested users*: the participant subscribes to an information service which will automatically send personalized messages in certain time intervals or event-triggered. The messages contain information and/or links to information that match the participant's profile. A recent development in the field of information subscriptions are so-called *news channels* or *news ticker* which permanently display news in a separate line e.g., at the bottom end of the screen (for examples for news ticker and information subscriptions on the Internet see Horn 1999, 62ff),
- *intelligent (search) agents*: the term *agent* in general denotes an autonomous piece of software that carries out actions for a user (Mertens et al. 1997, 6). Technologically, agents are based on approaches of distributed artificial intelligence. Like information subscriptions intelligent search agents automatically search in knowledge bases for information that matches a predefined participant's profile. Additionally, agents can e.g., negotiate with other agents in other systems to provide more intelligent search results and learn about the participant to extend his or her profile according to the history of searches and evaluation of search results,
- *personalization of user interface*: in order to avoid "information overload" due to the abundance of organization-wide knowledge resources, many KMS offer functions to personalize the participants' interface with the system,

534. See section 6.1.2 - "Knowledge management roles" on page 162.
535. See also chapter 8 - "Economics" on page 395.

sometimes called *my place* (e.g., Grothe/Gentsch 2000, 73f). The idea of a personalized, individual window to the organization's knowledge assets and applications is closely connected with enterprise information portals. *Enterprise information portals* (EIP) or corporate portals offer e.g., enterprise-wide search functionality, navigation, directory browsing as well as links to external Web sites and information sources (e.g., Kappe 2000). EIP software offers functionality for personalization so that every participant accesses the KMS with the help of an individual information portal. Examples for EIP software are the Hyperwave Information Portal (Hyperwave) or the E-Portal (Viador),

- *definition of roles for participants*: in analogy to networks and data base management systems, KMS administration can be greatly supported by the concept of roles. One individual employee can play several roles with respect to the use of KMS, e.g., various *functional roles*, such as consultant, sales person, engineer, member of R&D, *knowledge-related roles*, such as subject matter specialist, knowledge broker, knowledge manager as well as the *role of a technical administrator* of the KMS etc. On the one hand, roles determine the participants' privileges, e.g., for accessing, publishing, updating and deleting knowledge elements etc. On the other hand, roles can be used to narrow the search domain and help to navigate the organization-wide knowledge structure,
- *role-specific configurations of knowledge management systems*: roles can further be used as the basis for a pre-configuration of KMS. Specific groups of participants get predefined default parameters, e.g., for the selection of topical data bases in a Lotus Notes environment, specific on-line help or role-specific lists of experts, networks and communities. Examples are special configurations for newly recruited versus senior management bundles. Trainees at Andersen Consulting for example get a so-called starter package dependent on the trainee's educational background (e.g., IT versus business). The starter package pre-selects a number of data bases, news feeds, membership in communities etc. potentially interesting for the trainee, arranges them on the participant's screen and provides special instructions for the use of the KMS.

7.4.8 Access services

The KMS services described so far are accessed by a variety of access services. The simplest way to access a KMS is via a standard Web browser (e.g., Microsoft Internet Explorer, Mozilla, Netscape Navigator[536]). However, more advanced KMS have lived up to the requirement that KMS have to be seamlessly integrated into the ICT work environment that the knowledge worker chooses to use. This integration requires the following groups of functions:

- *transformation and translation to other applications*: access services translate and transform the contents and communication to and from the lower levels of

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536. URLs: http://www.microsoft.com/, http://www.mozilla.org/, http://www.netscape.com/

services in the KMS to heterogeneous applications. Examples for applications are a Web browser, a file management system (e.g., Microsoft Windows Explorer), an email client (e.g., Eudora Email, Netscape Mail[537]), personal information management applications such as calendar, to-do lists, address books (e.g., Microsoft Outlook, Palm Desktop[538]) as well as collaboration or Groupware platforms (e.g., Lotus Notes/Domino, Microsoft Exchange[539]).

- *transformation and translation in mobile environments*: knowledge workers have often advanced demands for mobility, thus access services also have to cope with varying communication environments, especially bandwidths anywhere between a fast local area network and rather slow telephone lines or even offline work with KMS contents and therefore replication of (parts of the) contents (see integration services). Examples for appliances that are used to access KMS are a PC, a notebook, a personal digital assistant (PDA), a smartphone or a feature phone. These appliances differ with respect to their resources, e.g., screen size, processing power, storage, or interaction capabilities. Contents have to be transformed, so that they can be handled with the different appliances.
- *integrated knowledge workspace*: synchronization between these different applications and appliances including an integrated management of meta-data can be provided by an integrated knowledge workspace (see also integration services). In its simplest form, the knowledge workspace can be thought of as a portal that provides access to the most important applications that the knowledge worker works with (see also personalization services). A more advanced knowledge workspace would be aware of the knowledge objects that a knowledge worker accesses in different applications and relate them to each other on the basis of an extended meta-data management (meta-data brokering, ontology brokering).
- *authentication and authorization*: the KMS have to be protected against eavesdropping and unauthorized use by tools for authentication, authorization and encryption. KMS in many cases have to be accessed not only from within the boundaries of a corporate LAN, but also from outside via telephone lines, e.g., using a remote access system, and/or the Internet which requires strong encryption. In this case, access and infrastructure services together have to be in place to provide secure access to the corporate KMS. An example is the use of a virtual private network (VPN) that realizes a kind of a secure "tunnel" through which data are transferred to and from the corporate KMS, e.g., using the point-to-point tunneling protocol (PPTP). Access has to be restricted to those knowledge objects that the knowledge worker is allowed e.g., to see[540],

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537. URLs: http://www.eudora.com/, http://www.netscape.com/
538. URLs: http://www.microsoft.com/, http://www.palm.com/
539. URLs: http://www.lotus.com/, http://www.microsoft.com/
540. "See" in this case means that the existence of a knowledge object is made known to the knowledge worker, but she is not allowed to access the contents of the knowledge object, e.g., a hypertext document.

to view its contents, to download, to change, to add versions to, to delete etc. (see also infrastructure services).

7.4.9 Example: Open Text Livelink

Open Text's product family Livelink represents one of the leading KMS platforms with a centralized architecture. Livelink has a large installed base of millions of users in 46,000 organizations in 114 countries[541] many of which are large organizations. Figure B-60 assigns Open Text Livelink's modules to the six layers of the centralized KMS architecture (see Figure B-59 on page 319). In the following, Livelink's components are briefly discussed.

Data and knowledge sources. Livelink data is stored in a relational data base system and the file system of the server's operating system on which Livelink is installed. Various other data and knowledge sources are made available by services on the infrastructure layer covering structured as well as semi-structured, organization-internal as well as -external sources.

Infrastructure services. Livelink is based on the organizational Intranet infrastructure. On the infrastructure level, it offers functionality for administration, workflow as well as import and export of XML data. Open Text offers a large number of modules targeted at enhancing technical access to the system (WebDAV, eLink, Directory Services, Remote Cache), integration with other Livelink instances or Open Text products (Brokered Search, Doorways, Collections Server Integration, Library Management Integration, GISLink, DocuLink) and external systems (Spider), easing administration of the Livelink server (Performance Analyzer, Monitoring Agent, DB Backup Validator, Object Importer, Recycle Bin) as well as enabling or supporting development of individual extensions based on the system's API (SDK, XML Workflow Interchange/Extensions).

Integration services. In Livelink, knowledge is stored in and represented by so-called "objects", e.g., documents, folders, discussions, news channels or task lists. All of them can be placed in a folder hierarchy that resembles traditional file systems. Meta-data is either added automatically, e.g., creation/change date, creator, protocol, or manually via customizable categories. Because all meta-data are stored in a relational data base, it can be queried using SQL statements in so-called reports. Optional modules offer functionality for manual or automatic creation of multiple alternative taxonomies (Classifications Professional, Taxonomy Workbench), extensions of the meta-data model (Attribute Extensions) and securing user information (Privacy Panel).

541. According to Open Text investor relations; see also: URL: http://www.opentext.com/investor/. With these figures, Livelink claims to be the largest independent provider of what it calls now enterprise content management solutions.

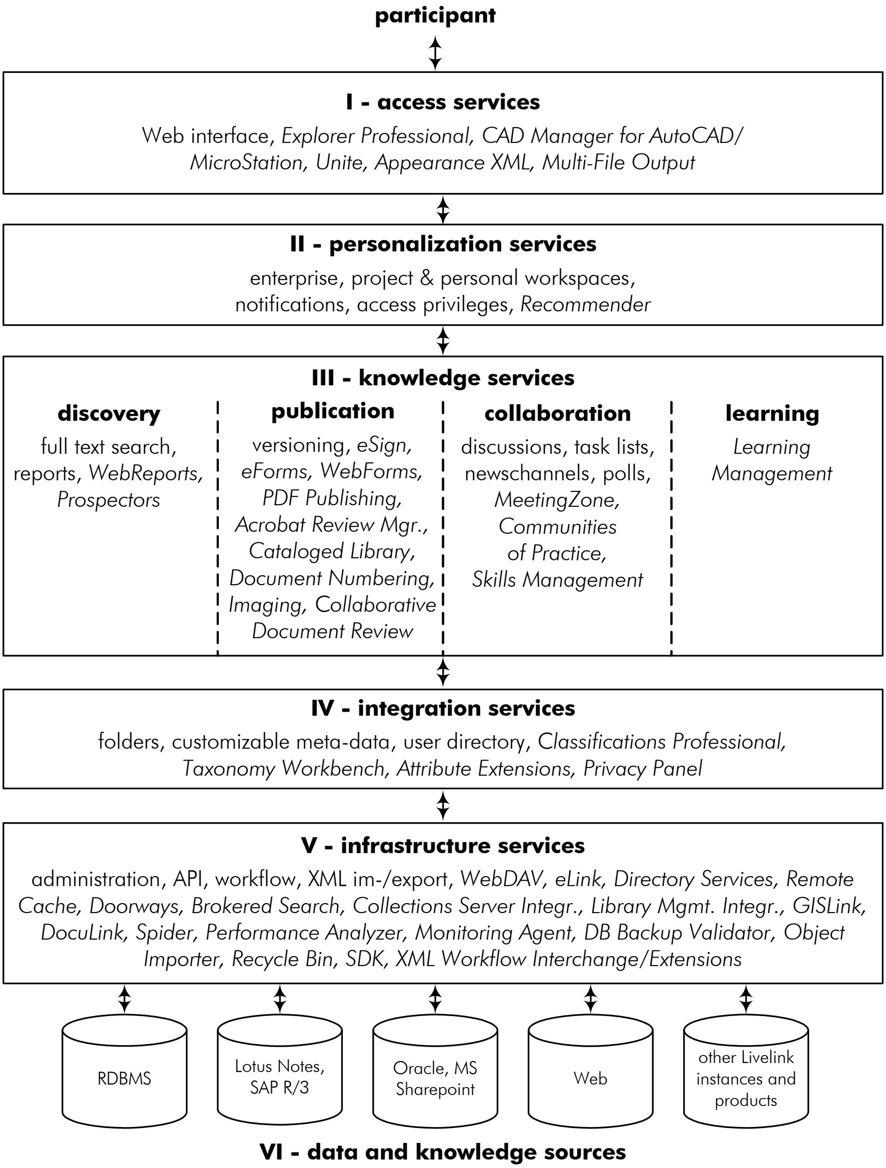

FIGURE B-60. Open Text Livelink in centralized KMS architecture[542]

542. Italic descriptions refer to separate software modules that extend Livelink's core functionality. It depends on the actual license agreement whether they are included or not. A variety of additional modules can be obtained from 3rd party vendors and are not considered here.

Discovery services. Livelink's full-text search engine allows basic and advanced keyword searches. Additionally, assigned meta-data can be used for limiting the search domain. A typical search result page not only includes a ranked list of various types of objects with short descriptions, e.g., documents, discussion topics, folders or objects from further knowledge sources made accessible through additional services on the infrastructure level, but also gives hints to what authors or creators have been most active according to the actual query. Livelink's notification mechanism allows users to place change agents on selected folders to be notified via email if changes occur, e.g., if a new document or a new version of a document is added. Comparable functionality is provided by an optional module to monitor changes of search queries to Web resources (Prospectors). Another module is available for generating reports on structured data, e.g., forms, external data bases or Livelink management data (WebReports).

Collaboration services. Some basic functions like discussions (black boards), polls, news channels, task lists, and advanced functions like workflows aim at supporting collaboration. MeetingZone comprises a set of meeting support tools that are integrated into Livelink, e.g., a whiteboard, a chat, a shared desktop and objects to be used during the meeting. Other optional modules offer basic functions for competence management (Skills Management) and support creation of community workspaces (Communities of Practice).

Learning services. The standard version of the Livelink server does not provide any learning services. Structured course units as well as question and answer tests can be created by means of an optional module that also allows for integration with the Skills Management module (Learning Management).

Publication services. Typical document management functions of Livelink are check-in/check-out of documents in order to avoid conflicts if more than one user works with a document, a versioning mechanism and workflows that support publication of documents, e.g., a release workflow. All types of files can be stored in Livelink. The most common types, e.g., formats of office systems, can be converted to HTML on demand. Thus, documents can be viewed without the native application and indexed by Livelink's search engine. Optional modules provide capabilities for electronic signatures (eSign), management of electronic forms (eForms, WebForms), creation of portable document format (pdf) files from within Livelink (PDF publishing) and managing linked annotations (Review Manager for Acrobat), administration of bibliographic resources (Catalogued Library), labelling documents (Document Numbering), and coordinating the steps of the document review processes (Collaborative Document Review).

Personalization services. Livelink offers three types of workspaces that differ mainly with respect to what groups of users are granted privileges to access them. The enterprise workspace is the central workspace for all users. A personal workspace belongs to every user with access restricted to this user. Project workspaces can only be accessed by participants defined by the project's coordinator(s). The operations users and groups of users may perform on an object are defined by detailed privileges at the granularity of single objects. Examples for operations are: see object, see content of object, delete object, change meta-data or add version. All knowledge services, e.g., discovery services, as well as access services consider these privileges. An additional module generates suggestions of potentially interesting contents based on the individual user profile (Recommender).

Access services. The standard way to access the system is with the help of a standard Web browser, e.g., Microsoft Internet Explorer, Mozilla or Netscape Navigator.[543] Thus, access to Livelink is relatively platform-independent and not limited to a corporate LAN. Due to the fact that access to Livelink requires no additional installations, e.g., of plug-ins[544], Livelink can also be accessed via the Internet from every networked computer that has a Web browser installed. Nearly all objects stored in Livelink can be exported to and imported from XML documents. Additional modules integrate Livelink with emails (eLink) or desktop applications such as MS Windows Explorer, MS Word, Adobe Acrobat, and CAD applications (Explorer Professional, CAD Manager for AutoCAD/MicroStation). The Explorer provides a drag & drop integration into the Microsoft Windows Explorer. A "professional version" extends this integration with basic online/offline synchronization functions and an integration e.g., into Microsoft Office. An example is check-in/check-out of documents directly from Microsoft Word. Other optional modules provide access to and consolidate multiple Livelink instances on the presentation layer (Unite), allow for adaptations of the Web interface (XML Appearance) and for printing, mailing or downloading multiple files over the Web interface (Multi-File Output).

Figure B-60 categorizes the most important functions and modules (in italics) of Open Text's core product, the Livelink Enterprise Content Management (ECM) Enterprise Server 9.7.0[545]. After acquisition of several companies such as Artesia, Gauss, IXOS, RedDot and, more recently, Hummingbird, the software provider offers an even larger variety of different products and variations of the Livelink ECM server under the umbrella of the Livelink ECM family and addresses topics such as

- KM and collaboration: Livelink ECM Knowledge Management, Collections Server, Discovery Server, Federated Query Server, Library Management, Collaboration,
- Web content management: RedDot Web Content Management, Livelink ECM Web Content Management Server,

543. URLs: http://www.microsoft.com/, http://www.mozilla.org/, http://www.netscape.com/
544. However, the comfortable use of Livelink requires the installation of Java Virtual Machine.
545. Available since December 2006.

- email archiving and management: Livelink ECM Email Archiving / Monitoring for Lotus Notes, Email Archiving / Monitoring / Management for MS Exchange),
- compliance, governance and archiving: Livelink ECM Internal Controls, Records Management, Regulated Documents, Accreditations Server, Collaborative Submissions, Litigation Management, Content Lifecycle Management, Contract Lifecycle Management, Document Management, Library Management, Archiving for File Systems, MS Sharepoint Integration,
- high volume document processing and imaging: Livelink ECM Production Document Management, Production Imaging,
- digital asset management and publishing: Artesia Digital Asset Management, Livelink ECM Enterprise Publishing,
- content and document management in public institutions: DOMEA Government Content Management product family,
- document management and archiving with SAP: Livelink ECM Suite for SAP solutions,
- connectivity between software platforms: Hummingbird Exceed product family, Hummingbird Security, NFS Maestro, HostExplorer product family,
- extensions for Oracle: Livelink ECM Accounts Payable for PeopleSoft Enterprise, for JD Edwards EnterpriseOne, and for JD Edwards World,
- business process management: Livelink ECM Advanced Workflow, Business Process Management Server,
- project management: Livelink ECM Clinicals, Construction Management, Program Management,
- reports: Livelink ECM Report Output Management, Vista Plus Suite,
- technology-enhanced learning: Livelink ECM Eloquent Media Server,
- portal integration: Livelink ECM Portal Integration Kit.

A recent addition to the product portfolio is Livelink ECM eDOCs, formerly the Hummingbird Enterprise Suite, a complimentary product family for document management, records management, contract management, correspondence management which also offers functions for collaboration, search, and workflow management and can be integrated with other products such as MS Sharepoint or MS Office[546].

Summing up, Open Text Livelink can be considered as a knowledge management system in the sense of a platform that combines and integrates a substantial number of functions for every level distinguished in the centralized KMS architecture. With roots in document management, Open Text Livelink's focus is on explicit knowledge, its publication and discovery across formats, platforms and the boundaries of a corporate LAN. Moreover, Livelink supports collaboration based

546. see http://www.opentext.com/, esp. http://www.opentext.com/2/sol-products.htm.

on co-authoring and sharing of documents. Livelink implementations can be found in many large organizations in Europe and the US. Although Livelink can be used (almost) out-of-the-box as a basic KM platform, most implementations adapt the user interface to corporate style guides and extend the integration and infrastructure capabilities of Livelink to cover organization-specific data and knowledge sources.

7.5 Distributed architecture

For quite some time, the only architecture that was discussed for KMS was a centralized one. This is due to the fact that a primary challenge for organizations has been to collect, organize and provide access to the pool of documented knowledge that is spread across a multitude of data and knowledge sources stored on a number of heterogeneous server systems and even on file systems of individual PCs. Centralized KMS provide a powerful instrument to consolidate the often fragmented organizational knowledge base. However, centralized KMS solutions require powerful machines, optimized software, i.e. a standard KM suite or an individual KMS software, and a lot of effort to tap into the multitude of existing data and knowledge sources and to semantically integrate them. Therefore, establishing a KMS with a centralized architecture is a costly approach.

Recently, the peer-to-peer metaphor has been discussed intensively as an alternative to server-based solutions that makes better use of the often abundant idle computing and storage resources that can be found in many organizations due to the fact that PCs have become powerful machines that provide abundant unused capacities.

In the following, section 7.5.1 reviews the peer-to-peer metaphor and section 7.5.2 discusses its application to KMS. Finally, section 7.5.3 presents Infotop, a peer-to-peer KMS that also targets another unresolved question in the design of KMS, namely the integration of KMS functions into the knowledge worker's personal workspace management.

7.5.1 Peer-to-peer metaphor

The term *peer-to-peer* denotes the idea of a network of equals (peers) that provide resources such as CPU time, storage area, bandwidth or information to each other so that collaborative processes are enabled avoiding a central coordinating instance (Schoder/Fischbach 2002, 587, Schoder et al. 2002). Ideally, peer-to-peer networks can be described by the following characteristics (Barkai 2001, 4ff, Schoder/Fischbach 2002, 587):

- *mutual client-server-functionality*: each peer can act as a client and as a server, thus rendering all nodes functionally equal,
- *direct exchange between peers*: there is no central node which coordinates the communication between the peers,
- *autonomy*: the peers are solely responsible for their activities, especially for determining what resources they share when and with whom.

In the terms of the client-server architecture, each peer, i.e., each computer participating in a peer-to-peer network, can act both as a client and as a server in the context of some application (Barkai 2001, 4). The peer-to-peer idea is not new, some argue that it is one of the oldest architectures in the ICT and telecommunication domain with the telephone system, the Usenet and the early Internet as major examples that employ this metaphor (Schoder/Fischbach 2002, 588). However, it is only recently that the peer-to-peer metaphor has received a lot of attention. The metaphor has been adopted in various application areas. Examples for application areas of existing peer-to-peer networks are[547]:

1. *instant messaging*, e.g., the well-known ICQ[548] network,
2. *file sharing*, with prominent examples, e.g., Gnutella, Kazaa, Napster or Overnet (Edonkey 2000)[549], i.e. peer-to-peer software that supports the sharing of files in networks of users, especially audio and video data as well as computer games,
3. *distributed and grid computing* which aims at a coordinated usage of distributed computing power, with the prominent example of the world-wide network that jointly processes data on the search for extraterrestrial life (SETI@HOME[550]),
4. *collaboration and Groupware*, with Groove[551] being the most cited distributed Groupware platform that employs the peer-to-peer-metaphor.

In the following, based on the ideas and developments in the fourth application area, collaboration and Groupware, the peer-to-peer-metaphor is applied to the complex area of knowledge management systems, called distributed or peer-to-peer KMS.

7.5.2 Peer-to-peer knowledge management systems

Recently, there are several attempts of KM researchers to profit from the promised benefits of a peer-to-peer metaphor in the design of an information sharing system and especially of a knowledge management system[552].

The following two figures, Figure B-61 and Figure B-62, together illustrate an ideal architecture of a peer-to-peer KMS or an extended peer-to-peer KMS respectively[553]. Figure B-61 shows a number of peers that together form a distributed knowledge management system. The peers are physically connected, e.g., via local area networks, telephone lines or the Internet. The connections are visualized by

547. Examples for existing application software realizing peer-to-peer networks more or less deviate from the ideal architecture. Most networks are supported by servers, or super peers, that aid e.g., awareness or localization of peers.
548. See URL: http://www.icq.com/
549. URLs: http://www.edonkey2000.com/, http://www.gnutella.com/, http://www.kazaa.com/, http://www.napster.com/
550. This project was initiated by the Space Sciences Laboratory of the University of California, Berkeley; URL: http://setiathome.ssl.berkeley.edu/
551. URL: http://www.groove.net/
552. Examples are Parameswaran et al. 2001, Benger 2003, Susarla et al. 2003, Maier/Sametinger 2004.
553. See also Maier/Sametinger 2004, Maier/Hädrich 2006.

solid gray lines. The dashed black lines show some examples of knowledge work processes that are supported by the peer-to-peer KMS. They include Nonaka's four processes of knowledge conversion, *externalization*, *internalization*, *combination* and *socialization*.

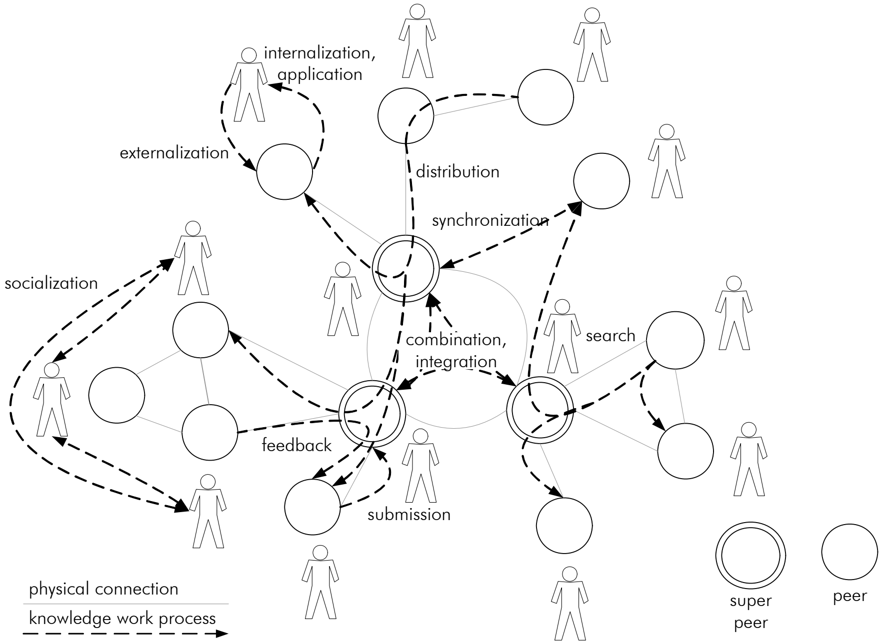

FIGURE B-61. Architecture of a peer-to-peer KMS[554]

In the following, the knowledge work processes shown in Figure B-61 are described shortly:

- *socialization*: as shown in the figure, socialization is only marginally supported by KMS, e.g., maintaining social relations over distances by instant messaging.
- *externalization*: knowledge is externalized, i.e. documented, contextualized and stored as explicit knowledge in one peer's individual knowledge base. This peer can now decide what other (groups of) peers should have access to this knowledge element.
- *internalization/application*: the reverse process also only involves the individual's personal knowledge base in its simplest form.
- *combination:* knowledge from several peers can be brought together semi-automatically or manually and stored as part of one, many or all the knowledge bases of the peers involved in the combination.

554. See also Maier/Sametinger 2004, Maier et al. 2005, 367.

- *distribution*: the distribution process means that knowledge is pushed from one peer to a certain group of other peers who can decide whether to accept the offered knowledge element(s) into their own knowledge bases.
- *search*: a search process can involve an individual's personal knowledge base as well as all the portions of other peers' knowledge bases (1) to which access has been granted and (2) which are accessible at the period of time when the search is performed.
- *feedback*: individuals can get feedback on their knowledge from any other peer who was granted access to that knowledge.

In many organizations, specific KM roles, such as a subject matter specialist or a knowledge (base) administrator, are established in order to e.g., collect, review, value, organize, store, refine or distribute knowledge that can then be reused by knowledge workers. In the ideal architecture of a peer-to-peer KMS shown in Figure B-61, these special roles are visualized by so-called "*super peers*".

Generally, super peers provide the same functionality as peers do. Every peer may act as a super peer and provide services of a subject matter specialist for a certain (set of) topic(s). The differences are that super peers also provide quality management to the distributed KMS architecture, improve performance of the network, increase accessibility of the workspaces and aid collaboration between the peers. Thus, super peers might provide a (large!) knowledge base that acts as a "knowledge cache" for a certain network segment. This reduces network traffic when peers from the same network segment repeatedly access certain knowledge elements from other peers in other segments. Specifically, super peers might provide the following services:

- *synchronization*: peers that sometimes work offline might subscribe to synchronization services offered by a super peer and thus improve their share in a peer-to-peer KMS and at the same time improve their network visibility even though they might be sometimes unavailable.
- *submission*: also, a submission process might be institutionalized by which every peer can push knowledge towards a subject matter specialist or knowledge base administrator respectively in order to get it reviewed, commented and, if accepted, get its quality certified. Possibly, meta-data on the knowledge element is also organized as part of the collection of (links to) knowledge elements that is administrated by the subject matter specialist.
- *integration*: super peers might also establish a joint effort to provide a standardized taxonomy or ontology of the knowledge domains that they are involved in and thus contribute to the integration of the diverse knowledge bases connected in the distributed KMS architecture.

Consequently, super peers ideally are powerful machines with abundant resources, a fast connection to the network and always online. Figure B-62 shows the architecture of a peer and a super peer in detail.

Both architectures basically consist of the same layers as the architecture of centralized knowledge management systems, but lack a centralized knowledge structure, taxonomy and repository. Thus, in the following only the differences to the centralized architecture are discussed[555].

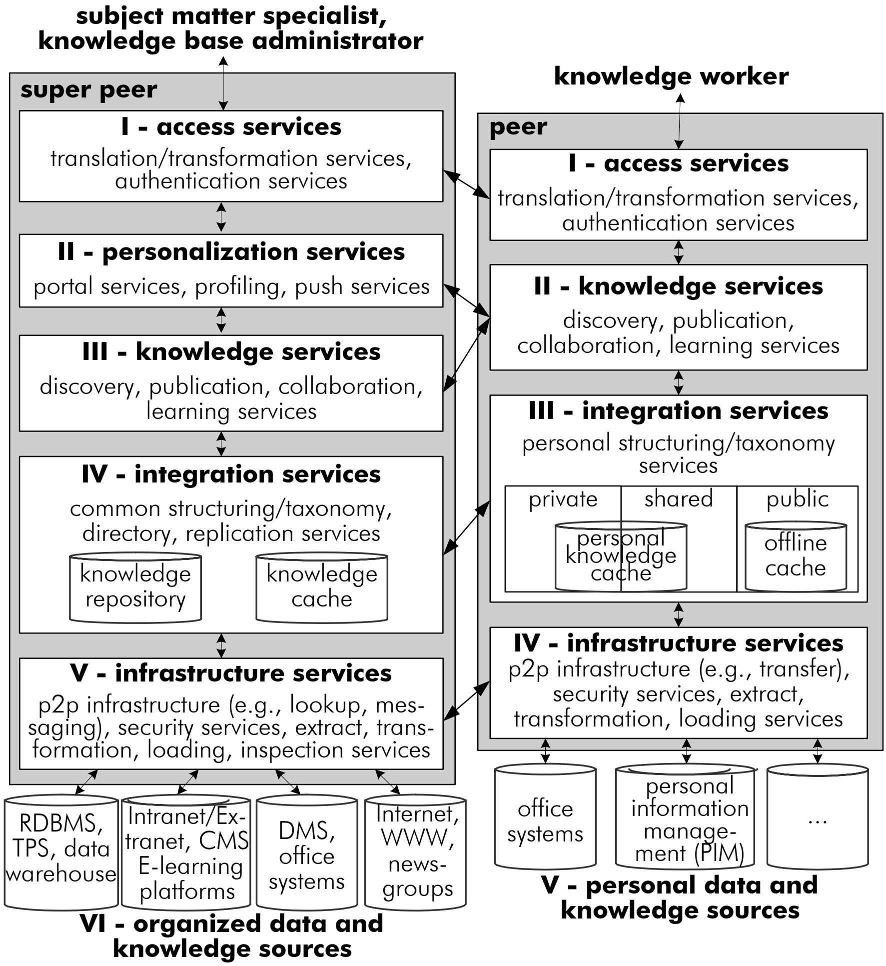

FIGURE B-62. Architecture of peer and super peer

Peer. The peer's architecture builds on infrastructure services that basically handle (1) extract, transformation and loading from personal data and knowledge sources and (2) provide the peer-to-peer infrastructure for locating peers, exchanging data with other peers and assuring security of the personal knowledge base. Integration services handle meta-data of the knowledge objects in the personal knowledge base

555. For the centralized architecture see section 7.3.3 - "Integrating architectures for KMS" on page 311.

and establish a personal knowledge structure or taxonomy. The knowledge base comprises private, protected and public areas. Private workspaces contain information that is only accessible for the owner of the private workspace. Public workspaces hold knowledge objects that are published via the Internet and accessible by an undefined group of users. Protected workspaces contain knowledge objects that are accessible to a single or a group of knowledge workers that the owner explicitly grants access.

The integration services also support caching of knowledge elements that are accessed repeatedly. A personal knowledge cache contains the knowledge elements of the user's own private knowledge base and of other peers' protected workspaces that the user has access to. The personal knowledge cache is used to optimize network traffic when shortly accessing the same knowledge elements multiple times. The offline cache holds those knowledge elements on the local storage medium that are often accessed by the user while being without a permanent connection to the Internet.

Just as in the centralized case, knowledge and access services build upon the knowledge base. The main difference is that the knowledge repository now is spread across a number of collaborating peers that have granted access to parts of their knowledge repositories. There is no central authority that takes care for the integration of the repositories that participate in a peer-to-peer KMS network. Access and knowledge services are similar to the centralized KMS architecture. However, the peer lacks personalization services as there are no "impersonalized" services in a peer's KMS.

Super peer. In addition to the services offered by a peer, a super peer might access a number of additional, shared data and knowledge sources, e.g., document management systems, content management systems, data warehouses, e-learning platforms, experience data bases or the organization's transaction processing systems. Every super peer consequently extracts, transforms and loads those parts of the data and knowledge sources that fall into the domain handled by a subject matter specialist. Inspection services support the access of documents without the applications that were used to create the documents. The peer-to-peer infrastructure might also provide services for lookup and message handling that improve the efficiency of the distributed KMS.

The integration services offer a shared taxonomy or ontology for the domain handled by the subject matter specialist. This addresses the challenge in a totally distributed KMS that the various knowledge bases cannot be integrated and thus pose a problem for e.g., the interpretation of search results by the knowledge worker. As laid out in Figure B-62, all or a number of subject matter specialists might standardize the terms and meta-data in use and thus provide a common scheme for meta-data, a common taxonomy or ontology for an even larger domain. Super peers might offer replication services to peers that sometimes work offline. Personalization services include portals, profiles and push services that ease the access to the organized collection of (quality approved or even improved) knowledge that a subject matter specialist administers. Access services and knowledge services are the same as the corresponding services of each individual peer.

Peer-to-peer KMS supposedly have the following advantages (Benger 2003, 167f):

- *autonomy*: semi-autonomous organizational units can easily create and share knowledge with the help of those tools and those ontologies that fit their domain,
- *direct communication*: knowledge is exchanged directly without central units that often act as an unwanted filter to knowledge,
- *flexibility*: peer-to-peer KMS allow for the configuration of temporary, dynamic networks of knowledge workers,
- *acceptance*: local storage together with an efficient management of access privileges reduces the barriers to provide knowledge that some central KMS solutions experience.

The peer-to-peer metaphor promises to resolve some of the shortcomings of centralized KMS. Examples are:

- to reduce the substantial costs of the design, implementation and maintenance of centralized KM suites, in terms of hardware, standard software as well as the often underestimated costs of designing, structuring and organizing a centralized knowledge server and the management of users and privileges. This is due to the fact that simple local KMS are often already in place. Compared to a central KMS, additional investments are minimal,
- to reduce the barriers that prevent individual knowledge workers from actively participating and sharing in the benefits of a KMS, e.g., by reducing the psychological barrier to publish knowledge elements to an unknown target group by giving the user full control over the access privileges to her knowledge elements,
- to overcome the limitations of a KMS that (almost) exclusively focuses on organization-internal knowledge whereas many knowledge processes cross organizational boundaries, because workspaces can easily and flexibly be extended to knowledge workers from partner organizations,
- to include individual messaging objects, e.g., emails, instant messaging objects, into the knowledge workspace that are rarely supported by centralized KMS and, moreover,
- to seamlessly integrate the shared knowledge workspace with an individual knowledge worker's personal knowledge workspace.

However, on the other hand, there are still serious technical challenges that have to be overcome in peer-to-peer computing in general. These challenges concern (Barkai 2001, 264ff):

- *connectivity*, e.g., locating peers that do not have public IP addresses and mechanisms for communicating through firewalls,

- *security and privacy*, especially the risk of spreading viruses, unauthorized access to confidential and private information and the installation of unwanted applications,
- *fault-tolerance and availability*, e.g., finding the required resources available when they are needed,
- *scalability*, especially concerning the naming scheme and searches in the flat structure of the distributed search domain,
- *self-managed systems* that are administered by individual users with limited experience and tools who provide services to others and
- *interoperability*, i.e., current peer-to-peer installations cannot connect to each other due to e.g., a variety of computing models, a variety of network settings and a wide range of application types.

There are also a number of organizational issues that still have to be resolved before a peer-to-peer KM infrastructure can be fully deployed in an organization. Examples are (Susarla et al. 2003, 133ff):

- *participation issue*: there have to be incentives to actively participate in the peer-to-peer network in order to foster information sharing and avoid the free rider issue,
- *trust issue*: security and reliability of the peer-to-peer infrastructure have to be believable for the participants of the peer-to-peer network if the system should be used as the sole, personal knowledge workspace of knowledge workers,
- *coordination issue*: structuring and quality management of the knowledge contained in a peer-to-peer network have to be supported in order to avoid information overload.

Working with a peer-to-peer KMS might quickly be less effective and especially less efficient than working with a centralized KMS if the coordinating mechanisms established in a central KMS are missing. Whether actual peer-to-peer solutions will soon overcome the major challenges of a (sufficient!) semantic integration of a variety of heterogeneous knowledge bases, still remains to be seen. Thus, the hybrid architecture proposed here that includes super peers that coordinate parts of the contents and handling of accesses in the KMS might work best for many organizations.

If peer-to-peer KMS are to be successful, they have to address not only the technical and organizational issues, but also have to show how they could resolve the shortcomings of centralized KMS, particularly how a peer-to-peer KMS application system can be seamlessly integrated with the knowledge worker's personal knowledge workspace, what these workspaces should look like, what mechanisms can support the semantic integration of the distributed knowledge workspaces, e.g., a predefined set of dimensions for meta-data, and how working with the peer-to-peer KMS can be made easy enough so that the barriers to participate are not too high. In the following section, Infotop is discussed in detail as an example for a peer-to-peer KMS that also provides ideas on how to address these questions.

7.5.3 Example: Infotop

Infotop[556] is a personal workspace designed to help knowledge workers (1) to organize their personal information and knowledge resources and (2) to share context and collaborate on the basis of peer-to-peer information workspaces. Infotop primarily addresses the challenge of an integrated knowledge workspace for networked knowledge workers. As centralized KMS often only marginally fulfill the requirement of their seamless integration into personal knowledge workspaces, a distributed knowledge environment is found suitable for Infotop. Infotop primarily targets the challenges of accessing, integrating and sharing of knowledge workspaces and proposes to replace the desktop as the primary metaphor for the interaction with personal computers.

Knowledge workers are the primary user group of personal computers. From an ICT infrastructure perspective, the desktop metaphor has been used for decades to administer small amounts of documents. This metaphor has been sufficient as long as the types, formats and amounts of contents to be administered were limited. Today, the desktop provides only a restricted view to the organizational knowledge base. Due to the increase in size and complexity of contents, much of the original desktop's functionality has moved into complex applications, e.g., Web browser, messaging system, document management system, KMS. Thus, the desktop has been replaced in many situations as the central view to collections of contents. This has resulted in today's scenario where there are many applications with many isolated and incompatible views on parts of the data and with many categorizations of these data.

Infotop proposes to replace the desktop with a new metaphor to interact with personal knowledge environments, what formerly was a personal computer. The term Infotop covers the dynamic aspect of knowledge, the flow of knowledge, which is best described by the term information. Infotop thus means to be "on top of the information" that flows in and out of the personal knowledge environment.

Desktop metaphor. A metaphor is one thing conceived as representing another. Using metaphors takes advantage of peoples' knowledge about them. For example, people in offices have been used to store paper documents in file folders. It makes sense to these people to store computer documents in folders on the computer, i.e., in containers that look and behave like folders. The desktop is the primary metaphor being used as interface on personal computers. It was introduced when computers were quite different to today's machines, see (Genter/Nielson 1996). While computers, users and the environment have changed, interfaces and the basic handling of data have stayed the same[557]. The desktop has become an unmanageable mess (Tristram 2001). Countless files are stored on increasingly more capacious

556. This section summarizes joint work done by the author and Sametinger which has been presented e.g., in Maier/Sametinger 2002, 2003, 2004.
557. See also section 4.1.3 - "From traditional work to knowledge work" on page 46.

storage drives. This has resulted in big hierarchies of folders that make it difficult to retrieve information. The problems can be summarized as follows:

- storing contents on traditional desktop and folder systems is limited to one single hierarchical folder structure rather than a flexible means of categorization,
- there are trivial and multiple categorization mechanisms in various applications, e.g., folder structure, personal information management, email system, Web browser,
- meta-data and versioning data are only available with specific applications,
- multiple documents are different representations of the same contents, e.g., a text document in the format of the text processing system, postscript and the portable document format, and
- there is insufficient meta-data about local and remote documents.

Infotop. Rather than having a desktop with a hierarchic folder view, Infotop supports multiple views on documents and a much more powerful way of accessing information. Two perspectives have to be considered.

- *island approach*: can be applied to a single computer and a single knowledge worker (a single peer). This computer may be connected to other machines, but there is no extra communication in support of the island approach.
- *peer-to-peer approach*: comprises many knowledge workers who use Infotop and, thus, can benefit from advanced features and shared context when communicating and working together.

Downward compatibility is a necessity in order to consider a shift to the proposed approach. Therefore, today's desktop metaphor with files and folders should be a special case or view of Infotop. Subsequently, the island approach is described with Infotop’s six *dimensions* for the categorization and visualization of knowledge. Due to its importance, the dimension *time* requires extra consideration. Also, *multi-dimensional views* and the handling of *meta-data* are described. Then, the peer-to-peer approach is shown, especially the *shared context* of collaborating users, the support of *knowledge work processes*, the proposed *peer-to-peer architecture*, and some thoughts about Infotop’s *implementation*.

Dimensions. Business intelligence software allows users to quickly analyze data that has been transformed into a subject-oriented, multidimensional data warehouse (Inmon 1992). Online analytical processing (OLAP) tools are used to perform trend analysis and statistics on e.g., sales and financial information in an interactive question-answer way. Infotop uses the six dimensions time, topic, location, person, process and type for effective categorization, visualization and navigation of collections of contents. In analogy to OLAP techniques, these dimensions are used for slicing, dicing, drilling down, rolling up, and ranging operations on contents of a personal knowledge environment:

- *time*: any representations with a timed order,
- *topic*: any topics a user is interested in,

- *location*: any geographic location like a city or country; local vs. LAN vs. Web,
- *person*: any person, physical or not, e.g., a company, an organizational unit,
- *process*: any project or process, e.g., a conference, a paper writing process, an administrative task with many steps,
- *type*: any type of document, e.g., text document, MS Word document audio or video file.

Figure B-63 shows a simple one-dimensional view where documents are shown that belong to various topics. On the right-hand side, there are six buttons that can be used to switch to different dimensions and to select sets of documents that are displayed in these dimensions. The pile metaphor (Mander et al. 1992) can be used to display information about sets of documents. Additionally, the numbers of documents are indicated for each displayed topic.

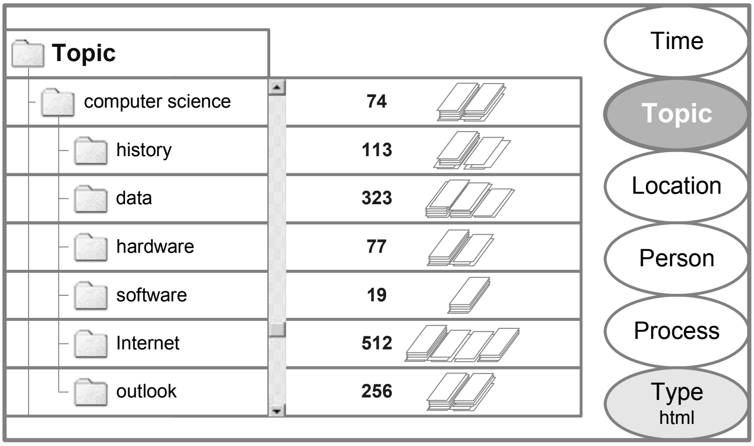

FIGURE B-63. Infotop - one-dimensional view

Visualization techniques like the well-known icons, thumbnails or lists are useful when displaying sets of documents. The knowledge worker can arbitrarily define several hierarchies of any of these dimensions and use them for display, e.g., in case of the dimension person the three hierarchies author, sender, receiver. One simple hierarchy for topics can be seen in Figure B-63. Views may be restricted to documents with specific attributes, e.g., documents of a specific process or documents of a specific range of dates. In Figure B-63, only documents of type html are displayed.

In addition to the dimensions, OLAP tools present facts in selected cells of a resulting spreadsheet, e.g., the amount of products ordered according to the dimensions *customer* and *region*. In this case, facts represent information on sets of contents represented in each cell, could be for example:

- the number of elements as represented in Figure B-63,
- the amount of data, e.g., the number of pages or MBytes used,

- the number of contributions or of questions answered of knowledge providers,
- an aggregate valuation of elements, e.g., the number of accesses to elements,
- a measure of the skill levels of knowledge providers in a domain, or, in finer granularity,
- any other meta-information that is stored along with elements, e.g., the titles of documents, or
- a comparative measure, e.g., the proximity of competencies between a number of potential knowledge providers in a certain domain.

Time. Time is one of the most crucial attributes of documents, e.g., time of creation, time of last modification, time of last read only access. Usage statistics may also be useful, such that frequently used documents can stand out. Figure B-64 shows documents assigned to the topic knowledge management that have a relation with the ECKM 2002[558] conference in a calendar view. The time of last modification is considered for display. Clicking one of the days will bring up information about all documents, i.e., icons or a list with detailed information.

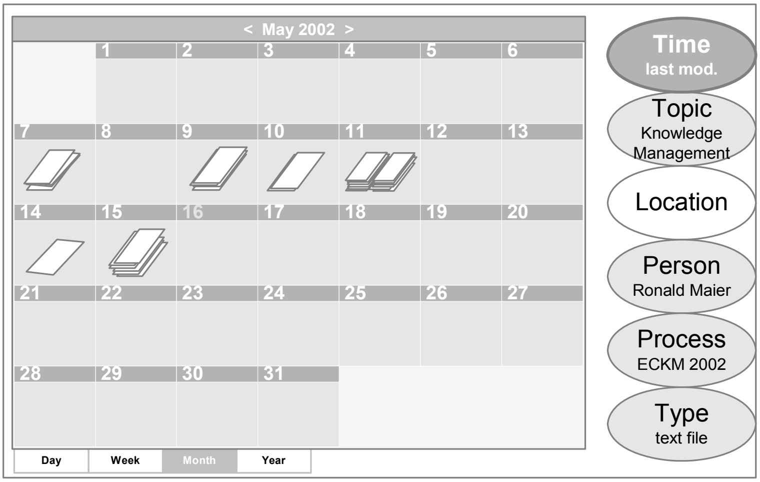

FIGURE B-64. Infotop - time-oriented view

Apart from usual appointments it is useful to have email messages, text documents and other forms of documents, e.g., comments, yellow stickers, displayed in calendars. It is also useful to display a selection of documents, e.g., all documents related to a project displayed in the calendar, or all documents of a person, i.e., all email messages from and to that person, all files exchanged with that person, all Web documents about that person that the knowledge worker has visited, etc.

558. European Conference on Knowledge Management 2002.

Multi-dimensional views. OLAP tools help users to interact with multitudes of statistics in order to isolate specific items. Infotop supports similar mechanisms to browse, navigate and filter information. The hierarchies can be used for this purpose. For example, the knowledge worker can select the two dimensions *process* and *person* for viewing, see Figure B-65.

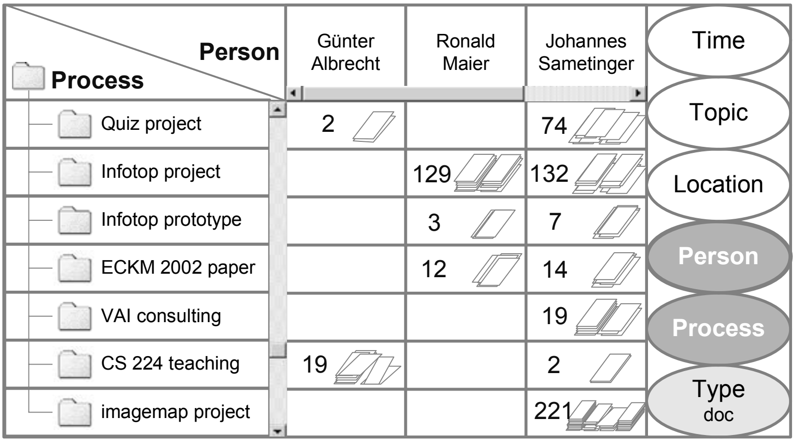

FIGURE B-65. Infotop - two-dimensional view

Six dimensions enable to select documents in one hierarchy and display this selection in another hierarchy. For example, select all Austrian documents, i.e., documents with location= Vienna, location= Linz, or location= any other Austrian location, and then display the documents according to a hierarchy based on persons.

Meta-Data. For efficient document retrieval and for grouping of documents, categories have to be associated with documents. Attributes have to be assigned with documents. This can become a nuisance to the knowledge workers, because they may not want to manually categorize each incoming and outgoing email message, or each Web page that they have visited. Therefore, an automated, or at least a semi-automated approach is needed for this task. A couple of attributes should be defined for each document, e.g., title, author, date, event, location, person, process. Each attribute of a document has an undefined or a defined value, e.g., location= Dublin, date= 9/25/2002. The meta-data can easily be extracted from context that comes with a document or the activities that are performed on a document, e.g., in the case of an email message Infotop can derive sender, receiver (person, location), date (time), subject (topic, process) and type of attached file (type).

Shared context. Users have information on their private computers and can also access public resources, typically on the Internet. Additionally, servers on local area networks provide extra information that is not accessible to the public, but only to a restricted number of users. Infotop separates a private, a protected and a public workspace. Private workspaces contain information that is stored locally on each knowledge worker's computer and accessible only for the owner of the private workspace. Public workspaces include information that is published via the Internet and accessible by an undefined group of users. Protected workspaces lie somewhere in between. They contain information that is not accessible for everyone, but for whoever the owner grants explicit access, e.g., digital libraries.

Private, protected and public workspaces of an individual knowledge worker can be placed on that worker's personal computer, see user 3 in Figure B-66. Additionally, user 3 shares in parts of other users' workspaces. The dashed line and the gray boxes indicate the shared-context information workspace of user 3, i.e., a virtual workspace that includes user 3's private, protected and public workspace as well as all public and parts of protected workspaces of other users. It is important to note that a user's protected workspace is not open to the public, but rather allows restricted access only to those individuals that the user wishes. Thus, access privileges of the protected workspace have to be configurable in a flexible manner. Typically, public workspaces grant permission to read only, whereas protected workspaces may be open to write.

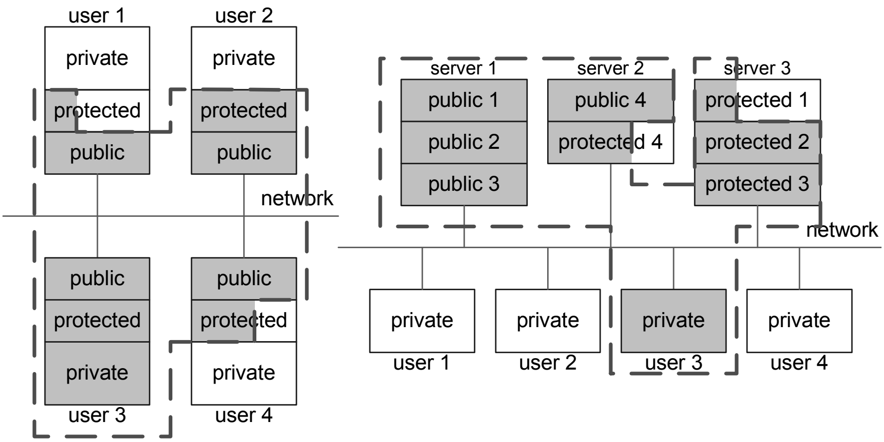

FIGURE B-66. Infotop - alternative architectures

The peer-to-peer approach on the left-hand side of Figure B-66 is contrasted with a client-/server-approach on the right-hand side. Infotop's concepts work in both worlds. In the server architecture, only private workspaces reside on the individual users' personal computers whereas the public and protected workspaces are submitted to dedicated servers. This architecture resembles most to the centralized KMS architecture as described in section 7.3.3, p. 311ff. In order to achieve the benefits promised by the peer-to-peer metaphor, the Infotop approach institutionalizes private, protected and public workspaces on all workplaces (Figure B-66, left-hand side). Additionally, any information in these workspaces has to have meta-information attached, according to the six dimensions mentioned above, such that powerful query mechanisms can be supported. Assignment to e.g., topics is crucial for workspaces. This supports several virtual workspaces for different topics of interest, i.e., several dashed lines in Figure B-66. Virtual workspaces can overlap, because workspaces and sets of documents can be assigned to more than one topic.

Organizing and visualizing this shared-context information workspace for each individual remains a challenging task. In the following, the multi-dimensional workspace as described above can be used with minor modifications in a shared context (see Figure B-67).

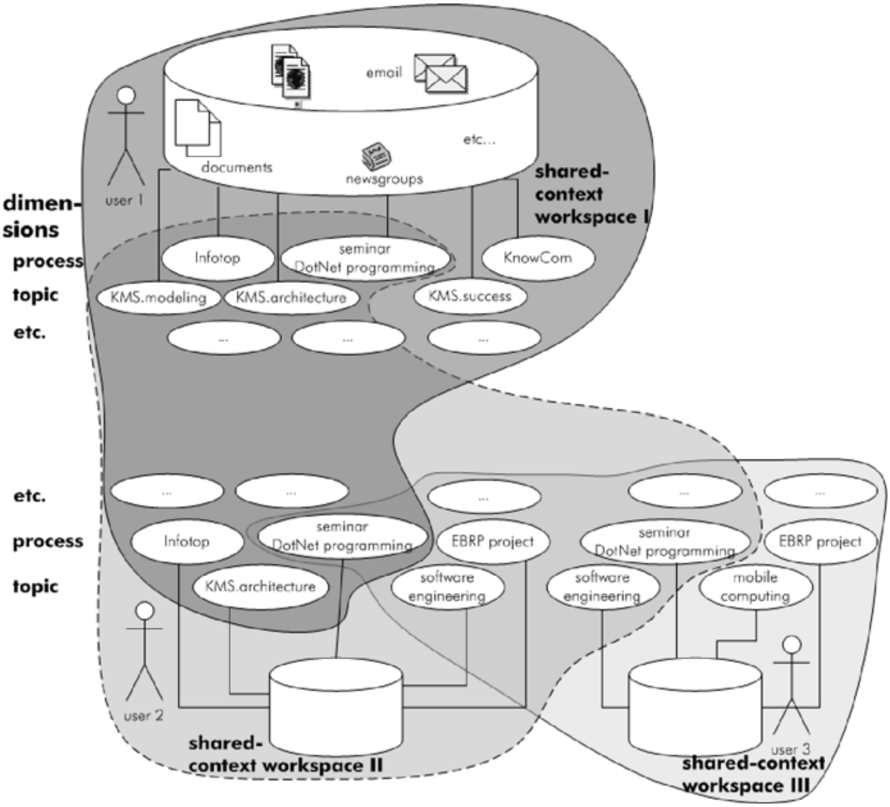

FIGURE B-67. Example for shared-context workspaces in Infotop

Figure B-67 shows how the dimensions of Infotop can be used to define shared-context workspaces and, thus, to distinguish private from protected information. Users 1, 2 and 3 all have access to their personal data store that is visualized by the data base symbol. The data store can contain text documents, personal information management documents, e.g., addresses, bookmarks, calendar with appointments, to-do-lists, hypertext documents, messaging objects, such as emails, contributions to newsgroups, multimedia elements, etc. Infotop provides access to the entire personal data store using its six dimensions. In Figure B-67, the two dimensions process and topic are used to define shared-context knowledge workspaces. User 2 grants user 1 access to all data in her data store that are assigned to "Infotop" and "Seminar DotNet Programming" in the process dimension and all data assigned to "KMS architecture" in the topic dimension whereas the "EBRP project" and the topic "software engineering" are not accessible to user 1. User 1 grants user 2 access to all data in his data store that are assigned to "Infotop" and "Seminar DotNet Programming" in the process dimension and all data assigned to "KMS modeling" and "KMS architecture" in the topic dimension whereas the "KnowCom" process and the topic "KMS success" are not accessible for user 2. Consequently, workspace management is easily accomplished in a flexible manner by assigning instances of each of the six dimensions to (groups of) users.

The six dimensions are helpful, no matter whether the information is private or shared. They have been introduced to get rid of the rigid file hierarchy. The shared context should conceal network structures and stress the logical boundaries among knowledge elements. However, explicit consideration of workspaces and thus a seventh dimension may be necessary to visualize social networks and promote the sharing of context.

Knowledge work processes. Figure B-68 outlines how Infotop supports important knowledge work processes. A user externalizes, distributes, submits, acquires, searches, applies information in her shared-context information workspace. The solid ellipse in Figure B-68 depicts the user's individual workspace, while the dotted ellipse depicts the user's shared-context information workspace.

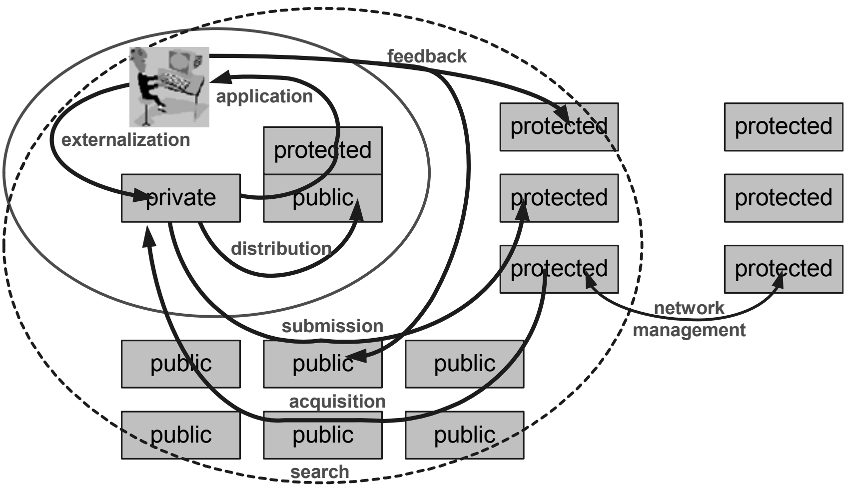

FIGURE B-68. Infotop - knowledge work processes

- *Externalization process*. Externalization of information is done with regular applications, e.g., a word-processor, or (co-)authoring tools. This process results in documents that typically are at first stored in the private workspace. It is important to have meta-information attached to these documents. This is not sufficiently supported by today's applications. Infotop provides rich contextualization of documents using the six dimensions.

- *Submission process*. In the simplest case, submission means publication of a new knowledge element and its distribution towards a topic-oriented network, i.e., in a protected or public workspace. Versioning of information and the support of workflows is required for the submission process.
- *Distribution process*. The distribution process involves moving or copying information from one's private to one's protected or public workspace. It is useful to have this process combined with some sort of notification, especially in the protected workspace.
- *Search process*. Searching is done primarily based on meta-information in one's workspace consisting of one's private, accessible protected and public workspaces. Protected and public workspaces have to be prioritized according to topics, e.g., workspaces of research groups have to be considered only when the search process is aimed towards the research topics of these groups. Findings in protected workspaces are typically more relevant than findings in public workspaces.
- *Application process*. The application process involves any usage of information that has been retrieved from an arbitrary source, i.e., from protected and/or public workspaces.
- *Feedback and improvement process*. Responses or reflections to information in an arbitrary workspace can improve the quality of information. Feedback includes communication to information holders, i.e., workspace owners, citations, etc.
- *Acquisition process*. The acquisition of information includes the extension of the search domain to include new workspaces, the location of information in any of the accessible workspaces and copying this information or a link to it into one's individual workspace.
- *Community or network management process*. Communities[559] share their interest in certain topics. It is necessary to have topic directories in public work spaces, where users can register and obtain permission to participate in protected workspaces that are assigned to these topics. The consideration of new topics results in new dashed lines, see Figure B-66. The acquisition of information is supported by the extension of one's workspace by including additional protected workspaces.

Figure B-69 shows how the knowledge work processes discussed above can be supported in a setting with a number of knowledge workers using Infotop and collaborating in overlapping knowledge communities (see also Maier/Hädrich 2006). In Figure B-69, three communities are visualized. Communities correspond to

559. See section 6.1.3 - "Groups, teams and communities" on page 177.

shared-context workspaces in which a number of knowledge workers participate. In the terms of Figure B-67, externalization of knowledge requires documentation of a knowledge element, organization according to the six dimensions and moving it into Infotop's knowledge base. Submission simply means that access privileges are granted to members of a community for instances of one or more Infotop dimensions. The search domain used in a search process consists of all locatable peers that have granted access to their knowledge base. Priority is given to those peers that participate in the same community the topic of which most closely matches the search term.

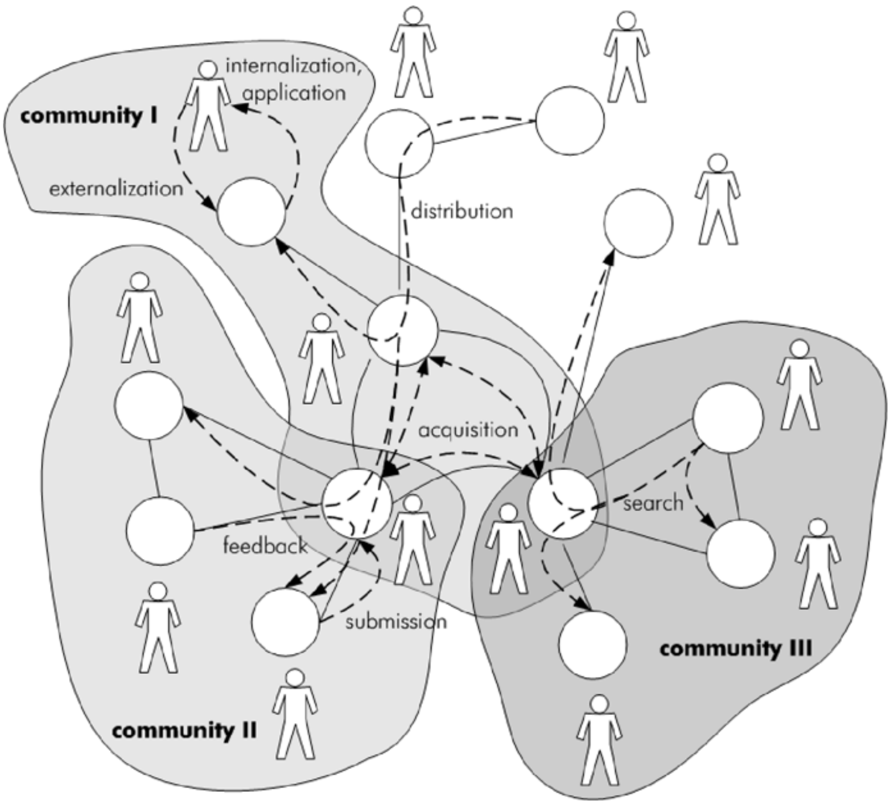

FIGURE B-69. Knowledge work processes supported by Infotop[560]

Peer-to-peer architecture. Infotop addresses all three main issues, (1) participation, (2) coordination and (3) trust, that challenge peer-to-peer KMS as identified above[561]. Participation should be no more of a problem than in centralized KMS

560. See also Maier/Sametinger 2004 for a preliminary version of this figure.
561. See section 7.5.2 - "Peer-to-peer knowledge management systems" on page 342.

within organizational boundaries. Moreover, if Infotop can provide a useful solution to personal knowledge management that does not require any additional effort to establish shared workspaces in a peer-to-peer network, a large number of users might be convinced to participate. In peer-to-peer knowledge networks that cross organizational boundaries, (professional) communities along with personal contacts, contracts, shared goals and interests might act as a kind of social infrastructure that induces social regulations and also trust into the peer-to-peer network.

Figure B-70 shows the architecture of one Infotop peer that consists of the four layers infrastructure, integration, knowledge and access services.

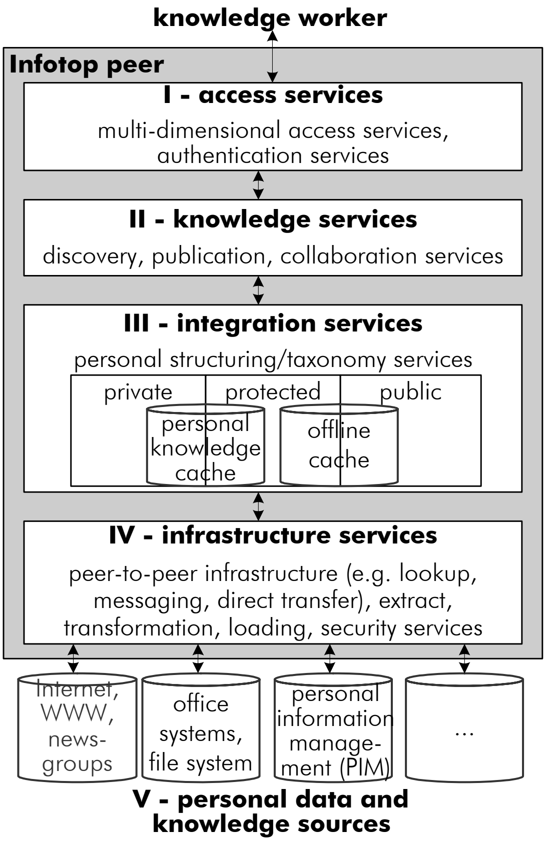

FIGURE B-70. Architecture of one Infotop peer

The architecture is closely tied to the ideal peer-to-peer KMS architecture and therefore includes the same layers as the centralized architecture[562], but lacks a

562. See section 7.3.3 - "Integrating architectures for KMS" on page 311 and section 7.5.2 - "Peer-to-peer knowledge management systems" on page 342.

centralized knowledge structure, taxonomy and repository. Personal data and knowledge sources are extracted, transformed and loaded into an integrated Infotop knowledge base. The integrated knowledge base comprises a private, protected and public area. A personal knowledge cache is used to optimize network traffic when shortly accessing the same knowledge elements multiple times. Due to the fact that knowledge workers might still at some time prefer to work offline, this knowledge base has an offline cache keeping those knowledge elements that are often needed on the local storage medium preferred by the knowledge worker. Just as in the centralized case, knowledge and access services build upon this integrated knowledge repository. The main difference is that the knowledge repository now is spread across a number of collaborating peers that have granted access to parts of their knowledge repositories. As Infotop itself realizes an integrated knowledge workspace, there are no translation and transformation services in the access layer. Instead, the access layer provides Infotop's visualization concept with the six dimensions time, topic, location, process, person and type as well as the OLAP-type functions as the main interface to collections of contents, both personal and shared across multiple workspaces of networked knowledge workers.

Implementation. Currently, Infotop's concepts are improved and implemented as a joint effort by two work groups headed by Sametinger at the Johannes-Kepler-University Linz[563] and by the author at the Universiy of Innsbruck. The implementation is based on a combination of Web services, data base, peer-to-peer and configuration management technology. Web services and peer-to-peer-technology can be used to seamlessly integrate other users' shared workspaces into one's own workspace in a platform-independent way. A data base is required in order to manage the meta-data created by Infotop. Configuration management and version control is needed to avoid versioning conflicts and to allow coordinated and cooperative work in the shared context. Also, Infotop has to exchange meta-data with other applications, e.g., messaging, office management and a search engine. The presentation of the workspace has to be modeled according to Infotop's six dimensions.

To sum up, KMS are typically restricted to one organization's boundaries. A significant portion of knowledge work processes crosses these boundaries and thus can only be supported on the level of a personal knowledge workspace. Infotop should act as the main access point both for personal knowledge management and for ad-hoc collaboration in a shared context. It is important to include multiple ways to visualize the structure of elements in the dimensions, such as hierarchies, networks (knowledge maps) and geographical information systems in order to meet individual visualization needs. Another promising direction for Infotop is to integrate personal KM techniques, e.g., portfolios, visualization of individual knowledge workers' knowledge status, learning and networking needs, with corporate KM instruments, e.g., content management, yellow pages, communities,

563. URL: http://www.se.jku.at/sametinger/.

project staffing or competence development programs. Infotop plays the role of an enabler and catalyst to spark usage of corporate KMS solutions and start a positive, reinforcing cycle of more and more active, motivated participants handling knowledge in organizations.

7.6 Classification

There are a great number of information and communication technologies that are discussed as supporting knowledge management. Apart from more traditional tools and systems as discussed in this book as the technological roots of KMS (section 7.1) there are a great number of functions providing knowledge-related services. These services have been combined into a centralized KMS architecture (sections 7.3.3, 7.4). As a contrast, section 7.5 has shown an alternative way of organizing KMS, a decentralized, peer-to-peer architecture.

However, both architectures can be seen as ideal in the sense that almost all actual tools and systems offered on the market or implemented in organizations only offer a certain portion of these services. The following section aims at organizing the abundant number of tools and systems that are discussed as being helpful for KM. Firstly, a number of classifications of tools and systems in support of KM as found in the literature are presented (section 7.6.1). The tools are then ordered into a classification scheme (section 7.6.2).

7.6.1 Knowledge Tools

There are a great number of tools, platforms and application systems on the market which claim support for organizational memory or knowledge management respectively[564]. The field is still immature, though, in the sense that there are no classes of systems that the literature has agreed on. So far, there are several proposals for classifications of systems which mostly lack completeness and also exclusiveness in the sense that one system fits into one and only one category. Table B-19 shows a comprehensive overview of classifications of technologies, tools and systems supporting KM[565]. Classifications in the literature fall into two categories:

Market view. These classifications try to cover either *technologies, tools and systems that potentially support KM* (wide view) or they cover the *functionality of KMS* (narrow view).

Theoretical view. These classifications are based on existing models describing *types of knowledge* (abstract view) or *KM, OL or OM processes or tasks* respectively (concrete view) that could potentially be supported by ICT in general or KMS in particular.

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564. For a list of KMS see the support Web site for this book http://iwi.uibk.ac.at/maier/kms/.

565. See also Maier/Klosa 1999c, 8ff, Klosa 2001, 63ff for a detailed discussion of some of the classifications listed here.

TABLE B-19. Classifications of technologies, tools and systems supporting knowledge management

author(s)	**categories**
classifications on the basis of types of knowledge	
Schüppel 1996, ILOI 1997 propose a classification according to the knowledge supported by KMS	• explicit—implicit knowledge • current—future knowledge • internal—external knowledge • experience-based—rationality knowledge
Warschat et al. 1999, 55ff classify ICT to support KM using the hierarchy symbol, data, information, knowledge	• data warehouse systems • document management systems • Web publishing systems • content management systems • knowledge-based information systems
classifications on the basis of knowledge management tasks, life cycle or strategies	
Apostolou/Mentzas (1998, 3.3) use Nonaka's (1991, 98f, 1994, 18f) knowledge transfer processes	• socialization (e.g., email, discussion lists, bulletin board, multimedia conferencing) • internalization (e.g., lessons learned DB, hypermedia CBT, process-history tracking, data warehouses, data mining) • externalization (e.g., semantic networks, ontologies, push technologies, agent technologies, issue-based argumentation, data warehousing) • combination (e.g., document management systems, workflow management systems, group decision support systems, search and filtering systems, computer-mediated communication)
Dieng et al. (1998, 3ff) classify methods and tools according to their support for phases of corporate memory management	• detection of needs • construction of the corporate memory • diffusion of adequate elements of the corporate memory • use of the corporate memory • evaluation of the corporate memory • maintenance and evolution of the corporate memory
Mentzas et al. (2001, 95f) classify KM software using two dimensions reflecting Hansen et al.'s (1999) two KM strategies: process-centered versus product centred.	• primarily process-centered (knowledge transfer, personalization): shared files, email, real-time messaging, net conferencing, discussion groups, white-boarding • primarily product-centered (knowledge content, codification): file management systems, full text retrieval, structured document repositories, semantic analysis, knowledge maps, Intranet • about equally high on both dimensions: push technology, automatic profiling

TABLE B-19. Classifications of technologies, tools and systems supporting knowledge management

author(s)	categories
classifications on the basis of definitions and models of OL and OM	
Ackerman 1994 classifies ICT to support the organizational memory	• store and retrieve data (e.g., data base systems) • share and publish information • OM and group memory components (new forms of systems, e.g., Answer garden, group meeting systems) • capture design processes and informal communication • access members of the organization • develop knowledge structures • document management systems • platforms (e.g., Lotus Notes)
Jacobsen 1996, 169 classifies ICT according to the two dimensions acquisition and deployment of competence	• acquisition of competence: perception, learning, application • deployment of competence: transfer, storing
Stein/Zwass (1995, 97ff) propose a framework for organizational memory information systems which consists of two layers (see also section 4.3 - "Knowledge management systems" on page 82)	layer 1: competing values model of effectiveness: functions of organizational effectiveness • integrative subsystem • adaptive subsystem • goal attainment subsystem • pattern maintenance subsystem layer 2: information processing model of memory: mnemonic functions • knowledge acquisition • knowledge retention • knowledge maintenance • knowledge search and retrieval
classifications on the basis of the functionality of KMS	
The **Delphi Group** (1997, 14) suggests five groups of KMS functions reflecting a narrow focus on explicit, documented knowledge: a knowledge repository, and a set of tools to filter, organize and present this knowledge (Delphi 1997, 15).	• intermediation: brokering information or knowledge seekers and knowledge providers • externalization: capturing knowledge, structuring and organizing it in a repository according to a framework or ontology • internalization: extraction and filtering of knowledge from a repository • cognition: system functions to make decisions based on available knowledge • measurement: measure, map and quantify corporate knowledge and the performance of KM solutions

TABLE B-19. Classifications of technologies, tools and systems supporting knowledge management

author(s)	categories
Apostolou/Mentzas (1998, 3.4) define ICT services which are part of a knowledge leveraging infrastructure	• knowledge search, retrieval and navigation • knowledge indexing, mapping and classification • knowledge storage, analysis and meta-data processing • knowledge distribution and publication • collaboration
Borghoff/Pareschi 1998a, 5f classify ICT specifically supporting KM. The classification is rooted in an empirical study of IT requirements for KM done by **Xerox** which in turn is based on Nonaka's (1991, 98f, 1994, 18f) knowledge transfer processes[a].	• knowledge repositories and libraries (documents): search, heterogeneous document repository, access, integration and management, directory and links, publishing and documentation support • communities of knowledge workers (people): awareness services, context capture and access, shared workspace, knowledge work process support, experience capture • flow of knowledge: using knowledge, competencies and interest maps to distribute documents to people • knowledge cartography (navigation, mapping and simulation): tools to map communities of practice, work process simulation, domain-specific concept maps, maps of people's competencies and interests (yellow pages), design and decision rationale
Bair (1998, 2) identifies four dimensions of functionality that differentiate KM technology from other (software) products	• semantic functionality: extends document and content management to increase the relevance of retrieved/pushed information and handle dynamic semantic relationships: categorization of documents, semantic networks, natural language processing • collaborative functionality: builds on Groupware, email and workflow technology to support the capturing of (tacit) knowledge: identification of experts based on skills, recognition, publications; collaborative filtering (e.g., evaluation of documents) • visualization functionality: use advanced graphical techniques to display relationships between knowledge elements • scale/integration: the ideal system provides access to all information resources in the organization as well as external resources, to any data type and to any application, including data warehouses
Wiemann (1998, 7ff) classifies systems for KM according to their impact on the knowledge	• divergent systems: support knowledge exchange between employees with no attention to quality assurance or synthesis of knowledge elements/contributions, e.g., communication systems, platforms for document exchange, skills data bases • convergent systems: systematically identify, evaluate, document, refine, categorize and provide access to knowledge elements, e.g., in the form of a data base of best practices

TABLE B-19. Classifications of technologies, tools and systems supporting knowledge management

author(s)	categories
Zack (1999a, 50), distinguishes systems supporting the handling of explicated knowledge and systems supporting collaboration of experts	• integrative KMS: electronic publishing, integrated knowledge base • interactive KMS: distributed learning, forums
Meso/Smith (2000, 227ff) identify ten key technologies for organizational KMS which support the functions using, finding, creating and packaging knowledge	• computer-mediated collaboration • electronic task management • messaging • video conferencing and visualization • group decision support • Web browsing • data mining • search & retrieval • intelligent agents • document management
Seifried/Eppler (2000, 31ff) define a KM suite as an open IT-platform that integrates four function areas	• collaboration: computer-supported cooperative work, computer-supported cooperative learning, workflow management • content management: document management, personal information management, group information management • visualization & aggregation: knowledge maps, knowledge portals, taxonomies, directory services • information retrieval: search methods, search results, search languages, sorting, retrieval
Versteegen (2000, 101) categorizes tools for KM according to their focus on bundles of KMS functions	• modeling and analysis of knowledge • storing and administration of knowledge • distribution of knowledge • access to and retrieval of knowledge
Alavi/Leidner (2001, 114) distinguish common applications of IT to KM initiatives	• coding and sharing of best practices • creation of corporate knowledge directories • creation of knowledge networks
Jackson (2001, 5f) classifies systems for gathering, dissemination, synthesis, communication and storage of knowledge	• document management systems • information management tools • searching and indexing • communications and collaboration • expert systems • systems for managing intellectual assets: mostly legal systems to maintain trademarks, patents and other intellectual property

TABLE B-19. Classifications of technologies, tools and systems supporting knowledge management

author(s)	categories
classifications of technologies supporting knowledge management	
Schmoldt/Rauscher (1994) classify technologies for KM which are rooted in AI	• knowledge-based systems • visualization systems • virtual reality systems • spatial data management: management of data using spatial models and spatial display techniques • computer-supported cooperative work / Groupware • hypertext systems
Allee (1997, 224f) identifies basic technologies as "musts" for knowledge-based organizations	• document management • on-line access: to documents, data bases for every employee • email connectivity: expanding simple communication to topic-based information resources, conferencing and bulletin boards • expert systems: for decision making and performance support • pattern-recognition: e.g., data, text mining, knowledge discovery in data bases
Allweyer (1998, 40ff) uses Scheer's (1998) four-level architecture of business process management for the classification of technologies supporting the management of knowledge processes[b]	• design level (modeling and analysis of knowledge processing, knowledge process re-design): tools for modeling, documentation, analysis and navigation of knowledge processes • management level (performing, controlling, monitoring, improvement of knowledge processes): tools and functions supporting controlling and monitoring of knowledge processes • steering level (distribution and sharing of knowledge, search of and access to knowledge): Groupware, Intranet, search engines • application level (creation, documentation, application of knowledge): office information systems, CAD, data bases, knowledge-based systems
Ruggles (1998, 82ff) surveys organizations and classifies the technologies that are implemented as part of a KM initiative	• Intranet: create an Intranet with KM in mind, e.g., for sharing information between (virtual) teams • knowledge repository: develop knowledge repositories and data warehouses to capture explicit, codified, contextualized knowledge • decision support tools: focus is on managerial decision making • collaboration: implementing groupware to support groups in generating, structuring and sharing of knowledge

TABLE B-19. Classifications of technologies, tools and systems supporting knowledge management

author(s)	**categories**
In the **Competence Center Business Knowledge Management** in St. Gallen several classifications of systems supporting KM have been developed (Thiesse/Bach 1999, 91ff, also IWI HSG 1998, 22)	• search engines: with the functions crawling, indexing, ranking, searching (e.g., Verity) • data warehouse/business intelligence systems • workflow management systems • document management systems • Web management systems (e.g., Gauss, Intranetics) • push services (e.g., GrapeVine, ChannelManager) • knowledge mapping (e.g., Aptex) • multimedia bases (e.g., InXight) • Intranet platforms • other tools for integration and information retrieval
Astleitner/Schinagl (2000, 173ff) classify software tools that are relevant for KM	• tools for information retrieval • data bases • broad KM tools (e.g., Lotus Notes, Grapevine) • focused KM tools (expert systems, constraint-based systems) • real-time KM tools (case-based reasoning) • long-term analysis tools (neural nets) • search engines • intelligent agents • Groupware • integrated performance support systems • tools for data mining and data analysis
Binney (2001, 37ff) reviews KM-enabling technologies classified according to six categories of theoretical KM approaches	• transactional KM: (rule-based) expert systems, cognitive technologies, semantic networks, probability networks, rule induction, decision trees, geo-spatial information systems • analytical KM: intelligent agents, Web crawlers, DBMS, neural computing, push technologies, data analysis and reporting tools • asset management KM: document management tools, search engines, knowledge maps, library systems • process-based KM: workflow management, process modeling tools • developmental KM: computer-based training, on-line training • innovation and creation KM: groupware, email, chat rooms, video conferencing, search engines, voice mail, bulletin boards, push technologies, simulation technologies

TABLE B-19. Classifications of technologies, tools and systems supporting knowledge management

author(s)	**categories**
Hoffmann (2001, 78f) gives a broad classification of basic technologies used in KM solutions	• Intranet technology • Groupware • electronic document management • information retrieval tools • workflow management system • data analysis and data warehousing • agent technology • help desks • machine learning • computer based training
IBM (Tkach 2001) identifies five strategy areas for KM efforts for which there are already existing tools and application systems	• business intelligence: analyzing data bases using data mining, data warehousing and OLAP, focusing on explicit knowledge • collaboration: expert modeling and decision-making analysis, focusing on tacit knowledge • knowledge transfer: identifying and launching communities or virtual teams, distributed and distance learning technology • knowledge discovery and mapping: text mining techniques and techniques for the contextualized representation of knowledge sources (people and information), clustering, classification and visualization of documents • expertise: organizational network analysis, expert yellow pages and networks; finding, cataloging and making available the best expertise in organization

a. See also Böhmann/Krcmar 1999 who use the same Xerox classification, but propose an extended list of ICT supporting KM, e.g., computer-supported cooperative learning, collaborative filtering, enterprise information portals, meeting support systems.

b. The term *knowledge process* as used by Allweyer (1998, 44) denotes knowledge-intensive business processes in the terminology used in this book (see section 6.3.2 - “Knowledge management processes” on page 212)

There are almost as many different classifications for KMS as there are authors who tried to shed some light on this still diffuse market. Taken together, the classifications comprise a wide field of tools and systems which basically fall into one of the following four categories:

Technological roots of KMS. This group comprises more traditional ICT which can be used to support KM initiatives, such as Groupware, data warehouses, business intelligence tools, modeling software, document management systems, workflow management systems[566].

566. For a brief description see section 4.3 - “Knowledge management systems” on page 82, a detailed description can be found in the literature on each of these technology bundles.

ICT platforms. Corporate Intranet infrastructures or Groupware platforms such as Lotus Notes can be designed "with knowledge management in mind"[567].

Specialized KM tools. Some KM tools have roots in the AI field and perform specific functions necessary for KM. Other KM tools are necessary to integrate several of these functions or several of the more traditional ICT[568].

KMS in a narrower sense. These comprehensive, integrated KMS solutions are also called KM suites and integrate a large set of technologies for knowledge sharing under a common platform.

In the following, the focus will be on ICT bundle solutions or platforms and therefore KMS in a narrower sense as a detailed description of each of the other bundles could fill bookshelves of literature.

7.6.2 Classes

In addition to the theory-driven classifications in the literature (see Table B-19), the theory-driven approaches can be based e.g., on the dimensions

- *contents* of the systems with respect to the types of knowledge focused,
- *roles* of the users, e.g., participants, knowledge broker, knowledge manager, members of the organization vs. externals,
- *organizational level*, individual, collective, e.g., group, team, community, entire organization as well as
- the *technologies* used.

The market-driven classifications vary basically with respect to how narrow or wide the focus on KM-related technology is.

In the following, a *market-driven classification* with a narrow focus on specialized tools for KM, or KMS, is presented which is based on bundles of functions of KMS[569]. The classification of KMS results from a detailed market survey of KM tools and systems conducted by the author (Maier/Klosa 1999c). Then a pragmatic theory-driven classification will be presented which will be used in part D to support different KM scenarios.

The KMS or KM suites are operated on the basis of an (organization-wide) information and communication infrastructure, in most cases an Intranet platform or Lotus Notes environment, on which information sharing between (virtual) teams, both within the organization and across organizational boundaries with allies, suppliers and customers is possible. The basic functionality of such an ICT platform designed "with knowledge management in mind" would comprise an integrated set of the following bundles of functions:

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567. See section 4.3 - "Knowledge management systems" on page 82.
568. For a brief description of some examples of this category see section 4.3 - "Knowledge management systems" on page 82, a detailed description can be found in the AI literature.
569. See also section 7.3.3 - "Integrating architectures for KMS" on page 311.

- *communication*: as well as coordination and cooperation, e.g., email, workflow management, newsgroups or listserver,
- *document management*: handling of documents throughout their life cycle,
- *access*: to various data sources, e.g., relational data bases, document bases, file servers or Web servers,
- *search:* basic search functionality, e.g., full text search functions for messages, (hypertext) documents, files and folders on file servers or data bases,
- *visualization*: basic functions for a presentation of multimedia files and hypertext documents etc.

A modern, integrated Intranet platform thus can be considered as a KM platform in the sense of a kind of "starter solution" for knowledge sharing. This KM platform comprises the levels Intranet infrastructure including extract, transformation and loading as well as access and security in the KMS architecture presented above[570].

Knowledge management systems in a somewhat narrower sense provide functionality that goes well beyond these basic functions. For each of the following areas, there are a number of application systems or tools respectively which are already available on the market.

Knowledge repositories (knowledge element management systems). Knowledge repositories can be best imagined as document management systems with added features, e.g., with respect to classification and structuring of knowledge elements or with respect to searching with sophisticated filters, user profiles etc. Knowledge is supposed to be embedded in (enhanced) documents and/or forms of discussion data bases. There are three different types of repositories: external knowledge (e.g., competitive intelligence), structural internal knowledge (e.g., research reports, product material) and informal internal knowledge (lessons learned). Knowledge repositories are different from more "traditional" document management systems in terms of added context to information or added functions, such as filtering or synthesizing of the contents. Examples: Fulcrum Knowledge Server (Hummingbird), Livelink (Open Text).

Knowledge discovery and mapping. This category comprises text mining techniques and techniques for representing knowledge sources in a context defined by their relationships reached through clustering, classification and visualization of documents. Example: Intelligent Miner (IBM), Knowledge Miner (USU), Onto-Broker (Ontoprise).

E-learning suites. These systems provide a complete and integrated environment for the administration of tele-learning, both asynchronous and synchronous and to find, catalogue and make available the best expertise within an organization using

570. See section 7.3.3 - "Integrating architectures for KMS" on page 311.

e.g., organizational network analysis, expert yellow pages or expert networks. Examples: E-Learning Suite (Hyperwave), Learning Space (Lotus).

Community builder. These systems help to identify and launch communities or virtual teams independently of the geographical location of team members, provide community homespaces and services. Examples are special tools for moderation, integrated search functionality for distributed messages, contributions to newsgroups and published documents and links in the community homespace. Example: Community Engine (webfair).

Meta-search systems. These systems search different knowledge sources with varying structures (e.g., on-line data base systems, document management systems, file servers, WWW). They offer sophisticated search functions (e.g., the use of meta search data, access to knowledge elements in different systems) and functions for media integration (interface functions bridging differing technologies and formats). Examples: InQuery (Open Text), K2 Enterprise (Verity).

Enterprise knowledge portals. These systems provide access to different knowledge sources and can be best imagined as a "shopping mall" containing a number of "knowledge shops". The portal allows to access these knowledge sources, but does not necessarily integrate all the diverse knowledge sources that can be accessed. Many portals also allow a personalization of the presentation (myportal). Examples are: Hyperwave Information Portal (Hyperwave), Enterprise Information Portal (Hummingbird) or the portal solutions offered by SAP Portals.

Push-oriented systems. These systems contain functions which automatically deliver knowledge elements to participants (e.g., information subscriptions, intelligent agents, support of communities) and thus support the flow of knowledge in an organization. Example: Push Application Server (Backweb).

Collaboration. Expert modeling and decision-making analysis should lead to more collaboration, information expertise and insight sharing among knowledge workers. Systems supporting expert yellow pages and skills directories also fall into this category. Example: Notes (Lotus), Simplify (Tomoye);

Visualization and navigation systems. These systems present relationships between knowledge elements and holders of knowledge. Examples for functions are the presentation of semantic closeness of knowledge elements, the visualization of access statistics to knowledge elements ("beaten tracks"), knowledge maps, mind maps, hyperbolic browsers. Examples for tools are Personal Brain (TheBrain Technologies), Correlate K-Map (Correlate), InXight SmartDiscovery (InXight).

KMS available on the market fall into at least one of these categories. They can be distinguished as well according to their functionality for administration and reporting, e.g., for statistics about the usage of certain functions (e.g., access paths and access statistics to knowledge elements, popular search key words, etc.).

The following exemplary list of KM tools and systems represents a pragmatic *theory-driven classification*. KMS are distinguished according to the main organizational level which they focus on. The list contains a wider set of KM related tools and systems as KMS in a narrow sense span the three levels:

1. **Organization-wide KMS:** enterprise-wide broadcasting systems (e.g., business TV), knowledge repositories, enterprise knowledge portals, directory services, meta-search systems, knowledge push systems (information subscriptions, community support), knowledge visualization systems (knowledge maps), knowledge work process support, e-learning suites, intelligent agents supporting organizational information processing (e.g., for searching organization-external knowledge sources),
2. **Group and community KMS:** community builder and workspaces, ad-hoc workflow management systems, multi-point communication systems (listserver, newsgroups, group video conferencing), collaboration systems, intelligent agents supporting information processing in groups (e.g., in the sense of a transactive memory system),
3. **Individual KMS:** personal search systems (user profiling, search filters), knowledge discovery and mapping, point-to-point communication systems (email, point-to-point video conferencing, instant messaging), intelligent agents supporting personal knowledge management (e.g., for knowledge search).

Last but not least, due to the fact that KMS are developed to support KM initiatives, a typology of KM initiatives can also be used for classifying KMS. Figure B-71 uses the typology of KM focus areas which has been developed by Wiig (1999) on the basis of his extensive consulting experiences and thus a large number of KM case studies. KMS support all KM focus areas even though there is one particular KM focus that relies (almost) exclusively on ICT. A comprehensive KMS certainly can address all focus areas at the same time and thus support KM initiatives of all types. However, each focus area can be supported by a specific bundle of services identified in the architecture for centralized KMS[571].

As in the classification of KM strategies into codification and personalization strategies[572], KMS services are structured according to the respective KM focus areas *ICT resources*, i.e. discovery, publication and integration services, and *person*, i.e. collaboration, learning and personalization services. The KM focus area *process* demands a connection of services according to the needs of the respective business or knowledge process[573]. Finally, the KM focus area *asset* is a mostly strategic and thus the least ICT supported focus area with the infrastructure service

571. See section 7.4 - “Centralized architecture” on page 318.
572. See Hansen et al. 1999.
573. This has been motivated with the concept of knowledge stance in section 6.6.2 - “Activity modeling” on page 250 which helps to conceptualize the assignment of KM services to business processes in a service infrastructure described in section 7.3.2 - “Service infrastructure” on page 304.

asset management as well as reporting and scorecard services that are typically part of business intelligence solutions not considered as KMS in a narrow sense.

asset maximize building and value reallocation of intellectual capital *asset management, reporting, scorecard services*	**process** maximize use of knowledge for operational effectiveness *integration services for business & knowledge processes*
person maximize effectiveness of people-centric learning organization *collaboration, learning, personalization services*	**ICT resources** use IT to maximize capture, transformation, storage, retrieval & development of knowledge *publication, discovery, integration services*

FIGURE B-71. KMS services according to KM focus areas[574]

A classification of KMS can only be considered as preliminary due to the considerable dynamics of the market for KMS. At this stage, the analysis of KMS is a great challenge. This is already visible in the difficulties of defining the term and continues in the trial to present a typical architecture of such systems or to give a comprehensive list of functions. The same is true for a classification of KMS. The pragmatic perspective that KMS are just document management systems with some added functionality which seems to dominate the market is unsatisfying. ICT support for knowledge management is not restricted to the handling of documented knowledge.

Examples for different technological "directions" which provide roots for KMS were suggested in section 7.1 - "Technological roots" on page 273. This list of roots is not complete. It shows from which fields and markets technological support for KM can be expected. Most organizations have installed a large number of application systems and ICT platforms that provide functionality for knowledge management. Especially Intranet platforms form a substantial investment and can provide basic functionality for KM.

Also, many organizations still hesitate to "jump on the bandwagon" as long as it is not clear which KMS vendors will survive the consolidation phase that has just begun and what KMS strategy their main application software suppliers will apply (e.g., Microsoft, Oracle, Peoplesoft, SAP).

574. The KM focus areas used here have been elicited by Wiig (1999, 158) as (1) intellectual asset focus, (2) enterprise effectiveness focus, (3) people focus and (4) information technology and information management focus.

Knowledge management systems might also be viewed as important organizational assets that provide core competencies for the organization. Especially highly knowledge-intensive organizations might view the systematic handling of knowledge in general and their ICT systems supporting KM in particular as their core competence and fear that they might loose a strategic advantage if they implement a standard software solution available on the market.

Most organizations that actually have implemented KMS solutions supposedly have combined several tools and implemented additional functions on their own rather than simply buying specialized KMS software on the market. This leads to the following hypothesis:

Hypothesis 20: The majority of organizations apply organization-specific KMS developments or a combination of organization-specific developments and KMS tools rather than just KMS available on the market.

7.7 Semantic integration

Data and knowledge elements in the data and knowledge source layer typically are scattered across a variety of application systems, e.g., collaboration systems, content management systems, document management systems, file systems and other enterprise systems. Integration of data has been a concern for many years. Relational data base management has unified the way (transactional) data is handled in organizations. The organization of structured, transactional data has been well-understood for years. However, the amount of semi-structured and unstructured data, such as (text) documents, messages, images, media files or Web content has grown substantially and needs to be integrated as well. The integration of these data sources requires other approaches. In addition to data integration, semantic integration provides standards and technologies to integrate knowledge elements from different systems on the conceptual level. Thus, it is not data or Web resources alone that are brokered from system to system, but meta-data about its semantics, its relationships, "meaning" and context. Many of these standards and technologies build on XML.

This section addresses the core integration layer of a KMS[575] that provides access to the heterogeneous data and knowledge sources of an organization in a semantically integrated way, so that knowledge services can be built on top. The integration layer consists on the one hand of function-oriented integration services (function and process integration) and on the other hand of data-oriented integration services (data, user and semantic integration). Data-oriented integration services are the focus of this section. The electronic resources mainly used in knowledge-intensive processes in organizations are semi-structured documents which

575. See sections 7.4.1 - "Overview" on page 319 and 7.4.2 - "Infrastructure and integration services" on page 322.

have to be semantically described using common meta-data standards and semantically rich content and ontology description languages.

Section 7.7.1 discusses the various concepts and elements of the Semantic Web stack. This heads towards machine-understandable semantics and automated reasoning about documents and requires the use of (semantic) meta-data standards for the description of knowledge elements (section 7.7.2) and knowledge modeling, also called the development of ontologies (section 7.7.3). These form the conceptual basis for integration services[576].

7.7.1 Semantic Web

As mentioned above, the differentiation into structured and semi-structured data is often found in e.g., document management or digital asset management (see also sections 2.3.1, 109ff and 4.2.1, 247ff). However, there is no clear demarcation between structured, semi-structured and unstructured data. Generally, all data can be stored in data base systems, even unstructured data in the form of binary large objects (BLOBs). The differentiation is rather of a technical nature. It is postulated that the handling of semi-structured data requires somewhat different technical solutions from relational data base management. These solutions are on the one hand systems specially designed for managing semi-structured data, e.g., content management systems and document management systems. On the other hand, standardization of languages to describe data differ as well. Whereas SQL is the widely accepted standard to define and manipulate structured, data base-oriented data, standards based on XML are used in the realm of semi-structured, content- and document-oriented data.

A number of institutions have developed standards and started initiatives to provide comprehensive frameworks for definition and exchange of meta-data, i.e. semantic information about documents, especially about books, journals, images, photographs, audio and video files. Examples for institutions, standards and initiatives are the World Wide Web (W3C) consortium with XML and the Semantic Web initiative, the International Standardization Organization (ISO) with a large number of standards for document exchange, e.g., the Motion Picture Experts Group (MPEG) 7 meta-data standard for images, audio and video files or the Topic Map standard as well as the Dublin Core standard for exchanging meta-data about text documents which was set up by a consortium including large public libraries.

Structuring, describing, translating, storing and securely accessing semi-structured data as well as reasoning about semi-structured data require a substantial effort. Figure B-72 structures the main technologies that are involved to support these tasks.

Semantic integration of semi-structured data is a complex undertaking. Thus, the Semantic Web initiative breaks down the variety of tasks into a layered structure that helps to understand what concepts have to be defined so that semantic

576. See section 7.4.2 - “Infrastructure and integration services” on page 322.

information about knowledge elements can be easily exchanged between a variety of heterogeneous ICT systems.

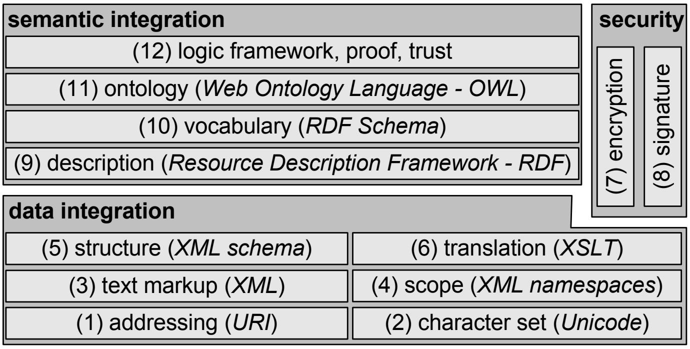

FIGURE B-72. Semantic integration with the Semantic Web stack

Data integration. Data integration requires that agents (users, institutions or applications) exchanging data agree (1) how to address data resources over a network, generally over the Internet, (2) about what character set to use, (3) about the internal structure of documents, called text markup, (4) about the scope or domain in which the specified names in the markup are valid, (5) about how to define a schema, a structure of the elements and attributes in the semi-structured text and (6) how to translate a document that is an instance of one schema so that it conforms to another schema.

In the Semantic Web stack, (1) addressing uses Unified Resource Identifier (URI). URIs are formulated in a standard syntax that is used to uniquely identify objects (or resources) located in any directory on any machine on the Internet, particularly on the World Wide Web, accessed via a specified access method. (2) The Unicode Standard is the universal character encoding scheme for multilingual text. It specifies a numeric value (code point), a name, its case, directionality, and alphabetic properties for each of its characters. Modeled on the ASCII character set, Unicode can encode all characters in all written languages in the world.

(3) The eXtensible Markup Language (XML) is a tag-based markup language for describing tree structures. XML is a set of syntax rules for creating markup languages used to define the structure of documents suitable for automatic processing, i.e. extracting content and structure of XML documents and checking whether an XML document conforms to rules defined by the XML standard, called well-formedness. (4) XML markup defines a vocabulary, also called a markup vocabulary. XML namespaces are a mechanism for creating universally unique names for XML markup vocabularies so that they can be reused by other XML documents. An XML namespace is a collection of names, identified by a URI reference, which is used in XML documents as element and attribute names.

(5) In order to define classes of XML (instance) documents, a number of schema definition languages have been developed that XML documents can be validated

against. The XML Schema language is defined in XML and provides a rich set of data types, extensible by users, for the definition of constraints on XML documents and rules for their construction. (6) The eXtensible Stylesheet Language Transformation (XSLT) provides a standardized way to convert XML documents conforming to one schema, e.g., defined using XML Schema, into XML documents conforming to a different schema. XSLT is also defined in XML and based on the XPath language used to address elements and attributes of XML documents.

Security. Secure access to semi-structured data requires technologies that prevent eavesdropping with the help of (7) encryption and technologies for verifying both, the sender and the receiver of data with the help of (8) electronic signatures.

(7) Encryption uses keys and an encryption algorithm to transform clear (text) data into encrypted data. Data (offline) encryption denotes the permanent codification of data for secure storage, whereas communication (online, wire) encryption is encoding data for secure transfer over networks. Symmetric encryption uses only one key to encrypt and decrypt. Examples for symmetric encryption algorithms are Blowfish, DES (data encryption standard) and AES (advanced encryption standard). Asymmetric encryption uses a pair of a private and a public key. An example for an asymmetric encryption algorithm is RSA (named after its developers Rivest, Shamir, Adleman). XML encryption provides encryption algorithms specifically designed for XML documents, i.e. taking into account the tree structure of XML documents and allowing for data (offline) encryption of sensitive parts of documents as compared to entire documents thus boosting performance[577]. (8) Digital signatures are used to verify the identity of the sender. They are generated using a private key to encrypt checksums of messages. Identity of the sender and integrity of the message can be verified with the corresponding public key. Both mechanisms can be combined to digitally sign the message. XML signature provides a standardized way of signing XML documents[578].

Semantic integration. Based on the standards that support the internal structuring of documents corresponding to a schema, semantic integration aims at providing standards for describing documents or, more generally, Web resources. This is done with the help of (9) statements that describe the resources, (10) a vocabulary for the definition of constraints on these statements, (11) ontologies that show the relationships between the concepts used in descriptions and vocabularies and (12) a logic framework that allows for reasoning about documents and their descriptions.

(9) Based on XML, the Resource Description Framework (RDF) standard is an XML-based language for representing meta-data about Web resources and to relate Web resources to each other. RDF provides mechanisms to add semantics to a resource as a standalone entity without assumptions about its internal structure. Web resources can be text, image, audio or video files, but also things identified on the Web, e.g., items described in a Web page. RDF is based on the idea of identify-

577. See also http://www.w3.org/Encryption/.
578. See also http://www.w3.org/Signature/.

ing things using URIs and describing them with properties and property values. An RDF statement consists of a triple of subject, predicate and object.

(10) The RDF Vocabulary Description Language (RDF Schema) supports designing vocabularies, i.e. classes for instance RDF specifications. Schemas are needed for describing terms used in RDF statements, i.e. types of things, properties and types of things that can be subjects or objects of statements with these properties. RDF Schema proposes well-defined rules for writing these definitions which can be exchanged and parsed automatically to extract semantics of RDF statements about Web resources.

(11) The Web Ontology Language (OWL) is a language for defining and instantiating Web ontologies[579] that include descriptions of classes, properties and their instances. The OWL formal semantics specifies how to derive the ontologies' entailments, i.e. facts not literally present in the ontology. Entailments can be based on multiple distributed ontologies that are combined using defined OWL mechanisms. OWL tools ease the task of applying knowledge representation to building domain ontologies rather than building entire reasoning systems. The normative OWL exchange syntax is RDF/XML, i.e. every OWL document is an RDF document. Compared to RDF Schema, OWL offers more facilities for describing classes and properties, e.g., relations between classes, cardinality, equality, richer typing of properties and characteristics of properties. OWL provides a number of language elements that specifically target the integration of concepts defined in different ontologies. This is especially useful when several systems storing parts of the contents in a KMS have to be brought together. One ontology might be developed per system to capture concept definitions in each system's specific environment. These concepts then might be mapped with OWL, e.g., to provide sophisticated discovery services.

(12) Whereas RDF, RDF Schema and OWL have been standardized for quite some time and there are a number of projects in many organizations that are based on these standards[580], there is still a lot of debate going on at the higher levels of the Semantic Web stack. Standards that allow for specifying entire logic frameworks, exchanging proofs and thus building trust between agents still remain to be seen. Concerning rules, a limited declarative language should standardize the way to query RDF statements. A rule language allows inference rules to be given which allow a machine to infer new assertions from existing ones. A comprehensive logic framework is meant to provide a vocabulary to fully describe and exchange logic assertions over the Web. Additionally, applications or agents can share logic proofs. One agent can send an assertion together with the inference path to that

579. See section 7.7.3 - "Ontology management" on page 387.

580. Examples can be found in Davies et al. 2003, particularly 197ff, or in Tochtermann/ Maurer 2006, particularly 249ff, Fensel 2004, 89ff. However, Fensel also sees some shortcomings of OWL compared to other ontology languages, particularly OIL, but predicts that only OWL has a chance of survival (Fensel 2004, 39ff). It should also be noted that there are more ontology languages following other types of logic such as predicate logic, e.g., CycL, KIF or frame-based logic, e.g., Ontolingua, Frame Logic (see Fensel 2004, 21ff and the literature cited there).

assertion starting from assumptions acceptable to the receiver. This requires a standardized language and a standard proof engine. The proof language together with digital signatures signing proofs should turn a web of reason into a web of trust.

7.7.2 Meta-data management

In a simple, yet frequently cited perspective, meta-data are data about data. A KMS contains knowledge elements, i.e. electronic resources of varying types and formats as well as meta-data which give further information about their content and associations. However, one knowledge element's meta-data can simultaneously be another knowledge element's data[581]. There are a number of reasons to assign meta-data to knowledge elements (also Gill et al. 2007):

- *increased accessibility*: Meta-data are a first step to provide meaning about knowledge elements and can be used for smarter information retrieval.
- *retention of context*: The context of a knowledge element is crucial for the reconstruction of knowledge by a user. Knowledge elements can only be correctly interpreted and integrated into a personal knowledge base, if the user can associate the knowledge elements with the correct context.
- *versioning*: Knowledge elements often exist in multiple versions according to storage format and content type, e.g., note of an idea, email message, abstract, research paper, update of the paper, book based on that research paper, learning object, portion of a WBT course[582]. Meta-data help to maintain relations between versions.
- *legal and security issues*: Access privileges and copyright information have to be maintained to assure correct handling of knowledge elements.
- *system improvement and economics*: Meta-data about the usage of knowledge elements can help to improve the system, e.g., by providing shortcuts for often used elements, or to reduce cost, e.g., by automatically transferring little used elements to cheaper storage media.

Meta-data can be used to describe any kind of data from structured to unstructured. The structure itself already is a form of meta-data and usually provides information about the name of the data element, its data type and its relation to other data elements (e.g., an XML Schema for an XML document). Element names are often not sufficient to carry all relevant information. Additional meta-data is needed that either describes the content, e.g., keywords, domain, or the context of

581. For a definition of and examples for knowledge elements see section 7.2.1 - "Types of contents" on page 282. The notion of meta-data versus data, though intuitively understandable, has been subject to a lot of attempts for more precise definitions. However, in this section, it seems to be sufficient to distinguish between data and meta-data according to the technical implications that a description of knowledge elements has for semantic integration. For example, the description of a person can be data of her skill profile, but meta-data assigned to her publications. It is often only a technical distinction between both.

582. See also the maturing process of knowledge objects in section 7.2.1 - "Types of contents" on page 282.

the data especially for semi-structured data. The context can be further subdivided into creation context, e.g., author, creation date, project, and the application context, e.g., customer, intended use. Summing up, three types of meta-data can be identified:

- *Content* meta-data relates to what the object contains or is about, and is intrinsic to an information object.
- *Context* meta-data indicates the aspects associated with the object's creation and/or application and is extrinsic to an information object, e.g., who, what, why, where and how aspects[583].
- *Structure* meta-data relates to the formal set of associations within or among individual information objects and can be intrinsic or extrinsic.

The structure is extrinsic in data base tables where data and structure are separated and intrinsic in XML documents where tags and content are mixed. Meta-data can be informal, e.g., free text description, semi-formal, e.g., structured according to a user-defined structure, or formal, e.g., structured and compliant to an organization-wide standard or a standard backed by a consortium of IT companies or a supra-organizational standardization body.

Integration of resources, more specifically knowledge elements, in KMS with the help of meta-data requires a standard language for the serialization of meta-data annotations, a content-oriented standard to define the available meta-data fields and a standard language to formalize an ontology[584]. The latter is used to define the domain and range of meta-data fields and relate meta-data on the type level as well as individual document objects or real-world objects on the instance level by reasoning about the defined concepts[585].

As mentioned in section 7.7.1, many institutions have developed a large variety of meta-data standards. Content-oriented meta-data standards focus on standardization of meta-data fields and can be serialized with the help of languages like XML and RDF[586]. There are a number of domain-independent initiatives to standardize meta-data, e.g., Dublin Core [Hi05], Digital Object Identifier[587], or the Text Encoding Initiative[588]. The Dublin Core Metadata Initiative is an example for a standardization effort primarily aimed at the description of text documents. The standard defines a set of elements that are mainly based on experiences made in public libraries, e.g., Library of Congress, Deutsche Bibliothek. Table B-20 gives some examples for elements in the standard and their descriptions.

Additionally, there are a large number of domain-specific meta-data standards, e.g., in the areas of publishing, library, education, museum or multimedia. Examples are Learning Object Metadata (IEEE 2007), PRISM[589] or MPEG-7[590].

583. See section 7.5.3 - "Example: Infotop" on page 349.
584. For this and the following detailing of these integration tasks see Maier/Peinl 2005.
585. See section 7.7.3 - "Ontology management" on page 387.
586. See section 7.7.1 - "Semantic Web" on page 375.
587. URL: http://www.doi.org.
588. URL: http://www.tei-c.org.
589. URL: http://www.prismstandard.org.

MPEG-7 is a standard that is used to describe multimedia data, especially data stored in MPEG4 video files. The MPEG-7 descriptions of content may include meta-data describing creation and production processes, e.g., director, title, related to usage, e.g., copyright pointers, broadcast schedule, about storage features, e.g., storage format, encoding, on spatial, temporal or spatio-temporal structure, e.g., scene cuts, segmentation in regions, region motion tracking, about technical features, e.g., colors, textures, sound timbres, about the portion of reality or imagination captured, e.g., actors, objects and events, interactions among objects, about how to browse the content in an efficient way, e.g., summaries, variations, spatial and frequency sub-bands, and about interaction of users, e.g., user preferences, usage history. Standards can be compared according to e.g., comprehensiveness, flexibility, languages used for serialization, adoption rate or user friendliness.

TABLE B-20. Examples of Dublin Core meta-data elements

element	description
title	name of the object; could be derived from the filename or from the content
description	abstract or summary of the content in free text form
subject	keywords can be assigned to illustrate topics
creator	entity responsible for authoring the content, e.g., a person, an organization or a service
date	date of an event in the lifecycle of the resource, e.g., creation
relation	links to Web resources (relation.uri) or other sources (relation.other)
language	country code (e.g., us, uk, de) representing the language of the object
rights	e.g., copyright, intellectual property rights, or digital rights (DRMS)
type	categorization, genre or similar aggregation
format	physical or digital manifestation of the object, usually in form of a MIME type

An ontology can be used to relate the meta-data fields. Popular ontology languages include DAML+OIL, Ontolingua and OWL[591]. Ontologies for an organizational KMS can be developed on the basis of existing ontology types, like enterprise ontologies that define organizational structure, domain-task ontologies that define processes, domain ontologies that define relevant topics and common sense ontologies that define e.g., location and time concepts (Gómez-Pérez et al. 2004). Recently, more comprehensive specific ontologies have been proposed for a variety of domains[592].

590. Martínez et al. 2002.
591. See sections 7.7.1 - “Semantic Web” on page 375 and 7.7.3 - “Ontology management” on page 387.

A semantic integration layer in a KMS has to offer services for (1) creating meta-data describing heterogeneous documents, (2) storing it either together with or separated from documents in a repository and (3) retrieving it for inferencing to enable advanced knowledge services. These are discussed in the following (Maier/ Peinl 2005):

Creation. The creation of meta-data in most organizations is primarily accomplished manually. Often, the user is prompted to type in author, title and keywords describing a document before it can be saved to e.g., a DMS. Even more inconvenient is manual creation of an RDF file to annotate e.g., a Web resource. From the perspective of a KMS, a manual approach is not appropriate due to the sheer amount of resources that would have to be annotated. There are some first steps towards (semi-) automated creation of meta-data which either use document-inherent structures and tags like DC-Dot[593] that utilizes HTML tags to generate Dublin Core conforming RDF annotations or sophisticated text mining and language processing algorithms to extract meta-data from content like TextToOnto[594]. There are, however, meta-data fields that can be more easily extracted if the document is structured using an XML format like DocBook[595] that already incorporates most Dublin Core elements.

Storage. Basically, meta-data can be stored either inline, as part of the resource or document that is annotated, like in MS Word or Adobe PDF documents, or document-external, e.g., in a separate RDF file or in a relational data base like in many DMS. XML documents also can store RDF annotations inline using the XML namespace concept. Inline storage is especially advantageous when documents are exchanged between several KMS, e.g., between a company and one of its cooperation partners or in a peer-to-peer scenario where resources are stored in a distributed environment. In this case, the sending KMS packs all resource descriptions relevant for the target environment together with every exchanged knowledge element which can then be extracted by the receiving KMS.

This could also be called a process transferring explicit knowledge between different contexts. This is a specific case of more general business processes and, in a more detailed perspective, workflows between organizational units or even between organizations. Theoretically, this is the traditional realm of workflow management. Historically, there have been three distinct perspectives on workflows implemented in workflow management systems (Jablonski et al. 1997, 91f):

592. Examples which are of special interest for the integration layer of KMS are publication descriptions using BibTeX in OWL (e.g., http://zeitkunst.org/portfolio/programming/bibtex_owl/) or the AKT Portal ontology that describes academic researchers, their publications and projects (http://www.aktors.org/ontology/).
593. http://www.ukoln.ac.uk/metadata/dcdot/.
594. http://sourceforge.net/projects/texttoonto.
595. http://www.docbook.org.

- *structured sequences of steps* which sets the focus on events, conditions and actions in the control flow, on disaggregation of tasks, their delegation to agents or resources and particularly on coordination of the tasks,
- *actualized conversation types* which is based on speech-act theories[596] and views workflows as regulated and structured exchanging of speech acts between agents and thus focuses agents and their possibilities to send messages and to react to messages,
- *migrating or stateful objects* which is also called object migration or information sharing model and focuses the objects, documents and their states that determine the actions that can, should or must be performed on the objects and is best to be used in cases where the workflow is determined largely by the type of document.

Inline storage of meta-data for knowledge transfer can be seen as the first step in "activating" resources in general and electronic documents in particular that has been subject to a number of research approaches. Basic idea is to store explicit knowledge about resources, their contexts, as well as application logic directly and inseparably with the resources which leads to the concept of smart, intelligent, living or active document[597]. Active documents represent another variant of the perspective on workflows as migrating objects. The difference to traditional workflow management is that active documents do not require central coordination, but carry all meta-data that is relevant for the workflow with them. These approaches differ with respect to the degree of activation as depicted in Figure B-73[598]:

- *Passive documents* are containers of data with no capabilities to influence the control flow of a receiving system. Meta-data annotations can only be stored separated from the document, e.g., implicitly in a folder structure or explicitly in a relational DBMS.
- *Enriched documents* contain their meta-data annotations as part of the document. With increasing adoption of XML-based document formats[599], this is the primary standard used in order to structure documents.
- *Reactive documents* can trigger (simple) actions for corresponding pre-defined events, e.g., adaptations to user environments, such as language, font size or image resolution.
- *Active documents* contain data, meta-data and application logic or are directly connected to application logic which is a fixed part of the document, cannot be separated from it without substantial loss of meaning, is transferred with the documents and can actively trigger, control or execute functions[600].

596. For speech-act theory see Austin 1962, Searle 1969, adapted to electronic communication and computers by Winograd/Flores 1986.
597. Carr et al. 2003, Schimkat 2003, Maier/Trögl 2006.
598. See Schimkat 2003, 54ff, Maier/Trögl 2006, 6ff.
599. Examples can be found in standard office systems, e.g., Adobe Intelligent Document Platform, Microsoft Office or OpenOffice.

- *Proactive documents* additionally attempt to autonomously achieve pre-defined goals. Actions to achieve the goals are integrated into the document. The sequence of actions is selected autonomously according to the reactions of the respective environment[601].

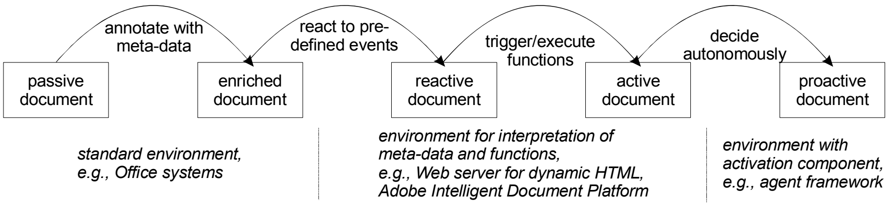

FIGURE B-73. Degrees of activation of electronic documents[602]

The approaches for the implementation of active documents differ not only with respect to the degree of activation. Primary goals vary from simple storage and retrieval of documents over adaptation of the presentation of documents to control of task and workflows. Theoretically, the approaches are all based on meta-data concepts and some aspects of object-orientation, but differ in their reliance on network theory, service-oriented architecture or agent theory. The technical environments for execution of active documents vary on the server side from standard Web servers over vendor-specific servers, especially document management systems, to specific middleware. Exceptions are solutions for proactive documents which rely on an agent platform. On the client side, the approaches rely on widely available platform-independent application software, e.g., Web browser or Adobe Acrobat Reader or on vendor-specific office systems. Documents are mostly realized as containers with diverse formats whereas meta-data are consistently represented in XML-based formats. Not surprisingly, the approaches differ mostly with respect to how they implement functions. Solutions include diverse macro, script and programming languages, the Web service concept as well as software agents.

However interesting and promising approaches for activation of documents are with respect to integration of several document bases and transferring explicit knowledge to other contexts, it is not efficient to store meta-data only inline or in separate files for searching large document collections. Thus, the need arises for a way to store meta-data, e.g., RDF triples, in and retrieve it from a data base. In general, either relational, object-oriented, XML-based data bases or proprietary data base formats can be used. In a KMS setting, relational data bases might be pre-

600. Examples for technical implementations of active documents are Web servers interpreting dynamic HTML documents, adaptive hypermedia systems (Brusilovsky 1996, DeBra et al. 1999, Brusilovsky 2001) or the Placeless Documents approach (Dourish et al. 1999, Dourish et al. 2000).
601. An example is Schimkat's research prototype for living documents, a middleware which is based on the agent framework Okeanos (Schimkat 2003).
602. After: Maier/Trögl 2006, 8.

ferred due to their dominance and the fact that common drawbacks for XML storage like missing white space preservation or breaking digitally signed contents do not seem to be an issue here. Thus, this approach is examined closer (Melnik 2001):

One method would be to store all RDF triples in one table which results in denormalized data. Separate tables for resources, literals, namespaces and statements would dramatically decrease required storage capacity, but also decrease performance as a number of computation-intensive joins have to be made. The Jena toolkit uses the former approach, whereas Sesame is an example for a tool that implements the latter approach. Finally, one could also store RDF data in a data base schema according to the RDF schema describing the structure of the RDF file. This potentially results in a large number of tables and makes it more difficult to retrieve statements independently from their RDF schema, but can also improve retrieval for a fixed and small number of schemas.

Retrieval. Established query languages like SQL, OQL or XPath/XQuery could be used in order to retrieve meta-data from the data base, depending on the type of data base management system used. However, there are many shortcomings that could be overcome with a query language that explicitly supports the RDF triple structure and other RDF language constructs. A number of proposals for such languages have been made, e.g., iTQL, RDFQL, RDQL, RQL, SeRQL, and SPARQL. Although these languages look similar, since they all imitate SQL, their capabilities are quite different.

Haase et al. (2004) evaluate a number of these languages and define the following requirements for an RDF query language: support for (1) RDF abstract data model, (2) formal semantics and inference, (3) XML schema data types for literals and (4) statements about resources. They further judge the languages according to their (5) expressiveness, (6) closure, (7) adequacy, (8) orthogonality and (9) safety. They conclude that especially grouping and aggregation, as well as sorting and optional matching are poorly or not at all supported. Also, RDF language elements like XML data types, containers and reification are only supported in a few cases. From a KMS perspective, language capabilities and industry support are important criteria. Stier's (2005) evaluations supervised by the author[603] as well as the updated results of Haase's (2005) research show that RDFQL scores better than other query languages. Nevertheless, it seems that either RDQL, due to its support by HP and implementation in several tools, e.g., Jena, RDFStore, Sesame, 3Store, RAP, or SPARQL due to its progress in the W3C standardization process will become widely accepted.

There are a number of tools available that support RDF storage and retrieval, most of which are the results of academic research and are freely available (Stier 2005). However, maybe as a result of that, only few tools are easy to use, most of them even lack a graphical user interface. Some remarkable exceptions are 4 Suite,

603. See also Maier/Peinl 2005.

Sesame, KAON and Kowari. Sesame supports RDQL as well as RQL and SeRQL, whereas most other tools only support one language. This is especially interesting for KMS for flexibility reasons, as long as there is no clear standard yet. RDFQL support is only available in the commercial tool RDF Gateway from Intellidimension. A prototype implementation developed at the author's department builds on top of Jena and enhances the toolkit with a Web-based client for retrieval as well as a Java-based graphical client with support for creating, storing and retrieving RDF from the data base (Stier 2005, Maier/Peinl 2005).

Figure B-74 summarizes the most important steps for creation, i.e. annotation and serialization, storage and retrieval of meta-data from the perspective of the integration layer in a KMS.

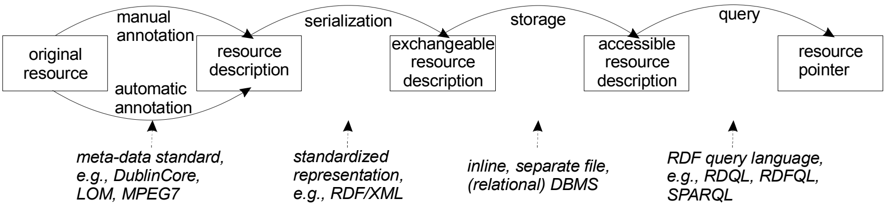

FIGURE B-74. Meta-data management

The integration layer in a KMS builds on semantic descriptions of documents to provide functionality to the knowledge services on the upper layers, such as semantically relating knowledge elements to each other or identifying experts based on authorship. Thus, creation, storage, retrieval and processing of meta-data and associated ontologies are required. With XML, RDF, OWL and RDF query languages as well as the use of content-oriented meta-data standards, a significant part of the required integration services can be realized.

However, the lacking standardization of RDF query languages together with missing capabilities of the proposed standards and insufficient tool support inhibits a broad implementation of semantic integration layers in organizations. Moreover, despite a number of content-oriented meta-data standards that seem well-suited for their designated domains, there is no broadly accepted standard that covers all relevant aspects in a KMS context.

The various developments in the technology-enhanced learning community on the standardization of learning objects, learners etc. as well as modularization that is already designed for some standards seem to be important steps in this direction. Probably a more flexible, modular meta-data annotation system with a few basic attributes for all documents together with a set of document type-specific attributes could link standards for specific domains. The meta-data should be organized in a kind of top-level ontology according to the identified categories and the dimensions time, topic, location, person, process and type[604].

This already points towards the concept of ontology management. On top of meta-data management which governs the basic services of semantic integration, ontology management can provide for semantically richer descriptions of resources, their properties, relationships and rules that allow for reasoning among the knowledge about resources.

7.7.3 Ontology management

The concept of ontology has already been defined and its impact on KM has been discussed in section 6.6.3 - “Knowledge modeling” on page 257. In this section, the model of an architecture for ontology-based knowledge management systems and a procedure model for ontology development are briefly introduced to illustrate how these concepts can be implemented in a KMS.

Figure B-75 shows a procedure model for developing ontology-based KMS which is based on several related procedure models (Sure/Studer 2003, 42ff) and has been applied in several projects at the AIFB institute, University of Karlsruhe (Germany). It gives guidance in developing a core knowledge structure that forms the basis for semantic integration of numerous data and knowledge sources.

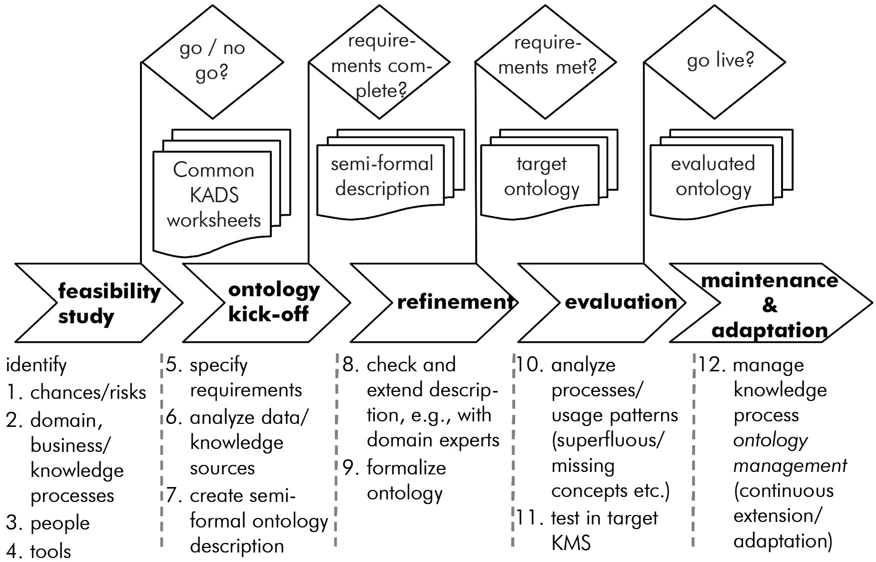

FIGURE B-75. Procedure model for ontology development[605]

Feasibility study. This process step in the procedure model aims at setting the scene for the ontology development project and leads to a decision about continuing the effort or terminating the project. Setting the scene means to determine scope and domain of the project as well as the people involved. Domain experts

604. See section 7.5.3 - “Example: Infotop” on page 349 and Maier/Sametinger 2007.
605. After: Staab 2002, 204, Sure/Studer 2003, 34.

have to be selected from the group of the latter. Also, the ontology language and the tools to be used have to be selected. Criteria for selecting an ontology language are e.g., (1) intuitiveness for domain experts and other users that participate in the modelling effort, (2) existence of a well-defined formal semantics with established reasoning properties in terms of completeness, correctness and efficiency and, increasingly, (3) the possibility to serialize in XML, RDF and OWL (Fensel 2004, 48). The main tool for ontology construction is an ontology editor during build-time, for example Protégé or OntoEdit, whereas a reasoning system, e.g., OntoBroker[606], is needed during runtime for the provision of inference services based on the ontology and thus answering questions with the help of the ontology.

Ontology kick-off. In the kick-off phase, requirements are specified that the ontology has to fulfill. Data and knowledge sources which should be integrated with the help of the ontology are identified and studied. Finally, a semi-formal ontology description is created that considers the requirements and covers all data and knowledge sources deemed relevant.

Refinement. The refinement phase relies heavily on support by domain experts and by ontology tools. First, the semi-formal ontology description is checked for consistency, completeness, relevance and other criteria. In the following step, a decision has to be taken concerning which ontology languages to use. In the meantime, most projects use some form of standard ontology language, e.g., OWL, as the basis. However, in many cases, additional ontology elements are used which are not covered by the standards. In this phase, also the support by an ontology editor and, subsequently, the existence of a corresponding ontology inference engine, are important prerequisites for an economically feasible ontology management process. The refinement phase concludes with a check whether the formalized ontology fulfills the requirements stated in the kick-off phase.

Evaluation. In the evaluation phase, the ontology is tested with the help of test cases simulating typical queries, certain usage patterns and processes. This should allow for a check whether all concepts are needed and/or whether additional concepts are necessary in order to support the patterns and processes deemed necessary. If revisions are required, then a switchback to the refinement phase might be necessary. Finally, the ontology is deployed in the integration layer of the target KMS in order to check whether it fits the environment in which it should be used.

Maintenance and adaptation. The final phase revolves around an operational system using the ontology. As ontology management is quite resource-consuming, it is crucial that maintenance and adaptation are planned systematically and supported by methods and tools. Whereas the ontology management process so far has the character of a project, it is this phase that points towards continuous management with respect to the integration layer of a KMS. However, there are less expe-

606. http://www.smi.stanford.edu/projects/protege/, http://www.ontoprise.de/

riences with this phase as compared to the earlier phases (Staab 2002, 205). Larger adaptations require another design cycle of refinement and evaluation phases.

Once the ontology is developed, it is deployed in a KMS. Figure B-76 shows components of a KMS from the perspective of ontology management.

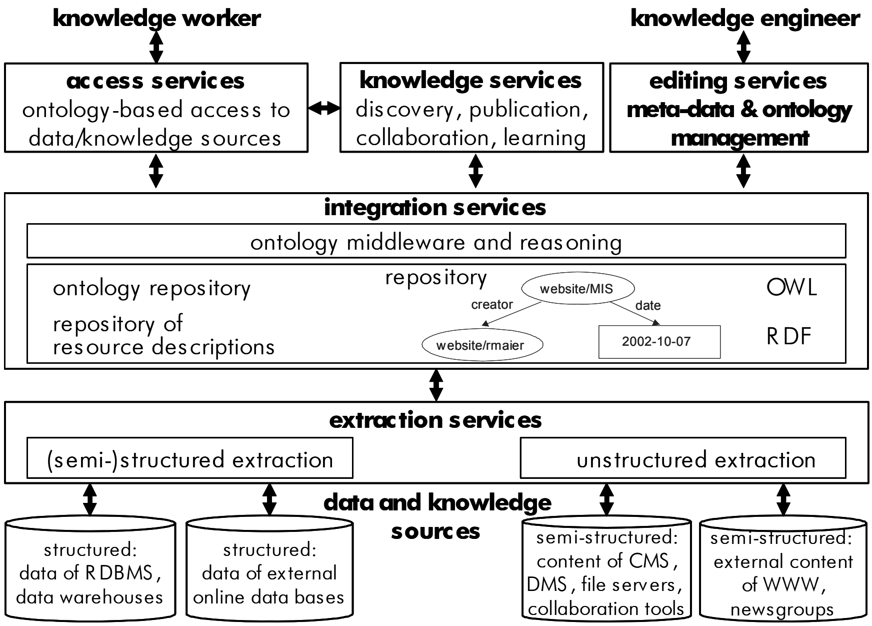

FIGURE B-76. Architecture for ontology-based KMS[607]

Extraction services are required in order to bring knowledge elements from structured and unstructured sources of data and knowledge or, more precisely, descriptions thereof and references to these elements into the repository of resource descriptions. This repository that also contains the integration ontology is the basis of integration services which are implemented with the help of an ontology middleware and reasoning systems. This is the central layer that realizes the inferencing services required by knowledge services built on top of them. Figure B-76 also shows the two main roles of a knowledge worker and a knowledge engineer which either use the system for an improved access to data and knowledge sources or for meta-data and ontology management processes.

607. This architecture integrates the architecture for Semantic-Web-based KM after Davies et al. (2003a, 6) with the architecture presented in Figure B-59, “Architecture for centralized KMS,” on page 319.

7.8 Résumé

This chapter was dedicated to the analysis of ICT tools and systems that can be used in a KM initiative. First, the *technological roots* of KMS were analyzed. The roots of KMS can be found for example in business intelligence, document or Web content management, communication, Groupware, learning management, portal, search and retrieval, visualization, workflow management and—last, but not least—artificial intelligence and knowledge-based technologies. Central to each KMS implementation are the *contents* that are managed by these systems. A list of sixteen types of contents will be used in the empirical study:

- knowledge about organization and processes,
- product knowledge,
- patents held by the organization,
- external patents,
- internal studies,
- external studies/reports,
- lessons learned,
- best practices,
- ideas, proposals,
- questions, answers (FAQ),
- employee yellow pages/skills directories,
- knowledge about business partners,
- directory of communities,
- internal communication,
- external on-line journals,
- private contents.

This list is not complete. There are also many more ways to classify contents some of which were addressed in this chapter[608]. The definition of the smallest unit of explicit, documented knowledge, the *knowledge element*, was found to be challenging. Unfortunately, we are still far from an agreed upon understanding of what exactly is stored and handled in a KMS both, in the literature and in the organizations. A number of examples for knowledge elements were listed that will be used in the empirical study, such as a document containing lessons learned, patents, a description of skills or of a best practice, a contribution to a newsgroup, an element in an experience data base or an entry in a list of frequently asked questions and answers. The description of a knowledge maturing process can help organizations to analyze their KMS, define types of knowledge elements on different levels of maturity and systematically manage maturity paths between them.

The size of the contents of a KMS will be measured in terms of the number of knowledge elements handled and in terms of the storage capacity used. Contents

608. See also section 4.2.2 - "Types and classes of knowledge" on page 66.

can be stored using different *types of media*, such as documents, multimedia contents, contributions to newsgroups or data base elements.

The structuring of an organizational knowledge base is often considered one of the key tasks in KM. However, as the current state of theory does not provide easy-to-use methods and instruments to aid this task, the investigation into the state of practice of knowledge organization and structuring will have to be limited. The number of knowledge clusters will be related to the number of knowledge elements. Additionally, organizations will be asked what ways of structuring the organizational knowledge base—hierarchical or network—they apply.

The concepts of KM service and a KM service infrastructure have been introduced and link the design of KMS with KM strategy, business and knowledge processes. Due to the substantial interest in KM and the subsequent vagueness with which the term KMS is used especially by vendors of ICT tools, platforms and systems to support KM, it is not surprising that there are a number of architectures proposed for KMS. An ideal *architecture* for a centralized KMS was presented that integrated theory-driven and market driven architectures as proposed in the literature and vendor-specific architectures that have been developed with one particular KMS in mind. The architecture consists of five layers that build upon each other and reflect the substantial complexity of KMS solutions in practice: (1) access services, (2) personalization services, (3) knowledge services, (4) integration services and (5) infrastructure services that build on data and knowledge sources. A comprehensive list of functions of KMS was presented, structured according to the architecture's layers. The architecture together with the list of functions can be used as a checklist to evaluate KM tools and systems. Due to the importance of the integration layer, a separate section deals with the Semantic Web initiative, metadata and ontology management as the main pillars of semantic integration in KMS.

Evaluation of the quality of contents and functions of a KMS can be supported by structured lists of criteria for information quality. Table B-21 assigns the criteria for information quality to the five layers distinguished in the architecture for centralized KMS.

TABLE B-21. Assignment of quality criteria to levels of KMS architecture

level of KMS architecture	information quality criteria
access services	accessibility, security
personalization services	applicability, conciseness, convenience, timeliness
knowledge services	accuracy, clarity, currency, interactivity, traceability
integration services	comprehensiveness, consistency, correctness
infrastructure services	maintainability, security, speed

Infrastructure services are evaluated according to their contribution to maintainability, security and speed of knowledge "transmission". Integration services provide comprehensive, consistent and correct knowledge. Knowledge services improve the knowledge's accuracy, clarity, currency, interactivity and traceability. Personalization services foster the applicability, conciseness and convenience of the knowledge presented to the knowledge worker. Also, push services provide timely knowledge. Access services obviously primarily deal with the accessibility and security of knowledge.

The ideal architecture of a centralized KMS was contrasted with an architecture of a distributed or peer-to-peer KMS. The proposed advantages concerning acceptance, flexibility and cost can only be realized if the substantial problems of a decentralized management of meta-data and the lack of semantic integration of the knowledge elements in this architecture can be overcome. Still, this is a promising direction for future research that might remove the barriers to use a (costly) centralized KMS solution, especially by small and medium-sized enterprises and for collaboration and knowledge sharing across organizational boundaries.

Functions of KMS can be categorized in a multitude of ways. In the following, an example for a pragmatic classification will be discussed which will be used in the empirical study. Once again, the differentiation between a technology-oriented and a human-oriented KM approach is visible in the distinction between groups of *integrative* and *interactive KMS functions*. In addition, there is one group that bridges these two groups of functions. There is also a group of KMS functions which can easily be classified as integrative, interactive or bridging functions. The links to KM tasks and processes are shown for every group[609].

Knowledge integration. These functions support knowledge processes. Examples are knowledge publication, structuring and linking, contextualization, quality assurance, storing and feedback:

- *knowledge search and presentation*: keyword search, meta-search system, user-initiated filters, navigation, information subscriptions for interested users, thesaurus/synonyms, presentation of new/unread documents, search assistants / search support, three-dimensional visualization, semantic closeness between knowledge elements, ranking of knowledge elements, presentation of full texts,
- *knowledge acquisition, publication and organization*: publication of pre-structured contents by participants, publication of not pre-structured contents by participants, indexing/integration of published contents, comments to knowledge elements, manual import of external knowledge elements, automatic import of knowledge elements from external sources, generation of knowledge elements from internal data sources, statistical data analysis, knowledge repository, automatic indexing of full texts, automatic classification/linking of knowledge elements, semantic analysis of knowledge elements, (hyper-) linking of published contents, structuring and management of knowledge clusters,
- *CBT*: computer based training.

609. See section 6.3 - "Process organization" on page 207.

Knowledge interaction. These functions support knowledge processes and knowledge-intensive business processes. Examples are asynchronous and synchronous communication and cooperation, person-to-person, team, community and enterprise-wide communication and cooperation, expert brokering:

- *knowledge communication and cooperation*: email, email distribution lists, listserver, ad-hoc workflow management system, newsgroups, point-to-point video conference, multi-point video conference, networked group video conference rooms, audio conference, group conference management, list of participants currently on-line, instant messaging, chat, electronic whiteboard, application sharing, co-authoring functions, electronic brainstorming,
- *tele-learning*: videoserver, live broadcasting of videos.

Functions bridging knowledge integration and knowledge interaction. This group of functions supports knowledge processes and knowledge-intensive business processes. They attempt to close the gap between integrative and interactive KMS by e.g., supporting direct interaction between participants and e.g., authors of knowledge elements, by using other participants' access patterns to integrative KMS or by integrating knowledge structures and knowledge networks into comprehensive knowledge maps. One particular sub-group of functions bridging knowledge integration and knowledge interaction can be called knowledge profiling: system-initiated automatic participant-oriented selection, repackaging and presentation of knowledge elements, push-technologies, automatic and participant-initiated building of user, group, team or community profiles, topic-oriented information subscriptions and the like:

- *knowledge search and presentation*: intelligent agents, user profiles, access statistics for knowledge elements, presentation of knowledge elements in maps, access paths to knowledge elements/clusters, presentation of related knowledge elements, navigation from knowledge elements to authors/communities,
- *knowledge acquisition, publication and organization*: feedback from participants to authors, automatic notification of potentially interested, definition of roles for participants,
- *administration*: role-specific configurations of KMS.

Knowledge management. These functions support the knowledge management process. Examples are identification and visualization of enterprise-wide knowledge, reporting of the use of the infrastructure, identification of knowledge gaps, enterprise-wide knowledge quality management (e.g., definition of criteria to be met for publishing knowledge elements) or administration of KMS.

This rather high-level classification can be detailed at will. However, interviews with knowledge managers suggest that to date organizations use only a couple of functions to support the administration of KMS, reporting and visualization (in the form of knowledge maps). The more advanced functions are supported at most with the help of prototypes. Moreover, these reporting, administration and visualization functions can be assigned to the three categories integrative, interactive and bridging KMS functions:

- *knowledge integration:* reports concerning knowledge elements,
- *knowledge interaction:* reports concerning participants or collectives of participants,
- *functions bridging knowledge integration and interaction:* administration of group, team and community profiles and privileges; personalization of user interface; development and management of knowledge maps.

Also, a number of approaches to the *classification* of KMS or, more generally, to the classification of ICT tools supporting a KM initiative were reviewed. The classifications comprised more traditional ICT, ICT platforms, specialized KM tools as well as comprehensive, integrated KMS solutions. Then, an amalgamated classification on the basis of the literature review as well as the market study on KMS was suggested (see Maier/Klosa 1999c). This classification leaves more traditional ICT tools, systems and platforms out of consideration[610]. It distinguishes knowledge repositories, knowledge discovery and mapping, e-learning suites, community builder, meta-search systems, enterprise knowledge portals, push-oriented systems, collaboration as well as visualization and navigation systems. Additionally, a theory-driven broad classification divides ICT to support KM on the organizational level, the group and community level as well as the individual level. Finally, an empirically motivated classification classifies ICT according to Wiig's KM focus areas.

Due to the considerable dynamics of the market for KM-related ICT, it must be noted that all these classifications can only be considered as preliminary. Several vendors currently attempt to integrate as many KMS functions into their KMS as possible[611]. These integrated KM platforms or KM suites bridge classes and combine e.g., a knowledge repository, an e-learning suite, a meta-search system, an enterprise knowledge portal, a push-oriented system as well as a visualization and a navigation system. It seems that architectures, lists of KMS functions and classifications presented in this chapter together provide a good foundation to structure the market of KM-related ICT.

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610. The more traditional ICT supporting a KM initiative was discussed in section 7.1 - "Technological roots" on page 273.
611. Recently, many vendors, e.g., Open Text, have acquired or merged with a number of other vendors in the KMS market to speed this integration process.

8 Economics

The determination of costs and especially the assessment of benefits of KM and KMS is still in its infancy. Many authors have contributed to the description and explanation of the substantial differences between standard economic theory and information economics. Examples are negligible marginal costs or network effects (e.g., Gersbach 1991, Hirshleifer/Riley 1992, Lehner et al. 1995, 179). Our understanding of the economics of knowledge or competence is even more "primitive" than our understanding of information economics (Teece 1998a, 291).

Basically, there are the following alternatives to assess benefits of the application of KMS[612]:

Qualitative assessment. This approach involves the subjective valuations of individuals which can be participants, the project manager or individuals not involved in the process, individuals with a technical or a business background etc. Regularly, in case of subjective assessment, senior management, the project manager or a sample of participants assess the KM initiative in general or the application of KMS in particular.

Quantitative assessment. Quantitative techniques are based on precisely defined variables which can be repeatedly measured rendering consistent results.

Semi-quantitative assessment. In this case a person or, more commonly, a group of individuals, assesses the KM initiative or the application of KMS on the basis of a structured evaluation process. Semi-quantitative techniques basically convert the subjective judgements of the evaluating team on a large set of items (variables) into several measures using statistical methods, such as factor analysis. Thus, the result is a small set of interesting factors which have quasi-quantitative characteristics (usually the measures use an ordinal scale from 1-5 or 1-7).

In many cases, organizations will apply a combination of these alternatives using quantitative measures where possible and enriching the results with semi-quantitative and qualitative measures. Organizations apply the whole repertoire of data collection as can be found in the literature: questionnaire, interviews with participants and selected special roles, such as knowledge brokers or subject matter specialists and—last but not least—measures that can be automatically collected by the KMS, such as access statistics.

Box B-9 shows a case study of a software house that has used KMS for quite a while. The case study is meant to illustrate the state of practice as can be found in many organizations and should also show the challenges for the development of a model to measure the success of KMS.

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612. See Hauschildt 1993, 317ff, see also section 5.2.1 - "Strategic goals" on page 114.

Assessing success of knowledge management systems at sd&m AG

The system house software design & management AG (sd&m AG) is based in Munich (Germany) and develops individual software for business information systems and is strongly oriented towards innovation with no specialization to technologies and industry sectors. The number of employees has grown at a yearly rate of occasionally more than 50% to 800 in the year 2000. Due to the substantial pace of growth, the executives identified weaknesses in the identification of knowledge within the organization, the transfer of knowledge between projects as well as in training and education.

sd&m implemented a KMS as part of a corporate KM strategy. The KMS consists of the Intranet-based system KWEB which is supported by a separate organizational unit called "technology management" with a number of so-called knowledge brokers. KWEB contains among other components

- a skill management system (a data base of the competencies of employees, voluntarily built up by the employees themselves),
- contributions of knowledge brokers about relevant knowledge areas (e.g., reports, studies, FAQs),
- descriptions of actual and completed projects,
- a data base of lessons learned from projects,
- personal homepages of the employees,
- a search engine about the complete corporate Intranet as well as several external (on-line) data bases and information services (e.g., Reuters).

The development of KWEB required an investment of five person years of developer time. Apart from one person year of developer time for annual maintenance, currently seven knowledge brokers are responsible for the maintenance of contents and the support of participants.

Success of the KM activities at sd&m is assessed with regular questionnaires on employee satisfaction a part of which deals with the satisfaction of participants with the KM services and the KMS. Success is thus basically measured in terms of improved user satisfaction. Apart from this questionnaire, success stories highlight advantages generated for sd&m's customers or reductions of the weaknesses as mentioned above. KMS use is measured generally with the help of rough numbers of accesses and the number of participants who provide information about their competencies in the skill management system.

BOX B-9. **Case study: Success of KMS at sd&m AG**

In the following, the state of the literature on economics of the application of KMS will be reviewed. An existing model will be extended to include factors and variables measuring benefits from the application of KMS. Beforehand, section 8.1 will take a closer look at the costs of the application of KMS and ways to finance such efforts. Section 8.2 will then briefly review some important existing concepts to measure intellectual assets in an organization in a top-down approach which basically reference the resource-based view of the organization[613]. These approaches are all broadly defined and can be used to assess the benefits of a KM initiative in general. The next sections will specifically focus on the support of these initiatives by information and communication systems. First, selected models to evaluate the benefits of information systems (IS) are reviewed and the DeLone/McLean model of IS success is discussed in detail (section 8.3). The DeLone/McLean model is selected as the basis for the model to evaluate the benefits of KMS presented in section 8.4. This section also discusses the application of the most interesting factors according to the distinction between integrative and interactive KMS as presented in section 7.6.1 - "Knowledge Tools" on page 361.

8.1 Expenses and funding

Determining costs of the implementation and operation of an IS in general and a KMS in particular is not a trivial task. In many cases, the development of a KMS is part of a major investment in new information and communication infrastructure in the organization, e.g., the development or upgrade of an organization's Intranet, Groupware platform, an organization-wide management information system, data warehousing and business intelligence systems, document management system, office management system etc. and a combination of these efforts. As a consequence, investments into KMS regularly fulfill other business goals as well and thus are difficult to assess or even estimate.

Because of these difficulties, the investigation will be limited to the most important types of expenditures for KM initiatives. Two major cost drivers can be determined:

- the expenses taken for development and installation of KMS including non-salary costs attributed to knowledge management and
- the salaries of employees who are assigned specific KM responsibility.

8.1.1 Expenses for knowledge management

The following categories of expenses for KM initiatives can be distinguished:

Hardware. In most cases, KMS will build on an already existing ICT infrastructure. State of the art is a high penetration of networked PCs and departmental or work group file server, data base, resource (e.g., printers, scanners, special hardware), application and Web servers running client-server and Web applications. Dedicated KM suites or organization-specific KMS usually will require one or in larger projects multiple specific *KMS servers* which are used as e.g., *document server, video server, listserver* or *data base server*. The hardware requirements of specialized KMS software are substantial[614]. This is especially true if the more advanced functions such as profiling of participants, semantic text analysis and

613. See section 5.1.1 - "From market-based to knowledge-based view" on page 94.

multi-format and multi-source search functions are to be used. The increased amount of documents and stored communications (e.g., in newsgroups) requires additional *storage capacity*. The establishment of advanced communication channels, such as video conferencing or even audio conferencing, require a modern *LAN network infrastructure* (>= 100 MBit) and, if multiple locations and/or organization-external participants have to be integrated, a *connection to the Internet* that allows for substantial bandwidth. Where a constant participation of mobile employees has to be considered, substantial investments in *mobile technology* (mobile devices, such as cellular phones, palms, laptops, wireless LANs etc.) are required.

Software. There are a large number of vendors that offer *comprehensive KMS solutions* which integrate a bundle of basic functions required to support KM. There is also an abundant market supply with specific *KM tools* which provide added functionality for specific problems. However, both, KMS and tools need *significant customizing* and according to an official of one KMS vendor, it takes 6-9 months to customize an organization-wide KMS solution. Many organizations consequently build their *own solutions* which usually are based on already existing software solutions, such as document management systems, workflow management systems, Intranet solutions and communication systems (see also part C).

Training and education. Needless to say that participants have to be trained to use the new systems although it seems that in many organizations employees are supposed to be computer-literate in the sense that they learn to use new (e.g., office) systems on their own with only minor support.

Literature, conferences, participation in benchmarking groups, consulting. The first step in a KM initiative is usually that "knowledge about KM" has to flow into the organization. Thus, the KM budget is spent on literature, (expensive) reports, the funding of (university) research programs to develop KM concepts, travelling and fees for the participation of members of the organization in KM-related conferences and benchmarking groups and on professional services companies that bring in their knowledge about how to set up a KM initiative.

Organization of KM events. Last but not least, the KM initiative has to be announced and explained to the members of the organization. Many organizations have organized KM events where all the employees interested in the topic could present their ideas, discuss and network (e.g., Siemens, DaimlerChrysler).

In addition to these one-time investments, the following categories for recurring costs can be distinguished:

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614. The author experimented with a Hyperwave Information Server 5.5 and Hyperwave Information Portal 1.0 on a Sun Sparc station with Solaris 2.7. The hardware proved to be insufficient to handle not even the light traffic of one work group with response times for simple accesses to documents in the region of 15-30 seconds.

Software. In this case the category comprises maintenance of organization-specific KM software and regular upgrades of software bought on the market.

Knowledge management overhead. Overhead is calculated for the coordination of the KM initiative.

KMS administration. In a time of increasing danger from hacker attacks, it is important that the assets contained in the organizational knowledge bases are protected from unwanted access and that the communication infrastructure is secure and works reliably.

8.1.2 Expenses for knowledge management staff

Many organizations have assigned special roles for KM staff or even installed separate organizational units. The salaries for these employees form a second important source of expenses for KM. However, there might also be a number of employees who are only partly responsible for KM tasks besides their "normal" work roles. As a consequence, the seemingly easy-to-answer question about the number of employees assigned to KM might be difficult to judge. This is all the more true, the more an organization relies on the more informal, interactive KM instruments, such as communities and expert networks where it is hard to say how much time employees spend on the participation within these groups and networks. However, the estimated number of employees who are formally assigned to KM gives a first rough estimate about what an organization is willing to spend on KM.

8.1.3 Funding

The financing of KM initiatives is in no way different from the financing of other service functions. Basically, there are the following four alternative ways of funding:

1. **Fixed budget**: a separate budget for the KM initiative,
2. **Internal accounting**: allocates costs to functional departments, e.g., considers to what extent each organizational unit shares in the benefits of the KM initiative, participates in communities, accesses KMS or uses specific KM services,
3. **Internal "selling" of KM services**: or judging the functional departments' willingness to pay for KM services,
4. **External "selling" of KM services and products**: e.g., through licenses, consulting or access to KMS.

8.2 Benefits of knowledge management initiatives

In this section, first the intellectual capital approach is presented which provides measures to assess the benefits of KM initiatives (section 8.2.1). Section 8.2.2 discusses an approach to develop knowledge balance sheets and measure knowledge transformations brought about by the application of KM instruments.

8.2.1 Intellectual capital approach

One of the most prevalent questions in the knowledge management area widely discussed in literature and practice is how to determine the value created and the benefits gained by the application of such efforts (e.g., Stuart 1996, 2). Considering the fact that there is still considerable disagreement about what exactly knowledge is or knowledge resources are which have to be managed[615] it is difficult to assess what the results of the application of such a concept would be and especially what the differences to not applying this concept would be. Apart from the traditional measures for firm performance[616], several approaches to this problem can be distinguished, e.g., human resource accounting, the balanced scorecard or the intellectual capital approach (Bontis et al. 1999).

The Intellectual Capital (IC) approach is a general, holistic perspective to the intangible assets—the intellectual capital or knowledge capital—of a company (Sveiby 1987, 1998). The fundament is based on the observation that the market value of a company[617] is usually higher than its monetary and non-monetary assets. The intellectual capital comprises the immaterial values which have been created by intellectual activities (Wiig 1997, 400). Examples for intellectual capital are (Wiig 1997, 1997a, Stewart 1997, for case studies see also Sveiby 1998, 254ff, Chase 1997b, 89ff): human capital, structural capital, customer capital, organizational capital, process capital, innovation capital (intellectual property, intangible assets, see Figure B-77).

Some organizations, the best known probably being Skandia (see Skandia Navigator below) have extended their reports on firm performance to include non-financial indicators, indicators of intellectual capital. Some authors have even suggest to further extend this approach to balance the organizations' intellectual capital books by including "intangible liabilities" which basically denote the opposite of intangible assets such as (Harvey/Lusch 1999, 88): poor product/service quality, poor reputation, inadequate R&D, lack of patents/copyrights, lack of strategic alliances, potential product liability suits from harmed customers or high employee turnover.

Even though the IC approach provides a sound theoretical basis to determine the value of knowledge in organizations, the corresponding methods of measurement are (so far) pragmatic ones. The more abstract the notion of knowledge is, the harder it is to estimate its value. In spite of this and the lack of an exact definition of "intellectual capital" the approach is used widely (Ulrich 1998, 16). Examples for concrete instruments to measure the IC of organizations are:

- the Intangible Assets Monitor (Sveiby 1998, 207ff),
- the Intellectual Capital Navigator (Stewart 1997, 243ff),
- the Skandia Navigator (Skyrme/Amidon 1997, Probst et al. 1998, 327ff),

615. See section 4.2 - "Knowledge" on page 60.
616. For example ROA, ROE or EVA, see also section 8.4.8 - "Impact on the organization" on page 426.
617. The market value of a company is usually determined by the capitalization (value of the shares on the stock market) of a company.

- the Balanced Scorecard (Kaplan/Norton 1996, 1997, Horváth/Kaufmann 1998, Mooray et al. 1999, Dimmeler/Sauer 2000),
- measuring the knower which assesses the meaning of knowledge elements to people with the help of attributes such as context, framing/problem representation, configural effects (Gestalt), temporal context and network externalities (Glazer 1998, 178ff),
- as well as single measures assessing the intangible assets, such as Tobin's q (North et al. 1998, 160f), the IC-index (Roos et al. 1997, cited after Heisig et al. 2001b, 71f) and the Calculated Intangible Value (Stewart 1997, 226ff).

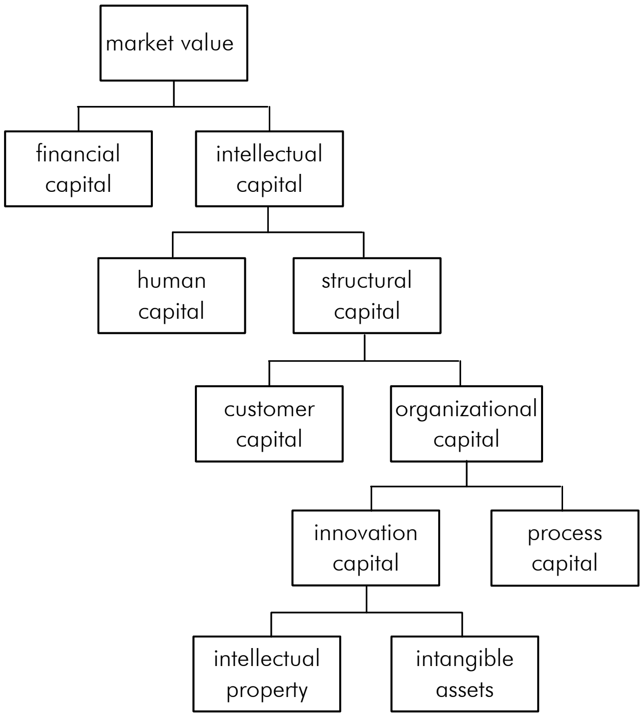

FIGURE B-77. Model of the intellectual capital[618]

8.2.2 Measuring knowledge transformations

Figure B-78 shows a comprehensive framework for the measurement of knowledge and knowledge transformation[619]. Particularly the dynamics, the changes in

618. Source: Wiig 1997, 401.
619. See North et al. 1998, 164; see also Wiig 1999, 161 who developed a similar model and Levett/Guenov 2000 who proposed a set of metrics for KM analysis.

an organizational knowledge base, matter most for a subsequent KM initiative (Amelingmeyer 2000, 176ff).

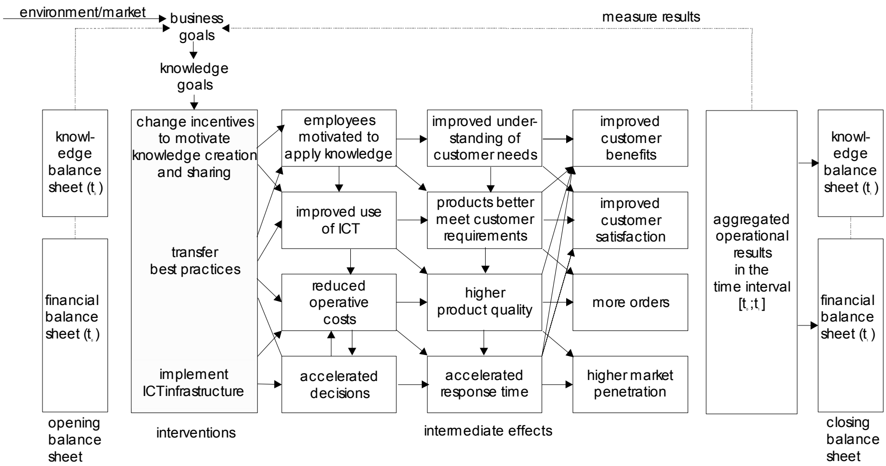

FIGURE B-78. Framework to measure knowledge and knowledge transformations[620]

The existing approaches to measure an organization's intangible assets in general and the success of KM initiatives in particular as briefly reviewed above lack operationalization. Probst et al. simply suggest to measure system use of e.g., an Intranet as part of the operative assessment of knowledge goals (Probst et al. 1998, 336). Other than that, success or failure of a KMS in these frameworks is only assessed at a highly aggregate level, e.g., with respect to measures such as turnover per employee or the share of investments in ICT infrastructure as compared to the organization's total value added, the fluctuation of experts or the share of customers that improve the organization's competencies (also Sveiby 1998, 263). These are all measures that are influenced by the use of KMS, but also by a large number of other interventions into an organization's way of handling knowledge and environmental changes as well.

Thus, the frameworks have to be detailed in order to provide an instrument which can be applied to the assessment of the success of KMS. As KMS are a special group of information systems, the literature dealing with measuring success of information systems provides a good starting point for the development of a more detailed framework to assess the success of KMS.

8.3 Information systems success

This section reviews the literature on IS success measurement (section 8.3.1). On the basis of this literature review, the DeLone/McLean (1992) model for IS success

620. Source: North et al. 1998, 164.

measurement is selected and discussed (section 8.3.2). Finally, some critics and extensions to this model are reviewed (section 8.3.3). The DeLone/McLean model will be used as the basis for the model to measure success of KMS which will be presented in section 8.4

8.3.1 A multi-faceted construct

Success of an information system (IS) cannot be measured directly, but has to be assessed using a number of measures which are relevant for success. Since the 70s, many authors have developed approaches to assess the success of an IS. They suggested a host of variables, indicators and measures. Examples are:

- *user (information) satisfaction*[621] or *system acceptance*[622],
- *user engagement*[623], *user participation*[624] or *user involvement*[625],
- *(perceived) information quality*[626] or *system quality*[627],
- *perceived service quality*: user satisfaction with the information services function (SERVQUAL)[628],
- *usage of IS*[629], *usage to support specific tasks*[630],
- *task-technology fit*[631],
- *success of specialized IS*: impact on individual, group or organizational performance, such as decision support systems[632], group (decision) support systems and group communication support systems[633], office systems[634], creativity support systems[635], computer-mediated communication[636] or end-user computing[637].

The measures as suggested in the literature cover all three levels of measurement—subjective assessment, semi-quantitative assessment as well as quantitative

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621. Zmud 1979, Bailey/Pearson 1983, Baroudi/Orlikowski 1988, Doll/Torkzadeh 1988.
622. Ives/Olson 1984.
623. Hwang/Thorn 1999.
624. Kim/Lee 1986.
625. Zmud 1979, Ives/Olson 1984.
626. Bailey/Pearson 1983, Ives et al. 1983, King/Epstein 1983, Miller/Doyle 1987, Blili et al. 1998.
627. Ives/Olson 1984.
628. Kettinger/Lee 1994, Pitt et al. 1995, Nelson/Cooprider 1996. Many authors refer to an instrument called SERVQUAL originally developed to measure consumer’s perceptions of service quality, see Parasuraman et al. 1988, see also Kettinger/Lee 1994, 745 for an overview of studies using the SERVQUAL instrument.
629. Zmud 1979, Hiltz/Turoff 1981, Srinivasan 1985, Kim/Lee 1986, Straub et al. 1995, Gelderman 1998.
630. Doll/Torkzadeh 1998.
631. Goodhue/Thompson 1995.
632. Sanders/Courtney 1985.
633. DeSanctis/Gallupe 1987, Kraemer/Pinsonneault 1990, Dennis 1996, Chun/Park 1998.
634. Millman/Hartwick 1987.
635. Massetti 1996.
636. Kettinger/Grover 1997, Kock 1998.
637. Blili et al. 1998; an early generalized review of MIS success can also be found in Zmud 1979.

assessment. There are far more variables assessing the perceived quality or usefulness of IS than there are "objective" criteria. If one can assume transferability of the results found in strategic management to IS, it seems, however, that perceptual assessments of IS performance provided by knowledgeable managers have a high level of convergence with objective IS performance measures (Venkatraman/ Ramanujam 1987).

In wide parts of the MIS literature, the system-use construct has been considered as a dependent variable, a success measure (Doll/Torkzadeh 1998, 173). More usage has always been considered desirable. This simple construct provides only a crude measure, though, as it makes no statement about for example the quality of the information retrieved, the perceived usefulness for the individual's work processes and the relation between these perceptions and efficiency on the organizational level. Thus, what is needed is a well-defined dependent variable for IS success (DeLone/McLean 1992, 61).

DeLone and McLean went to the trouble of a comprehensive analysis of all the different streams of research about IS success and proposed an integrated model for information system success (DeLone/McLean 1992). This model is one of the most cited and empirically tested frameworks of IS success[638], in spite of many respecifications and extensions mostly in its original form, probably due to the fact that it is comparably well-defined, theoretically founded and yet simple and easily tailored to specific situations.

In the following, the theoretical foundation of the model is briefly reviewed. According to Shannon and Weaver's well-known mathematical theory of communication (Shannon/Weaver 1949), the output of a communication system can be measured at three different levels: the technical level, the semantic level and the level of effectiveness[639] (see Figure B-79).

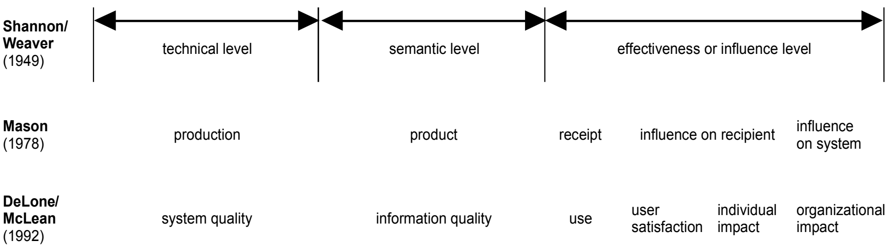

FIGURE B-79. Categories of IS success[640]

638. E.g., Seddon 1997, Ballantine et al. 1998, Garrity/Sanders 1998b, Myers et al. 1998, Wixom/Watson 2001.

639. This distinction resembles the also well-known semiotic levels syntactics, semantics and pragmatics often used to distinguish between data, information and knowledge (Lehner et al. 1995, 222ff, see also section 4.1.2 - "From data to knowledge management" on page 39).

640. Source: DeLone/McLean 1992, 62.

The *technical level* measures the accuracy and efficiency of the communication system that transports the information, the *semantic level* measures to what extent the information can convey the intended meaning and the *level of effectiveness* measures the effect of the information on the receiver.

Mason extended the effectiveness level to include a hierarchy of events taking place at the receiving end. After receiving the information, it influences the recipient and also leads to a change in system performance (Mason 1978, 227). DeLone/McLean build on this idea of a series of events on the receiving end of information, but changed the concepts substantially to fit to the analysis of complex organizational systems.

8.3.2 The DeLone/McLean model

The resulting model of the measurement of IS success is used to classify the abundant variables described in a large number of empirical studies and comprises the following six components (see Figure B-80, DeLone/McLean 1992, 64ff):

System quality. Measures of system quality describe the system itself and comprise criteria such as reliability, response time, resource utilization or system flexibility. The criteria reflect a more engineering-oriented performance evaluation of the system.

Information quality. This category measures the output of the information system, e.g., in the form of reports or search results, such as relevance, accuracy, timeliness, reliability, completeness, informativeness. Most of the criteria used in this component are assessed as perceived by the users, thus this component has a close relationship to user satisfaction and many of the criteria in fact were developed as part of instruments measuring user satisfaction (e.g., the multi-item instrument developed by Bailey/Pearson 1983).

Use. Variables describing the use of IS are among the most frequently applied success measures reported in the MIS literature. Use comprises both, objective criteria such as login times, number of IS functions used as well as perceived measures of use. Even though use seems to be easy to quantify and an objective measure (DeLone/McLean 1992, 68), the construct is not well understood (Goodhue/Thompson 1995, 218) and there are several issues to be considered, e.g.: voluntary versus mandatory use, direct versus chauffeured use, single versus recurring use, intended/appropriate versus unintended use or general use of pre-defined reports versus specific use with personally-initiated requests for information. Moreover, the fit between task and technology characteristics as well as individual characteristics of the person influence the attitude towards utilization, namely the expected consequences of using the system (Goodhue/Thompson 1995, 217).

User satisfaction. User satisfaction is, together with system use, the most widely applied measure of IS success. The popularity is probably supported by the existence of a widely used 39-item instrument developed by Bailey/Pearson (1983), that allows for comparisons to other studies and by the fact that data is easily obtained when compared to other measures. User satisfaction—and also the use—are always related to user attitudes towards computer systems which consequently have to be measured as well.

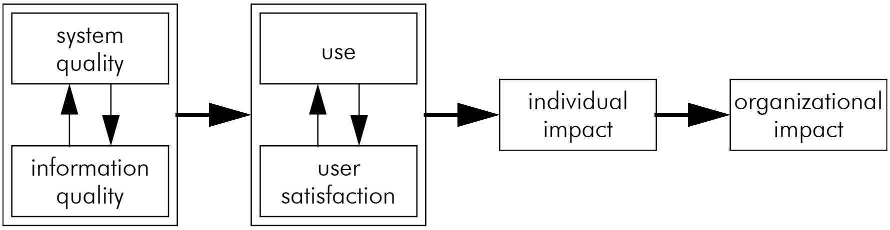

FIGURE B-80. Information system success model[641]

Individual impact. This component is closely related to the performance of an individual, although in the chain of events also encompasses preceding events and thus more than actual performance, e.g., a better understanding of a decision or a better decision productivity. It comprises measures describing to what extent the use of an IS has changed the behavior of individuals. Most of the measures have been developed and applied in controlled laboratory experiments. Examples for measures are decision-making productivity, average time to make a decision, the number of alternatives considered, the confidence in the decision, increased user productivity or willingness to pay for certain IS outputs.

Organizational impact. This component assesses the impact of the use of an IS on the level of the organization (e.g., a strategic business unit, a factory or the entire organization). The challenge for measures on the organizational level is to isolate the effect of the IS from other effects which influence organizational performance, a problem which caused many researchers to avoid this last question even though IS practitioners' interest in the topic is high (DeLone/McLean 1992, 74). Measures used are usually performance indicators, such as overall productivity, organizational effectiveness, and financial measures such as return on investment, return on assets, market share, stock prices[642]. The measures applied for the evaluation of intangible assets (intellectual capital) as described above also fall in this category[643]. They promise variables that are closer to the central goals of the application of KMS, namely the improvement of an organization's way of handling knowledge and thus will be integrated into the model to measure success of KMS.

The success of IS therefore can be assessed by a multitude of measures. It is suggested that one should apply a weighed set of variables from several, if not all

641. After: DeLone/McLean 1992, 87.
642. See also section 8.4.8 - "Impact on the organization" on page 426.
643. See e.g., Sveiby 1998; see also DeCarolis/Deeds 1999 who analyze the impact of knowledge stocks and flows on firm performance.

of the six categories outlined, so that success is a multi-dimensional construct with six interdependent categories. Doll and Torkzadeh also develop a multidimensional construct to measure system-use which they call the system-to-value chain: causal factors -> beliefs -> attitude -> behavior -> social & economic impact. Thus, they argue, one can avoid the shortcomings of a one-dimensional construct.

Figure B-80 also shows that the six categories are interrelated and describe a process view of IS success, a series of constructs which include temporal and causal influences in determining success (DeLone/McLean 1992, 83ff). The first level—system quality and the quality of the system's outputs—are interrelated and jointly and independently affect the second level—use and user satisfaction—which are interrelated as well. Use and user satisfaction directly influence the individual impact which in turn leads to impacts on the organizational level.

8.3.3 Critique and extensions

The clear structuring of the measures and especially the interrelationships hypothesized in DeLone/McLean's model have been subject to repeated criticism. Examples are (Li 1997, Seddon 1997, Ballantine et al. 1998, Garrity/Sanders 1998b, Myers et al. 1998):

Dependent variables. It is unclear which of the categories and especially the variables within the categories are dependent variables in the sense that they describe IS success and independent variables in the sense that they are precedents that influence IS success. This question can only be resolved with respect to a specific application of the model.

Nature of relationships. The nature of the interrelationships between the categories is left open: on the one hand, the model can be seen as a variance model explaining that the measures depend on each other and thus variance in one category causes variance in a dependent category, on the other hand, it can be seen as a process model which explains "events" that trigger each other. Each event in the chain is necessary, but not sufficient for the outcomes to be produced (see especially Seddon 1997 who analyzes this argument in great detail).

Contribution to overall success. It remains unclear to what extent the individual variables in the categories contribute to the overall success of the application of an information system. Also, it is unclear how individual variables influence or depend on each other.

Missing feedback links. As opposed to Mason's (1978) approach, the DeLone/McLean model does not include any feedback loops which could lead to a different use of the system or even change the system itself or its contents. Also, as others have shown, user involvement in the design process of IS impacts system use and user information satisfaction significantly (e.g., Baroudi et al. 1986) and thus has to be accounted for.

Missing consideration of environment. The model is limited to the most direct influences of the application of an IS and thus neglects environmental variables. The environment has to be measured or at least controlled in order to render results of IS success comparable. Examples are: the organization's strategy, the organizational structure, the tasks which are supported by the IS, the fit between tasks and IS as well as the human aspect, e.g., the quality of services provided by IS or IT personnel or departments or individual characteristics of the users.

Organizational impact. This category almost exclusively comprises financial measures which are inappropriate to assess the influence of the application of IS. In the case of KMS, these measures can be extended to cover variables assessing the organization's intellectual capital which are closer related to KMS success than the general financial criteria[644]. Additionally, with the advent of group support systems and the emphasis on work groups, teams and communities, it is suggested to include another construct in between individual and organizational impact: *work-group impact* (Myers et al. 1998).

Several authors have extended the original DeLone/McLean model (e.g., Pitt et al. 1995, Li 1997, Myers et al. 1998), re-specified parts of the interrelationships (e.g., Seddon 1997) or even presented alternative models that follow an entirely different logic (e.g., Ballantine et al. 1998). Ballantine et al.'s 3-D model of IS success can be taken as a surrogate for several attempts to re-specify the DeLone/ McLean model.

Figure B-81 shows this model. IS success in this model is divided into three consecutive levels: the *technically realized system*, the *used information system* and the *effective information system*. The results that are obtained are "filtered" on their way up through the levels. There are three filters: the *implementation filter*, the *integration filter* and the *environmental filter*. Feedback is conceptualized with the help of a *learning cycle* that encompasses all the levels of the model.

Even a short glance to the 3-D model reveals its substantially increased complexity when compared to the original DeLone/McLean model. The same is true for other attempts to re-specify the original model (e.g., Seddon 1997).

The model allows for a much more comprehensive analysis of independent factors influencing IS success and takes into account most of the critique directed at the original DeLone/McLean model. However, it seems questionable whether constructs like a fit between strategy, style, structure, status and culture has any empirical relevance. It is doubtful that enough data can be obtained to populate all the levels and filters in the model and even if it would be possible, it might be an inefficient way to assess an IS's success. Even though the levels seem to clearly differentiate between dependent variables (results of the levels) and independent variables (influencing variables on the levels), to cite a cliché: "the devil is still in the detail". Individual variables depend on each other, even between the levels and

644. See section 8.2.1 - "Intellectual capital approach" on page 400.

contrary to the relationships depicted in the model. Ballantine et al. do not provide measures for constructs as complex as learning cycle, project management, culture or movements of competitors. Even though the model represents a brave attempt to respond to a great part of the critique against the DeLone/McLean model, it still lacks operationalization and raises more new question than it answers.

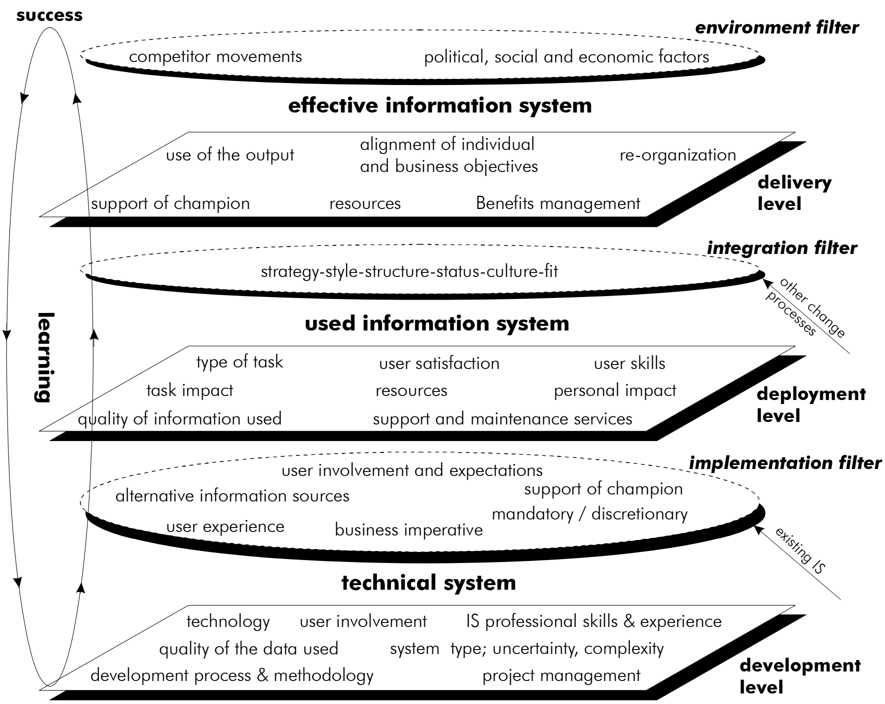

FIGURE B-81. The 3-D model of information systems success[645]

Thus, despite the critique, the DeLone/McLean model—especially in a slightly modified and extended version—still seems a pragmatic basis for empirical investigations because of its simplicity and understandability, the focus on a handful of relevant and relatively clearly structured categories which makes it applicable in practice. In order to apply the model to the measurement of success of KMS, it has to be extended, though.

645. Source: Ballantine et al. 1998, 54.

8.4 Success of knowledge management systems

Figure B-82 shows the model for measuring success of KMS. The model consists of three consecutive levels which correspond to the three levels identified by Ballantine et al. (1998) in their 3-D model[646].

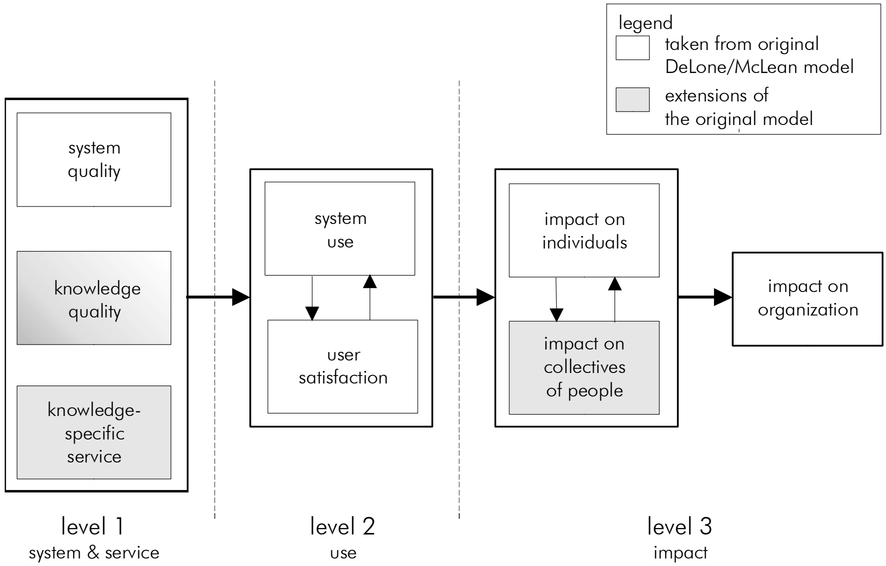

FIGURE B-82. Model of knowledge management systems success[647]

The first level deals with criteria describing the system itself, the quality of the presentation of knowledge as well as the knowledge-specific service, the development level. The second level comprises the usage and the user's satisfaction, the deployment level. The third and last level finally contains criteria to evaluate the impact of the system's use, the delivery level. The white boxes in Figure B-82 show those categories that were taken over from the original DeLone/McLean model. The grey boxes show the categories that were either extended or added to the original model. In the following, the extensions and additions will be discussed.

Knowledge quality. As mentioned earlier[648], KMS differ from IS with respect to the context of knowledge. One example is the documentation of links to other knowledge elements, to experts, users and communities. Thus, the original category "information quality" was extended to include *knowledge quality.*

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646. See section 8.3.3 - "Critique and extensions" on page 407.
647. The figure is based on: DeLone/McLean1992, 87, see also Maier/Hädrich 2001, 6 for a previous version.
648. See chapter 7 - "Systems" on page 273.

Moreover, *communication* is of central importance for the sharing of knowledge between individuals and also in collectives (e.g., teams, work groups, communities). Communication is the defining phenomenon for a memory of groups or organizations: a *transactive memory system* (Wegner 1986, 191). KMS can play the role of a context-rich medium supporting the communication within transactive memory systems. *Information and knowledge quality* was therefore extended to include *communication quality*. Due to the fact that information and communication are considered two sides of the same coin and for reasons of simplicity, the category was simply termed *knowledge quality*. Additionally, the category *system use* was extended to include measures for the assessment of the frequency and extension of communication and measures concerning the impact of KMS on the communicative behavior of teams and communities were also added on the impact level in the category *impact on collectives*.

Knowledge-specific service. Several authors have suggested that service quality is an important factor determining success of ICT in organizations (e.g., Bailey/Pearson 1983, Ferguson/Zawacki 1993, Kettinger/Lee 1994, Pitt et al. 1995, Li 1997). This category is based on the analogy to the customer perspective of organizations which leads to an alternative design of organizations in terms of business processes the goal of which is to improve customer service throughout the organization. Accordingly, the IS/IT function or organizational unit in an organization is viewed as providing IS service for the rest of the organization. Many instruments suggested to measure IS service quality are based on Parasuraman et al.'s (1988) instrument originally developed for the retail industry called SERVQUAL. Service quality measures for example reliability, responsiveness, competence, accessibility, courtesy, credibility of IS personnel. Thus, it is not surprising that several authors have suggested to include service quality into the DeLone/McLean framework (e.g., Li 1997, Myers et al. 1998).

The category *knowledge-specific service*, however, targets a different service unit. Many organizations have established specific roles to support the handling of knowledge in an organization, especially search and retrieval, transfer and dissemination as well as the publication of knowledge, e.g., *knowledge brokers* or knowledge stewards, but also *subject matter specialists*[649]. If designed accordingly, these roles can substantially increase the usefulness of KMS. Thus, knowledge-specific service assesses to what extent specific roles exist that support the participants of KMS in using the organization's knowledge base.

Impact on collectives of people. As discussed[650], collectives of people represent the most important organizational unit for jointly developing, evaluating, sharing and applying knowledge. Apart from traditional work groups, project and virtual teams, it is communities which are in the central focus of many KM initiatives.

649. See section 6.1.2 - "Knowledge management roles" on page 162.
650. See section 6.1.3 - "Groups, teams and communities" on page 177.

Thus, a model for assessing success of KMS has to consider the impact of these systems on the handling of knowledge in social groups, especially communities.

As a consequence, the model consists of eight categories as depicted in Figure B-82. Many more influences on the success of KMS are thinkable as already briefly sketched out[651]. Apart from individual characteristics of the participants, it is in general the *goals*, the *organizational design*, the *organizational culture*, the organization's *business environment* and the *KM instruments* applied in the organization's KM initiative that influence the impact of supporting KMS[652].

Thus, a complete and consistent assessment of a KM initiative or an organization's way of handling knowledge has to take into account a lot more effects which impact success. Many authors have suggested corresponding approaches which all lack operationalization due to the massive amount of variables that would have to be included[653]. The model is restricted to the most direct influences of the use of KMS and thus neglects many of these additional influences. It is seen as a first step towards the operationalization of the approaches to assess the success of KM initiatives in general and should provide a foundation for the systems support part of these initiatives.

The following sections will step by step discuss the eight categories of the model of KMS success. Selected measures will be described for each of the categories. Each measure can be assessed by a number of variables or indicators which are described in detail in the literature. A prior version of the list of measures was co-developed by the author (Maier/Hädrich 2001[654]). 133 measures were selected based on an extensive literature research[655] and another 105 measures were added with the help of the literature on KM and KMS as well as the results of the empirical study (especially the interviews) as described in part C. In the following, a subset of these measures will be discussed which seems to be most critical for KMS success.

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651. See section 8.3.3 - "Critique and extensions" on page 407.
652. See also the research model used as the basis for the empirical study in part C which encompasses all these influences.
653. See also section 8.2 - "Benefits of knowledge management initiatives" on page 399.
654. A comprehensive overview of variables and links to the corresponding literature where these variables and their operationalization with the help of instruments to measure the variables have been defined and empirically validated can be found in Hädrich 2000.
655. The literature research was based on the extensive literature review documented by DeLone/McLean for the literature up until 1992. The journals *Management Information Systems Quarterly*, *Decision Sciences*, *Information Systems Research*, *Information & Management*, *Communications of the ACM*, *Management Science* and the journal *Wirtschaftsinformatik* were searched for recent additions. The variables were mostly applied to Management Information Systems, MIS, decision support systems, DSS, group support systems, GSS, group decision support systems, GDSS and communication systems, such as email or voice mail. The selection of measures was based on two criteria: (a) *citation*: the variables were repeatedly applied in a cumulative manner and (b) *empirical validation*: they were empirically tested in field studies. These two criteria should support the applicability of the resulting measures in practice.

8.4.1 System quality

This category comprises variables which assess the processing system itself, in this case a KMS. The measures reflecting system quality of IS are generally technical, performance-oriented, engineering criteria (DeLone/McLean 1992, 64). As the focus is on one specific class of systems, measures can be added which specifically assess the quality of KMS functions. Table B-22 gives an overview of the most important measures for an assessment of integrative KMS, measures for interactive KMS and of measures which can be applied to assess both types of KMS.

TABLE B-22. Measures for system quality

integrative KMS	interactive KMS	both
• efficiency of support for the publication of knowledge • orientation/quality of visualizing context and structure • quality of the presentation of search results • quality of the design of feedback about contents • integration of knowledge sources • quality of the support for dynamics of contents • quality of search engine	• quality of communication media • design and number of communication channels • perceived social presence • ease of feedback • quality of the support for community-workspaces • quality of search for experts	• response time • ease of use • complexity • flexibility • reliability • availability/accessibility • quality of documentation • quality of integration of functions • resource utilization • support for multiple languages

Integrative KMS have to basically provide functions for the publication, search, retrieval and maintenance of knowledge elements in knowledge repositories. The measure *orientation/quality of visualizing context and structure* shows a close link to the category information, knowledge and communication quality. The KMS has to provide functions to support participants' *navigation* in the knowledge elements (e.g., mindmaps, hyperbolic browser[656]) and the *restriction* of the abundance of knowledge elements to a portion that is relevant for the participant in order to avoid information overload (e.g., oriented on the business process or the topic in or on which the participant works). The latter effect is closely coupled to role models of different types of users which should be supported by the KMS. The measure *integration of knowledge sources* assesses to what extent the KMS spans knowledge sources with different architecture or formats (e.g., internal documents on file servers, Lotus Notes data bases, the organization's Intranet, the WWW or external on-line data bases) and supports the user in accessing all these systems (e.g., registration, authentication, translation of search terms and logics). The measure *quality of the support for dynamics of contents* assesses to what extent the

656. See 7.3.3 - "Integrating architectures for KMS" on page 311.

KMS helps for example participants to find new documents, authors to update their knowledge elements, information subscriptions that notify participants about new or updated knowledge elements within their area of interest. There are a number of measures to assess the *quality of a search engine* or an information retrieval system respectively which basically relate the number of documents found that are deemed relevant to the number of documents that were not found, found and irrelevant or not found and irrelevant (referred to as the *Cranfield model* of information retrieval evaluation, see Harter/Hert 1997, 8f and 27ff for a discussion of the evaluation of Internet search engines and extensions of this traditional model).

Quality of **interactive KMS** is assessed with the help of the measure *quality of the communication media*, e.g., reliability, exactness and clarity of the medium as well as design and number of communication channels. Additionally, *social presence* theory can be applied to assess whether the communication medium is able to convey a trustful, personal, warm, sociable, sensitive atmosphere (Short et al. 1976, 64ff, Kettinger/Grover 1997, Karahanna/Straub 1999). *Ease of feedback* aims at the KMS's support of spontaneous answers which are often crucial for the close interaction necessary for sharing knowledge (Kettinger/Grover 1997). There is an analogous measure in the area of integrative KMS which reflects the option to easily give feedback to contents of a knowledge repository.

There are a number of measures that can be applied to the assessment of **both types of KMS**. Most of these measures were already suggested for general IS, such as *response time*, *ease of use* which assesses e.g., the number of errors regularly made, perceived *complexity of the system* etc., *reliability* and *accessibility*, e.g., of communication media or of integrated external knowledge sources. *Support for multiple languages* is of increasing importance in organizations where there might be one or even more than one organization-wide language, but there might still be abundant knowledge elements and communication in often multiple local languages as well.

8.4.2 Knowledge quality

This category describes the quality of the contents and/or the output of KMS rather than the quality of the system performance and the functions provided. It covers the knowledge stored, distributed and presented by the KMS (e.g., search results, experts found for a given topic) as well as the communication that is mediated by the KMS. The original measures for IS success are assessed from the perspective of the user, thus it is not surprising that many of the variables were developed and applied in instruments to measure user satisfaction (e.g., Bailey/Pearson 1983). Table B-23 shows the most important measures for this category.

The quality of the information and knowledge provided by **integrative KMS** assesses the quality of knowledge elements, the *structuring*, *linking* and the *meta-knowledge* of knowledge elements as well as *participants' confidence* in the knowledge presented. It is also important that the *context* of knowledge elements in the system corresponds to the context held by the members of the organization. As an example the context realized in the KMS might be a concrete business process, a project, an important research topic or an area of competence and this context must reflect the mental models of the participants. In a concrete evaluation, one could study for example to what extent participants think that the context can provide a productive limitation of search results. *Completeness or sufficiency of the knowledge base* can be assessed e.g., using participants' perceptions or comparing the quantity of the documents and links contained with a reference system (e.g., the KMS of a benchmark leader, detailed with respect to e.g., topics).

TABLE B-23. Measures for knowledge quality

integrative KMS	interactive KMS	both
• quality of the content of knowledge elements • quality of context correspondence • quality of knowledge structure and linking • quality of meta-knowledge • confidence in knowledge elements • completeness/sufficiency of knowledge base	• quality of expert profiles and skills directories • structure of newsgroups and discussion lists • quality of contents of community-services/community work spaces • timeliness of answers • confidence in communicated knowledge	• understandability (e.g., of knowledge elements, expert profiles or skills directories) • reliability of contents • currency • accuracy • conciseness • relevance • quality of format • quality of relevance valuations

The assessment of **interactive KMS** is a challenging task as contents of communication are difficult to evaluate. Moreover, there are legal barriers in several countries, e.g., the Austrian or German data privacy law (e.g., Höller et al. 1998, 289ff). However, *expert profiles* and *skills directories* can be assessed as well as *work spaces* to support communities and the *structure of* platforms for multilateral communication, such as *newsgroups* or *discussion lists*. These instruments are believed to provide means for preparing or initiating communication between knowledge seekers and knowledge providers. One important measure might be the perceived *timeliness of answers* of participants in general and experts in particular which reflects an important part of the organization's routines and culture. In analogy to *confidence in knowledge elements* within the integrative KMS, the measure *confidence in communicated knowledge* generally assesses trust in knowledge sharing. KMS can help to provide trust by making the competencies of a knowledge provider visible to the knowledge seekers.

Both types of KMS can be assessed using general measures of information quality, such as *understandability*, *currency*, *accuracy*, *conciseness*, *relevance*, the *quality of the format*. Whereas these measures are used to assess documented knowledge in the case of integrative KMS, they can be applied to expert profiles, skills directories and—in part—also to messages transported by the KMS. An example for the latter is the quality of format that measures to what extent the KMS helps the participants to structure their responses, automatically link them or suggest links with relevant knowledge elements, such as a glossary or similar cases etc. The *quality of the valuations of relevance* could be oriented towards certain types of users, e.g., novices versus experts, general versus specific knowledge, abstract/scientific versus narrative knowledge[657].

8.4.3 Knowledge-specific services

The measures in this category assess the success of the knowledge-related services in an organization which are produced by specialized employees in the roles of e.g., knowledge brokers or subject matter specialists with support of the KMS. The service should support the participants in handling knowledge with the help of the KMS. The literature provides a number of criteria for the evaluation of IS services[658]. The criteria have to be adapted to knowledge-specific services. Table B-24 presents a number of measures to assess knowledge-specific services.

TABLE B-24. Measures for knowledge-specific services

integrative KMS	interactive KMS	both
• quality of support of knowledge publication • quality of refining/ repackaging knowledge • quality of support of knowledge search • quality of distribution of knowledge elements • quality of maintenance of knowledge base (e.g., archiving/ deletion of obsolete knowledge elements, maintenance of knowledge structure)	• quality of communication support (e.g., help with selection and use of communication channels) • quality of support for communities (e.g., moderation and structuring of discussion lists, cross-postings) • quality of support for the development of expert profiles and skills directories	• transparency of services • reliability of services • responsiveness/promptness • availability of personnel • assurance (credibility, competence, courtesy of personnel, communication, security) • empathy (understanding/knowing KMS participants) • ability to motivate participants • quality of training and education • one-on-one consultations or helpline • appropriation support • integration of knowledge-specific services into KMS • error recovery (time to correct errors in KMS) • time required for new developments/changes to KMS

657. See also the types of knowledge distinguished in section 4.2 - “Knowledge” on page 60.
658. See e.g., Ferguson/Zawacki 1993, Pitt et al. 1995, Myers et al. 1998, 105f, Guimaraes et al. 1999; see Parasuraman et al. 1985 and 1988 for the SERVQUAL instrument; see also

In the case of **integrative KMS**, the quality of services to support *publication*, *refinement*, *distribution* and *search of knowledge elements* could be assessed as well as the *maintenance of the knowledge base*. In many organizations, subject matter specialists are involved in the publication process for example (a) to identify participants who could potentially publish knowledge interesting for a larger group of knowledge seekers, (b) to support authors to document, structure and link their knowledge, (c) to assess and improve the quality of documents and (d) to notify potentially interested knowledge seekers of the new documents. Knowledge brokers play an important role to improve the efficiency of participants who search the KMS for knowledge. Last but not least, a knowledge base requires continuos attention in order not to loose focus, to adapt the structure to cover new topics and to remove knowledge elements that are not needed anymore.

In the case of **interactive KMS**, the quality of knowledge-specific services to *support the communication* between knowledge seekers and knowledge providers can be assessed, e.g., helping to develop expert profiles and skills directories, initiating communication, demonstrate and help to select communication media and help with using new communication media (e.g., video conferencing). So-called community managers are responsible for the moderation and structuring of discussion lists and newsgroups, cross-posting of contents interesting for other communities and the like.

A number of more general measures (adapted from the SERVQUAL instrument and its extensions, see above) can be applied for **both types of KMS**, e.g., *reliability*, *responsiveness*, *transparency*, *availability* and *understanding* of specialized employees providing knowledge services, *consultations* or a *helpline*. *Assurance* means that the specialized employees providing knowledge services manage to instill trust and confidence of participants in their services. It is also important that specialized employees *motivate participants* to actively use the KMS, publish knowledge elements, engage in discussions, ask and answer questions and the like. As the installation of KMS often requires a substantial change in the ICT infrastructure, the quality of the training to use the KMS provided for the participants is an important factor determining success of the KMS's use. More generally, the KMS service should *support appropriation*, e.g., through guidance, facilitation, norms and policies as well as specific training so that KMS are used appropriately (Dennis et al. 2001, 173). One example is the moderation of communities, newsgroups or discussion data bases.

Also, knowledge-specific services should be as much *integrated into the KMS* as possible, e.g., the moderation of communities, but also the support of knowledge publication or search should be mediated by the KMS. Last but not least, the knowledge-specific service is responsible for *correcting errors*, for *new developments* and for *processing change requests* to the KMS.

8.4.4 System use

System use is probably the most frequently assessed category both in conceptual models as well as empirical studies measuring IS success[659]. System use comprises many measures which, at least theoretically, can be easily quantified and automatically recorded with the help of a system monitoring. However, there has been an intensive debate about whether the use of a system is a good indicator for success (for counter-arguments see e.g., Doll/Torkzadeh 1998, 172f, Gelderman 1998, 12ff). System use is a necessary determinant for IS success, but not a sufficient one. The system use construct might at best help to identify the most unsuccessful systems. However, quantitative data about the frequency and duration of system usage without further detailing the extent, intensity and the tasks for which the system was used carry little value and the results are subject to misinterpretation (Gelderman 1998, 12f).

Thus, the measures assessing system use have to be detailed for the use of KMS (see Table B-25). Generally, KMS can be used actively (e.g., publishing, contributing to discussions, answering, valuing, commenting) and passively (e.g., searching, reading discussions). The ratio between participants actively and passively using KMS is an important criterion for a KMS successfully stimulating interaction and, as a consequence, knowledge sharing between participants.

An assessment of the use of **integrative KMS** could evaluate the *frequency*, *regularity*, *duration*, *intensity* and the *extent* of the *direct* and *chauffeured use* of specific KMS functions and knowledge-specific services for the *publication*, *distribution*, *access of* and *feedback to knowledge elements*. The measure *use in support of horizontal integration* describes to what extent the KMS are used to coordinate activities or knowledge sharing within the work groups, teams or communities. The *use in support of vertical integration* comprises to what extent KMS are used along the hierarchy and thus for coordination and knowledge sharing with superiors/subordinates (Doll/Torkzadeh 1998). One important group of measures assesses the dynamics of an organizational knowledge base, to what extent KMS are used and the knowledge-specific services contribute to *actuality, refinement and repackaging of knowledge elements*.

The use of **interactive KMS** can be assessed with analogous measures focusing communication and interaction between knowledge seekers and knowledge providers and in communities. Examples are the *number of emails sent, received or forwarded* which can be detailed according to the *type of usage* (e.g., in task-related, social and broadcast use of email, Kettinger/Grover 1997, 517ff), the *relationship between sender and receiver* (e.g., within work group or team, in communities, along hierarchy), with respect to the *type of message* (e.g., questions, answers, valuations, voting, scheduling meetings, announcing events, reports, new knowledge elements or links to experts), *contributions to newsgroups*, the *communication acts* that use KMS, such as video conferencing, audio conferencing, chat or instant messaging and finally the use of interactive KMS to *locate experts* or *search skills directories*. A purely quantitative assessment cannot be recommended as it is the

659. See DeLone/McLean 1992, 66; see also e.g., Zmud 1979, Hiltz/Turoff 1981, Srinivasan 1985, Kim/Lee 1986, Finholt et al. 1990, Rice/Shook 1990, Straub et al. 1995, Kettinger/Grover 1997)

(type of) contents that are communicated, the actuality and relevance of the knowledge shared, that count. The interaction in communities can be assessed with respect to the *focus* or the *range of the discussions* and knowledge exchange going on, the *evenness of contributions*, that is the distribution of activity in the community (e.g., by grouping members of the community with respect to their levels of activity).

TABLE B-25. Measures for system use

integrative KMS	interactive KMS	both
• use for knowledge publication (e.g., number/size of knowledge elements published per topic) • use for knowledge-search and retrieval (e.g., number/size of knowledge elements accessed per topic) • use for knowledge distribution (e.g., number of information subscriptions per topic) • use in support of maintaining quality of knowledge elements and structure (e.g., actuality, number of refined/ repackaged knowledge elements, number of changes to knowledge structure) • use in support of horizontal/ vertical integration • use in support of feedback to knowledge elements (e.g., number of comments)	• number/type of task-related, social, broadcast messages sent/ received/forwarded • number/size of contributions in newsgroups, discussion lists • number/type of communication acts per communication medium (e.g., audio-/videoconferencing) • percentage of employees with profiles in skills directories • number of profiles accessed • use in support of horizontal/vertical communication or communication within communities • use in support of locating experts and skills • use in support of feedback (e.g., number/focus of responses to questions) • evenness of participation • focus/range of communication (especially in communities)	• number of users • regularity of use • intensity of use • extent of use (e.g., use of certain KMS functions or contents, levels of use) • frequency of past, intended, voluntary use • frequency of direct/chauffeured use • duration of use • use of KMS by business partners (e.g., customers, alliances, suppliers)

As already mentioned above, the more general measures such as the *number of (active and passive) users*, the *frequency*, *regularity*, *intensity*, *duration* and *extent of use* can be applied to assess **both types of KMS**. Last but not least, the *use of KMS by business partners* can be evaluated as well and the share of external versus internal users gives an indication of the openness of the KMS to organization-external users and topics.

8.4.5 User satisfaction

Similar to the category *system use*, *user satisfaction* is assessed frequently in the literature. One of the best known and most applied instruments to measure user (information) satisfaction is the one originally developed by Bailey/Pearson (1983) and shortly after improved (shortened) by Ives et al. (1983, 789ff)[660] as well as the similar instrument developed for the area of end-user computing by Doll/Torkzadeh (1988)[661]. The instruments are quite extensive: Bailey and Pearson's instrument comprises 39 variables (Bailey/Pearson 1983, 539ff), Doll and Torkzadeh's consists of 12 variables (Doll/Torkzadeh 1988, 266ff). However, most of the variables in these instruments fall into the categories (perceived) *information* and *system quality* and *service quality* and thus were discussed in the corresponding categories[662]. In other words, these variables assess user satisfaction indirectly. In the following, those variables will be discussed which *directly* assess user satisfaction as well as a couple of variables measuring the perceived participation and control of users in the KMS's design (see Table B-26).

TABLE B-26. Measures for user satisfaction

integrative KMS	interactive KMS	both
• satisfaction with the publishing instruments & procedures • satisfaction with knowledge search functions • knowledge satisfaction: difference between knowledge elements needed and amount of knowledge elements received • satisfaction with knowledge elements presented in KMS (contents and structure)	• satisfaction with communication media • satisfaction with interactions in communities • satisfaction with functions and contents supporting the location of experts/knowledge providers	• overall satisfaction • positive attitude towards KMS • realization of expectations/ demand for redesign • perceived utility • demand for redesign • satisfaction with interface • satisfaction with knowledge-specific services • understanding of KMS • enjoyment • feeling of participation • feeling of control over KMS developments/changes

Satisfaction with **integrative KMS** can be detailed according to the main functions that are supported by the systems, namely publishing and accessing knowledge elements. Furthermore, participants can be asked for their satisfaction with the contents of the KMS as well as the knowledge structure and visualization of links. *Knowledge satisfaction* describes in analogy to information satisfaction the difference between knowledge needed and the amount (and also the quality) of knowledge elements received (e.g., Olson/Ives 1982, 51).

660. See also Zmud 1979, Ives/Olsen 1984, Baroudi et al. 1986, Baroudi/Orlikowski 1988, Li 1997, Blili et al. 1998.
661. See also its applications, e.g., in Igbaria/Tan 1997, McHaney/Cronan 1998, Downing 1999.
662. See sections 8.4.1 - "System quality" on page 413 and 8.4.3 - "Knowledge-specific services" on page 416.

In the case of **interactive KMS**, *satisfaction with communication media* assesses to what extent the communication needs of participants (bilateral as well as multilateral) are met by the KMS. Also, the *satisfaction with interactions in communities* assesses how well participants think that the existing communities serve their needs for sharing, evaluation and development of knowledge. A third group of measures within interactive KMS assesses the satisfaction with functions and contents of *expert locators* and *skills data bases*.

In addition to these specific variables, there is a large group of measures taken from the instruments to measure user satisfaction as mentioned above that can be applied to measure **both types of KMS**. Apart from the *overall satisfaction* these measures assess the involvement of the participant in design and management of the KMS (Franz/Robey 1986, 351ff), specifically whether the participants' *expectations were fulfilled*, whether the participant has a *positive attitude towards the KMS* (Winter et al. 1998), whether he or she could *participate in the design of the KMS* and *feels to control developments or changes made to the KMS*.

Furthermore, *satisfaction with knowledge-specific services* across integrative or interactive KMS can be assessed. Another group of measures targets the *usefulness of the KMS* for participants' tasks (also Franz/Robey 1986, 353f) and the *understanding of the system* and even assess whether the participant enjoys to use the KMS.

8.4.6 Impact on individuals

There is a substantial amount of literature dealing with the question of how the use of IS impacts individual behavior[663]. Most of the measures in this category assess the perceptions of individuals about the impact of the use of IS in general and KMS in particular on their behavior and performance (mostly decisions and productivity in performing a specific task). The majority of these measures have been empirically tested in laboratory situations (DeLone/McLean 1992, 74).

In those cases where "objective" measures were applied, the tasks or problems were predefined and thus the quality of the results (e.g., decisions, task performance) could be judged straightforwardly. However, it will be challenging to translate these measures into "real world complexity", especially with respect to KMS where problems—and solutions—tend to be unique and thus it will be difficult to define a "reference task" which could be used to objectively measure performance. Therefore, the evaluation will have to rely in large parts on participants' perceptions of the impact of KMS on their individual performance (see Table B-27).

In the case of **integrative KMS**, the *impact on capabilities for unaided publication of knowledge* as well as the *impact on capabilities to access knowledge elements* measure new ways to access knowledge from a variety of sources and new

663. See e.g., Millman/Hartwick 1987, Rice/Shook 1990, Massetti 1996, Kettinger/Grover 1997, Blili et al. 1998, Igbaria/Tan 1998, Lucas/Spitler 1999 and the 39 sources cited in DeLone/McLean 1992, 76ff.

ways to publish knowledge potentially relevant for other participants. Examples for measures are autonomy (e.g., access or publication possible with the help of a specialist, with the help of another participant or without any help, Blili et al. 1998, 149), the number of knowledge sources accessible, privileges for knowledge publication and distribution as well as the ease-of-use of the KMS to publish knowledge and retrieve relevant knowledge from various sources. The actual *impact on the access to knowledge* can be measured in terms of speed, e.g., time required for access or publication, amount of KMS output that has to be processed in order to get to the knowledge elements needed, number of clicks needed (there are a number of variables defined in the literature measuring both, speed of access and ease of information retrieval, e.g., Blili et al. 1998, 151). Finally, a good knowledge structure, visualization and profiling might result in a *reduced feeling of information overload* because the KMS present the right amount of information targeted at participants' information needs.

TABLE B-27. Measures for individual impact

integrative KMS	interactive KMS	both
• impact on participants' capabilities to publish knowledge elements • impact on participants' capabilities to access knowledge elements • impact on actual access(es) to knowledge elements • impact on feeling of "information overload"	• impact on individuals' communication capabilities • impact on communication behavior (e.g., response time for emails, use of alternative communication channels) • impact on locating knowledge producers/ appliers/experts	• impact on creativity (e.g., number, novelty and value of ideas) • impact on personal productivity (time savings) • impact on decision making (e.g., time, confidence, number of alternatives) • impact on autonomy • impact on awareness of importance of systematic handling of knowledge • willingness to pay for KMS use

Interactive KMS impact participants' *communication capabilities* e.g., by adding communication channels or by pre-formatting and supporting electronic conversation. These new capabilities might influence the actual *communication behavior* which can be measured e.g., by the response time for emails, the number of alternative (new) communication channels used, the perceived appropriateness of communication channels for predefined communication aims. Finally, the support of interactive KMS in *locating knowledge producers, experts or other knowledge appliers* to exchange know-how is assessed using measures such as the amount of time required to locate an expert in a given topic or to answer a specific question or the number of knowledge appliers with a similar background and/or application context found in a certain amount of time.

For **both types of KMS**, the impact on specific aspects of the way individuals handle knowledge can be studied. The *impact on creativity* and thus the creation of knowledge can be assessed e.g., as a perception (peer estimation) or as the number and the perception of novelty and value of ideas generated (Massetti 1996, 87). The influence on task completion and on decisions were the two most studied of all the measures applied in empirical studies to assess the impact of IS on individual behavior (DeLone/McLean 1992, 76ff). The *impact on personal productivity* can be assessed using e.g., the time required to complete a (predefined) task or the improvement in personal productivity for specific tasks (e.g., the staffing of a new project).

There are a number of variables measuring the *impact on decision making*, e.g., the time to make a decision, the confidence of the individual in the decision, the speed, extent and quality of decision analysis (e.g., the number of alternatives generated and/or considered, the accuracy of interpretations), the quality of the decision (e.g., accuracy of forecasts) or, generally, the perception of the individual that the use of the KMS has led to changed or new decisions. The use of KMS might also influence (perceived) functional *autonomy* of a position (e.g., Blili et al. 1998, 151).

One of the more subtle influences of KMS might be a change in participants' *awareness of the importance of a systematic handling of knowledge* (e.g., avoiding unnecessary double developments or the "not invented here" syndrome, importance of trust in and help for other departments/work groups or speed up distribution and realization of ideas). Last but not least, participants might be asked what they would be *willing to spend* for their participation in communities, for the use of the expert locator, skills data bases or knowledge repositories in general or for individual KMS outputs in particular (e.g., search results, reports).

8.4.7 Impact on collectives of people

Participants work in social groups or collectives, such as work groups, project or virtual teams and more recently in communities. Although there is increasing interest in the implementation of communities in organizations, there is still a lack of reports on the impacts of KMS on this new organizational instrument to support knowledge development, and especially knowledge valuation and distribution (e.g., Ferrán-Urdaneta 1999). However, there are a number of approaches in the literature dealing with the effects of group support systems or group decision support systems on the performance and culture of groups, teams or more generally collectives of people[664]. Group performance can be assessed with the same measures as applied for individuals, e.g., impact on creativity, productivity, decision making, autonomy as well as satisfaction[665]. Generally, these measures should be positively influenced if the ICT systems (no matter whether GSS or KMS) fit the tasks of the group or community and if the group uses the technologies appropriately which

664. For an overview see e.g., DeSanctis/Gallupe 1987, Kraemer/Pinsonneault 1990, Dennis 1996, Chun/Park 1998, also Reagan/Rohrbaugh 1990, Kamel/Davison 1998, Kwok/ Khalifa 1998, Shirani et al. 1998, Gibson 1999, Huang et al. 1999, Dennis et al. 2001.
665. See section 8.4.6 - "Impact on individuals" on page 421.

can be supported e.g., through guidance, facilitation, restrictiveness or appropriation training (Dennis et al. 2001, 172ff).

However, one has to be careful in the application of measures developed to assess group performance for communities. This is especially true for variables measuring the impact of IS on the group's productivity or decision making. As opposed to teams or work groups, communities lack a common task and regularly do not decide as a collective (e.g., Ferrán-Urdaneta 1999). Also, the knowledge developed and distributed in communities might or might not be aligned with the organization's goals making it even more difficult to conclude from a positive impact on communities to a positive organizational impact. Table B-28 gives an overview of the most important measures in this category.

In the case of **integrative KMS**, groups and communities might have a positive influence on the *contextualization of knowledge elements*. Groups or communities with their similar interpretation, background and shared history ease the interpretation of knowledge elements developed within and for the group or community. The positive effects of shared context for interpretation and sharing of knowledge are not restricted to integrative KMS. Sharing knowledge within a community also aids to build *confidence in the knowledge elements* (e.g., Ferrán-Urdaneta 1999).

TABLE B-28. Measures for impact on collectives of people

integrative KMS	interactive KMS	both
• impact on contextualization of knowledge elements • impact on confidence in knowledge elements	• improved quality of communication in groups/communities • impact on interactions in communities (knowledge creation and sharing) • confidence in communication • activity (active participation of members in communities) • thoroughness of (virtual) meetings	• impact on group/team productivity • impact on group/team decision making • impact on members' attitudes towards the group/team/community • impact on group/team autonomy • impact on group/team/community consent • impact on group/team/community creativity • impact on social structures • impact on integration of members of collectives (e.g., communities) • impact on valuations of knowledge in communities

The use of **interactive KMS** can have a positive impact on the *quality of communication* (e.g., Finholt et al. 1990, Kock 1998) which could be measured e.g., as the perceptions of members of a community whether contributions to discussion lists and newsgroups have improved because of the use of a KMS. The *impact on knowledge creation and sharing* measures e.g., the number, novelty and value of ideas developed in communities or groups (Massetti 1996), the speed of distribution of ideas, the response time for questions to be answered in newsgroups, especially in communities, but also the type of knowledge created or shared, e.g., social knowledge. As with integrative KMS, communities and groups might have a positive impact on *confidence in communication*, e.g., contributions to discussions, answers or lessons learned. It is closely related to the rate of *activity* of members' participation in the communities, e.g., measured by the percentage of members that regularly contribute to discussions or the number of knowledge transactions performed in the community (e.g., requests, revisions, publications and references, Adams/Freeman 2000, 42f). Interactive KMS can also be applied to support virtual or electronic meetings, e.g., using multi-point audio- or video conferencing or chat. The effectiveness of these meetings can be measured in terms of *thoroughness and focus of the discussions* as well as the *quality of the moderation* in the meetings[666].

The measures listed in the column for **both types of KMS** are probably more influenced by the interactive KMS then by the integrative KMS as most of them rather build on direct interaction between group members. In many cases collectives of people will use both, integrative and interactive KMS together in order to support their (individual or group) tasks so that it seemed appropriate to move the general measures taken from GSS research to be applicable for both KMS. *Consensus* in collectives of people can be measured e.g., by the total number of positions members were away from the most agreed-upon policy (see e.g., Shirani et al. 1998, 235, Huang et al. 1999 and the literature cited there) or in this case the most agreed-upon knowledge element. In analogy to the impact on decision making on the individual level[667], *group decision making* might be affected by KMS resulting in e.g., a deeper analysis of the decision problem, the generation of more and/or better alternatives or ideas, more active involvement of group members, a better understanding or comprehension by and more interaction between the members of the group, positively or negatively affect confidence in and satisfaction with the decision (e.g., Chun/Park 1998, Kwok/Khalifa 1998, Dennis et al. 1999).

The use of KMS can also have effects on the *attitudes of members towards the group or community* which can be measured e.g., by assessing the satisfaction with the group or the willingness to work with the group or participate in the community (e.g., Kraemer/Pinsonneault 1990, 378) The *impact on social structures* in groups comprises phenomena such as group cohesion, collectivism, personal and cultural tensions, removing of communication barriers, group pressure, normative, social and intellectual influences, domination of discussions, perceived status differences of members or the degree of anonymity (also Kamel/Davison 1998, Gibson 1999, Huang et al. 1999, Karahanna/Straub 1999, 242). Additionally, KMS use might have an impact on the size of communities, the attitudes towards membership and on the process of *integrating (new) members in the community.*

666. See also section 8.4.3 - "Knowledge-specific services" on page 416.
667. See section 8.4.6 - "Impact on individuals" on page 421.

8.4.8 Impact on the organization

As opposed to the large number of approaches in the literature analyzing the individual impact of IS and the influences on the group level, the organizational impact has not received equally high attention in the literature[668]. This is due to the significant challenges that are required for the isolation of organizational impacts due to the use of an IS from the abundance of other factors that influence organizational performance[669].

As a consequence, most of the studies assessed the impact of overall IS or IT investments on firm performance instead of the performance implications of an individual IS. Overall IS or IT investments were measured in terms of e.g., total IS budget, also as a share of other variables, such as total sales; the number or share of IS employees or details about what the budget is spent on. Examples for performance indicators used are

- *sales performance*, e.g., total sales or market share,
- *financial firm performance*, e.g., operating costs; economic value added (EVA), divided by sales, general and administrative expenses; return on assets (ROA); return on capital employed (ROCE), return on equity (ROE); return on investment (ROI); return on sales revenue (ROS) or share prices and
- *indirect or intermediate performance indicators*, e.g., labor productivity or asset turnover.

Additionally, there are studies that suggest to use the subjective perceptions of the (strategic) benefits achieved by an IS or IS project (see e.g., Mirani/Lederer 1998 who asked IS professionals to estimate the benefits of their projects). The effects on cost and benefits on the organizational or strategic level are very high on the agenda of CKOs and CIOs and every practitioner interviewed as part of the empirical study described in part C was concerned with some form of cost/benefit analysis to justify expenses and demonstrate explicit value creation or cost savings stemming from the use of a KMS.

The effects of KMS use on the organizational level are difficult to measure, apart from some crude measures such as time and money savings for avoided travelling, saved costs for the access of external on-line data bases or participants' perceptions of the quality of KMS and its impact on business performance. One promising direction might be the intellectual capital approach which at least concentrates on knowledge-related organizational performance. Thus, effects can be easier attributed to KMS use than in the case of the general financial indicators. Table B-29 presents a set of measures to assess the organizational impact of KMS.

Business partners, especially customers, might have to pay for accessing **integrative KMS** and thus generate *additional profits*. Several professional services

668. See DeLone/McLean 1992, 74 and Prattipati/Mensah 1997, Mirani/Lederer 1998 and the literature cited in these articles, also Nelson/Cooprider 1996, Rai et al. 1996, Kettinger/Grover 1997, Hoopes/Postrel 1999, Li/Ye 1999.

669. See e.g., Lincoln 1986, 26 for a good example; see also section 8.3.3 - "Critique and extensions" on page 407.

companies have already started to charge their customers for accessing their knowledge repositories. The use of knowledge maps and knowledge structures as well as the authentication of knowledge documents might improve the *visibility of knowledge structures* and—together with the counterpart on the side of interactive KMS, the *visibility of knowledge networks*—support the identification of experts which in turn is the basis for greater flexibility and generally for the (strategic) management of knowledge resources in the organization[670]. KMS that integrate various knowledge sources might help to *reduce costs for the access of organization-external knowledge services*, e.g., on-line data bases, knowledge repositories of business partners, news services, benchmarking and competence centers.

TABLE B-29. Measures for organizational impact

integrative KMS	**interactive KMS**	**both**
• additional profits through selling access to the KMS • impact on visibility of knowledge structures • impact on costs of access to organization-external knowledge services	• impact on communication on an aggregated level • impact on visibility of knowledge networks • savings on travelling	• efficiency of the KMS • impact on financial/sales performance/ competitive advantage • impact on innovations • impact on products and services • impact on business relations • impact on the amount/quality of training and education • impact on building of social networks • reduction of fluctuation • impact on willingness to share knowledge • effectiveness of environmental scanning

Interactive KMS can help to *improve communication* on an aggregated level, e.g., between strategic business units, across countries and cultures or between departments with varying professional background (e.g., engineering versus business background). Interactive KMS improve visibility of knowledge networks, e.g., through analysis of contributions within and across communities. Also, a newly recruited employee or an employee moving within the organization onto another job might quickly take over the (official) knowledge networks of the new position, thus reducing time for settling in a new position. Cost reductions are also possible through *avoiding travel expenses* with the help of interactive KMS (e.g., video conferencing, electronic access to expert and community know-how from any place).

Generally, for **both types of KMS** the economics can be assessed in terms of perceived efficiency of the KMS (e.g., Kettinger/Grover 1997). As discussed above, performance indicators such as *impact on innovations, relations to business partners, products and services* and especially *financial or sales performance* are

670. See section 5.1.1 - "From market-based to knowledge-based view" on page 94.

indirect and determined by a large set of variables which can hardly be assessed or controlled empirically.

Three more effects of KMS use directly target the organization's employees. *Impact on the amount and quality of training and education* should in turn effect the employees' competencies and can be assessed with the help of employee-oriented measures from the field of HRM (e.g., Drumm 2000). Some organizations interviewed, especially the professional services companies, specifically targeted newly recruited employees. KMS could help to accelerate the *building of social networks*, coaching and mentoring as well as an improved training on the job because of the access to a wealth of knowledge and information about experts and peers. If organizations manage to use KMS to support the development of unique networks of competencies, they might also help to *reduce fluctuation* as employees cannot transfer these networks into other organizations.

KM initiatives and the use of KMS also aim at increasing participants' *willingness to share knowledge*, a dimension of organizational culture[671]. *Effectiveness of environmental scanning* describes how rapidly and how accurate an organization identifies problems or opportunities in its relevant environment (Huber 1990, 62f).

8.5 Résumé

The assessment of success or benefits of KMS is a difficult task even if the measures are restricted to the ones presented here. It requires a combination of quantitative, semi-quantitative and qualitative assessments applied in a thoroughly defined and repeatedly applied KM audit. Thus, comprehensive results about success and failure of KM initiatives and KMS cannot be expected from a survey on the basis of a questionnaire as part of the empirical study. However, some of the proposed measures are easier to assess and therefore will be included into the questionnaire. In the following, the measures used in the empirical study are described and the hypotheses are discussed which relate to the usage and economics of KMS. The following measures will be applied in the empirical study:

Size of KM initiative. The size will be assessed using two measures:
- *KM expenses*: total expenses for KM excluding salaries,
- *number of employees working for KM*: the number of KM staff or KM expenses can also be related to the number of participants giving the rate of KM support per participant.

Funding of KM initiative. The following three alternatives will be given:
- a separate budget for the KM initiative,
- internal accounting or internal "selling" of KM services,
- external "selling" of KM services e.g., through licenses, concepts.

671. For an instrument see section 6.4 - "Organizational culture" on page 221.

Rate of participation. This variable is computed as the number of employees participating in KM activities divided by the total number of employees.

Rate of KM activity. This variable is computed as the number of active participants divided by the number of employees participating in KM activities.

Access to KM-related systems. These variables are computed as the numbers of employees having access to email, WWW, advanced Internet systems, Groupware or KMS respectively divided by the total number of employees.

Frequency of KMS use. This variable measures the frequency with which particular (sets of) functions of KMS are used.

Intensity of KMS use and KM services use. Respondents will have to estimate to what extent their KMS and KM services are used per month. A list of six functions and services will be presented covering knowledge publication, distribution, search and retrieval, communication and KM service. In order to relate these figures to the size of the KM initiative, the following ratios will be used:

$$s_1 = \frac{i(u)}{p} \qquad s_2 = \frac{i(u)}{ap}$$

legend:

$s_{1,2}$	*success measures*
i(u)	*intensity of usage*
p	*number of participants*
ap	*number of active participants/authors;*

General support of business goals. A single question will be used to assess to what extent respondents think that business goals are supported by their KM initiative.

Support of particular business goals and KM goals. Two lists with ten business goals and with fourteen KM goals will be presented for which respondents again will have to indicate to what extent they feel that these goals are supported by their KM initiative. The lists were derived from previous empirical studies[672].

The following hypotheses support the analysis of the relationships between (a) the existence of and the regulation of access to KM-related systems and KM services on the *system level* and (b) the impact on individuals aggregated on the *organizational level*.

Hypothesis 21: Organizations with KMS have a higher rate of KM activity than organizations without KMS

672. Surveys and field studies: APQC 1996, Bullinger et al. 1997, 18f and 32, ILOI 1997, 15, Heisig/Vorbeck 1998, 7, Earl/Scott 1999, 31; see also section 5.2.1 - “Strategic goals” on page 114.

Many of the KMS functions aim at a stronger support of a more active role of users than is the case in basic Intranet systems. In Intranet solutions, the publication, structuring and organization of documents are often centralized. Looking at the market for KMS, the most propagated benefits of the use of KMS are that it is a lot easier to document, publish and distribute knowledge elements, to comment on documents, to locate and to communicate with knowledge providers as well as knowledge seekers, to share in an electronic discussion or to give feedback to questions or proposals of participants or experts than before. Additionally, the integration between documentation, contextualization and communication functions eases direct or indirect interactions between participants.

Hypothesis 22: The more employees have access to Groupware and/or KMS, the more they are willing to share knowledge

The implementation of Groupware tools or KMS requires that the organization focuses more on the support of groups and teams as well as the communication and collaboration between groups and teams. The higher the share of employees who can access these systems, the easier it is for these employees to exchange ideas within and between groups and teams and the more groups and teams are emphasized as the units holding documents and receiving messages rather than the individual. This heightened awareness, the increased ability to share knowledge, the higher visibility of groups and teams as well as the easing of knowledge-related tasks with respect to groups might support willingness to share knowledge.

Additionally, the following hypothesis concerning general success of the KM initiatives will be tested:

Hypothesis 23: The more rigorously knowledge management is established in an organization, the more business goals are achieved in that organization

Rigor of the systematic establishment of knowledge management will be measured according to the investment in KM per participant. There were two measures for this: firstly, the ratio *KM expenses divided by the number of participants* and secondly the *number of employees assigned to KM divided by the number of participants*. Supposed that KM instruments generally support the achievement of business goals, then the more organizations invest into that approach, the more they should benefit.

Relationships between the organizational design of a KM initiative, the use of contents and the application of KMS and the achievement of business goals will be explored along with this hypothesis. As the state of theory in this area is still in its infancy, the statistical tests will be run in the sense of exploratory research and used to generate hypotheses for subsequent studies. The following measures will be correlated to business goals:

Reporting level of the head of knowledge management. This measure is a good indicator for the attention that the organization pays to KM. The higher the attention and the closer the KM initiative to the CEO, the more probable it is that business goals can be supported with the help of this initiative.

Centralization and formalization of knowledge-related tasks. The best organizational design for a KM initiative might be a decentral assignment of responsibility because the handling of knowledge generally is a decentral activity. Similarly, communities have been proposed as an important organizational instrument for KM suggesting a rather informal approach. However, a centralized KM unit might be able to successfully coordinate KM activities. KM projects might be able to overcome important barriers to KM which are due to formal organizational structures and processes. It is uncertain whether decentral or central, formal or informal approaches should be more successful and in what cases. The interviewees believed that KM-related tasks should be decentralized as much as possible. The KM initiative should have a formal organizational design that increases visibility and trust in the approach. They suggested that a central KM unit or at least a KM project should coordinate the activities.

Rate of KM activity. One of the primary targets of KM initiatives and the use of KMS is to stimulate employees to actively contribute to the organization's knowledge flows. It is expected that a higher activation should positively influence the achievement of business goals.

Management of types of contents as part of the KMS. A systematic handling of certain types of contents in the organization's KMS might also promise improved performance on business goals. There is not enough knowledge about what types of contents might support what types of business goals yet. It is supposed, though, that a greater variety in the types of contents is an indicator for a more thorough design of the KM initiative, a more rigorous establishment of KM in that organization and thus might have a positive impact on business goals.

Use of KMS. This relationship assesses the impact of an extensive (large number of KMS functions) and intensive (high frequency of usage) implementation and use of KMS on the achievement of business goals. Even though the relationship is an extremely indirect one, its exploration should lead to hypotheses about the impact of different types of KMS or KMS functions that can be tested in subsequent studies.

This chapter discussed the challenging tasks to assess costs and especially benefits of a KM initiative in general and the success of KMS in particular. After a brief review of concepts and approaches to determine an organization's intellectual capital, a model for the assessment of success of KMS was proposed. This model was built on the popular model to measure success of IS proposed by Delone/McLean (1992). Then, a selection of the most important or most interesting success measures was discussed using the classification of KMS into integrative and interactive KMS (Zack 1999a). The measures could be used in the case study presented in the beginning of the section (sd&m AG) to assess the success of KM services and the implemented KMS in a more detailed way (Maier/Hädrich 2001). The results of this analysis could in turn provide a basis for the improvement of KMS functions, of the role of knowledge brokers and of knowledge processes.

The assessment of success of KMS and of a KM initiative are extremely complex tasks. KMS comprise a wide variety of systems in support of KM[673]. Thus, it is not surprising that there is also a wide array of measures which could be applied to assess the success of such systems. The model for measuring success of KMS is meant to provide an organizing framework for the many variables thinkable. The selection of measures within each of the eight categories gives an overview of the variety of different approaches to assess the value of IS in the literature. The state of the art of the literature does not allow to give detailed recommendations for the selection of variables to assess a specific KMS because the interdependencies between specific variables still remain to be empirically tested. Due to the large number of variables this is a challenging task. Additionally, many of the variables that are suggested in the literature measure on an ordinal scale. They also reflect the subjective estimations and perceptions of various groups of people in different relations to the KMS, such as the knowledge manager, knowledge brokers, IS professionals, authors, participants etc. A portion of the factors describing system quality, information quality and system use can be objectively obtained, e.g., with the help of functions for system monitoring. Due to restrictive data privacy laws even these measures are far from being easily applicable[674].

The model presented here is also intended to provide a set of practicable measures that should spark ideas for the development of concepts to assess concrete KMS applications in organizations. A set of measures that covers all of the categories supposedly provides a much more solid basis for the currently unavoidable subjective assessment of the success of KMS in practice.

More generally, a model for success of KMS is confronted with the high requirements which result from a combination of measurement instruments from the natural sciences and engineering on the one hand and from the social sciences and management science on the other hand. Once again, the technology-oriented and the human-oriented side of KM have to be combined in order to obtain acceptable results. Moreover, success of KMS is influenced by many more factors than the ones considered in the model. Examples are:

- *characteristics of the participants*: Individual characteristics such as creativity, training and education or age play a role with respect to the success of KMS which cannot be clearly defined at this stage, but have to be considered when comparing results from different organizations and thus require statistical corrections (e.g., Massetti 1996).
- *communication not supported by KMS*: Interactive KMS are only one medium which supports and thus influences organizational communication processes.

673. See chapter 7 - “Systems” on page 273.
674. This is the case at least in European countries, especially in Germany, although workplace privacy has been an important US legal issue during the last decade as well and is supposed to be of even higher priority during the next years with other parts of the world pressuring the US to expand their privacy protection (e.g., Boehmer 2000, 32).

Telephone and direct personal interaction (both, formal and informal) are other examples which supposedly are also influenced by the existence of a KMS. The impact of changed communication processes on e.g., task performance is difficult to assess due to the fact that the biggest part of communication processes is not observable and also protected by data privacy law[675]. A central problem is the measurement of tacit knowledge and its sharing through socialization (Nonaka/Takeuchi 1997, 75ff).

- *organizational structure and processes*: The design of structure and processes of an organization influences the design of the KM function as well as the institutionalization of collectives of employees, their form, processes and relationships in and between e.g., work groups, project and virtual teams, networks and communities. Therefore, they also influence the success of KMS[676].
- *organizational culture*: The organizational culture and sub-cultures, such as work group, departmental, network or professional cultures within an organization are one, if not the most important factor influencing an organization's way of handling knowledge and its employees' willingness to share knowledge. Measurement of organizational culture is difficult as the actual norms and (basic) values of members of the organization can only be indirectly assessed through e.g., stories, symbols, rites, language, architecture, so-called clans or role models of supervisors[677].

An integration of all of these aspects into the model to measure success of KMS would further increase the complexity of the model. It is likely that the measurement of success would become a virtually insoluble empirical challenge. As a consequence, the number of measures that were included into the questionnaire had to be limited. Still, some interesting results are expected from the analysis of correlations between variables describing the organizational design, contents and systems of a KM initiative to the estimations of respondents about the achievement of business and KM goals that they aimed at.

675. For an overview of measures to assess communication processes see e.g., Rubin 1994.
676. See also the contingency approach in the area of GSS, e.g., Zigurs/Buckland 1998; see sections 6.1 - "Structural organization" on page 158 and 6.3 - "Process organization" on page 207.
677. See e.g., Drumm 1991, 166f; and section 6.4 - "Organizational culture" on page 221.

9 Summary and Critical Reflection

Part B was dedicated to the investigation of the state of theory of KMS supported KM initiatives. The analysis revealed two major classes, namely human- and technology-oriented KM. Table B-30 summarizes the distinctions made. The second and third columns contain examples illustrating human-oriented and technology-oriented KM according to approach, perspective taken, focus area[678] and definition of knowledge[679], KM strategy and goals[680], roles, tasks, KM instruments, focus of modeling and organizational culture[681], architecture, contents, type and functions of KMS[682] and finally evaluation objects, aspects, categories and procedures[683].

Critical reflection of the material presented in part B leads to the proposition that KM research should try to bridge the gap between human- and technology-oriented KM. Many authors have propagated a so-called "holistic" approach to KM. However, in most cases the authors leave it to the interpretation of the reader what such an approach could look like. The examples in the last column of Table B-30 are intended to detail in which direction research should move in order to close the gap. This approach is called "bridging the gap" KM.

As will be shown in the discussion of the empirical results in part C, the elements of a human- and a technology-oriented KM initiative will not be obsolete with the advent of a KM initiative bridging the gap between the two. Instead, these approaches have to be extended in order to include roles, tasks, systems and in order to foster an organizational culture that support closing the gap. Moreover, roles, tasks and systems of the two sides have to be linked, connected and contextualized to ease navigation from one side to the other. The redesign of knowledge-intensive business processes and the design of knowledge processes might provide a platform for the required links and contextualizations. Part D will present scenarios that will show how this will affect KM initiatives in organizations. Within each of the four main areas, (1) strategy, (2) organization, (3) systems and (4) economics, a set of hypotheses will be tested in part C. KMS supported KM initiatives are a comparably new phenomenon for most organizations. Therefore, a large part of the empirical study will have the character of an exploratory study. However, the instruments used to collect data (questions, categories for answers, scales) were based on other empirical studies in order to improve validity as much as possible.

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678. See section 7.6.2 - "Classes" on page 369; also Wiig 1999.
679. See chapter 4; Schneider 1996a, 17ff, Schüppel 1996, 187ff, Roehl 2000, 88ff, Swan 2001, 1f, Swan/Scarbrough 2001, 10 for similar attempts to contrast the underlying theoretical basis of human- and technology-oriented KM.
680. See chapter 5; see also Hansen et al. 1999. for the distinction between a codification and personalization strategy.
681. See chapter 6.
682. See chapter 7; see Zack 1999a for the distinction between integrative and interactive KMS; see Jennex/Olfman 2003 for the distinction between infrastructures, also called generic systems, and process-oriented systems.
683. See chapter 8.

TABLE B-30. Comparison of approaches to knowledge management

dimensions	**technology-oriented**	**human-oriented**	**bridging the gap**
approach	technology-oriented	human-oriented	holistic; knowledge processes integrate both orientations
perspective	engineering, cognitive	cultivation, community	business, customer, socio-technical systems engineering
focus area	IT: maximize capture, transformation, storage, retrieval and development of knowledge	people: maximize effectiveness of people-centric learning organization	intellectual asset & enterprise effectiveness: maximize building & value reallocation of knowledge assets, maximize operational effectiveness
definition of knowledge	documented, separable from people	exclusively in the heads of people	asset, skill, competence, embedded in social networks and (knowledge) processes
strategy			
KM strategy	codification; reuse documented knowledge	personalization; foster handling of knowledge of persons/in groups	on-demand; situation-oriented design of knowledge processes for business processes
goals	improve documentation, retention, acquisition of knowledge, turn implicit into explicit knowledge	improve communication, knowledge sharing, personnel development, train newly recruited	improve visibility of knowledge, improve access to and use of tacit and explicit knowledge, improve innovation, change culture
organization			
instruments	product-oriented instruments; semantic document and content management, experience management, knowledge maps	person-oriented instruments; competence, idea & proposal management, personal knowledge routines, expert advice, communities, self-managed ad-hoc learning	process- and organization-oriented instruments; management of patents & licenses, KM scorecards, case debriefings, lessons learned, good/best practices, knowledge process reengineering, technology-enhanced learning
roles	author, knowledge (base) administrator, knowledge broker	expert, mentor, coach, network chair, community manager, moderator	knowledge process owner/manager, knowledge partner, coordinator, boundary spanner, subject matter specialist,
tasks	storing, semantic release, distribution, refinement, deletion/archiving of knowledge, acquisition of external knowledge	establish, foster and moderate communities, document competence and expertise, organize knowledge sharing events	identify knowledge stances, design knowledge maps, profiles, portals & processes, personalize organizational knowledge base, implement learning paths

TABLE B-30. Comparison of approaches to knowledge management

dimensions	technology-oriented	human-oriented	bridging the gap
modeling	ICT, topic	person, topic	process, person, topic, ICT, instrument
culture	technocratic	socio-cultural	socio-technical, discursive
systems			
architecture	integrative KMS	interactive KMS	KMS bridging the gap
contents	knowledge about organization, processes, products; internal studies, patents, on-line journals	employee yellow pages, skills directories, ideas, proposals, knowledge about business partners	cases, lessons learned, best practices, learning objects, profiles, valuations, comments, feedback to knowledge elements
KMS type	infrastructure for documented knowledge	infrastructure for communication, management of competencies	process-oriented system for knowledge and business processes
functions	publication, classification, formalizing, organization, search, presentation, visualization of knowledge	(a)synchronous communication, collaboration, cooperation, community support	profiling, personalization, contextualization, recommendation, technology-enhanced learning, navigation from knowledge elements to people/processes
tools	semantic document and content management system, Wiki, knowledge portal	skill management system, social software, technology-enhanced learning system	process warehouse, integrated case-based reasoning, lessons learned, learning object & best practice repository
economics			
evaluation objects	computer-supported knowledge bases	skills, competencies, expertise	knowledge processes, knowledge services
evaluation aspects	content, structure, functions of and accesses to integrative KMS	degree and domain of expertise, communication, social networks, interactive KMS	time, cost, quality of processes, content, accesses, expertise, communication, KMS bridging the gap
evaluation categories	system quality, knowledge quality, use, user satisfaction, impact on individuals	communication quality, knowledge-specific services, use, user satisfaction, impact on collectives of people	all evaluation categories
evaluation procedure	bottom-up; from contents and functions via use to organization-level-benefits	top-down; from IC to required individual and group competencies to contents and functions	middle-up-down; from knowledge processes/knowledge-intensive business processes to IC, to competencies, contents and functions

PART C *State of Practice*

Part C is dedicated to empirical results on how KMS are used in organizations, what goals and strategies organizations apply, what kind of organizational structure and KM processes they have implemented, how they measure success, what organizational culture issues they have encountered, how they evaluate their KM initiative, what lessons they have learned and what barriers they have had to overcome. Figure C-1 shows the structure of this part in detail.

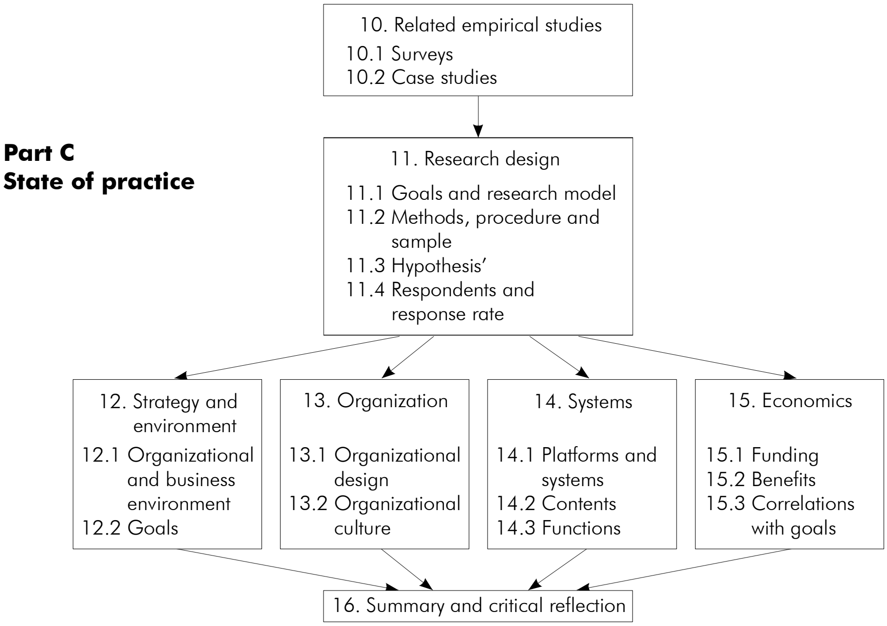

FIGURE C-1. Detailed structure of part C

Chapter 10 briefly reviews related empirical studies, mostly on the application of KM (section 10.1). Section 10.2 briefly reviews case studies on the use of KMS and related topics. Again, most case studies deal with the more general KM approach and do not focus the use of KMS explicitly. However, as the goal here is to identify scenarios for the successful application of KMS, general KM issues, such as KM strategies, organizational, economic and cultural issues are as important as information and communication technologies. Chapter 11 presents the design of the empirical study. The results of this study are presented in the same order as concepts and theories were laid out in part B: strategy extended by an investigation of the organizational and business environment of the responding organizations (chapter 12), organization (chapter 13), systems (chapter 14), as well as economics (chapter 15). Within these chapters, first the results of this empirical study are discussed in detail and then they are compared with the results of the related empirical studies and case studies mentioned above. Section 16 summarizes the most important empirical findings and concludes part C. Part D will then present the scenarios which were identified on the basis of the empirical results and the theoretical results presented in part B.

10 Related Empirical Studies

10.1 Surveys

This section presents an overview of a number of empirical studies on KM and/or KMS. The studies were selected on the basis of their

- *focus*: Studies on knowledge management were selected that included information and communication technology supporting this concept or studies focusing on KM tools and systems;
- *availability*: There are several studies of professional services companies which were too expensive to be bought by the author's Department, e.g., IT Research 2000.

Therefore, studies with a more general focus, e.g., on corporate Intranets without a consideration of KM (e.g., Jesczemsky 1997) or on the learning organization (Nagl/Fassbender 1997) and studies with a narrow focus on one instrument or process of knowledge management, such as best practices, strategy development or measurement of knowledge (see the studies cited in Mertins et al. 2001, 244) or studies that do not focus the organization, but an individual and his or her handling of knowledge (e.g., Götz/Hilt 2000) were not included. The studies will be briefly characterized by the topic, the year of empirical investigation, the target group (sample) and the respondents of the study and the method applied (e.g., questionnaire, interviews, benchmark). The results of these studies will be compared to the findings of the empirical study presented here to show trends and developments in the application of KMS.

10.1.1 APQC

The American Productivity & Quality Center (APQC) International Benchmarking Clearinghouse (IBC) performed a benchmark study of eleven organizations pioneering KM internationally and additionally surveyed organizations considered innovative in their KM approach (APQC 1996). Table C-1 gives an overview of the benchmarking study.

TABLE C-1. The KM study by the APQC

topic	knowledge management. General aim of the study was to identify best practices in this emerging field. The APQC assessed KM strategies and their relationships to the organizations' business strategies. The implementation of these strategies was investigated considering the organizational structure, funding, cultural issues and enablers, information and communication technology, measurement, phases of KM and lessons learned during the implementation of the KM approach
year	1996
target group	16 organizations sponsoring the APQC for the benchmarking group, 90 selected innovative organizations for the screening group

TABLE C-1. The KM study by the APQC

response	11 organizations for benchmarking, 33 organizations for screening
method	questionnaire, non-representative for the screening group, for the benchmarking group additional half-day on-site or telephone interviews respectively; the study employed the benchmarking methodology developed by the APQC/IBC
characterization of sample	the study only lists those organizations participating in the benchmarking study and does not provide information about the screening group. The benchmarking group consisted of big, multinational organizations and was not restricted with respect to industry sector
characterization of respondents	the interviews were conducted with key personnel sharing their strategies on KM. This was in most cases the equivalent of a CKO or Intellectual Asset Manager or a member of the board responsible for the KM program

10.1.2 ILOI

The International Institute for Learning Organization and Innovation (ILOI) did an empirical study on knowledge management in German speaking countries (ILOI 1997). Table C-2 gives an overview of the study.

TABLE C-2. The KM study by ILOI

topic	knowledge management. Apart from some general questions about the perceived importance of knowledge and KM, the study was based on Schüppel's (1996, 195ff) structured list of KM instruments. Respondents had to indicate whether or not these instruments were actually used in their organizations
year	1996
target group	90 selected organizations of all sectors and all sizes in Germany, Austria and Switzerland
response	44 organizations responded
method	questionnaire, non-representative
characterization of sample	about a third of the organizations had fewer than 500 employees, 500-5,000 employees or more than 5,000 employees respectively. The organizations were approximately evenly distributed between the industry and the service sector
characterization of respondents	30% were members of the board or human resource managers, 20% were managers of R&D and 20% were others

10.1.3 Delphi-Group

The Delphi Consulting Group, a division of the Delphi Group, investigated the awareness of organizations with respect to KM in general and KM technologies in particular. The following characterization is based on a 25 page Delphi report summarizing the findings (Delphi 1997). Table C-3 gives an overview of the study.

TABLE C-3. The KM study by the Delphi Consulting Group

topic	knowledge management. The study investigated the organizations' awareness of KM, the state of implementation of KM, perceived obstacles and organizations' plans for a future adoption, especially with respect to technologies and KMS
year	1997
target group	US organizations using or evaluating KM solutions in the sense of KMS and related information and communication systems
response	total of 790 organizations; two surveys on KM awareness, attitudes and activities each received 370 respondents; a third survey was conducted with 50 KM experts
method	not available, probably questionnaires and (telephone) interviews
characterization of sample	not available
characterization of respondents	employees responsible for the application or evaluation of KM solutions

10.1.4 Ernst & Young

The Ernst & Young Center for Business Innovation investigated the state of practice of KM in US and European organizations in a major survey of senior management's views towards knowledge management. The following characterization is based on a 10 page summary of the findings (Ruggles 1998). Table C-4 gives an overview of the study.

TABLE C-4. The KM study by Ernst & Young

topic	knowledge management. The study investigated what kind of KM projects organizations were engaged in, what projects they planned and what activities organizations should engage in. The projects included technology-oriented instruments, such as Intranet, data warehousing/ knowledge repositories, decision-support tools and Groupware and thus had a wide focus on ICT supporting KM. Also, Ernst & Young asked the respondents to estimate their performance on eight predefined knowledge processes
year	1996/1997
target group	US and European organizations using or evaluating KM solutions in the sense of KMS and related ICT systems. The survey was sent to a total of 8,000 executives in Fortune 1000 companies in North America and 1,800 senior executives in Europe
response	431 U.S. and European organizations

TABLE C-4. The KM study by Ernst & Young

method	questionnaires with follow-up interviews
characterization of sample	not available
characterization of respondents	executives familiar with KM in their organization

10.1.5 Journal of Knowledge Management

The Journal of Knowledge Management studied the state of practice of the knowledge-based organization (Chase 1997a) with assistance of the Best Practice Club (IFS International Ltd., Bedford, UK) and The Benchmarking Exchange (Aptos, CA, USA). Table C-5 gives an overview of the study.

TABLE C-5. The KM study by the Journal of Knowledge Management

topic	knowledge management. The study investigated the importance of knowledge for organizational success, perceived benefits of and obstacles to KM, KM projects planned or under development, KM performance as well as the perceived (in-)effectiveness of KM tools
year	1997
target group	members of the Best Practice Club; an international network of over 400 organizations and of The Benchmarking Exchange; an international electronic forum of practitioners
response	total of 143 responses, 73 from the Best Practice Club, 70 from the Benchmarking exchange
method	questionnaire sent to the members of the Best Practice Club, and Web survey mounted on the Web site of The Benchmarking Exchange
characterization of sample	46% UK, 36% North American, 6% European without UK, 5% South American, 4% Australasian and 3% African organizations; 52% had more than 1,000 employees, 74% had more than US$500 million annual revenues/budgets; 37% belonged to the industry sector (manufacturing, process), 26% to the services sector, 14% to the public sector, 7% to financial, 7% to utilities, 5% to telecommunications and 4% to consumer (wholesale, retail and consumer goods); not a representative sample as all of these organizations had business improvement strategies/programs in place and thus supposedly were pioneers in KM
characterization of respondents	organizational change agents, i.e., employees responsible for improving organizational performance; they belonged to the following functional areas: 29% operations, 22% quality/business improvement, 14% senior management, 8% strategy/planning, 7% HRM, 6% corporate services, 5% finance and 3% IT, sales/marketing and R&D each

10.1.6 Fraunhofer Institute Stuttgart

Bullinger, Wörner and Prieto of the Customer Management Center in the Fraunhofer Institute for Industrial Engineering (Institut für Arbeitswirtschaft und Organisation, IAO) in Stuttgart investigated knowledge management in a broad empirical study in German companies (Bullinger et al. 1997). Table C-6 gives an overview of the study.

TABLE C-6. The KM study by Fraunhofer Stuttgart

topic	knowledge management. Bullinger et al. structured their study on the basis of Probst et al.'s (1998) building blocks for KM. Bullinger et al. studied the perceived importance of the topic, the status quo of the use of instruments, expectations, deficits and barriers for KM as well as success factors affecting an implementation of a KM concept
year	1997
target group	representative sample of German organizations of all sizes and sectors
response	250 organizations responded to a questionnaire (about 10% response rate); as part of this study, Fraunhofer Stuttgart did 61 structured interviews with selected companies exhibiting on an industry fair in Hannover in 1997. All results are based on a total of 311 companies
method	questionnaire, directed at the board of directors of the organizations; structured interviews
characterization of sample	41% of the organizations belonged to the service sector, 48% were producers of investment goods, 11% produced consumer goods. 38.8% of the organizations had less than 50 million DM turnover, 26.8% had between 50 and 250 million DM, 17.7% had between 250 million and one billion DM and 16.7% had more than a billion DM turnover
characterization of respondents	41.5% were members of the board, 8.1% headed a division or area, 27.1% were department heads, 5.8% heads of teams or work groups and 11.6% were not in a managing position

10.1.7 KPMG United Kingdom

The Harris Research Center of KPMG Management Consulting surveyed selected large organizations in the United Kingdom (KPMG 1998). Table C-7 gives an overview of the study.

TABLE C-7. The KM study by KPMG United Kingdom

topic	knowledge management. The study investigated the organizations' awareness of KM, their attitude towards this concept, the state of implementation of KM, barriers as well as benefits and business reasons expected and actually realized
year	1998
target group	100 selected UK companies with more than GBP 200 million turnover/year
response	All selected organizations participated
method	questionnaire
characterization of sample	56% of the organizations belonged to the service sector (including trade retail/wholesale with 14%), 31% manufacturing, 10% utilities and telecommunications, 3% did not answer this question
characterization of respondents	chief executives, finance or marketing directors as well as employees responsible for KM in their organizations

10.1.8 Fraunhofer Berlin

Heisig and Vorbeck conducted an empirical study on knowledge management for the Fraunhofer Institute Production Technology Centre (Institut für Produktionsanlagen und Konstruktionstechnik) in Berlin with support of the German magazine Wirtschaftswoche. This study was used as the basis for benchmarking knowledge management with a group of 26 organizations identified in the study. The following characterization is based on a 27 page report summarizing the findings (Heisig/Vorbeck 1998, 2001). Table C-8 gives an overview of the study.

TABLE C-8. The KM study by Fraunhofer Berlin

topic	knowledge management. The study is based on Probst et al.'s (1998) KM building blocks and investigated the organizations' awareness of KM, KM objects or contents that have to be handled, the state of implementation of KM, KM activities, organization and success factors
year	1998
target group	TOP 1000 German companies and TOP 200 European companies
response	146 responses; 10 of these were selected as benchmarking partners who were also interviewed
method	questionnaire, (telephone) interviews, four on-site visits
characterization of sample	all industries; but mostly chemistry/pharmaceuticals (16.3%), professional services (15.4%), automotive/aircraft (15.4%), computers/telecommunications (15.4%), machine engineering/metal processing (14.4%), multiple responses possible)
characterization of respondents	respondents belonged to different functional areas, mostly R&D, strategy, marketing and HRM or the board of directors respectively

10.1.9 Journal Personalwirtschaft

Jäger/Straub asked human resources (HR) managers about the state of practice of knowledge management in their organizations (Jäger/Straub 1999). Table C-9 gives an overview of the study.

TABLE C-9. The KM study by the journal Personalwirtschaft

topic	knowledge management. Jäger and Straub asked a number of general questions about potential benefits of KM, KM instruments systematically used within HRM, barriers to an effective KM, realized benefits, future directions of KM and about which organizational unit was responsible for KM
year	1999
target group	TOP 200 German companies
response	34 responses; 27 actually answered KM related questions
method	questionnaire
characterization of sample	not available
characterization of respondents	HR managers

10.1.10 Fachhochschule Cologne

Döring-Katerkamp and Trojan of the Department of Economics and Business Administration of the Fachhochschule Cologne (FH Cologne, University of Applied Sciences Cologne) did an unrestricted online survey investigating the state of awareness and implementation of KM in private organizations (Döring-Katerkamp/Trojan 2000) and a follow-up study of the same design in 2001 (Döring-Katerkamp/Trojan 2001). Table C-10 gives an overview of the study.

TABLE C-10. The KM study by FH Cologne

topic	knowledge management. The study contained a number of general questions about the organizations' awareness of KM, the state of implementation with respect to formal authorization, formal organization, (project) status, procedure and problems encountered
year	2000 (study 1), 2001 (follow-up study)
target group	unrestricted; organizations with Internet access
response	347 responses from 12 countries in study 1 (German speaking countries Germany, Austria, Switzerland; EU-Countries: Finland, France, Denmark, Sweden, United Kingdom, The Netherlands; USA; Romania and Turkey); 136 responses in the follow-up study
method	online questionnaire (www.wissenskapital.de, www.knowledge-MARKT.de)

TABLE C-10. The KM study by FH Cologne

characterization of sample	organizations of all sizes and all industry sectors with a bias towards software and system houses as well as professional services companies in both studies; however, as the categories given in that questionnaire did not include the service sector except for banks and insurances, almost half of the organizations reported to belong to "other" industry sectors (168 out of 338, 49.7%). 39.8% (46% in the follow-up study) of the responding organizations had up to 100 employees, 26.7% (23%) had between 101 and 1,000 employees and 33.5% (31%) had more than 1,000 employees
characterization of respondents	Less than half of the respondents (44.3%) had more than one year personal interest in KM, 22.8% were interested since about one year and more than a quarter (28.7%) had less than half a year of personal interest in KM

10.1.11 KPMG Germany

KPMG Consulting AG Germany performed a survey of organizations of all industry sectors and all sizes in the German speaking countries about the state of implementation of knowledge management and eBusiness (KPMG 2001). Table C-11 gives an overview of the study.

TABLE C-11. The KM and eBusiness study by KPMG Germany

topic	knowledge management and eBusiness. The study investigated the organizations' awareness of KM, the state of implementation, the existence of a KM and an eBusiness strategy, barriers as well as benefits and business reasons expected and actually realized, ICT support for the KM initiative and expectations towards the functionality of KM software
year	2001
target group	1,300 organizations in Germany, Austria and Switzerland
response	145 responses
method	questionnaire, non-representative
characterization of sample	42% belonged to the industry sector (22% consumer goods, 20% investing goods), 24% were IT, media or telecommunication companies, 22% financial services, 12% belonged to the public sector/energy organizations. 17% had 10,000 or more employees, 39% between 1,000 and 10,000, 23% between 100 and 1,000 and 21% had fewer than 100 employees
characterization of respondents	Almost two thirds of the respondents were managers with 17% executives, 19% senior management and 26% middle management[a]

a. KPMG did not provide information about the rest of the respondents.

10.2 Case studies

There are a large number of case studies of pioneering organizations applying KM and KMS. The most prominent ones have received wide attention. Examples are[1]:

1. **Companies pioneering certain aspects of KM(S):**
   - *3M–Minnesota Mining and Manufacturing:* organizational culture, definition of knowledge goals, Brand 1998, Davenport/Prusak 1998, 208ff,
   - *Buckman Laboratories:* institutionalization of a separate organizational unit, K'Netix, Pan/Scarbrough 1988, Probst et al. 1998, 355ff, Wilson/Koskiniemi 1998,
   - *Chaparral Steel:* learning laboratories, Leonard-Barton 1992b, 24ff,
   - *Dow Chemical:* intellectual asset management, North 1998, 43ff, Oriel 2003
   - *HP–Hewlett Packard:* HP Knowledge Link or K-Desk and K-Net respectively, Davenport/Prusak 1998, 241ff, Servatius 1998, 104, Sieloff 1999, Wyrsch/Blessing 2000,
   - *IBM–International Business Machines:* Intellectual Capital Management tools to support the exchange of knowledge in a global environment, Vorbeck et al. 2001,
   - *Nortel Networks*: KM for new product development; process-oriented KM; development of a supportive KMS called "virtual mentor", an electronic performance support system (EPSS); success of KM (Massey et al. 2002)
   - *Skandia:* Skandia Intellectual Asset Navigator, Sveiby 1998, 254ff, Heisig et al. 2001a,
   - *Xerox:* communities of practice, the KMS Eureka, a relational data base of hypertext documents, Douglas 2000, also Skyrme/Amidon 1997a, 298,
   - or the Japanese companies, e.g., *Canon*, *Honda*, *Nissan*, *Sharp* that implemented manyfold organizational concepts to improve knowledge creation and sharing as described by Nonaka/Takeuchi 1995, 1997,
2. **Major professional services companies[2]:**
   - *Accenture[3]:* Knowledge XChange, e.g., Baubin/Wirtz 1996, Communities of Practice, Henschel 2001, 224ff,
   - *Arthur Andersen:* Arthur Andersen Online, Global Best Practices, Knowledge Space, Schlund/Wiemann 1997, Neumann et al. 1998,
   - *Arthur D. Little:* ADL link, Ortwein/Spallek 1998, Dömer/Ortwein 1999,

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1. See also Chase 1997b, Güldenberg 1997, Davenport/Prusak 1998, Probst et al. 1998, Sveiby 1997, 1998, Bach et al. 1999, 267ff, McCampbell et al. 1999, 175ff, Antoni/Sommerlatte 2001, Eppler/Sukowski 2001, Mertins et al. 2001, 127ff, Davenport/Probst 2002, Riempp 2004, 253ff, Jennex 2005 for the analysis and/or comparison of KM initiatives in multiple organizations.
2. See also Sarvary 1999, Blessing/Bach 2000 and the case studies published by the Harvard Business School.
3. Accenture was formerly known as Andersen Consulting.

- *Booz-Allen & Hamilton:* Knowledge On-Line, Skyrme/Amidon 1997a, 209, Vorbeck/Habbel 2001,
- *Ernst & Young:* Center for Business Knowledge, the KMS K-Web, e.g., Madey/Muzumdar 1997, Ezingeard et al. 2000,
- *McKinsey & Co:* structuring of separate organizational units for knowledge development: competence centers and knowledge distribution, Probst et al. 1998, 207f, 240f, Sveiby 1997, 168ff, also Hansen et al. 1999,

3. **Pioneering organizations in the German speaking countries:**
   - *BMW:* various in-house developed knowledge management tools on the basis of a corporate Intranet platform, e.g., Stelzer 1998, Schulze 1999,
   - *Credit Suisse:* SmartNet, Reich 1999,
   - *DaimlerChrysler*: Corporate University, e.g., Schüppel 1996, 293ff,
   - *DHC–Dr. Herterich & Consultants:* knowledge modeling, Herterich 1998,
   - *Ford Motor Company*: best practice replication, Wolford/Kwiecien 2003,
   - *Hoffmann-La Roche:* knowledge maps, Probst et al. 1998, 115ff,
   - *Roche Diagnostics:* KM at the team level, team building, empowerment and team culture, process rallies, Vorbeck/Finke 2001b,
   - *SAP:* Knowledge Engineer, Klein-Magar/Birimisa 1998,
   - *sd&m–software design & management*: skills data bases, knowledge broker, Denert et al. 2000, Trittmann/Brössler 2000 and
   - *Siemens:* certified knowledge engineer, knowledge management maturity model, knowledge communities, Hein 1998, Schneider 1999, Augustin 2000, Ehms/Langen 2000, Klementz 2000, Kukat 2001.

Many authors have analyzed these case studies and extracted the most important lessons learned or "pioneering practices" from these case studies[4]: opportunities, benefits and challenges of the knowledge economy, critical success factors, instruments, initiatives, levers of change, starting points and lessons learned.

10.3 Résumé

The case studies as well as the surveys listed above together give a good overview of the state of practice of knowledge management. They show a wide variety of knowledge problems, barriers or knowledge gaps addressed. These seem to be as diverse as the ideas, approaches, organizational instruments, and activities that have been implemented in organizations[5].

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4. See e.g., Skyrme/Amidon 1997, Davenport et al. 1998, Mentzas/Apostolou 1998, Probst et al. 1998, Lehner 2000, 408ff, Sveiby 2001, Wojda/Schwendenwein 2000, 320ff, O'Dell et al. 2003.
5. A discussion of the variety of knowledge management goals and activities can also be found in section 5.2 - "Goals and strategies" on page 114. Success factors and barriers were studied in section 5.3 - "Success factors, barriers and risks" on page 132.

Some of the studies comprised one or two questions about information and communication technologies. The general impression is that most of the surveyed organizations relied on more traditional ICT with no special focus on KM, such as data warehouses, Groupware platforms or Intranet infrastructure. Advanced KM-related technologies, such as AI technologies were not used frequently. However, none of these empirical studies was focused on KMS.

It is difficult to compare the studies with each other due to the substantial variation in the samples. The studies involved samples of organizations form North America, Europe, the UK or the German-speaking countries. Some were targeted at big organizations, some at selected organizations pioneering KM and some did not target a certain sample of organizations at all (open Internet survey). Generally, the most important findings were generated in those studies that were focused on selected organizations that pioneered KM (e.g., the APQC study).

Thus, the empirical study reported here differs from the studies discussed above with respect to its focus which is on KMS here and more generally on a KM initiative in the other studies as well as the sample of organizations[6]. There are numerous fragments on ICT support for knowledge management which can be compared to the corresponding findings of the empirical study reported here. This is especially true for knowledge management goals, some aspects of the organizational design of a KM initiative, the use of Groupware and Intranet platforms, a few KMS functions as well as contents of KMS. Thus, in the following, the corresponding findings of the surveys and case studies will be compared to the results of the empirical study presented here as much as possible.

6. The empirical study reported here was targeted at the TOP 500 German companies and the TOP 50 banking and insurance companies; see section 11.2 - "Methods, procedure and sample" on page 453 for details.

11 Research Design

11.1 Goals and research model

The main goals of the empirical study were two-fold:

- the investigation of the state of practice of the use of KMS in large German organizations,
- the investigation of concepts, scenarios and strategies for the management of KMS in organizations.

Figure C-2 shows how the empirical study is embedded into the research program on knowledge management (systems) directed by the author and, more specifically, into the research design of the research project "Knowledge management systems: concepts for the use in organizations" as described in detail in part A.

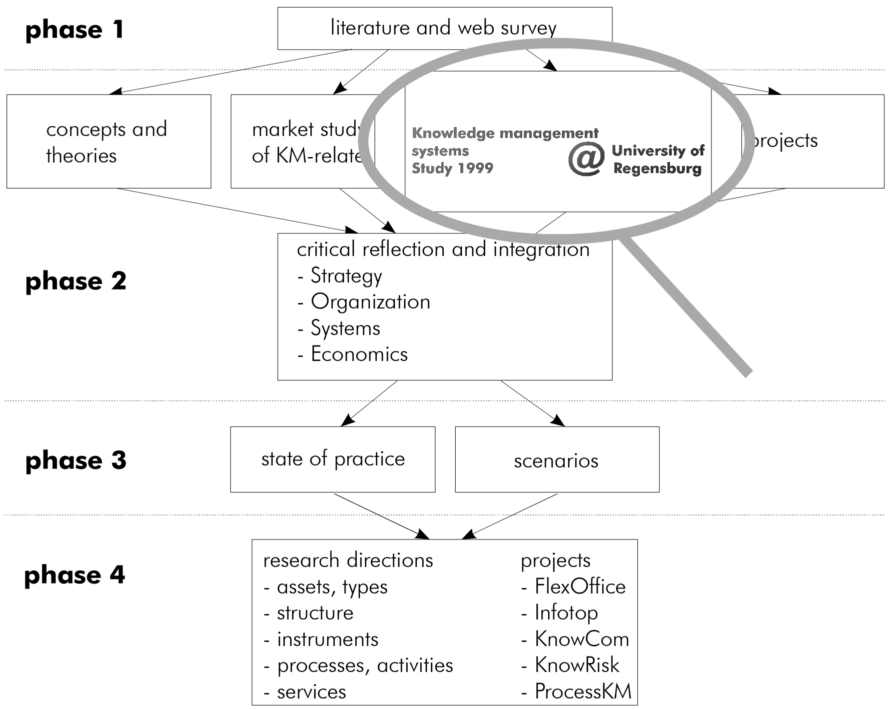

FIGURE C-2. Embedding of the empirical study in the general research design[7]

7. The figure shows the research design of the project "Knowledge management systems: concepts for the use in organizations"; see also Figure A-1 on page 11.

The research program consists of the four phases which are depicted in Figure C-2 and which have been described in detail in part A. The central activity of the second phase was the *empirical study* "Knowledge management systems 1999" which is reported here. The study was complemented by a number of knowledge management *projects*. Additionally, a *market study* on KMS and generally on ICT supporting KM was performed. These empirical and practical activities as well as numerous discussions in an interdisciplinary work group at the University of Regensburg and a knowledge community (AG Wissensmanagement)[8] influenced the qualitative interpretations that will be given in addition to the quantitative results obtained in the empirical study. The results will also be compared to results of other empirical studies[9]. Together, all these efforts provide the basis for an intense analysis of the state of practice of the use of KMS in organizations[10].

In the following, the focus will be on the empirical study[11]. Figure C-3 shows the research model which also guides the presentation of the findings in the following chapters.

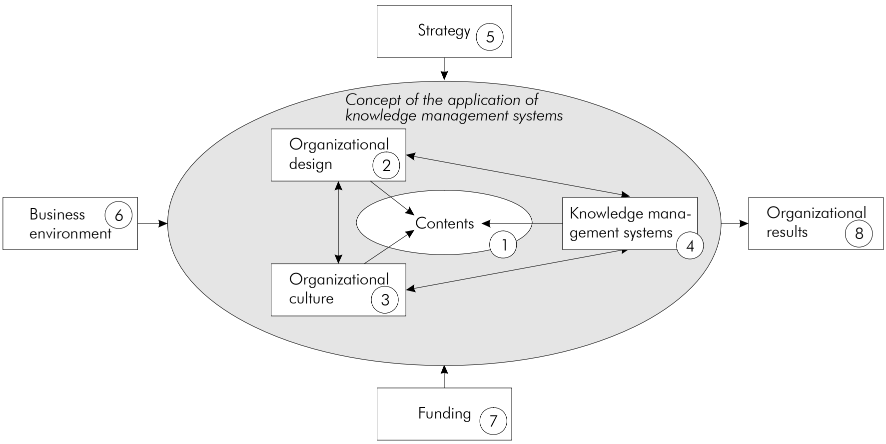

FIGURE C-3. Research model of the empirical study

The research model analyzes KMS supported knowledge management initiatives. The shaded ellipse visualizes the *concept of the application of KMS*. The concept comprises instruments applied to improve the handling of knowledge, the *contents (1)*. The contents consist of the knowledge of the members of the organi-

8. See also chapter 3 - "Procedure, Methods and Overview" on page 11.
9. For a characterization of these studies see chapter 10 - "Related Empirical Studies" on page 439.
10. The state of practice is summarized in chapter 16 - "Summary and Critical Reflection" on page 581.
11. The operational work of the empirical study was a joint effort with Oliver Klosa who used a portion of the data of the study in his work that concentrated exclusively on the two parts *knowledge management systems* and *contents*, Klosa 2001).

zation and of documented knowledge which can be paper-based and/or in electronic form. The contents can be structured according to an organization-wide knowledge structure.

The concept of the application of KMS influences how the organization deals with its content. The concept consists of the *organizational design* of KMS use *(2)*, e.g., the structuring of knowledge-related tasks and roles, the scope of the application of KMS, *the organizational culture (3)*, especially values, rules and norms concerning knowledge sharing and *knowledge management systems (4)*. The concept is the main unit of analysis in this study.

The KM initiative that implements this concept is managed by a KM unit which sets the KM *strategy (5)* and thus the goals for the concept of the application of KMS. The KM unit can be a separate organizational unit, a project or a committee that is responsible for the KM initiative. The concept is dependent on the organizational and *business environment (6)*, especially on structural and process organization, e.g., the degree of centralization, the size of the organization and the industry sector which the organization belongs to. The concept is also dependent on its *funding (7)* and will produce *organizational results (8)*, benefits of the concept, e.g., the achievement of business goals, an improved degree of organizational effectiveness or the achievement of KM goals, i.e., improvements in the management and handling of knowledge.

The eight parts of this model were studied in part B. Each part was described briefly followed by a list of variables assessing certain aspects of each part. The empirical results for the eight parts will be discussed in the following chapters. Table C-12 is meant to provide a quick finder for the theoretical and empirical sections that deal with the eight constructs of the research model.

TABLE C-12. Navigation aids for constructs in the research model

construct	**theoretical sections**	**empirical sections**
1. contents	7.2, p. 281ff	14.2, p. 532ff
2. organizational design	6.1, p. 158ff; 6.3, p. 207ff	13.1, p. 482ff
3. organizational culture	6.4, p. 221ff	13.2, p. 511ff
4. KMS	7, p. 273ff	14.1, p. 524ff; 14.3, p. 548ff
5. goals	5.2, p. 114ff	12.2, p. 471ff
6. business environment	-[a]	12.1, p. 468ff
7. funding	8.1, p. 397ff	15.1, p. 564ff
8. organizational results	8.2, p. 399ff; 8.3, p. 402ff; 8.4, p. 410ff	15.2, p. 568ff

a. The variables describing the business environment are a set of control variables (e.g., size, number of hierarchical levels, industry sector) that are not specific to knowledge management and can be found in many empirical studies. Therefore, they do not require a detailed discussion in the theoretical section.

11.2 Methods, procedure and sample

In the empirical study, the methods exploratory unstructured interview, questionnaire, telephone interview and structured personal interview were used. Figure C-4 shows how the empirical study proceeded and how it was embedded in the rest of the theoretical, empirical and practical activities of the research project. Concepts and theories, related empirical studies, the market study as well as the KM projects influenced the design of the empirical study. This is especially true for the questions selected, the structure of the interviews and questionnaires as well as the selection of the interviewees. The results of the study will be presented in the form of a description of the state of practice of knowledge management as well as scenarios of the application of KMS (see part D).

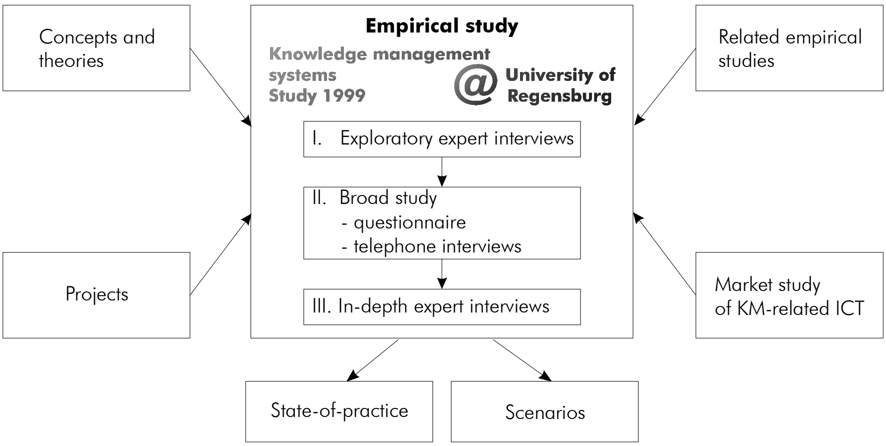

FIGURE C-4. Methods and procedure of the empirical study

The study consisted of the following three steps:

- *I: Exploratory unstructured expert interviews* were conducted with knowledge managers who claim that they already successfully apply knowledge management systems.
- *II: A broad study* was performed on the basis of a questionnaire and telephone interviews. The target group consisted of the 500 largest companies and the top 50 banking and insurance companies in German speaking countries which apply KMS and/or have a definite organizational design reflecting the application of the concept of organizational memory (e.g., a department, project or work group for knowledge management),
- *III: In-depth structured expert interviews* were performed with selected companies participating in step II to get detailed data on the use of KMS in these organizations (e.g., to identify success factors, pioneer solutions, particular organizational concepts).

The language used in the questionnaire is German. The questionnaire comprised 26 questions and was divided into three parts: (1) the organization, (2) organizational design of knowledge management, (3) Intranet, Groupware and knowledge management systems[12]. In the following, the management of the questionnaire is described in detail.

Selection of target organizations. First, the target organizations were selected with the help of the 1998/1999 edition of a yearly published list of the TOP 500 German companies and the TOP 50 banks and insurance companies (Schmacke 1998). The actuality of the data was confirmed prior to the study on the WWW. Some organizations had been acquired or merged with other organizations (e.g., Daimler and Chrysler). In other cases, the telephone calls revealed that there was only one mother company engaged in knowledge management for several daughter companies that were also listed in the TOP 500. Finally, there were 445 industrial and service companies and 59 banks and insurance companies in the sample. The telephone numbers of the (German) headquarters were checked on the WWW.

Identification of contact person within organization. Most questionnaires were sent directly to a contact person in a personalized way so that the questionnaire was not lost or misdirected within these large organizations. In order to identify the contact person, all organizations selected in step (1) were called by telephone to find out whether there was a chief knowledge officer, a knowledge manager, an organizational unit called "knowledge management" or a knowledge management project. If this was not the case, the organizations were asked for the person responsible for the organizational perspective of the organization's Intranet or Groupware system (not the system or network administrator!). If there was no such position or unit, most organizations directed the questionnaire to the CIO.

Pretest. The design of the questionnaire was tested with the help of four knowledge managers representing two organizations from the industry sector, one from the service sector and one professional services company which were all part of the sample. The design was substantially improved according to the terminology used and the format to reduce ambiguities.

Sending out the questionnaire. The questionnaire was sent out by normal mail as a DIN A4-sized letter including the questionnaire and a two-page description of the goals and the design of the research project. Three incentives were offered for the target group to participate in the study: one free copy of a research report of the Department for Management Information Systems III at the University of Regensburg of their choice, an exclusive report of the results of the empirical study and a surprise chocolate typical for Regensburg for all the respondents.

12. The questionnaire can be accessed at http://www-wi.uni-regensburg.de/~mar23522/.

Follow-up calls. There were four rounds of follow-up telephone calls in order to make sure that questionnaires had reached the right person and in order to motivate respondents to fill out the questionnaire. During these telephone calls, the goals of the study and the importance of their contribution were explained to contact persons in detail and assistance in filling out the questionnaire was given where necessary. An interesting side result of the follow-up rounds was that in a matter of a couple of months, about one in four persons had either left the respective organization or taken on a different position, or the organization was redesigned, acquired or merged so that the questionnaire had to be re-sent or faxed to somebody else in that organization in over 130 cases. In the final round of 243 telephone calls, a couple of general questions were asked about whether the contact persons were engaged in a knowledge management effort and whether they had an Intranet in place.

Statistical analysis. The following statistical methods were used: descriptive statistics, bivariate correlation analysis, regression testing and factor analysis. Reliability of statistical relations for support or rejection of hypothesis was tested using $\alpha \leq 0.05$ as the main threshold. Additionally, the exact level of significance will be given for each test reported in the study. In the case of correlation analyses, a Bonferroni type correction to the significance level was used in those cases where all entries in a correlation matrix were examined (for an application within the domain of MIS see Watson 1990; for a statistical discussion see Fahrmeir/Hamerle 1996, 92). For any significance level α, the significance level $\alpha_{corrected}$ for any entry in a n:m correlation matrix becomes:

$$\alpha_{corrected} = \frac{\alpha}{n \times m}$$

As the Bonferroni correction is a rather conservative correction (see Fahrmeir/Hamerle 1996, 92) and the area analyzed can be viewed as exploratory research, the significance level before correction is set to $\alpha \leq 0.10$ for these statistical tests. The Bonferroni correction was applied particularly in the correlation tests that involved the sets of business goals and knowledge goals[13]. The data was processed with the help of the analytical software system SPSS for Windows (version 10.0.7) which supports the statistical methods used in this study (see the list presented above, see also Backhaus et al. 1996, XXIIIff).

11.3 Hypotheses

In the following, the hypotheses tested are briefly summarized[14].

Hypothesis 1: The share of organizations with a KM initiative has increased compared to earlier studies

13. See section 15.2.4 - “Correlations with goals” on page 575.
14. The numbers of the hypotheses link them to the corresponding hypotheses in part B.

KM concepts, activities and instruments get more and more well known with organizations so that awareness of KM increases. Also, the need for a systematic management of the way an organization handles knowledge increases as the share of employees in the role of "knowledge workers" rises. At the same time, "good" or "best practices" of organizations successfully applying KM get published which might also motivate organizations to implement KM.

Hypothesis 2: Service organizations have a higher share of employees with access to KM-related systems than industry organizations

This hypothesis is based on the fact that the share of knowledge workers in service organizations is generally higher than in industry organizations. Also, on the whole, there are more non-routine business processes in service organizations than in industry organizations. This implies that if a service organization uses KM-related systems, the roll-out should be more comprehensive than in an industry organization.

Hypothesis 3: Knowledge management activities span business processes rather than focusing on exclusively one business process

Supposedly it is the information and knowledge flows between (knowledge-intensive) business processes that matter most for knowledge management. Thus, it is expected that the organizations support several if not all business processes rather than focusing on one single business process.

Hypothesis 4: Organizations with systematic knowledge management that has been established for at least one year are more likely to have installed KMS than organizations without systematic knowledge management

In the more recent approaches to knowledge management, most authors suggest to follow a holistic approach overcoming the distinction between human-oriented and technology-oriented knowledge management. Organizations with a formal KM initiative supposedly apply a more in-depth approach to knowledge management and thus should be more aware of the positive results that are expected from a joint application of organizational and ICT measures for KM. However, this might not be true for the first year of implementation as it takes some time until complex ICT is selected to support the initiative.

Hypothesis 5: Organizations converge in their use of ICT and increasingly use communication-oriented functions of knowledge management systems

This hypothesis is based on the suggested trend that organizations are transformed into communication-intensive organizations that are supported by corresponding ICT systems (Blackler 1995, 1030). In this case, this would mean a trend towards the use of more interactive KMS functions than in surveys preceding this empirical study.

Hypothesis 6: Compared to earlier studies significantly more organizations use ICT in general and knowledge management systems in particular to support their KM activities

The increasing amount of literature, Web portals, software and conferences on KM in general and KMS in particular suggests that KMS to support KM initiatives are on the rise. More and more vendors integrate KM functionality into their products or offer specialized KMS. Consequently, it is likely that the support of KM initiatives by information and communication technologies in organizations is on the rise as well.

Hypothesis 7: The majority of organizations strongly aim at more than half of the KM goals (>7 goals) at the same time

The relationships between KM goals and strategies (e.g., which ones are complementary and which ones contradict each other) were certainly not understood well, neither in theory, nor in practice, at the time of the empirical study. Thus, it is likely that organizations implement many KM activities at the same time hoping that some of them might trigger a substantial improvement of the way the organization handles knowledge.

Hypothesis 8: The more formal the organizational design of a knowledge management initiative, the higher are the expenses for knowledge management

It is expected that those organizations that institutionalize a separate organizational unit, staff it with more employees and also invest more in KM[15] than those organizations that set up a KM project or have an entirely decentralized, informal approach with no functional organization at all. The reasoning behind this hypothesis is that organizations that already have had a functional unit responsible for certain KM-related tasks such as information brokering preceding the KM unit, have already assigned employees to a unit and a defined budget and, thus do not have to assign new ones. Moreover, the installation of a separate organizational unit for KM shows compared to a project that this organization regards KM as a permanent task rather than a temporary one.

Hypothesis 9: Employees are more willing to share knowledge within than outside their work environment (group or team)

The "Not invented here" syndrome was frequently reported in the literature, meaning that individuals regularly show a negative attitude towards experiences made by individuals not known to them. This might also be reflected by a higher willingness to share knowledge within a work group or team than between groups and teams. Different teams or work groups might also often compete with each other. Communities might help to reduce these barriers between teams and work groups as common interests and thus an "experienced similarity" between members of the community might also lead to a higher willingness to exchange knowl-

15. Investment is measured in terms of non-salary expenses; see also section 8.1 - "Expenses and funding" on page 397.

edge. Additionally, it is also plausible that members of the organization have more opportunities to share knowledge within their traditional work environment than outside, say, privately or at company events and the like.

Hypothesis 10: The higher the share of newly recruited employees is, the more knowledge exchange is taking place outside traditional work environments

Newly recruited employees need to build social networks within the organization whereas employees who have been with the organization for longer already have had time to build enough social relationships. Newly recruited employees might be willing to devote more leisure time to their job engagements and eager to build social networks privately with colleagues. This is especially probable if newly recruited employees had to move prior to their new job engagement and thus had to leave parts of their social relationships. Additionally, a "generation factor" might also cause the effect that more exchange takes place outside traditional work environments. A large part of newly recruited employees might be within their first couple of years of work, young and childless which might once again positively affect motivation to meet with colleagues outside traditional work environments[16].

Hypothesis 11: A high share of employees leaving the organization negatively affects willingness to share knowledge between groups and teams

In organizations that lay off a large part of their employees, usually the atmosphere suffers. Those employees that have to leave might not be motivated to hand on their experiences. Those employees that remain in their jobs might fear to be replaceable if they share their knowledge. They might think that "knowledge is power" and sharing of that knowledge means to give up power. It is expected, however, that this behavior is most obvious between groups and teams where social relationships are traditionally lower than within these collectives. Within groups, employees might still be willing to share knowledge because the work group or team may offer a "social home" in times of unpleasant changes.

Hypothesis 12: In organizations with systematic knowledge management, willingness to share knowledge is improved

One of the first activities in most KM initiatives is to raise awareness throughout the organization about the potentials and benefits of sharing knowledge, to build trust between employees and to stress the importance of every employee's knowledge. Thus, these activities might already trigger a change of employees' attitudes towards knowledge sharing because they feel taken seriously (Hawthorne effect, see e.g., Schreyögg 1999, 45f) and because they want to share in the benefits of KM.

16. Recently, this effect has been repeatedly described in articles about start-up companies in the popular press (e.g. DER SPIEGEL). Start-up companies in many cases have been viewed by their employees (who are in their 20s and 30s) as a kind of "family" and boundaries between work and leisure time in many cases have become increasingly blurred.

Hypothesis 13: Organizations with systematic knowledge management target different contents than organizations without such an initiative

This hypothesis is tested to show that organizations with a systematic KM differ from organizations without KM with respect to contents handled in their KMS. In this case, a concentration on instruments, such as best practices, lessons learned or employee yellow pages is expected.

Hypothesis 14: If an organization allows private contents as part of their knowledge management systems, willingness to share knowledge is higher

Private contents were included in the list of items describing the contents of KMS because they supposedly are an indicator for alternative ways in which organizations handle knowledge. By allowing employees to publish private contents or to present themselves, organizations can show that they respect the individuals' off-the-job interests and networking needs. If organizations take these needs and interests seriously, it might in turn have a positive influence on the building of trust and as a consequence the willingness to share knowledge of their employees.

Hypothesis 15: Organizations with systematic KM handle a larger knowledge base than organizations without such an initiative

The volume of the knowledge base will be measured in terms of the number of knowledge elements and the amount of storage capacity used. Identification, providing access to and/or documentation of existing knowledge turned out to be among the first activities of KM projects in most organizations. The result of these activities should increase the amount of knowledge elements visible in organizations. These organizations should therefore use increased amounts of storage capacity for knowledge elements.

Hypothesis 16: Organizations with systematic KM handle a higher share of multimedia elements, contributions to newsgroups and data base elements in their KMS than organizations without such an initiative

Organizations with a systematic KM initiative might also include more differing types of media in their knowledge bases than organizations without one. These organizations should pay more attention to the activities identification of knowledge, providing access to knowledge and documentation of existing knowledge. The activities should lead to a greater variety of types of media used to represent knowledge elements.

Hypothesis 17: There are more organizations which apply a network structure to their knowledge areas than organizations with a hierarchical structure of knowledge areas

The hypertext is the single most important metaphor for organizing documents in an organizational Intranet or KMS. Navigation of hyperlinked documents has become a basic standard within an Intranet and KMS. The next step would then be to use the hypertext or network metaphor not only for navigation within documents, but also for the overall organization of knowledge areas. Thus, the network supposedly is the predominant principle applied to structure knowledge areas.

Hypothesis 18: Organizations with KMS have a larger number of KMS functions than organizations without KMS

It is supposed that organizations with a KMS solution (no matter whether bought on the market or developed internally) have implemented a larger number of KMS functions than organizations without a dedicated KMS solution.

Hypothesis 19: KMS functions in organizations with KMS bought on the market are more integrated than KMS functions in organizations without KMS

As KMS architectures strongly aim at an integration of existing data and knowledge sources, a positive correlation between the existence of KMS in organizations and the integration of KMS functions is expected.

Hypothesis 20: The majority of organizations apply organization-specific KMS developments or a combination of organization-specific developments and KMS tools rather than just KMS available on the market

Supposedly, most organizations had already installed a large number of application systems and ICT platforms that had provided (basic) functionality for knowledge management before they installed a formal KM initiative. Especially Intranet platforms form a substantial investment and many organizations might hesitate to invest heavily in an ICT platform yet another time as long as it is not clear which KMS vendors will survive the consolidation phase. KMS might also be viewed as important organizational assets that provide core competencies for the organization. Especially highly knowledge-intensive organizations might view the systematic handling of knowledge in general and their ICT systems supporting KM in particular as their core competence and fear that they might loose a strategic advantage if they implement a standard software solution available on the market. Thus, it is expected that most organizations that actually have implemented KMS solutions have combined several tools and implemented additional functions on their own rather than just buying specialized KMS software on the market.

Hypothesis 21: Organizations with KMS have a higher rate of KM activity than organizations without KMS

One of the most propagated benefits of the use of KMS is that it is a lot easier to publish documents or to share in an electronic discussion than before. Due to the integration between documentation, contextualization and communication, participants should be more motivated to directly or indirectly interact with each other. Rate of KM activity is defined as the number of active participants divided by the total number of participants[17].

17. See section 8.5 - “Résumé” on page 428.

Hypothesis 22: The more employees have access to Groupware and/or KMS, the more they are willing to share knowledge

The implementation of Groupware tools or KMS requires that the organization focuses more on the support of communication and collaboration between groups and teams than those organizations that do not have such tools or which apply them to a lesser extent. The higher the share of employees who can access these systems, the easier it is for these employees to exchange ideas within and between groups and teams and the more groups and teams are emphasized as the units holding documents and receiving messages. This heightened awareness, the increased ability to share knowledge, the higher visibility of groups and teams as well as the easing of knowledge-related tasks with respect to groups might support willingness to share knowledge.

Hypothesis 23: The more rigorously knowledge management is established in an organization, the more business goals are achieved in that organization

Rigor of the systematic establishment of knowledge management will be measured according to the investment in KM per participant. There were two measures for this: firstly, the ratio KM expenses divided by the number of participants and secondly the number of employees assigned to KM divided by the number of participants[18]. If KM instruments generally support the achievement of business goals, then the more organizations invest into that approach, the more they should benefit.

11.4 Respondents and response rate

As mentioned above 73 organizations responded. Table C-13 shows the sample, respondents and the *response rate*.

TABLE C-13. Sample, response and response rate

sample description	sample size	response	response rate
TOP 500 organizations	445	53	11.91
TOP 50 banks and insurance companies	59	20	33.90
total	504	73	14.48

The group of banks and insurance companies had a substantially higher response rate than the group of industry and service companies. One explanation might be that—on average—the IT function in banks and insurance companies in terms of number of employees is bigger and more centralized and thus it is easier (a) to determine a person suited to fill out the questionnaire and (b) for this person

18. See section 8.5 - “Résumé” on page 428.

to get the data needed to fill out the questionnaire than in the case of a decentralized IT. In the sample, the number of IT employees is significantly higher in the case of banks and insurance companies than in the case of industry and service companies (Spearman's rho: 0.279, significance: 0.027, n=63).

Respondents were asked about the *job position* they held. Out of the 71 answers 65 different terms describing the position were used showing the wide variety and the low degree of standardization of KM-related positions in today's organizations. Thus, the terms were classified according to the two dimensions "generic position" in the sense of a level of hierarchy (employee – manager – senior manager – executive) and "functional area". Table C-14 shows the distribution of generic positions that the respondents held. 52 out of 63 respondents (= 82.5%) answering this question held a managing position. The rest either were functional specialists, indicated in the table as "employee" (7 cases), or internal consultants of the organization (4 cases). As some respondents were more specific in their answers, department heads and heads of main departments/areas were separated from the group of senior managers and project managers were separated from (line) managers. The number of project managers filling out the questionnaire was quite low compared to the high figure of senior line managers which were in most cases CIOs or heads of the IT/organization department.

TABLE C-14. Generic position (level of hierarchy) which the respondents held

respondent's generic position	frequency	percent
senior manager	30	47.62
department head	8	12.70
manager	8	12.70
employee	7	11.11
internal consultant	4	6.35
head of main department/area	3	4.76
project manager	3	4.76
total	63	100.00

Table C-15 shows the *functional areas* which the respondents worked for. More than half of the respondents belonged to the IT area. One in five respondents held a job position in an organizational unit called knowledge management, document management or the Intranet area/internal communications. Of the 8 respondents specifically indicating a job position in knowledge management, three were on the senior manager level, two were project managers, one internal consultant and two held the position of a functional specialist. Examples for positions were "knowledge manager", "knowledge networking officer", "consultant knowledge processes" or "project manager knowledge management".

In some cases, the CIOs or heads of the IT/organization departments also coordinated the KM efforts so that the actual number of respondents who specifically worked (at least partially) for KM was higher. In the functional areas, most respondents' positions had to do with business development, organization or general management. As for the other functional areas one respondent working in the public relations department coordinated several organizational members who contributed to the questionnaire and one respondent belonged to the department "protection of the environment and security" and was supposedly also coordinating the KM activities of that organization.

Similarly, in the 2001 KPMG study 36% of the respondents stated that the IT area had *initiated KM* (KPMG 2001, 9, multiple responses possible). 19% said it was R&D, 18% marketing, 15% corporate organization and 13% sales and distribution and only 2% production. In the same 2001 KPMG study, IT (28%), the executive board (27%) and corporate organization (13%) were also found to be the primary units *coordinating the KM activities* (KPMG 2001, 12, multiple responses possible). HRM (10%) and marketing/communication (7%) were in charge in substantially less cases.

TABLE C-15. Functional area which the respondents worked for

respondent's functional area	frequency	percent	frequency total	percent total
knowledge management and related areas				
knowledge management	8	12.70		
document management	2	3.17		
Intranet/internal communications	2	3.17	**12**	**19.05**
general IT/organization				
chief information officer (CIO)	21	33.33		
head of an IT group/department/project	15	23.81	**36**	**57.14**
functional areas/departments				
business development	4	6.35		
organization/human resource management	3	4.76		
general management	3	4.76		
marketing/customer Service	2	3.17		
production	1	1.59		
other functional areas/departments	2	3.17	**15**	**23.81**
total			**63**	**100.00**

To sum up, knowledge management at this stage seems to be mostly dealt with in traditional IT/organization units or in management services units concerned with business development or management of change. Most respondents held a position at the senior management level.

Table C-16 shows the distribution of responding organizations according to *industry sectors*. The three main sectors – industry, services and trade – are detailed for all those industry sectors which were represented by more than one organization. Industry on the one hand as well as services and trade on the other hand were each represented by approximately half of the responding organizations.

TABLE C-16. Group of respondents according to industry sector

sector	frequency	percent	frequency total	percent total
industry				
mechanical engineering	7	9.59		
electrical engineering/electronics	5	6.85		
chemical	4	5.48		
energy	4	5.48		
food	2	2.74		
health care	2	2.74		
automotive	2	2.74		
other industry	12	16.43	**38**	**52.05**
service				
financial services	12	16.44		
insurance	8	10.96		
IT/telecommunication	5	6.85		
other services	2	2.74	**27**	**36.99**
trade				
general trade	6	8.22		
trade association	2	2.74	**8**	**10.96**
total			**73**	**100.00**

In 22 out of 73 responding organizations (30.1%) *KM was well established* in the sense that they had already started (formal) knowledge management programs (Question: "Does your organization systematically apply knowledge management?"). A telephone survey was performed with 243 non-responding organizations in the sample in order to check this percentage. 17 out of 47 phoned persons (36.2%) willing to answer this question said they had a KM initiative in place, so that all in all 39 out of 120 respondents (= 32.5%) applied knowledge management.

The 1998 KPMG study reported 43% of organizations with a KM initiative in place (KPMG 1998, 6). However, only 26% of these were in the implementation phase, whereas the others were investigating (19%), reviewing (23%), preparing (12%) or setting budget (7%) for this approach. 14% did not state in which phase they were (KPMG 1998, 12). Thus, the question asked in the 1998 KPMG study is less restrictive than the one in the study presented here. In order to compare the results, only those organizations have to be considered that were in the implementation phase. These were 11% of the organizations (0.43*0.26*100) which is significantly lower than the share of 30.1% found in the study presented here (t-test of mean differences: t-value: -3.539, significance: 0.001, n=73). In the 2001 KPMG study, 21% had an existing KM initiative and another 37% planned to introduce one (KPMG 2001, 8). As KPMG studied organizations of all sizes, the share of organizations with a KM initiative seems to be lower in smaller organizations.

Similarly, the share of 28% of organizations with KM activities as found in the 1997 survey of the Delphi group might be considerably lower when broken down into different phases (Delphi 1997, 16). Additionally, the Delphi study found an extremely high growth rate of this share with 50% of organizations either having established KM activities or planning to do so within the next year, 77% within the next two years and 93% within the next four years suggesting that (at least some form of) KM might soon be established in almost every organization (Delphi 1997, 16f). All in all, these results show a strong upward trend of KM from possibly around 7% of organizations in the implementation stage in the 1997 Delphi study via around 11% in the 1998 KPMG study to 30.1% in the study presented here. Thus, these results support Hypothesis 1: 'The share of organizations with a KM initiative has increased compared to earlier studies'.

11 respondents answered the question about when they had systematically established KM. 8 of these (= 72.7%) had started their programs within the last two years before the study was conducted (in 1998 or 1999). In many organizations there was a project group or a committee established which was responsible for a feasibility analysis of KM. The telephone survey supported these findings. In most organizations, knowledge management either was part of other initiatives (e.g., the introduction of Intranet solutions) which meant that there was not too much attention paid to knowledge management or there was a group of people who started knowledge management activities which could lead to formal projects in the future. Thus, it can be stated that knowledge management is a very young effort. Most organizations in German speaking countries were either still engaged in preparatory analysis or their efforts were in the first two years after introduction.

11.5 Résumé

In the following, the design and process of the empirical study is critically reflected. The following points were observed during the study:

"Questionnaire overload". It is fairly difficult to motivate experts to fill out questionnaires. In the telephone calls, interviewees frequently made comments such as "We get several questionnaires a week" or "There are three questionnaires about knowledge management or a related topic on my desk". These days, there are empirical studies in abundance which can be divided into three groups:

Firstly, major professional services companies and (partly) state-funded research companies perform mostly pragmatic descriptive studies on topics that are "en vogue". These studies are usually highly visible to companies as they are advertised effectively and the results can be bought at high prices.

Secondly, master students from Universities and Universities of Applied Sciences (Fachhochschulen, a form of practice-oriented University in Germany) perform broad studies (in terms of target group) on narrow topics. The results of these studies usually do not gain high visibility. Their results can be bought in the form of a research report and they are hardly advertised.

The third category are serious attempts to test constructs by researchers from Universities and research institutes (researchers, Ph.D. students, professors). They usually deal with more complex phenomena resulting in more complex questions. Their results can be obtained for a comparably small fee in the form of journal articles or in the form of research reports which get medium visibility as compared to the two other types of studies.

For a potential respondent, it is not easy to judge whether the results will be useful for his or her work and even whether he or she will get any results as some authors do not hold their promises to provide their respondents with the results of their study. Thus, it is very hard these days to motivate experts to fill out a questionnaire. This is especially true for a "modern" topic where experts in organizations are addressed by a multitude of people from inside and outside their organizations. A lot of effort was put into finding the right person in the organizations of the target group and motivating them to fill out the questionnaire. An empirical study on the basis of a questionnaire is a very exhaustive and expensive effort these days. However, I still think that the results are worth the effort as questionnaires are about the only way to gain representative data.

"Emergent topic". Knowledge management in general and the use of KMS in particular were emergent fields at the time when this study was performed – and they still are. It was hard to find pioneering organizations and then to find those employees who had already gathered experience in this field. It was difficult to compare these pioneering activities with each other because the efforts were in most cases not separate KM projects, but activities that were parts of other projects. These projects were hard to identify.

Moreover, it was difficult to use the "right" terms in the sense that the experts in the target group would understand them as there was no broad agreement on these terms, neither in the language used in the academic literature nor in practitioners' language. This made the design of the study, the selection of the variables and the wording of the questions difficult. Certainly, this is a lot easier in more stable research fields where well-established theories and approaches exist, where terminology is more or less clear and where basic concepts are understood well in both, the academic and the business worlds. Examples are data base theory or data modeling. As the field develops very dynamically, results of such studies might just prove "common understanding". Insights are most needed in those areas that are "under construction or development". So (immediate) usefulness of research results is traded in for stability of the theoretic foundations and understandability of the constructs. This trade-off has been addressed in the MIS community on-line on ISWORLD, at a multitude of conferences[19] and also in research journals[20] (e.g., in MISQ) in a much more generalized way under the headline "rigor versus relevance".

A good empirical study might be able to combine both, rigor and relevance. Secondly, it seems important to work in both, emergent and rather stable research fields. Emergent topics have to be addressed as the (IT) world develops very quickly and otherwise contact with what is happening in the organizations is lost, but existing and (seemingly) well-proven theories and approaches have to be questioned in order to gain further insights into the theoretical basis of the field. In my opinion, it is especially important to build on existing theories, to do cumulative empirical work. The attempt was made to build on existing constructs as much as possible. Thus, the empirical study is in many respects not exclusively addressing an emergent topic as it also deals with technologies and especially organizational issues that have been around for some time: Intranet technologies, Groupware systems, organizational questions how to handle the management of documents, cultural issues etc. The half-life of some of the insights gained might be short as the empirical basis of the study presented here – the organizations – is changing quickly. Other insights might prove more stable as the research field develops into a more mature stage. However, this is true for most of the topics in the field of MIS as even mature areas like data base design have changed dramatically during the last years[21].

The study addresses a dynamic topic which is currently in the middle of being shaped by a multitude of players. I hope that the insights gained in this study improve the understanding of this field and thus help to shape the next generation of knowledge management systems.

19. Examples are on ICIS, the International Conference on Information Systems, on ECIS, the European Conference on Information Systems and on the German conference on MIS, WIRTSCHAFTSINFORMATIK.
20. Examples are the journal MISQ, Management Information Systems Quarterly, and the journal WIRTSCHAFTSINFORMATIK.
21. See section 4.1.2 - "From data to knowledge management" on page 39.

12 Strategy and Environment

This chapter will first analyze several variables describing the organizational and business environment in which the KM initiatives are embedded (section 12.1). Then, the state of strategic considerations within KM will be studied with respect to KM goals that the initiatives target, as well as estimations to what extent these goals are actually achieved and to what extent these goals are documented and systematically evaluated (section 12.2).

12.1 Organizational and business environment

The organizational and business environment of the organization was included in the questionnaire in order to provide control variables for some of the analysis. Several variables were used in order to assess the size of the organization (section 12.1.1) and the organizational structure (section 12.1.2).

12.1.1 Size of organizations

Size of the organizations was measured in terms of number of employees and turnover. The average size of the responding organizations was 13,647 employees, the median was at 4,450 employees with a maximum of 220,000 and a minimum of 25 employees (n=72 respondents). Table C-17 gives an overview of the distribution of organizations according to the *number of employees*. 35 respondents (= 48.6%) reported 5,000 or more employees and are considered very large organizations. 15 organizations (= 20.8%) reported fewer than 500 employees, 3 organizations (= 4.2%) fewer than 100 employees. Respondents were asked to indicate the number of employees of the business unit for which the KM initiative was responsible.

TABLE C-17. Size of the organizations in terms of number of employees

x = number of employees	frequency	percent
$x < 100$	3	4.17
$100 \leq x < 500$	12	16.67
$500 \leq x < 1{,}000$	5	6.94
$1{,}000 \leq x < 5{,}000$	17	23.61
$5{,}000 \leq x < 10{,}000$	18	25.00
$10{,}000 \leq x < 50{,}000$	13	18.06
$x \geq 50{,}000$	4	5.56
total	72	100.00

The “business unit” had to be either a legally independent organizational unit or the whole organization, not just a department or division of an organization. Thus, there were several cases where the business unit for which the number of employees was given, was only a part of a large multinational organization. In two cases, the small number of employees can be attributed to the fact that the organization was a management holding. In two more cases, the organization was an association or union (e.g., a purchasing society or association).

The average size of the responding organizations in terms of *turnover* was 6.1 billion German marks (n=48, without financial services and insurance companies) with a maximum of 50 billion German marks and a minimum of 120 million German marks (median = 3.2 billion German marks). Most organizations had a turnover between 1.5 and 5 million German marks (see Table C-18). Three organizations reported a turnover of less than 1 billion German marks. This can be explained in the same way as in the case of respondents indicating a low number of employees (see above).

TABLE C-18. Size of the organizations in terms of turnover

x = turnover in million German marks (DM)	frequency	percent
$x < 1{,}000$	3	6.25
$1{,}000 \leq x < 2{,}500$	17	35.42
$2{,}500 \leq x < 5{,}000$	10	20.83
$5{,}000 \leq x < 7{,}500$	7	14.58
$7{,}500 \leq x < 10{,}000$	6	12.50
$x \geq 10{,}000$	5	10.42
total	48	100.00

The average *number of IT employees* was 285 (n=63) with a maximum of 2,500 and a minimum of 1 employee. 10 organizations (= 15.9%) reported fewer than 10 IT employees, 6 organizations (= 9.5%) reported more than 1,000 IT employees.

The number of employees, the annual turnover and the number of IT employees are highly correlated[22].

Responding organizations belonging to the service or trade sector (mean = 4,204 employees) were significantly smaller in terms of number of employees than industrial organizations (mean = 22,581 employees, Spearman's rho: -0.368, significance: 0.001, n=72). However, the service organizations had on average more IT employees (mean = 317 IT employees) than the industrial organizations (mean = 251 IT employees), although the difference was insignificant. There was also no significant difference between service and industrial organizations in terms of turnover.

22. Number of employees – number of IT employees: Spearman's rho: 0.696, significance: 0.000001, n=62, number of employees – turnover: Spearman's rho: 0.686, significance: 0.000001, n=48 and number of IT employees – turnover: Spearman's rho: 0.595, significance: 0.000051, n=40.

12.1.2 Organizational structure

Table C-19 shows the total *number of hierarchical levels* in the organizations questioned. Of the 19 organizations responding to this question 12 had three or four hierarchical levels (63.2%) which shows that most of the organizations with a systematic KM initiative in the sample can be characterized as having a rather “flat” organizational structure. Not surprisingly, the number of hierarchical levels is positively correlated with the number of employees (Spearman’s rho: 0.460, significance: 0.047, n=19).

TABLE C-19. Number of hierarchical levels in the organization

number of hierarchical levels	frequency	percent
3	4	21.05
4	8	42.11
5	3	15.79
6	2	10.53
7	1	5.26
8	1	5.26
valid total	19	100.00

Table C-20 shows the *geographical (de-) centralization* of the responding organizations. Almost 9 in 10 organizations had multiple sites and more than half of the organizations had international operations (58.9%). Thus, the responding organizations were quite decentralized. This more complex organizational structure than in the case of just one site requires additional efforts in terms of coordination between the various sites. Also, in the international case coordination is even more of a challenge due to language barriers and different national cultures[23].

TABLE C-20. Geographical (de-) centralization of the organizations

geographical (de-) centralization	frequency	percent
one location	9	12.33
multiple locations in German speaking countries	21	28.77
multiple locations, internationally	43	58.90
total	73	100.00

23. See Gupta/Govindarajan 2000 and Subramaniam/Venkatraman 2001 for empirical studies analyzing the substantial requirements for knowledge to be effectively transferred between different national locations of multinational companies.

12.1.3 Résumé

Apart from traditional variables describing the organizational or business environment, such as size and industry sector, two more variables were included which hypothetically had an influence on KM initiatives. The number of hierarchical levels is a measure of structure of the organizations, especially when related to the number of employees. Geographical decentralization supposedly influences the complexity of the KM initiative as well as the heterogeneity of the corresponding organizational culture that has to take into account different national cultures and language barriers.

The sample mainly consisted of large to very large organizations of all industry sectors. The median organization had 4,450 employees with most organizations distributed in a range between 1,000 and 10,000 employees. The median turnover was 3.15 billion German marks. Most organizations (not including the sectors financial services and insurance) reported a range between 1.5 and 7.5 billion German marks. However, as some of the organizations had special organizational forms, such as management holdings or purchasing societies which accounted for a high turnover, but a low number of employees, these values varied considerably. Most of the organizations had between three and five levels of hierarchy and multiple locations in several countries, to a large part internationally, i.e., not restricted to the German-speaking countries Germany, Austria and Switzerland.

In about a third of the organizations, knowledge management was well established showing a significant increase over previous studies. Most of these organizations had started their KM initiatives within the last two years before this study.

Thus, in general the organizations in the sample were of considerable size suggesting that a systematic handling of knowledge was relevant and potentially generated substantial benefits to this set of organizations. This is supported by the finding that the share of organizations who had already implemented such an approach was on the rise.

12.2 Strategy

As already discussed before, strategy is an important, yet underrepresented area in knowledge management[24]. This is all the more true for the state of practice of strategic considerations in KM initiatives. The interviews showed that many organizations had no explicit knowledge management strategy and the initiative lacked integration with the business strategy. In the following, section 12.2.1 will discuss what knowledge management goals were targeted in the organizations' KM efforts. Section 12.2.2 will show to what extent respondents thought they had achieved these goals. Finally, section 12.2.3 will study how organizations deal with KM goals, if and how they document them and whether these goals are systematically evaluated or not.

24. See chapter 5 - "Strategy" on page 93.

12.2.1 Targeted goals

The list of knowledge management goals which was used in the empirical study was derived from case studies documented in the literature (e.g., Davenport et al. 1998) as well as empirical data found in studies on knowledge management that were available at the time when this study was designed[25]. The respondents were asked to indicate in the questionnaire whether their organization aims “strongly”, “partly” or “not at all” at a certain goal.

Figure C-5 shows which goals the responding organizations aimed at with their KM activities[26]. Each bar represents the number of organizations that aimed strongly, partly or not at all at a KM goal. In the figure, the goals are ordered according to the number of organizations aiming strongly at a goal and if two or more goals received the same number of respondents then according to the number of respondents aiming partly at the respective goals.

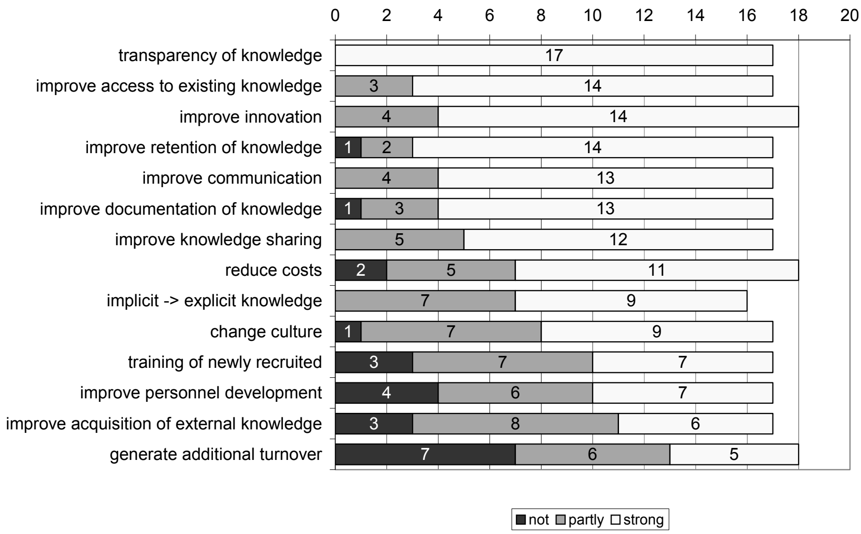

FIGURE C-5. Goals which knowledge management efforts aimed at

All respondents indicated that they wanted to *improve the transparency of knowledge* with their KM efforts. Thus, identification of knowledge sources – a prerequisite for many other goals – was a goal in every activity surveyed. This is not surprising as in the ILOI study half of the organizations estimated that only 20-40% of their knowledge was actually used. The other half of the organizations indicated a higher share of knowledge actually used at 60-80%. According to 82% of

25. APQC 1996, Bullinger et al. 1997, 18f and 32, ILOI 1997, 15, Heisig/Vorbeck 1998, 7, Earl/Scott 1999, 31.
26. Original question: “To what extent does your organization aim at the following knowledge management goals”

the organizations, unused knowledge potentials account for a "medium" to "high" loss of benefits which could not be quantified by the respondents (ILOI 1997, 13). In the 1998 KPMG study, 47% of the organizations with a KM initiative said they were benchmarking or auditing the current situation in their organization and another 23% were planning to do so (KPMG 1998, 13). Jäger/Straub found similar results with most of the HR managers thinking that transparency is the most important goal of knowledge management (Jäger/Straub 1999, 21).

On the other end of the list of KM goals, *generating additional turnover* with knowledge and the improvement of the process of acquiring knowledge from outside the organization were more specific goals that most of the responding organizations only partly aimed at or not at all. Thus, in most of the organizations so far knowledge management is an internal activity that is focused exclusively on the organization-internal knowledge base. The support of traditional human resource activities like personnel development or training of newly recruited employees is not highly regarded as an important goal in many companies.

With the exception of *improving innovation* which can be seen as a very general KM goal, those goals that were focused strongly by most if not all organizations were

- *improve the handling of existing knowledge* in documents or in people's heads: improve transparency (17 organizations indicated to strongly aim at that goal), improve access (14), improve documentation (13) and retention of knowledge (14),
- *improve the sharing of knowledge*: improve knowledge sharing (12) and improve communication (13).

16 out of 17 organizations indicated that they wanted to *change their organizational culture* with their knowledge management efforts partly (7) or even strongly (9 cases). Employees and managers concerned with KM efforts (e.g., knowledge managers, project managers, developers of systems) usually are aware of the fact that these activities influence organizational culture. However, the changing of culture (supposedly primarily to improve the willingness of employees to share knowledge and to help each other) seemed to be a serious goal in more than half of the organizations answering this question. This result is consistent with a share of 57.7% of respondents in the Fraunhofer Stuttgart study which thought that an improvement of the organizational culture was the single most important potential of a successful KM, even more important than other highly ranked goals and instruments (mixed in that study), such as transparency of knowledge demands, organized opportunities for knowledge exchange or an improvement of the IT infrastructure (Bullinger et al. 1997, 32).

12 out of 18 organizations (=66.7%) answering this question aimed at eight or more KM goals strongly at the same time. These KM goals covered both, the codification strategy[27] and the personalization strategy[28] at the same time. Thus, it seems that KM initiatives are currently very broadly and vaguely defined projects. Many organizations try to do "everything at the same time". Hypothesis 7: 'The

majority of organizations strongly aim at more than half of the KM goals (>7 goals) at the same time' therefore was supported.

Moreover, only 49% of the organizations surveyed by Fraunhofer Berlin thought that the definition of KM goals was either important or very important (Heisig/Vorbeck 1998, 7). One might assume that the other half of the organizations rather "plunged" into whatever KM activities promised "success" or "quick wins" in the modern management language.

Comparing these results with the results of the ILOI study reveals a shift in the focus of KM efforts. In the ILOI study, organizations primarily aimed at an organization-wide explication of individual knowledge, making it independent from individuals (ILOI 1997, 15). This explicit knowledge then should be made accessible for as many employees as possible.

In the study presented here, KM efforts seemed to be no longer focused exclusively on codifying existing knowledge. Organizations tried to improve the sharing of implicit knowledge via communication and cooperation of knowledge seekers and knowledge providers (experts) as much as they try to elicit knowledge elements out of employees. Likewise in Jäger/Straub's study of HR managers, the support of the *internal transfer of knowledge* was the second highest item only surpassed by a better use of existing knowledge resources (Jäger/Straub 1999, 21). Moreover, in the 2001 KPMG study *knowledge sharing* was cited as the single most important goal of KM with 91% of the respondents targeting this goal (KPMG 2001, 15). The rest of the KM goals pretty much repeats the picture painted in the study presented here with the exception that *improving transparency* dropped in importance and is now surpassed by goals such as *access to existing knowledge* and *improve retention of knowledge*.

Similarly, in the interviews many organizations thought that a sole focus on untying knowledge from the person holding it is not a fruitful approach as it neglects the very nature of knowledge. Also, the effort necessary to explicate knowledge is huge when compared to the benefits which might be reaped from a reuse of this type of knowledge. In the interviews, it turned out that organizations selected KM efforts strictly oriented toward well-defined business goals and not an unfocused, organization-wide approach. Thus, they attempted to overcome this gap between knowledge independent of people and networks of experts jointly bringing up organizational core competencies. This approach is intended to bridge and integrate the personalization and codification side of KM into a more holistic approach[29].

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27. Codification was supported for example with the goals improve documentation of knowledge, acquisition of external knowledge and retention of knowledge, turn implicit into explicit knowledge; see section 5.2.3 - "Generic knowledge management strategies" on page 129 for a discussion of the two strategies; see also chapter 9 - "Summary and Critical Reflection" on page 434 for the relationships between KM goals and these two strategies.
28. Personalization was covered for example by the goals improve communication, training of newly recruited, improve knowledge sharing, improve personnel development

12.2.2 Achieved goals

Additionally, it was studied to what extent KM goals were already achieved with the help of a KM initiative. The organizations were asked to indicate the level of achievement of the KM goals[30]. Figure C-6 shows the means and standard deviations of the achievement of these goals. All those responding organizations that indicated not to aim at a particular goal were omitted from the statistics. Thus, the number of respondents is lower than in the case of targeted goals (section 12.2.1 above).

The rates of achievement were ranked on average between 3.71 and 4.63 showing a medium level of achievement. Although the differences were not substantial, it seems that companies so far were least successful in achieving a *change of organizational culture* (mean = 3.71) which is not surprising, considering that

- culture is a concept that describes the long lasting values, norms, unwritten rules and attitudes of an organization that are not subject to fast changes and
- it is difficult to measure organizational culture and even more difficult to measure or even judge changes.

Transparency of knowledge—the goal aimed at strongly by all the participating organizations—had a low value for achievement at 3.75 as well. This is all the more interesting because transparency is a prerequisite for many other knowledge related goals. Thus, it seems that the KM efforts of the responding organizations on average still have some way to go until the more advanced benefits can be harvested. This is supported by the observation that the two highest ranked goals, *improve access to existing knowledge*, mean = 4.63, and *improve communication*, mean = 4.56, were achieved easier than more advanced goals like *turning implicit into explicit knowledge* (4.07) or *improving innovation* (3.94). Measurable goals were consequently rated lower than the overall mean as well: *reduce costs* (4.07) and *generating additional turnover* (3.88).

All in all, the analysis of achieved KM goals paints a rather fragmented picture. There was no clear set of KM goals that was achieved substantially more than others. Also, due to the small amount of cases it was not possible to reduce the list of KM goals to a number of factors which could then be correlated with variables describing organizational instruments, willingness to share knowledge, KMS as well as the funding of a KM initiative. Thus, the analysis has to be restricted to business goals[31].

However, even though these results do not reveal specific KM goals as being more important than others, all interviewees were convinced about the positive impact of their initiatives, at least in the long run. Generally, there is broad agreement among both researchers and practitioners as to the relevance of KM for orga-

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29. See chapter 9 - "Summary and Critical Reflection" on page 434, see also section 14.3 - "Functions" on page 548.
30. Original question: "To what extent does your organization achieve the following knowledge management goals"
31. See section 15.2.4 - "Correlations with goals" on page 575.

nizations. In the Delphi study, 85% of the respondents agreed on KM providing value for the organization and usage of corporate information with 32% indicating that KM is a new strategic imperative for staying competitive (Delphi 1997, 11). In the eyes of private organizations, KM is "here to stay" and even will gain importance. In the FH Cologne study, 90.1% of the organizations thought that KM would have increasing relevance for their organization, 9.6% thought that the importance would stay about the same and only 0.3% felt a decreasing importance of this approach (Döring-Katerkamp/Trojan 2000, 10).

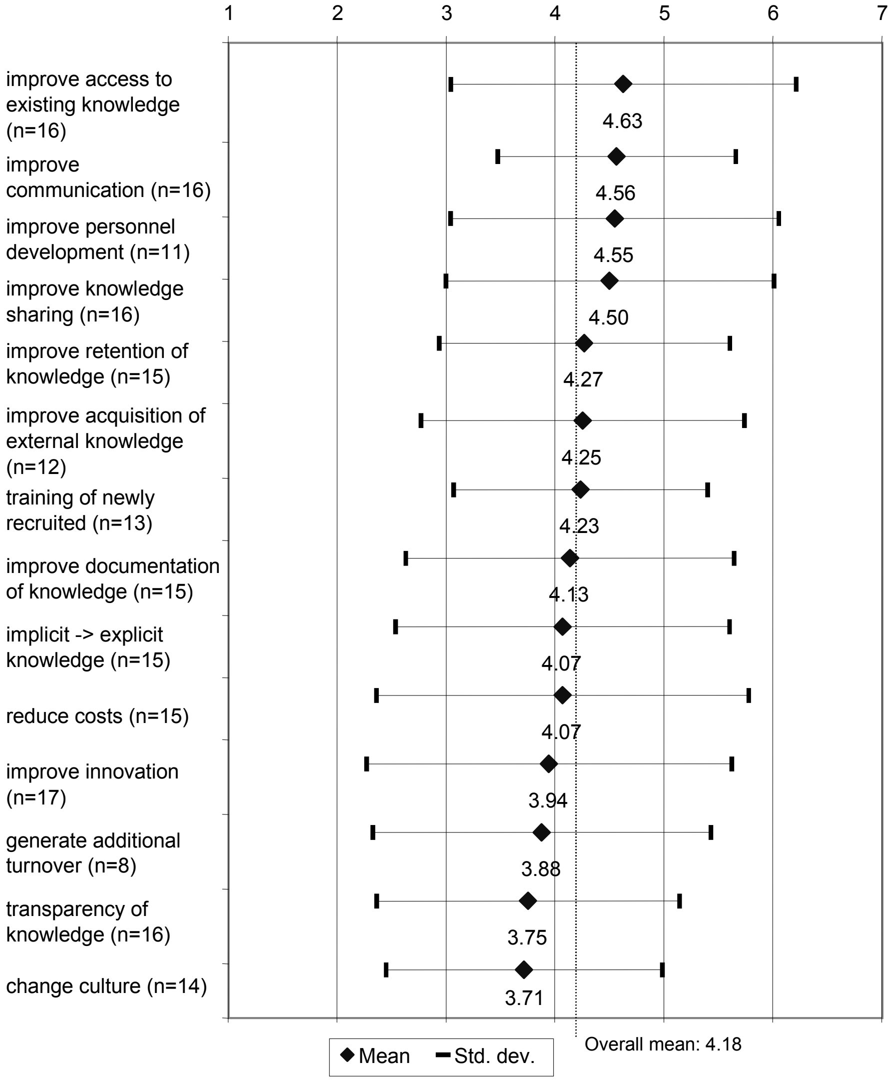

FIGURE C-6. Goals which knowledge management efforts achieved[32]

Thus, the “production factor” knowledge and its systematic management also gain increasing importance. In the ILOI study, about 40% of the organizations said that knowledge accounts for a share of 80 or more percent of the value creation activity of the organization. Another 39% said that this share was between 60 and 80% and in only 21% of the organizations the share was between 20 and 40%.

In the Fraunhofer Stuttgart study, these values were substantially lower, but still 18% of the organizations said that knowledge accounts for 80 or more percent of their value creation and only 14% of the organizations believed this value was less than 20% (Bullinger et al. 1997, 16). The rest of the organizations was about equally distributed in the categories 20-40% (25% of the organizations), 40-60% (22%) and 60-80% (21%). Bullinger et al. found no significant differences in the perceptions between organizations of different industry sectors (Bullinger et al. 1997, 16). In both studies, 80% of the respondents supposed that the importance of knowledge as a factor of production would still increase (Bullinger et al. 1997, 16, ILOI 1997, 11f).

Thus, it seems that knowledge in general and a systematic management of the handling of knowledge in particular receive a high rate of attention in organizations. However, in the Fraunhofer Stuttgart study, only 20% of the respondents thought that the use of existing knowledge and only 23% thought that the transfer of knowledge between employees in their organizations were “good” or “very good”. In the Delphi study, 59% of respondents ranked themselves average or worse than competition with respect to their organization’s awareness of a systematic KM (Delphi 1997, 11). This gap between the perceived importance of knowledge and the low estimation of success in handling of knowledge reveals a high potential of KM concepts and instruments. In the following, the level of documentation and evaluation of KM goals will be studied which will reveal to what extent organizations manage their KM goals.

12.2.3 Documentation and evaluation

The level of managing goals was measured using two questions. The first question addressed the detailing of the formulation of goals. Table C-21 shows the answers to this question. 7 out of 19 respondents (36.8%) stated that they just used general statements, vaguely defined goals like a set of slides showing general benefits. 6 respondents (31.6%) had their goals well documented which meant an in-depth exploration of knowledge management goals specific to the organization. 5 organizations (26.3%) had measurable variables defined which could be used to evaluate the success of knowledge management projects. About a third of the organizations fell into each of the categories which might be described as “vaguely defined goals”, “well defined goals” and “advanced goal management” respectively. Thus, all in all 57.9% of the organizations had their KM goals well documented or precisely defined.

32. Legend: 1=not achieved, 2=low, 3=rather low, 4=medium, 5=rather high, 6=high, 7=very high. The number of respondents is shown in parenthesis.

TABLE C-21. Form of documentation of knowledge management goals

form of documentation	frequency	percent
general statements/declaration of intent	7	36.84
well documented and described	6	31.58
precisely defined (including control variables)	5	26.32
do not know	1	5.26
total	19	100.00

This result compares to a share of 33% of those respondents with a KM initiative in the KPMG UK study who had defined a KM strategy and an additional 30% of organizations which were planning to create one (KPMG 1998, 13). In the KPMG Germany study 32% of the respondents said that they had a KM strategy in place (KPMG 2001, 11). However, as there were no questions detailing this general statement and considering the statements made by those interviewees in the study presented here who actually had a KM strategy, the level of detail of this "strategy" supposedly was mostly low and certainly not precisely defined. Interestingly, in the Fraunhofer Berlin study only 49% of the organizations thought that it is important to define knowledge goals (Heisig/Vorbeck 1998, 7). Compared to the results of the study presented here, it seems that fewer organizations were contented with vaguely defined and documented KM goals.

The second question asked to investigate the level of management of goals dealt with the instruments used for an evaluation of KM goals. Table C-22 shows that most of the organizations with defined KM goals subjectively assessed the achievement of these goals (12 out of 17 respondents, 70.6%).

TABLE C-22. Instruments for evaluating the achievement of knowledge management goals

evaluation of KM goals	frequency	percent
subjective assessment	12	70.59
audit/evaluation team	6	35.29
measuring	5	29.41
others	2	11.76
total	17	100.00

However, almost a third of the respondents said that they were measuring their goal attainment (29.4%). Two respondents indicated that they used other instruments. These were in both cases surveys of the participating employees to evaluate their KM efforts. These instruments would fall into the category "subjective assessment" which was also indicated by these respondents.

In order to get a more detailed picture about the evaluation of KM goals, the interviewed organizations were asked what measures they used for the evaluation of KM goals. The answers can be divided into the following groups:

Surveys. Participants were surveyed according to their needs and expectations concerning KM and to assess employee satisfaction with KMS and KM services. Most organizations used these kind of measures to justify investments in KM.

Usage patterns. Use of KMS was reviewed in some organizations. Simple measures were used for this, such as the number of accesses to KMS, the number of new documents, categories, contributions to newsgroups etc., the average age of documents, the number of participants who have entered information in yellow pages or who have written documents or contributed in newsgroups. Additionally, usage patterns were assessed, such as what are the knowledge elements that are retrieved most frequently or which groups or types of participants accessed what information. However, one interviewee said his organization had stopped the measurement and especially the presentation of usage figures as too many participants "cluttered" the KMS only to achieve the number of contributions they were supposed to have. More generally, evaluation of usage patterns requires caution as

- it might conflict with data privacy regulations (especially in German organizations,
- it might influence the way participants use KMS in a negative way and
- participants might not be motivated to use the KMS if they feel their behavior is monitored.

Success stories. The KM staff gathered cases in which KM had played a substantial role e.g., winning a contract which otherwise might have been lost or measured improvement of a learning curve in production which can be at least partly attributed to KM. Success stories are a mixture of subjective assessment by participants and objective measures which show an improvement over a period without KMS.

The organizations surveyed by the APQC listed similar items, however, the measurement of usage patterns was slightly more prominent with US organizations as data privacy regulations have been not as restrictive in the US than in German speaking countries (APQC 1996, 62ff). Additionally, Skandia described its measurement system which included indicators and so-called "intellectual capital ratios" on a highly aggregate, organization-wide level (APQC 1996, 63, see also the well documented case of the Swedish financial service organization *Skandia*[33].

Bullinger et al. found in their empirical study that the definition of KM goals often remained on the strategic level and lacked operationalization (Bullinger et al.

33. See Sveiby 1997, Skyrme/Amidon 1997; see also section 8.2.1 - "Intellectual capital approach" on page 400.

1997, 18). According to Bullinger et al., organizations defined the core competencies they needed as strategic knowledge goals, but did not turn them into operational, especially measurable goals, e.g., for individuals, teams or the use of KMS. 60% of the respondents indicated that they determine the knowledge needs of their employees, however, only 20% do this systematically e.g., with the help of instruments for the analysis of demands, moderated workshops or internal projects (Bullinger et al. 1997, 19). They found that most organizations did not measure or evaluate knowledge, although some experimented with abstract "intellectual capital balances" following Skandia's example, a result consistent with the findings of the 1998 KPMG study where only 19% developed or measured intellectual capital and only 11% were planning to do so (KPMG 1998, 13). On the operational level, Bullinger et al. only found very general quantitative measures like the number of accesses to a Web page and no qualitative evaluation of the contents of KMS (Bullinger et al. 1997, 38).

12.2.4 Résumé

Organizations have high expectations towards knowledge management. The approach potentially causes high positive returns and is here to stay. There is broad agreement over all empirical studies that KM is a relevant and important topic as the share of knowledge workers and knowledge-intensive business processes is constantly increasing. However, as much as organizations are convinced that the potential benefits of KM are high, as much difficulties they have in establishing clear, well-documented and measurable knowledge or KM goals. The lack of a well-defined and (empirically) proven set of KM strategies is obvious as most organizations aim at a large number of different KM goals at the same time which in many cases are not very well documented.

These findings might be explained by the relative newness of KM to most of the organizations surveyed with many of them still searching for those strategies that form "best" or "good practice" of KM. However, the field develops rapidly. There is a shift in focus of KM initiatives from explication or codification of knowledge to a more holistic, theme-oriented approach. This approach supports the identification and handling of existing knowledge as well as the distribution and sharing of knowledge between members of the organizations, e.g., in networks or communities. KM initiatives aim less at knowledge that crosses organizational borders. Most organizations neither aim at supporting the acquisition of external knowledge, nor do they make use of knowledge developed internally to proactively offer it on the market.

It seems that by now organizations have realized that KM is not an exclusively technical or infrastructural approach, but that a combination of infrastructural, organizational and person-oriented measures promises the most benefits. As almost all organizations try to change their culture with the help of a KM initiative, it seems that organizations also recognize that a positive environment fostering willingness to share knowledge is a prerequisite for an efficient and effective application of KM measures and instruments.

So far, organizations are most successful in achieving rather basic KM goals in both, the codification and personalization side of KM, such as improved access to existing knowledge or improved communication. More ambitious KM goals, such as turning implicit into explicit knowledge or changing culture were achieved to a much lower degree. Thus, it seems that organizations still have some way to go until they achieve the more advanced potentials that KM promises. As the interviews showed, organizations focus personalization and codification at the same time because both strategies promise potentials.

13 Organization

This chapter will first investigate important aspects of the structural and process organization of the KM initiative (section 13.1). The second section of this chapter will deal with important dimensions of organizational culture, willingness to share knowledge and turnover in employees (section 13.2).

13.1 Organizational design

Organizational design that takes into account the handling of knowledge is not an entirely new phenomenon. Thus, some form of knowledge management is supposedly an ongoing effort in organizations and has been there for a long time. All the tasks related to KM and carried out in an organization are called the KM function in analogy to the information function which describes all tasks in an organization that are related to the efficient and effective use of information and communication technology (Heinrich 1996, 8). Successful organizations have always organized their knowledge resources efficiently (Roehl 1999, 13). However, in many organizations the relevant activities have rested in the hands and minds of talented individuals. New is the systematic approach to the management of the knowledge resource which requires organizational (re-)design.

The most visible phenomenon in this context is the establishment of the position of a Chief Knowledge Officer (CKO) in many organizations which leads to the creation of new corporate executive positions and corresponding organizational units[34]. New roles are defined, such as subject matter specialists or knowledge brokers, which are assigned responsibility for knowledge-related tasks. The scope of a KM initiative is another important aspect of the organizational design. Organizations differ largely with respect to the share of employees that participates in such an effort.

In the following, the organizational design of the knowledge management function in the responding organizations is described structured into the scope (section 13.1.1), the structural organization (section 13.1.2) and the organization of KM tasks and roles (section 13.1.3).

13.1.1 Scope

An important criterion for the distinction of approaches to knowledge management in organizations is the scope of the KM activities. “Scope” denotes here the share of employees or the share of organizational units (e.g., divisions, departments, work groups related to business processes or the whole organization) that participate in the KM efforts.

It seems that in many organizations the “first steps” of KM are taken by rather small project groups with limited scope, sometimes called “nucleus” of knowledge

34. See Earl/Scott 1999; see also section 6.1.2.1 - “Knowledge manager (CKO)” on page 163.

management (e.g., KM to support one work group, project, business process, business or project goal etc.). Other organizations have a broader view on KM and establish enterprise-wide groups serving the whole organization. Big multinational companies (e.g., Siemens, DaimlerChrysler and the like) have many individual KM efforts on different levels of the organizational hierarchy.

Several measures were used to get a picture of the scope of KM in the organizations or, in other words, the rate of penetration of KM:

- *supported business processes*: number of business processes that are supported as opposed to all business processes if the whole organization is supported,
- *rate of participation*: *breadth of participation*: number of employees, teams/work groups participating in KM efforts divided by the total number of employees, *depth of participation*: number of active participants divided by the total number of employees participating, number of communities/groups of interest supported with the KM initiative,
- *regulation of access to KM-related ICT systems*: number of employees having access to Intranet functions, Groupware and KMS as portion of the total number of employees.

First, it was asked how many *business processes* the organizations targeted with their KM initiatives. About one third of the respondents answering this question (7 out of 20, 35%) did not know how many business processes their organization targeted. This relatively high share might be due to the fact that many organizations had not yet implemented process-orientation in a profound manner. In the interviews, many respondents indicated that their organizations had undergone a process management or a business process reengineering project. However, a substantial portion of the organization was still designed in a more traditional form focused on resources, regions or business functions rather than business processes. The results of the process management efforts was in these cases mainly used to guide the implementation of business standard software (enterprise resource planning systems) or workflow management systems.

Of the remaining 13 respondents answering this question nine did not restrict their KM initiatives to selected business processes, but supported all business processes throughout the organization. The other four respondents focused 2, 3, 4 and 10 business processes respectively (one case per answer). As hypothesized, it seems that process orientation is not yet focused in KM activities of German organizations despite the fact that most organizations had already undergone business process reengineering or process management programs in the past. However, in no case only one business process was focused, in other words, KM is an approach which is implemented to support the flow of knowledge between business processes. This supports Hypothesis 3: 'Knowledge management activities span business processes rather than focusing on exclusively one business process'.

In order to calculate the *rate of participation* of the members of the organizations in knowledge management activities it is useful to first take a look at the distribution of the number of participants and the number of active participants (see Table C-23 and Table C-24).

TABLE C-23. Number of employees participating in KM

number of participants	frequency	percent
< 10	2	5.41
10 – 49	7	18.92
50 – 99	4	10.81
100 - 499	9	24.32
500 - 999	5	13.51
1,000 - 4,999	7	18.92
5,000 - 9,999	2	5.41
≥ 10,000	1	2.70
total	37	100.00

The numbers vary considerably. Three sizes of KM activities can be identified in terms of the *number of participants* with each size being represented by an almost equal number of organizations:

- *small KM activities* with up to 99 participants: 13 cases (35.1%)
- *medium KM activities* with between 100 and 1,000 employees: 14 cases (37.8%)
- *large KM activities* with 1,000 or more employees: 10 cases (27%).

Table C-24 shows the distribution of the responding organizations with respect to the number of active participants.

TABLE C-24. Number of employees actively participating in KM

number of active participants	frequency	percent
< 5	2	6.67
5 - 9	3	10.00
10 - 24	13	43.33
25 - 49	5	16.67
50 - 99	2	6.67
100 - 499	2	6.67
500 - 999	1	3.33
≥ 1,000	2	6.67
total	30	100.00

Active participants are participants who directly or indirectly interact with other participants with the help of KMS. They act for example as authors of knowledge documents published in the KMS or as contributors in newsgroups. As expected, the number of active participants were in most cases much lower than the number of participants. Seven organizations that provided the number of participants could not tell the number of active participants. It was expected that there would be more passive participants than active ones because it is a lot easier to read than to write a document or to just listen to a discussion than actively participating in it. The numbers of active participants will be compared to the numbers of participants below (see Table C-27 on page 487).

In 18 out of 30 organizations answering this question (60%) the number of active participants was lower than 25. Only five organizations (16.7%) reported more than 100 employees actively participating in their KM efforts. Thus, in many cases KM seems to be a quite exclusive initiative where only a core group of employees is actively involved in.

Table C-25 shows that about two thirds of the KM initiatives supported between 2 and 24 *teams* or *work groups* (13 out of 20 cases, 65%). Only two organizations (10%) had their KM efforts focused on just one team or work group. Another two organizations had organization-wide efforts with a large number of teams or work groups involved. The maximum number of teams/work groups indicated by a respondent was 1,000.

TABLE C-25. Number of teams and work groups participating in KM

number of teams/work groups	frequency	percent
< 2	2	10.00
2 - 4	4	20.00
5 - 9	4	20.00
10 - 24	5	25.00
25 - 49	3	15.00
50 - 99	0	0.00
100 - 499	0	0.00
≥ 500	2	10.00
total	20	100.00

Table C-26 shows the number of *communities* the organizations supported. Only 11 out of those 39 organizations (28.2%) which answered at least one of the questions about the rate of participation reported on the number of communities. One might suppose that many of the other organizations do not apply the concept of a community in a systematic way at all. Of these eleven organizations, only two organizations (18.2%) had more than ten communities with a maximum of 100 communities which could be seen as an intensive application of the concept.

In three cases (27.3%) only one community was established. This might be a community of those members of the organization who are interested in KM—the “KM community”. Thus, it seems that the community concept is still in its infancy with most organizations not having supported any communities systematically and those who have communities just use a very small number of such collectives. The “real” share of organizations exploiting more or less systematically the concept of theme-oriented informal collectives of people might be higher than the 28.2% found here.

TABLE C-26. Number of communities participating in KM

number of communities	frequency	percent
< 2	3	27.27
2 - 4	4	36.36
5 - 9	2	18.18
10 - 24	1	9.09
25 - 49	0	0.00
50 - 99	0	0.00
100 - 499	1	9.09
≥ 500	0	0.00
total	11	100.00

One interviewee responsible for KM in a large industry organization responded that his organization does not call their networks communities, but “knowledge networks”. This is due to the fact that members of these networks are suggested by a central KM unit that also supports the networks. Consequently, these networks lack the self-organizing character of communities[35]. Also, the networks observed in the interviews were of varying degrees of formality from unrecognized or bootlegged communities unknown to the next level of hierarchy to strategic or even transformative collectives openly supported by the organization by allocated time and budgets (e.g., in the case of a post-merger integration project).

In the 1998 KPMG study, 63% of the organizations with a KM initiative said they had already established some form of informal KM network (KPMG 1998, 13). It might be that in some of the organizations these networks could be qualified as communities or as a network of employees interested in KM or both. The observation that organizations with KM initiatives pay a lot of attention to informal networks of knowledge sharing is supported by the finding that while 63% of the organizations established informal KM networks, only 40% had formal KM networks (KPMG 1998, 13).

In the following, the number of participating employees or employees with access to certain KM-related ICT systems will be compared to the total number of

35. See section 6.1.3.3 - “Communities” on page 180.

employees. Table C-27 shows the distribution of responding organizations according to the two measures for participation and KM activity:

- *rate of participation*: the share of employees participating in KM activities compared to the total number of employees (Table C-27),
- *rate of KM activity*: the share of active participants compared to the number of employees participating in KM activities (Table C-28).

In seven organizations (18.9%), all employees participated in the KM activities, thus the *rate of participation* was 100% (see Table C-27). In eight organizations (21.6%), less than one percent of the employees shared in the benefits of KM efforts. In more than two thirds of the organizations (70.3%) less than half of the employees participated. Generally, the rate of participation varied widely: from core groups or nuclei of knowledge management (share < 1%, 8 cases) via low (< 10%, 6 cases), medium (< 50%, 12 cases) and high penetration (< 100%, 4 cases) to all-encompassing efforts (100%, 7 cases).

TABLE C-27. Rate of participation

$x = \frac{participants}{employees}$	**frequency**	**percent**
x < 0.10%	3	8.11
0.10 ≤ x < 1.00%	5	13.51
1.00 ≤ x < 10.00%	6	16.22
10.00 ≤ x < 25.00%	6	16.22
25.00 ≤ x < 50.00%	6	16.22
50.00 ≤ x < 75.00%	3	8.11
75.00 ≤ x < 100.00%	1	2.70
100%	7	18.92
total	37	100.00

Concerning the *rate of KM activity*, in more than two thirds of the organizations (69%) at least every tenth participant actively contributed to KM whereas in only one case the rate was lower than 1 percent (see Table C-28). The mean rate of KM activity in the responding organizations was 32.5%. Thus, it can be concluded that KM is in most organizations a highly interactive effort turning a great proportion of the supported employees from passive receivers of organizational communication into active participants of KMS.

The distinction between a high and a low rate of KM activity is especially important for mid-range KM initiatives because it might reflect the process of selecting participants. If experts with special KM needs spread across organizational units are selected, then the rate of KM activity will be high. If a selected business process or organizational unit is targeted no matter whether there are a sufficient number of experts who can actively contribute, then the rate of KM activity will be low. The rate of KM activity is an important descriptor of an organization's KM initiative, especially if it is related to other measures.

TABLE C-28. Rate of KM activity

$x = \frac{active-participants}{participants}$	**frequency**	**percent**
x < 0.10%	0	0.00
0.10 ≤ x < 1.00%	1	3.45
1.00 ≤ x < 10.00%	8	27.59
10.00 ≤ x < 25.00%	6	20.69
25.00 ≤ x < 50.00%	6	20.69
50.00 ≤ x < 75.00%	3	10.34
75.00 ≤ x < 100.00%	3	10.34
100%	2	6.90
total	29	100.00

One of the most propagated benefits of the use of KMS is that a lot more employees would actively contribute to KMS due to the fact that it is a lot easier to publish documents or to share in an electronic discussion than before (Hypothesis 21: 'Organizations with KMS have a higher rate of KM activity than organizations without KMS'). The hypothesis was tested using the correlation between the rate of KM activity as the first variable and whether or not the organizations used KMS as the second variable. The correlation showed a negative sign meaning that those organizations that had KMS had a higher rate of KM activity, but the correlation was not significant (Spearman's rho: -0.112, significance: 0.571, n=28). A more detailed analysis reveals that those organizations that had exclusively used KMS bought on the market had a significantly higher rate of KM activity (Spearman's rho: -0.387, significance: 0.042, n=28). The hypothesis therefore was supported for organizations with KMS bought on the market, but rejected for organizations with KMS developed internally[36].

As mentioned above, the rate of KM activity decreased with an increasing rate of participation. The corresponding negative correlation was highly significant (Spearman's rho: -0.523, significance: 0.004, n=29). The average rate of KM activity was 65% in organizations with core KM groups and a rate of participation smaller than 1% and compares to a low average rate of KM activity of 12.8% in organizations with a high rate of participation of 50% or more. Table C-29 com-

36. For this distinction see also section 14.1.2 - "Knowledge management systems" on page 526.

pares the average rate of KM activity for organizations with a low, medium and high rate of participation.

TABLE C-29. Rate of participation and rate of KM activity compared

x = rate of participation	**rate of KM activity (in %)**		
	mean	**std.dev.**	**n**
x < 1.00%	65.00	32.27	7
1.00 ≤ x < 50.00%	25.66	24.97	16
50.00 ≤ x ≤ 100.00%	12.84	13.62	6

Table C-30 shows the distribution of responding organizations according to the share of employees having *access to email* and *WWW* in a restricted or unrestricted form.

TABLE C-30. Shares of employees with access to email and WWW

x = share of:[a]	**internal email**		**unrestr. email**		**restr. WWW**		**unrestr. WWW**	
	freq.	**percent**	**freq.**	**percent**	**freq.**	**percent**	**freq.**	**percent**
x < 0.10%	1	1.45	1	1.56	0	0.00	2	3.08
0.10 ≤ x < 1.00%	0	0.00	0	0.00	2	9.52	5	7.69
1.00 ≤ x < 10.00%	5	7.25	10	15.63	4	19.05	26	40.00
10.00 ≤ x < 25.00%	8	11.59	11	17.19	5	23.81	10	15.38
25.00 ≤ x < 50.00%	14	20.29	10	15.63	5	23.81	7	10.77
50.00 ≤ x < 75.00%	7	10.14	6	9.38	2	9.52	4	6.15
75.00 ≤ x < 100.00%	11	15.94	7	10.94	2	9.52	1	1.54
100%	23	33.33	19	29.69	1	4.76	10	15.38
total	69	100.00	64	100.00	21	100.00	65	100.00

a. legend: freq. = frequency; restr. = restricted, unrestr. = unrestricted

Generally, by now every organization surveyed had access to the Internet. The organizations varied widely with respect to the rate of penetration—the share of employees with access to the Internet. Access to email was standard for at least half of the employees in 41 out of 69 organizations (59.4%) in the restricted and 32 out of 64 organizations (50%) in the unrestricted case.

In the case of the WWW, only 15 out of 65 organizations (23.1%) had unrestricted access to the WWW established for more than half of their employees. In most organizations, between 1 and 25% of the employees had access to the WWW (36 out of 65 cases, 55.4%). In the majority of organizations that restricted the use of the WWW between 1 and 50% of the employees had access to restricted parts of the WWW (14 out of 21 cases, 66.7%). The overall means of the share of employees were in the case of internal email 62.7%, in the case of unrestricted email 54.1%, in the case of restricted WWW 32.2% and in the case of unrestricted WWW 28.2%.

Industry organizations reported on average a significant smaller share of employees with access to internal (mean = 47.8%) and unrestricted email (mean = 40.1%) than service organizations with means of 78.1% and 68% respectively (Spearman's rho: 0.462, significance: 0.000064, n=69 for internal email, Spearman's rho: 0.351, significance: 0.00451, n=64 for unrestricted email). However, in the case of both, restricted and unrestricted WWW, the differences were not significant. Thus, Hypothesis 2: 'Service organizations have a higher share of employees with access to KM-related systems than industry organizations' is predominantly supported for the basic information and communication infrastructure supporting KM.

Table C-31 shows the same measures for employees having access to more advanced systems like *external on-line knowledge sources*, *Groupware*, *knowledge management systems* and *other Internet services*.

TABLE C-31. Shares of employees with access to advanced Internet systems, Groupware and KMS

x = share of:[a]	**ext. sources**		**Groupware**		**KMS**		**Internet services**	
	freq.	**percent**	**freq.**	**percent**	**freq.**	**percent**	**freq.**	**percent**
x < 0.10%	2	3.77	2	5.71	2	12.50	0	0.00
0.10 ≤ x < 1.00%	11	20.75	0	0.00	2	12.50	3	14.29
1.00 ≤ x < 10.00%	19	35.85	5	14.29	0	19.05	5	23.81
10.00 ≤ x < 25.00%	6	11.32	4	11.43	2	12.50	4	19.05
25.00 ≤ x < 50.00%	6	11.32	3	8.57	2	12.50	2	9.52
50.00 ≤ x < 75.00%	3	5.66	5	14.29	1	6.25	0	0.00
75.00 ≤ x < 100.00%	1	1.89	4	11.43	2	12.50	2	9.52
100%	5	9.43	12	34.29	5	31.25	5	23.81
total	53	100.00	35	100.00	16	100.00	21	100.00

a. legend: freq. = frequency; ext. = external

There were fewer valid responses to the questions of employees having access to external electronic sources for information and knowledge, other Internet services, Groupware and especially to KMS. This is partly due to the fact that many organizations had no KMS in place. A part can also be attributed to the fact that a substantial portion of respondents had to be omitted because they obviously misunderstood the question and indicated the number of different Groupware platforms they used (21 respondents misunderstood the question, 33.9% of all respondents answering this question) or KMS in use (8 respondents, 15.4%) instead of the number of employees having access to these systems.

In most organizations, having access to external sources was a rather exclusive privilege. In 60.4% of the organizations (32 out of 53) less than 10% of the employees had access to external sources. However, as the organizations were large on average, the absolute numbers still by far exceeded a mere group or department. In 68% of the organizations (36 out of 53), 50 or more employees had access to external sources.

In the case of KMS and especially Groupware, the picture is quite different. In about a third of the organizations answering these questions every employee had access to Groupware and KMS. Groupware platforms were accessible by at least half of the employees in 60% of the cases (21 out of 35). Only 7 organizations (20%) reported less than 10% of the employees with access to Groupware. In the case of KMS the distribution was quite similar to Groupware with the exception that 4 organizations (25%) reported less than 1% of the employees with access to KMS. The organizations can be split into three groups according to their policy for accessing KMS. Half of the organizations had a high rate of penetration concerning their KMS with more than half of their employees and in most cases more than 1,000 employees having access to KMS. Some organizations had a very restrictive rollout of their KMS with fewer than 10 employees having access (= less than 1% of the employees). In the rest of the organizations a larger group of employees had access to KMS with anywhere in between 30 and 450 employees (= between 1 and 50% of the employees).

The organizations were fairly evenly distributed with respect to the share of employees with access to other Internet services, e.g., newsgroups. About a third of the organizations reported 75% or more of the employees and again about a third of the organizations reported less than 10% of the employees with access to other Internet services. The earlier might have a completely unrestricted access policy with access to all services for (almost) every employee and the latter might view only a small group of employees as working on organizational tasks that required them to efficiently use advanced Internet services.

Again, industry organizations reported on average a significantly smaller share of employees with access to external sources (mean = 14.1%), Groupware (33.1%) and KMS (28.9%) than service organizations with 28.4% for external sources, 80% for Groupware and 74.8% for KMS respectively (Spearman's rho: 0.387, significance: 0.00421, n=53 for external sources, Spearman's rho: 0.621, significance: 0.000069, n=35 for Groupware and Spearman's rho: 0.578, significance: 0.019, n=16 for KMS). In the case of other Internet services, the difference is not significant. Thus, Hypothesis 2: 'Service organizations have a higher share of employees with access to KM-related systems than industry organizations' again is predominantly supported for these advanced KM-related systems. Service organizations reported on average a very high share of employees with access to Groupware or KMS when these systems were in place. In most of the service organizations both, Groupware and KMS, were seen as organization-wide platforms for the quick and easy exchange of knowledge whereas in industry organizations these platforms remained reserved for a much smaller portion of the employees.

13.1.2 Structural organization

The design of the structural organization of KM efforts varies greatly in practice. Indicators are the organizational positioning of the KM effort (level of reporting of the head of KM), the organizational design of the KM initiative or of a separate KM unit as well as the overall size of the effort in terms of the number of employees and the budget allocated for KM[37].

The design alternatives range from an informal initiative with no separate organizational unit or project over a temporary installation of KM as a project to a fixed, formal installation in the organizational hierarchy either as a service unit or as a functional unit. Thus, an ordinal variable has been defined that describes a range of design alternatives for the structural organization of the KM function which ranges from a formal, lasting approach to an informal, temporary approach:

1. separate organizational unit (formal, lasting),
2. project (formal, temporary),
3. no separate organizational unit (informal).

In the case of "no separate organizational unit", KM initiatives were performed either by committees with a budget coming from each member of the committee and senior management support, or by entirely informal initiatives not supported by formal authorities.

Figure C-7 shows what kind of organizational design the organizations applied for their KM initiatives.

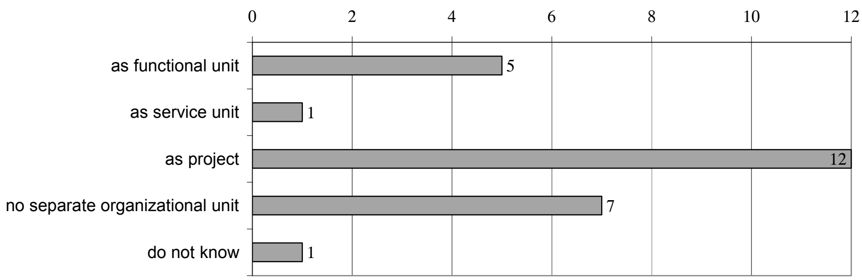

FIGURE C-7. Organizational design of the KM function[38]

Almost three quarters of the organizations (70.4%) had established the KM function either as a project (12 out of 26 organizations responding to this question, 46.2%) or informally with no separate organizational unit (7 organizations,

37. See section 15.1 - "Funding" on page 564.
38. n=26.

26.9%). Six organizations (23.1%) had a formal organizational design with all but one organized as a functional unit (e.g., group or department). One respondent indicated that their KM initiative was organized as a service unit (staff).

In the case of KM activities with no formal organizational unit, most organizations established or supported a committee or network of employees interested in KM to develop the initiative which might be approved and turned into a project or a formal organizational unit later.

Similarly, the FH Cologne found 38.5% of the organizations surveyed with no separate organizational unit responsible for KM: 28.7% performed KM activities together with like-minded colleagues and 9.8% of the organizations had only one single person engaged in KM (Döring-Katerkamp/Trojan 2000, 4). However, 83.2% of the respondents in that study said that KM was an “official” theme in their organizations and in 70.5% of the organizations KM was also supported by management (Döring-Katerkamp/Trojan 2000, 4). The higher share of organizations with no formal organizational unit compared to the study presented here can be explained by the fact that the organizations surveyed by the FH Cologne on average were smaller and had less experience with KM. About two thirds of the organizations (64.5%) had started KM within the last year (Döring-Katerkamp/Trojan 2000, 2f, 5). There are supposedly fewer resources to fund a separate organizational unit or even a dedicated KM project in smaller organizations. Still, 31.7% had a KM project and 21.9% had a separate organizational unit (Döring-Katerkamp/Trojan 2000, 4). Like in the study presented here, there were more projects than formal organizational units responsible for KM.

Jäger/Straub found similar results in the TOP 200 German organizations in 1999 with only a minority of organizations having institutionalized a separate organizational unit responsible for KM. Most of these organizations had KM projects or were planning to start one (Jäger/Straub 1999, 21).

In the APQC benchmarking study 7 out of 11 organizations had a centralized KM function that was partly responsible for KM activities (APQC 1996, 47). The organizations investigated by the APQC were pioneers in KM and considered knowledge as an important part of the products or services they sell. Thus, it seems that the more serious an organization is about the implementation of KM, the more likely it is to have established a separate organizational unit, even though no organization exclusively relies on the centralized approach, but also defines decentral KM roles & responsibilities within the business units[39].

To sum up, KM is organized in a variety of ways in the organizations with a trend towards more formal organizational design. Those organizations that set up a separate organizational unit or a project dedicated to KM use a variety of approaches. Considering the statements made by knowledge managers in the interviews, there are at least three approaches to be distinguished:

- *new informal initiative*: A number of employees set up a community which starts out rather informally and might get supported or funded by senior man-

39. See also section 13.1.3 - “Knowledge management tasks and roles” on page 498.

agement and (later) turned into a formal initiative, either as a KM project or as a separate organizational unit.

- *new formal initiative*: KM is implemented as a separate project or organizational unit with employees assigned partly or exclusively to this initiative from the beginning.
- *extending an existing organizational unit*: The to-do-list of an already existing department is changed or extended to include KM. Examples for former names of the unit are: market research, competence center, technology management, center for business intelligence. This approach can be found in many professional services companies which had turned those organizational units into KM units that previously had helped "front line" consultants to satisfy their information needs. In the 1998 KPMG study, a third of the organizations who had a named person responsible for KM said it was a person in an existing position whose responsibility was extended to include KM (KPMG 1998, 13).

Table C-32 shows which hierarchical level KM reported to. In 13 of the 16 organizations responding to this question KM reported to the first or second level of the organizational hierarchy (81.25%) with five organizations (31.25%) reporting directly to the board of directors or chief executives.

TABLE C-32. Hierarchical level to which knowledge management reports

KM reporting level	frequency	percent
1	5	31.25
2	8	50.00
3	1	6.25
4	2	12.50
valid total	16	100.00

Thus, in most cases KM was located on a high organizational level. This reflected the strategic relevance organizations attributed to this function. The result is supported by the 1998 KPMG study that found in 60% of the organizations a member of the board being responsible for the KM initiative (KPMG 1998, 13).

There is a significant correlation between the total number of hierarchical levels in an organization (see also Table C-19 on page 470) and the hierarchical level KM reports to (Spearman's rho: 0.509, significance: 0.0439, n=16). The more hierarchical levels there are the lower is the reporting level of KM.

The *relative KM reporting level* is defined as follows:

$$rrl(KM) = \frac{hl - rl(KM)}{hl - 1}$$

rrl(KM) = relative KM reporting level
hl = number of hierarchical levels
rl(KM) = KM reporting level

Thus, the relative KM reporting level is defined in the interval [0;1]. A mean of 0.73 shows that the average KM reporting level is quite high. Table C-33 shows the distribution of organizations according to the KM reporting level relative to the number of hierarchical levels in the organization.

TABLE C-33. Relative knowledge management reporting level

x = relative KM reporting level	frequency	percent
$x < 0.40$	1	6.25
$0.40 \leq x < 0.60$	4	25.00
$0.60 \leq x < 0.80$	3	18.75
$0.80 \leq x < 1.00$	3	18.75
$x = 1.00$	5	31.25
valid total	16	100.00

21 organizations answered the question “Is knowledge management organizationally embedded in a functional area (e.g., Marketing, Research & Development, IT). If yes, in which functional area is knowledge management embedded?”. 38.1% of the organizations (8 respondents) said that KM was not part of a functional area and the remaining 61.9% (13 respondents) said it was part of a specific functional area. Table C-34 shows which functional areas KM was embedded in.

TABLE C-34. Functional areas in which KM is embedded

functional area	frequency	percent
(centralized) technical area	4	30.77
information technology (IT)	4	30.77
research & development	2	15.38
sales	1	7.69
strategic development	1	7.69
other	1	7.69
total	13	100.00

In 8 cases (61.5%) KM was part of a technical area, either a technical department, the technology area, IT or information management. The technical departments were usually those organizational units that handled the organization’s product and process innovations and thus were obvious candidates in need of a more systematic handling of knowledge. In the cases where the IT departments were responsible for KM, the KM effort primarily consisted of the implementation of an ICT infrastructure and the corresponding organizational processes supporting the handling of knowledge. In two organizations KM was part of R&D. One KM initiative was placed in the sales area (customer relationship management) and one initiative was part of the strategic development group. One respondent used an internal organizational code unknown to the author shown in the table as "other" functional area.

Comparing these results to those of related studies helps to detail this picture. Table C-35 gives an overview of what organizational units were found as being responsible for KM or as advancing KM as a topic in the organizations.

TABLE C-35. Related empirical studies compared concerning organizational units responsible for KM

organizational unit	KPMG 1998	Jäger/ Straub 1999	FH Cologne 2000	FH Cologne 2001
IT/organizational design	44.1%	11.1%	22.2%	27.0%
strategic development/planning	20.3%			13.0%
functional area	8.5%[a]		14.3%[b]	26.0%[c]
human resource management	11.9%	55.6%	2.0%	
research & development		14.8%		16.0%
internal communication		11.1%		
board of directors, CEO, CKO	15.3%[d]		21.3%[e]	
interdisciplinary team			40.2%	

a. finance
b. a functional area with a KM project
c. marketing and sales
d. every department head or every director (6.8%); CKO (8.5%)
e. board of directors or CEO

The results differ widely which can be attributed at least partially to the substantial differences between the samples of the related empirical studies[40]. Also, the typologies of the organizational units used in these studies differ which explains some of the differences and empty cells in Table C-35 (e.g., only one study used the category "interdisciplinary team").

In the 1998 KPMG study, of those organizations which had appointed responsibility for their KM initiative, it was put in the hands of an IT function (44.1%), strategic development or business improvement respectively (20.3%), HRM (11.9%) or finance (8.5%). The rest of the organizations either had every department head or board director responsible (6.8%) or they had established a dedicated CKO position responsible for the initiative (8.5%, KPMG 1998, 14).

40. See section 10.1 - "Surveys" on page 439.

The FH Cologne found 40.2% of the organizations having appointed an interdisciplinary KM team responsible for the initiative (Döring-Katerkamp/Trojan 2000, 5). Unfortunately, the study did not ask for what disciplines participated in these teams. In 21.3% of the organizations the board of directors or the CEO were responsible for KM, 14.3% assigned responsibility to a functional area with a concrete KM project, 13.5% held IT responsible, 8.6% organizational design and 2% HRM. In the same study, about a third of the respondents (33.5%) reported that they had called in or planned to call in external support (e.g., by consultants, Döring-Katerkamp/Trojan 2000, 9).

In the follow-up study performed in 2001, it were IT (27%), R&D (16%), planning (13%), marketing (13%) and sales (13%) that primarily advanced KM as a topic (Döring-Katerkamp/Trojan 2001, 3). Compared to the earlier study of the FH Cologne responsibility seemed to have moved higher up the organizational hierarchy. In 49% of the organizations the board of directors decided about the implementation of KM, in 20% it was a head of a division/functional area and in only 6% it was a department head (Döring-Katerkamp/Trojan 2001, 2).

Jäger/Straub found that in 55.6% of their cases HRM was responsible for KM. This surprisingly high share can be explained by the fact that their questionnaire was directed to the HR managers of organizations. Strategic development and R&D scored second with 14.8% each followed by internal communication and IT with 11.1% each (Jäger/Straub 1999, 21).

Taken all these results together, many organizations placed their KM efforts within IT which is all the more interesting because in the literature KM is certainly viewed as a function which should be placed outside technical departments to show its clear non-technical focus. One explanation for this finding could be that in the beginning, KM was mostly occupied with technical issues like developing the information and communication infrastructure suitable for KM in these organizations. This might be the installation of a corporate Intranet which in most organizations is certainly seen as an IT task.

Apart from the major role that IT plays in many KM efforts, the findings vary widely as to what other organizational units were responsible for KM. At least three different approaches can be distinguished:

- KM is assigned to a concrete project or program within a functional area, such as marketing or sales, within R&D or a technical department that have a serious interest in applying KM instruments,
- KM is advanced as part of the organization’s strategic development, planning or HRM programs,
- the board of directors, a member of the board or the CEOs themselves are responsible for the KM initiative.

In accordance with the literature, in many organizations KM involves a number of different departments that are each responsible for a certain part of the effort. This suggestion is supported by the results in the FH Cologne 2000 study that found most of the organizations had appointed interdisciplinary teams reflecting the heterogeneity of requirements encountered when implementing KM. The statements that were made in the interviews seemed to point in that direction as well. Some organizations had split their KM efforts into a technical department being responsible for the set up of the electronic infrastructure and a functional area (e.g., corporate strategy) being responsible for the (non-technical) KM concept. The latter might include the structuring of the content, the organization of KM events and the internal "selling" of KM to knowledge workers, the establishment of communities and the like.

However, the interdisciplinary nature of KM teams might also be at least partly responsible for the lack of a clear definition, model or goals of KM in the organizations. Only 42.9% of the organizations surveyed by the FH Cologne had developed a common understanding of KM or had taken over an existing KM model (e.g., the building blocks for KM, Probst et al. 1998). Also, just 40.8% of the organizations had a clarified understanding of how KM should be implemented in their organization (Döring-Katerkamp/Trojan 2000, 6).

13.1.3 Knowledge management tasks and roles

Apart from the structural organization it is primarily the systematic design of KM tasks and the consequent assignment of responsibility for KM-related tasks to roles that makes knowledge processes visible and subject to evaluation and improvement. It is interesting to know to what extent organizations have already implemented KM tasks, whether they have assigned formal responsibility for these tasks, who is responsible for the KM tasks in organizations and finally whether KM tasks are performed centrally or decentrally. Due to the limitations of a written questionnaire, the focus was on the most important KM-related tasks which have an impact on the use of KMS or can be supported by KMS (see also below). The extensive list of KM roles presented in part B had to be substantially reduced[41].

The list of KM tasks as used in this study does not cover all knowledge-related tasks which have been discussed in the literature[42]. The list was derived from the definition of knowledge management systems[43] and the model of the tasks and flows in knowledge management[44]. Figure C-8 once again shows this model with those KM tasks highlighted that were used in the questionnaire.

All four levels, the strategic level, the design level, the operational management level and the operational level were considered in the questionnaire. One of the goals here is to determine the degree of centrality of the KM initiatives. Thus, those tasks were selected that

- were supposedly well suited to differentiate between organizational design alternatives with respect to the degree of centrality. The selection of the tasks was based on a number of expert interviews before the questionnaire in which vary-

41. See section 6.1.2 - "Knowledge management roles" on page 162.
42. See section 6.3.1 - "Knowledge management tasks" on page 207.
43. See section 4.3 - "Knowledge management systems" on page 82.
44. The model was presented in chapter 6 - "Organization" on page 153; see particularly Figure B-22 on page 154.

ing organizational designs of knowledge management were identified and compared to each other,

- the corresponding questions could be quite easily understood and answered by a single respondent in an organization.

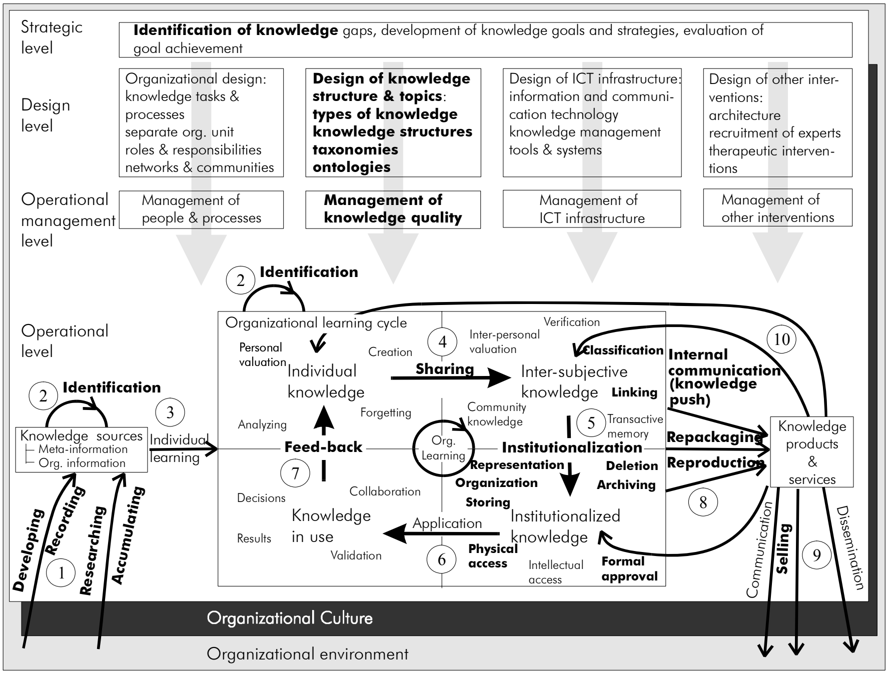

FIGURE C-8. Model of the tasks and flows in KM and its application in the questionnaire[45]

Strategic level. On the strategic level, the identification of knowledge was selected because every organization engaged in a KM initiative more or less fulfilled this task. Identification is an ongoing effort due to the dynamic nature of an organizational knowledge base and thus is also an operational task.

Design level. On the design level as well as the operational management level, the focus was on the design of the knowledge structure and topics. The assignment of responsibility for the design of the content of KMS was found to be a crucial task in a KM initiative. The organizational design alternatives reach here from a central and rigid approach with one committee defining the structure and categories which can only be changed by that committee to a decentral approach where every participant can alter the knowledge structure (e.g., add a new category).

45. Tasks considered in the study are highlighted.

As for the other two elements on the design level, the organizational design of the KM function is assumedly a quite central task which might be influenced by broader groups, but not fulfilled. The organizational design was considered elsewhere in the questionnaire[46]. As for the design of the ICT infrastructure, the corresponding processes and tasks were in most organizations part of the IT function and thus the organizational design was dependent primarily on the organizational design of the IT function.

Operational management level. Management of the knowledge structure and topics in terms of operational management is primarily a task of managing knowledge quality which was reworded into quality assurance of knowledge elements in order to be well understood by the respondents.

Operational level. On the operational level all KM tasks except for *individual learning* and *application* were considered. These two tasks were omitted because every individual or participant targeted by a KM initiative is responsible to learn on his or her own and to apply the knowledge so that there are supposedly no organizational design alternatives for these tasks.

The complete list of KM tasks finally used is as follows (in case of rewording of tasks the original terms as used in Figure C-8 are given in parenthesis):

- identification of knowledge,
- acquisition of external knowledge (developing, recording, researching, accumulating),
- semantic release of new knowledge elements (formal approval),
- storing of new knowledge elements (representation, storing, physical access),
- integration of knowledge into existing structure (knowledge classification, linking, organization),
- update of knowledge structure (design of knowledge structure and topics),
- distribution of knowledge (internal communication, knowledge push, knowledge sharing),
- quality assurance of knowledge elements (management of knowledge quality),
- refinement of existing knowledge (repackaging, reproduction; feedback),
- deletion or archiving of knowledge,
- selling of knowledge.

In the following, the roles that are responsible for the KM tasks are focused. Central hypothesis in this section is that the organizational design alternatives of KM efforts differ largely in terms of centralization. The extreme points of the dimension centralization are:

- a liberal, laissez-faire approach where only the base technology in the sense of an information and communication infrastructure is installed and content of

46. See section 13.1.2 - "Structural organization" on page 492.

knowledge repositories as well as networks and communities of participants evolve on their own and
- a central approach where all the knowledge elements are developed, institutionalized and distributed by one single central KM unit and where networks are established by central authorities.

These are only the extreme points. Actual implementations in organizations supposedly use a mixed approach in which some KM tasks will be more centralized than others. Therefore, it was examined (a) whether KM tasks were fulfilled centrally or decentrally and (b) which role was responsible for what KM tasks. The questionnaire contained for each KM task the following checkboxes:
- *central*: task is carried out centrally,
- *decentral*: task is carried out decentrally,
- *not fulfilled*: task is not carried out at all,
- *no responsibility*: task is carried out, but no specific responsibility is assigned for it,
- *do not know*: respondent does not know about the assignment of responsibility for this specific KM task.

Additionally, the questionnaire comprised knowledge management roles for each KM task. The list of KM roles [47] had to be simplified for the questionnaire for two pragmatic reasons: firstly, the results should be comparable to each other. Thus, the questionnaire had to contain terms that were widely used in practice. What is called a knowledge integrator might be called a knowledge steward or knowledge administrator in a different organization. Additionally, a knowledge broker in one organization might have an entirely different list of tasks and responsibilities assigned than a knowledge broker in a different organization (homonyms/ synonyms). It seemed impossible to use such vaguely defined terms in a questionnaire as long as KM roles have not been consolidated. Secondly, the full list of roles would have been too long to be included into the questionnaire. However, the full list was used in the interviews to get a more detailed picture of the distribution of responsibility in the organizations. Finally, the following three roles were distinguished in the questionnaire:
- *knowledge manager/integrator*,
- *subject matter specialist*,
- *participant/author*.

The three roles were predefined in the questionnaire and just had to be checked. Again, these three roles reflect different degrees of centralization. The knowledge manager is the most central role responsible for certain knowledge processes or tasks. He or she resides within a separate organizational unit (no matter whether temporarily as project manager or permanently as head of a department). The subject matter specialist is an expert in a specific (or a list of specific) topic(s) and is

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47. See section 6.1.2 - “Knowledge management roles” on page 162.

responsible for exactly this (list of) topic(s). Supposedly, there are a much larger number of subject matter specialists than the number of knowledge managers. Also, subject matter specialists are supposedly formally recognized in the respective organizations. Thus, it is assumed that to assign responsibility to a subject matter specialist is less central than to assign responsibility to a knowledge manager. Lastly, to assign responsibility to the participants means a decentralized approach, because every employee with access to KMS is responsible for the respective knowledge process or task.

In the following, the results are presented for all tasks according to the organizational design variables (de-) centralization and roles responsible for the tasks[48].

Figure C-9 shows the distribution of responsibility to the KM roles according to the eleven KM tasks as defined above.

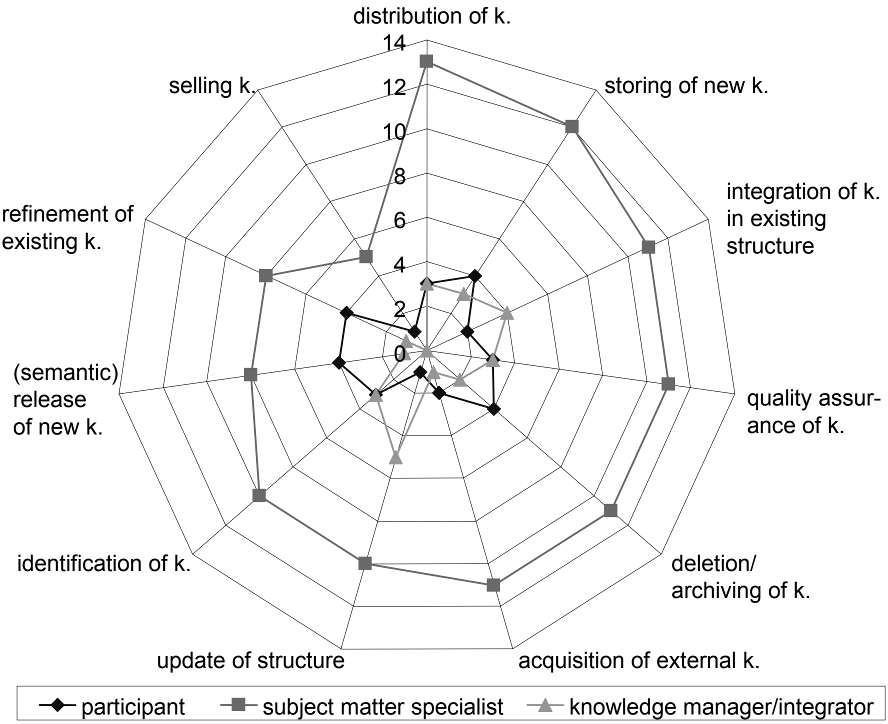

FIGURE C-9. Responsibility for KM-related tasks assigned to knowledge management roles[49]

48. The detailed results for the individual tasks can be found in URL: http://iwi.uibk.ac.at/maier/kms/.
49. Legend: k.=knowledge.

The data points show the number of respondents who indicated that their organization had established the corresponding role responsible for a particular KM task. Example: in the case of distribution of knowledge 13 respondents indicated that they held subject matter specialists responsible for this task. Multiple responses were possible to indicate that more than one role was responsible for a certain task. The KM tasks are ordered clockwise according to descending values for subject matter specialist (first criterion) and for knowledge manager/integrator (second criterion).

In the majority of cases subject matter specialists were responsible for the tasks. This is true for every KM task questioned. Participants were held responsible in only a few organizations. The only tasks for which in more than three cases participants were responsible were *storing of new knowledge*, *(semantic) release of new knowledge*, *refinement of knowledge* and *deletion/archiving of knowledge*. These tasks can be compared to the basic operations insert, grant privileges, update and delete of a relational data base system. All other tasks were not in the hands of the participants in all but one or at most two organizations, especially the design task *update of the structure*, but also the *integration of knowledge into an existing structure* and those tasks that cross organizational boundaries, *acquisition of external knowledge* and *selling of knowledge*.

Knowledge managers or integrators in many cases seemed to cooperate with subject matter specialists in order to administer the knowledge structure(s). Apart from these tasks, knowledge managers were rarely held responsible for KM tasks. *Selling of knowledge* is a special case. Most organizations currently do not seem to care about this new and potentially profitable source of revenue.

Table C-36 gives an overview of the share of organizations that assigned responsibility for KM tasks to more than one role and/or to both, central and decentral units.

TABLE C-36. Assignment of responsibility to multiple roles

KM task	**multiple roles**		**central and decentral**	
	frequency	**percent**	**frequency**	**percent**
deletion/archiving of knowledge	5 of 12	41.67	2 of 11	18.18
storing of new knowledge	5 of 14	35.71	4 of 12	33.33
distribution of knowledge	5 of 14	35.71	5 of 12	41.67
update of structure	4 of 12	33.33	5 of 10	50.00
refinement of existing knowledge	3 of 10	30.00	3 of 7	42.86
knowledge identification	3 of 12	25.00	2 of 12	16.67
quality assurance of knowledge	3 of 13	23.08	3 of 9	33.33
integration of knowledge in existing structure	3 of 14	21.43	4 of 10	40.00
release of new knowledge	2 of 11	18.18	1 of 10	10.00

TABLE C-36. Assignment of responsibility to multiple roles

KM task	multiple roles		central and decentral	
	frequency	**percent**	**frequency**	**percent**
acquisition of external knowledge	2 of 12	16.67	2 of 15	13.33
selling of knowledge	0 of 6	0.00	2 of 9	22.22

One can conclude that the *degree of centralization* of knowledge management is low for tasks on the *operational level* (with subject matter specialists and participants in most cases responsible for the corresponding tasks) and medium for tasks on the *level of operational management*, the *design level* and for the *strategic level* (subject matter specialists, knowledge managers). However, as subject matter specialists could either belong to central or decentral parts of the organization, more clarification is needed on the degree of centralization.

Figure C-10 shows the results to the question whether the knowledge processes and tasks were assigned to central or decentral positions or roles respectively.

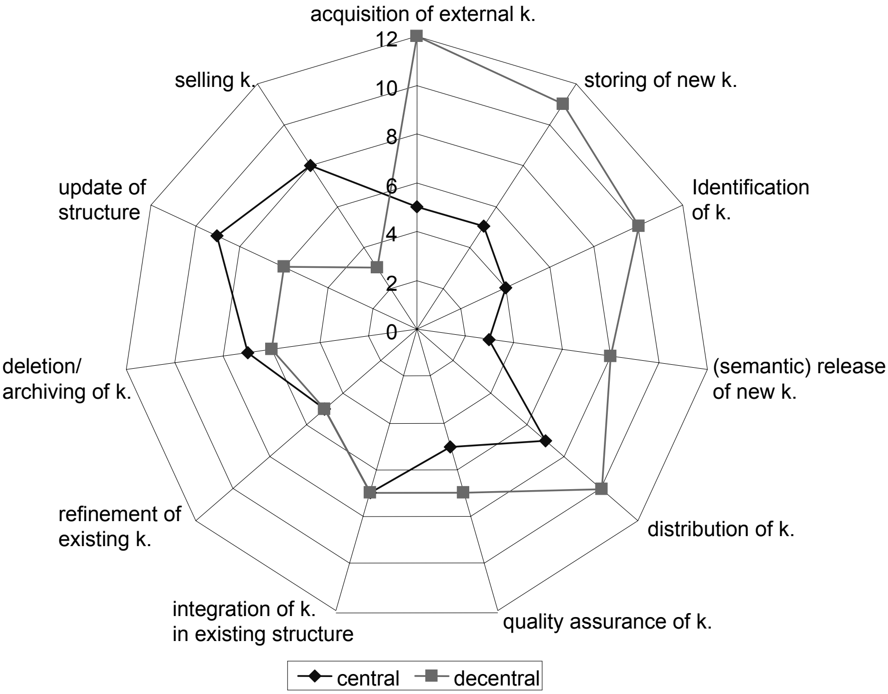

FIGURE C-10. Centrality/decentrality of KM-related tasks[50]

50. Legend: k.=knowledge.

Again, the data points show the number of respondents who indicated that they had assigned the corresponding task to either a central or a decentral position. The results are ordered according to the difference between the values for decentral and central responsibility in descending order (first criterion) and according to descending values for decentral responsibility (second criterion).

Most organizations acquired external knowledge decentrally. Of the four tasks that were assigned in most cases to participants as shown in Figure C-9 on page 502—*storing of new knowledge*, *(semantic) release of new knowledge*, *refinement of existing knowledge* and *deletion/archiving of knowledge*—only the publishing part was organized decentrally in most organizations: *storing of new knowledge* and *(semantic) release of new knowledge*. Once the knowledge was documented and inserted into a KMS, both, central and decentral organizational positions took care of it. This was also true for *quality assurance of knowledge* which in some cases might mean *deletion, archiving of knowledge* or *refinement of existing knowledge*. The design level task *update of structure* was in most organizations primarily a central task. The same was true for *selling of knowledge*. This task might be imagined as assigned to one department that is responsible for licensing patents to other organizations or employees in a particular organizational unit work as consultants for other organizations.

These variables describing the distribution of responsibility to central and decentral units of organization were aggregated to the construct *decentrality of knowledge management*—written *decentrality (KM)*—which is determined by the following formula:

$$decentrality(KM) = \frac{\text{number of decentral KM tasks}}{\text{number of decentral KM tasks + number of central KM tasks}}$$

Values for decentrality (KM) are defined in the interval [0;1]. An overall mean of 0.64 shows a tendency for organizations to assign responsibility to decentral units rather than central ones. Table C-37 shows the distribution of organizations according to the level of decentrality of KM.

TABLE C-37. Decentrality of knowledge management

x = decentrality (KM)	frequency	percent
x < 0.40	3	17.65
0.40 ≤ x < 0.60	5	29.41
0.60 ≤ x < 0.80	3	17.65
0.80 ≤ x < 1.00	2	11.76
x = 1.00	4	23.53
valid total		100.00

Figure C-11 shows which KM tasks were not carried out or for which no responsibility was assigned in the organizations. The tasks are ordered according to the number of respondents indicating that they had no such task in place (first criterion) and the number of organizations with such a task, but with no formal responsibility assigned (second criterion). Not surprisingly, every organization carried out the tasks *storing of new knowledge* and *deletion/archiving of knowledge*, the basic operations insert and delete of an organizational knowledge base. But almost 45% of the respondents indicated that they would not *sell knowledge* which is not surprising as a "market" for knowledge elements was – apart from licensing of patents and consulting services – still not widely established. However, more than a quarter of the organizations (27.8%) did not *refine their existing knowledge*, four organizations (22.2%) indicated that there was no formal *(semantic) release of new knowledge*, three had no *quality assurance* and two organizations (11.1%) had not implemented tasks systematically handling a *knowledge structure*.

As for the assignment of responsibility, *identification of knowledge* seems to be an informal task in many organizations, as is the case for *storing of new knowledge*.

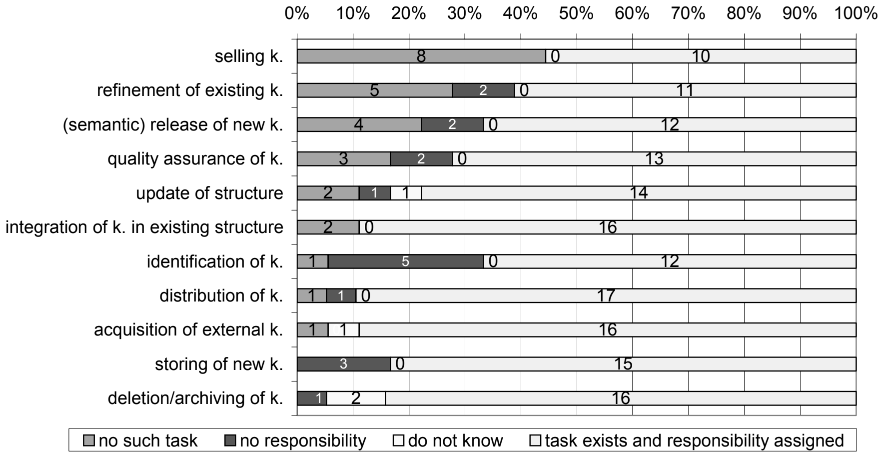

FIGURE C-11. Formally "unorganized" knowledge-related tasks

One of the reasons why some organizations had no explicit responsibility defined could be that organizations doubt that the benefits gained by a separate function or organizational role would justify the expenses that the implementation of such a role would require, possibly due to the unclear profile of such a role. One other reason might be that organizations fear a loss of control of important knowledge if its systematic treatment is concentrated in the hands of just a handful of employees. Even though 85% of the organizations responding to the Fraunhofer Stuttgart questionnaire indicated their positive attitude towards the installation of a knowledge broker, it was precisely these arguments that made some of them hesitate to implement this concept (Bullinger et al. 1997, 23).

Also, organizations might not find every task equally important for their organization. In the Fraunhofer Berlin study, the four general KM activities generate, store, distribute and apply knowledge were distinguished along with the two management functions define knowledge goals and identify knowledge. Most organizations found the distribution of knowledge (91%) either important or very important (Heisig/Vorbeck 1998, 7) with the latter share being quite as high as the 89.5% of organizations who had assigned formal responsibility for that task in the study presented here. A much smaller share of organizations in the Fraunhofer Berlin study (65%) thought the identification of knowledge was important or very important, a result closely matching the finding presented here that 66.7% of the organizations had a formal responsibility defined for this task. 78% thought the same of storing knowledge compared to a similarly high value of 83.3% of organizations in the study presented here. Thus, some of the organizations might concentrate on the personal side of KM and might not pay equally high attention to the codification of knowledge.

The list of tasks presented here seems to focus more on the codification side of KM whereas the personalization side does not receive equally high attention. However, "knowledge" in an organizational knowledge base which is handled by the tasks listed here is by no means restricted to codified knowledge as the analysis of contents will show[51]. Moreover, knowledge repositories contain in many cases links to experts, skills, projects, business partners etc. and thus support the personalization side of KM as well. Specific personalization tasks such as the moderation of communities were not included because the expert interviews conducted before the broad questionnaire had shown that these functions were neither well-known nor widespread in the organizations.

In the 1998 KPMG study, the redesign of jobs and processes was the single most frequently applied or planned initiative in those organizations that were pursuing KM. 49% of these organizations had already redesigned jobs and/or processes and an additional share of 28% of respondents said they were planning to do so (KPMG 1998, 13). This once again shows that organizations are well aware of the importance of a systematic organizational design that considers KM tasks, roles and processes.

13.1.4 Résumé

In the following, the most important findings with respect to scope, structural organization and the organization of KM processes, tasks and roles will be summarized.

Scope. Taking all the different measures into account that assess the scope of an organization's KM-related activities, there is a distinctive difference between

- the number of business processes supported by a KM initiative and the regulation of access to basic ICT infrastructure on the one hand and

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51. See section 14.2.1 - "Types of contents" on page 532.

- the rate of participation of employees in KM initiatives, the rate of KM activity as well as the regulation of access to KMS and more advanced KM-related ICT infrastructure on the other hand.

All KM efforts investigated in this study span *business processes* supporting the proposition that it is the knowledge flows between business processes that matter most for knowledge management and thus have to be systematically handled and supported. In the majority of organizations all business processes were targeted and thus the KM initiative represented an organization-wide effort.

Also, in the majority of organizations *basic ICT infrastructure*, such as email and Groupware, was accessible for at least half of the employees. More than a third of the organizations even offered access to all of their employees. By now, Internet access is standard in every organization as is the use of Groupware or an Intranet platform to support internal electronic communication. This finding is at least representative for big organizations as surveyed here which all have established email and WWW. Service organizations generally reported significantly higher shares of employees with access to KM-related systems than industry organizations[52].

However, the picture is different with respect to the *rate of participation*, the share of employees who actually participate in an organization's KM effort. There are a number of organizations that have only a small group of employees share in the KM activities and only this group has access to the organization's KMS. Organizations can be classified according to the scope of their KM activities into the following three groups:

- *core KM groups or nuclei*: About 20% of the organizations had small KM activities with up to 99 participants, which means less than 1% of the employees participating and a core group responsible for the activities. The narrow focus is also reflected in a rather low rate of participation and also restrictive policies limiting access to advanced KM-related information and communication systems, such as KMS or external sources to less than 1% of the employees.
- *mid-range KM initiatives*: In about 50% of the organizations KM efforts are much broader than the ones in the first group, though participants are still selected carefully, e.g., a selected group of knowledge workers of an organization or all employees working in a couple of organizational units with special KM needs. KM activities are targeted mostly to between 100 and several 1,000 employees depending on the size of the organization, which gives between 1 and 50% of the employees. Correspondingly, the access to KM-related systems is loosened, but far from being completely unlimited.
- *pervasive KM initiatives*: In about 30% of the organizations KM is viewed as an approach rolled out to the entire organization with every or close to every employee participating in the effort (more than 1,000 employees, 75% or more). Access to KM-related systems is (almost) unrestricted, no matter whether or not every employee actually is able and/or willing to use the systems and no matter

52. For a detailed analysis of KM-related systems in use see chapter 14 - "Systems" on page 524.

whether his or her role requires access to KM-related systems. Consequently, in these types of organizations the rate of KM activity is much lower (less than 25%) than in the rest of the organizations.

Thus, the *rate of KM activity* is negatively correlated with the rate of participation in a KM effort. Most organizations have a high rate of KM activity with more than 10% of the targeted employees actively participating in a KM initiative.

Communities are not a widespread organizational phenomenon with about a quarter of the respondents reporting the number of communities they had established. Although in most cases there were only a handful of communities established, organizations generally seem to pay a lot of attention to supporting informal knowledge networks and the informal exchange of knowledge. Some of the organizations might not have been familiar with the concept of communities.

Structural organization. Organizations vary according to the structural organization of their KM function. If an organization had established a separate organizational unit that provided other areas with e.g., studies or reports thus assuming the role of an information broker before, this organizational unit was likely to be turned into a *separate KM unit*. The unit's responsibility was extended to broaden its perspective to include KM and to introduce and support KM-specific organizational and ICT instruments. Many professional services companies have followed this approach providing case studies highly visible in the KM literature. In the study presented here, less than a quarter of the organizations with a systematic KM initiative actually had established a separate KM unit.

In more than a quarter of the organizations KM was advanced in the organization by an *informal group of employees* interested in KM. This could be a network of employees, a committee or a community with varying degrees of support from formal authorities. The most prevalent form of structural organizational design applied to KM, however, was the *KM project*. Projects were established in almost half of the organizations.

In many organizations, KM quickly gains high visibility and its efforts are closely watched by senior management. Many CEOs even of large corporations such as Siemens and DaimlerChrysler have put KM on their agendas. This is reflected by the high *reporting level of KM*. Most of the KM initiatives reported to the two highest levels of the organizational hierarchy.

More than a third of the organizations did not integrate KM within a single *functional area*, but employed an interdisciplinary approach which is regularly considered most suited for this kind of activity. There is also a shift from exclusively embedding KM in a technical environment, especially IT, to an involvement of business-oriented areas responsible for KM, such as strategic development, marketing or sales. Whereas a couple of years ago the establishment of an information and communication platform—Groupware and Intranet—required most attention, organizations now have sophisticated functions implemented and are in search of concepts, measures and instruments to effectively use these platforms for KM[53].

Additionally, it seems that in many cases the IT focus, the business focus and the organizational or HRM focus of KM co-exist without taking very much notice of each other. This might be one explanation for the finding that many organizations had difficulties in exactly defining how they will implement KM measures and thus being hesitant to allocate substantial resources to this approach.

KM tasks and roles. Knowledge management was implemented as a predominantly decentral approach leaving as much responsibility with decentral functions as possible. With few exceptions[54] all KM tasks were assigned to decentral organizational units or members rather than central ones. In many organizations the responsibility is shared between central and decentral authorities. Also, responsibility in most cases is shared between the author of a knowledge document (active participants) and subject matter specialists who help the authors to document, link and organize their experiences.

The key role in KM initiatives therefore is the *subject matter specialist*. Most of the organizations surveyed assigned responsibility for the majority of their KM tasks to this role. Subject matter specialists are primarily responsible for KM tasks on the operational level[55]. In many cases they share responsibility for these tasks with *participants*.

Subject matter specialists also provide the "linking pins" for knowledge-related design and operational management tasks[56]. In these cases they share responsibility with *knowledge managers*. The strategically relevant identification of knowledge and the operational distribution of knowledge are in many organizations joint efforts with responsibility split between all three roles.

There are also several organizations in which responsibility for KM tasks is not assigned at all. About a third of the organizations just assigned responsibility for basic tasks related to the publication and distribution of knowledge, but did not pay equally high attention to what happens to the knowledge once it is documented and inserted into the organizations' knowledge bases[57]. Moreover, a third of the organizations had not assigned responsibility for the identification of knowledge. This might be taken as a signal that organizations had difficulties to decide how to achieve this KM goal at which all respondents aimed strongly[58].

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53. See also section 14.3 - "Functions" on page 548.
54. The exceptions were the deletion or archiving of knowledge which was almost equally distributed between central and decentral authorities, the design level function update of knowledge structure and the selling of knowledge which in almost half of the organizations was not defined at all.
55. Examples are the storing and release of new knowledge, refinement of existing knowledge, deletion and archiving of knowledge as well as the acquisition of external knowledge.
56. Examples are the update or reorganization of knowledge structure(s) or the integration of knowledge into the existing structure.
57. This is especially true for quality assurance, refinement of existing knowledge elements or the (semantic) release of knowledge.
58. See section 12.2.1 - "Targeted goals" on page 472.

To sum up, the typical organizational design of a KM initiative can be described as follows. One or more interdisciplinary KM project(s) are responsible for the implementation of KM instruments. Strategic development, functional departments, IT and organization as well as HRM jointly drive the KM initiative in the organizations. The organization-wide activities are targeted at a selected group of employees who have unrestricted access to sophisticated ICT infrastructure and who are expected to actively participate in KM. Subject matter specialists and participants share responsibility for most of the defined KM tasks which are performed mostly decentrally. Only coordination of the KM activities, the management of a corporate knowledge structure as well as the commercialization of knowledge are in the hands of central authorities.

13.2 Organizational culture

Organizational culture is an implicit phenomenon, is natural and obvious to the members of the organization, comprises collective orientations and values that impact the individual's behavior, is the result of a learning process about how the organization has dealt with the internal and external environment, provides patterns for the selection and interpretation of behavior, provides orientation in a complex world and is handed on in a social process[59].

Most researchers and practitioners agree that a culture supportive of knowledge sharing is one of the key requirements for a successful application of KM. However, the organizations differ in what steps they take to create or improve a supportive cultural environment. *Cultural goals* that were reported in the interviews were for example to raise awareness about the importance of knowledge and its systematic handling, to foster a strong professional ethic encouraging knowledge sharing, to instill trust among employees, especially across borders of organizational units, to reduce the importance to "save faces" and to "be creative"[60] and to increase the positive attitude towards reusing ideas invented somewhere else.

The *instruments* applied to foster a supportive organizational culture are also manyfold. Examples are material or immaterial rewards for knowledge sharing, mentoring programs, HR trainings in sophisticated skills in teaming, especially with respect to cross- or multi-functional teams (e.g., APQC 1996, 49). A third of the organizations with a KM initiative surveyed by KPMG had established KM training and awareness programs and about another third of these organizations (32%) was planning to do so (KPMG 1998, 13). The organizations participating in the benchmark study by the APQC thought that leadership, the selling of successful

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59. For a more in-depth discussion of the notion of organizational culture see section 6.4 - "Organizational culture" on page 221.
60. Sometimes this overly stressed importance to be inventive results in the "not invented here" syndrome (NIH) well described in the literature. Organizational units refuse to take over results from other organizational units or from outside. In some cases reported, organizational experts rather accepted knowledge brought in by external experts than by their peers within the organization.

KM business cases (success stories, quick wins), endorsement by senior managers and a common information and communication infrastructure (technological as well as conceptual, e.g., a standardized business language) were best suited to create a culture more supportive of KM (APQC 1996, 54).

It is commonly agreed upon that *leadership* is important to foster an organizational culture supportive of KM. Managers have to encourage knowledge sharing and set good examples by their own behavior. The CKO's own behavior has the most symbolic character in an organization, e.g., with respect to knowledge sharing (see Bontis 2001, 31). Nevertheless, behavior that is adequate for KM cannot simply be delegated. The CKOs colleagues, middle managers and KM promoters have to set good examples as well because managers' behavior is closely watched by their peers and subordinates if a fundamental change to a more open organizational culture is targeted by the KM initiative.

One of the requirements for this is that senior managers support the KM initiative. In the APQC study, it turned out that the highest commitment to KM was found among knowledge workers and professionals. Between 80 and 100% of this group strongly bought into the KM initiative. Senior management also committed itself strongly at between 63 and 73%, but middle and supervisory management was less convinced of the approach at between 43 and 55% (APQC 1996, 49). This result is not really surprising as KM in many cases requires middle management to adapt most to the new ways of handling knowledge. Participants and experts profit most of the approach and senior management is not directly involved in the change processes of the implementation of KM.

The *assessment or measurement of organizational culture* is a serious problem[61]. The actual values and assumptions of people about other people, time, space and goals are less observable than official statements about values and indicators such as stories, symbols, language, clans (Schein 1984, Drumm 1991, 166). Cultural analysis thus is a complex undertaking. In the study presented here, the single dimension measured reflecting organizational culture is willingness to share knowledge.

In the following, section 13.2.1 will present the results of the investigations about willingness to share knowledge. Then, section 13.2.2 will address fluctuation which is partly determined by organizational culture, but also influences the atmosphere in an organization. More generally, different rates of fluctuation potentially require different KM instruments and activities.

13.2.1 Willingness to share knowledge

Measuring willingness to share knowledge in a questionnaire directed to a single person in an organization certainly is a compromise[62]. Most of the interviewees,

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61. See also section 6.4.2 - "Willingness to share knowledge" on page 223.
62. For a detailed discussion of the pros and cons of alternatives to include measures of organizational culture into the empirical study see section 6.4.2 - "Willingness to share knowledge" on page 223.

however, stated that they had studied KM-related cultural issues in their organizations regularly. Examples for the instruments applied are employee surveys, structured interviews and workshops. Several organizations had called in consultants to help them design and evaluate employee surveys on contentedness with the KM initiative, with KM services or with the organizations' KMS. These surveys also contained several questions to analyze willingness to share knowledge. As a consequence, the respondents might have had a reasonable feeling about the general situation in their organizations[63]. Still, the results have to be interpreted carefully.

17 statements were used in order to determine the willingness to share knowledge in an organization as the main construct measuring organizational culture[64]. Responses were measured along a seven-point Likert scale. Respondents had to indicate to what extent they thought that the corresponding item described the situation in their organization. The higher the value they assigned to an item, the more they agreed that this item described the situation in their organization.

In order to ease the interpretation, this relatively large number of variables was reduced to a number of underlying factors using the statistical method *factor analysis*. Factor analysis attempts to identify underlying variables, or factors, that explain the pattern of correlations within a set of observed variables. Factor analysis is often used in data reduction to identify a small number of factors that explain most of the variance observed in a much larger number of manifest variables (for a detailed description of factor analysis e.g., Backhaus et al. 1996). Goal was to use factor analysis to reduce the number of observable variables of organizational culture to a handful of dimensions of organizational culture which influence the organization's willingness to share knowledge. The factors shall be interpreted as dimensions of organizational culture.

The method used for factor extraction was *principal components*. The criterion used to determine the number of factors was a minimum *Eigenvalue > 1*. The application of this criterion lead to a four-factor solution. The four factors together explain 68.9% of the total variance. Thus, the data reduction led to a loss of information. In order to ease the interpretation of factors the initial solution was rotated according to Kaiser's Varimax method of factor rotation. Missing values were excluded listwise. Table C-38 shows the rotated factor matrix[65].

The interpretation of factors is an important, although difficult step in factor analysis as there remains room for subjective assessment. The dimension of organizational culture describing the first factor can be called *inter-group organizational learning atmosphere* which reflects mutual understanding, trust, influence and support of teams and/or work groups and the general willingness to learn from each

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63. The general situation, however, might hide possibly important aspects of sub-cultures in organizations. It would be interesting to detail the results and shift the unit of analysis from the organizational level to the level of organizational sub-cultures.
64. Most of the statements used here have been tested in other empirical studies before. For a description and discussion of the statements and the literature where they have been developed see section 6.4.2 - "Willingness to share knowledge" on page 223.
65. See URL: http://iwi.uibk.ac.at/maier/kms/ for detailed results.

other. The second factor can be called *workspace-related organizational learning atmosphere* and comprises the exchange of ideas in the work environment as well as communication and support within teams and/or workgroups. The third factor describes that part of the organization's reward system which targets knowledge sharing. It can be called *rewards for knowledge sharing*. The fourth and last factor encompasses those variables that describe the most voluntary part of knowledge sharing activities: the exchange of ideas outside the "normal" work environment. It can be called *knowledge sharing outside the workspace*.

TABLE C-38. Rotated component matrix of the variables describing willingness to share knowledge

observable variables[a]	**factor 1**	**factor 2**	**factor 3**	**factor 4**
emp. often communicate with other g/t	<u>0.80045</u>	0.16062	0.09383	0.13435
emp. influence decisions of other g/t highly	<u>0.78656</u>	0.08928	0.29010	0.00962
emp. know work of other g/t well	<u>0.76724</u>	0.17305	0.20837	-0.00721
emp. value achievements of other g/t highly	<u>0.71031</u>	0.35185	0.22983	0.02192
emp. often help other g/t	<u>0.67942</u>	0.26068	-0.14515	0.12645
trust between g/t is high	<u>0.55924</u>	0.22594	0.29133	-0.36835
willingness to learn is high	<u>0.53009</u>	0.23336	0.11357	0.03883
strong exch. in, before and after meetings	0.24615	<u>0.79772</u>	0.32300	-0.00699
emp. often help within group/team	0.27485	<u>0.74275</u>	-0.21684	0.16825
emp. communicate openly within group/team	0.40307	<u>0.70084</u>	-0.03095	-0.06350
strong exch. during work hours	0.40002	<u>0.61324</u>	0.23624	0.18518
strong exch. in breaks	0.08853	<u>0.61082</u>	0.19878	0.43823
k. sharing supports careers	0.18086	0.12149	<u>0.85215</u>	0.21348
k. sharing strongly rewarded financially	0.27440	-0.19046	<u>0.80313</u>	0.17728
cooperative behavior strongly rewarded	0.12044	0.36733	<u>0.76855</u>	-0.15758
strong exch. at company events, parties	0.14919	0.13169	0.12176	<u>0.91660</u>
strong exch. privately, outside work environment	-0.01829	0.10588	0.05556	<u>0.88015</u>

a. emp. = employees; exch. = exchange of ideas; g/t = groups/teams; k. = knowledge

In the following, respondents' estimations how their organizations score on the organizational culture items are aggregated and presented factor by factor. Figure C-12 through Figure C-15 show for each item the means of the estimations and the interval [μ-σ; μ+σ] which is one standard deviation to the left and to the right of the means. The items are ordered by descending means (first criterion) and ascending standard deviations (second criterion). Additionally, the overall means encompassing the whole set of 17 variables is given. At 4.14, it is slightly higher than the middle of the scale. Detailed results can be found in the appendix[66].

Factor 1: inter-group organizational learning atmosphere.
Figure C-12 shows the seven items making up inter-group organizational learning. The means of five out of the seven items were higher than the overall means. Thus, the inter-group organizational learning atmosphere was relatively positive on average. This was especially true for those items that describe the more personal, voluntary or informal relationships between groups or teams like *groups helping each other* or the *communication between groups*. The actual *influence on decisions of other groups*, but also *knowledge about the work of other groups or teams*, were rather low. The latter result suggests that transparency about what is going on in other groups or teams, even within the same business processes, was neglected in many organizations. It might help for example to orient the KM initiative in general and KMS structure and organization in particular on the organization's business processes in order to reduce this lack of visibility.

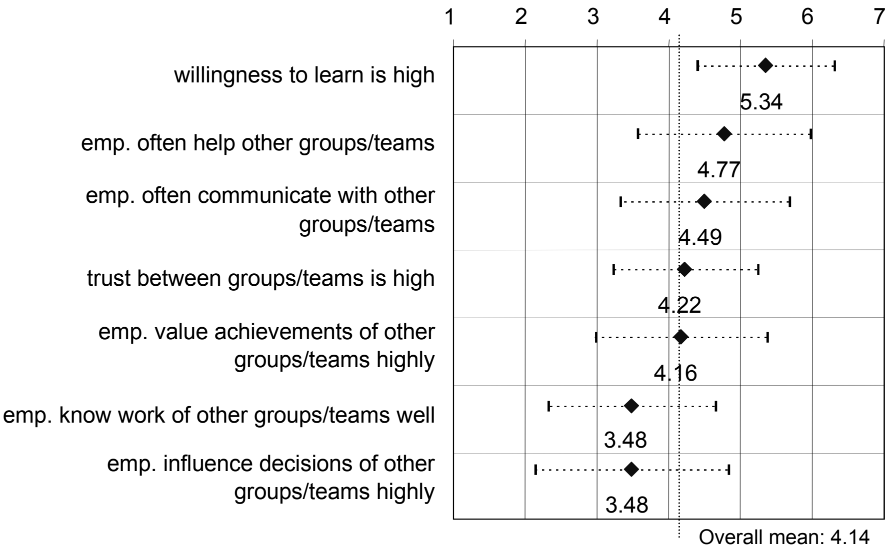

FIGURE C-12. Factor 1: inter-group organizational learning atmosphere[67]

Willingness to learn had a somewhat special position in this factor as it could apply to both situations, learning within the learner's work environment and learning between groups and teams. The coefficient of the item "willingness to learn is

66. See URL: http://iwi.uibk.ac.at/maier/kms/.
67. Diamonds represent the means μ of the item. The ranges indicate the interval $[\mu-\sigma; \mu+\sigma]$ using the standard deviation σ.

high" in the factor analysis showed a much higher value of 0.53009 for factor 1—inter-group organizational learning atmosphere as compared to 0.23336 for factor 2—workspace-related organizational learning atmosphere. One explanation for this finding might be that respondents interpreted willingness to learn as a description of learning from experiences made outside the daily work environment, because it requires a much higher willingness to learn in order to accept or reuse knowledge from outside the learner's team or work group than from within (see also factor 2).

Factor 2: workspace-related organizational learning atmosphere.
The estimates describing workspace-related organizational learning atmosphere were on average significantly higher than those for inter-group organizational learning atmosphere (see Figure C-13). Thus, as expected willingness to share knowledge was substantially higher within the workspace than between groups and teams and also substantially higher than outside the traditional work environment. Hypothesis 9: 'Employees are more willing to share knowledge within than outside their work environment (group or team)' thus was supported.

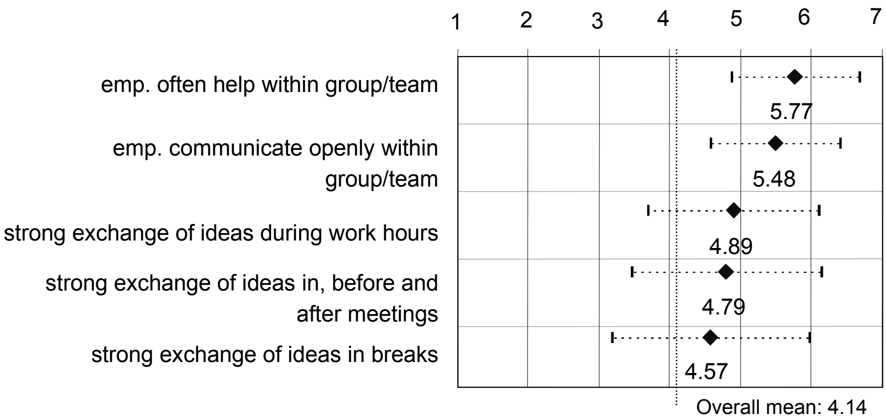

FIGURE C-13. Factor 2: workspace-related organizational learning atmosphere[68]

Factor 3: rewards for knowledge sharing. On the contrary, organizations having a sophisticated reward system for knowledge sharing seemed to be still the exception. This was especially true for financial rewards and incentives, but also for the support of careers (see Figure C-14). The interviews showed that in those organizations that made their careers dependent on the contribution to knowledge sharing, the employees were subjectively assessed along general, basic categories like "cooperative behavior" or "helpfulness". In some organizations, there were already advanced evaluation procedures in place that contained not only subjective, but also objective measures like the requirement to become a (recognized) expert in

68. Diamonds represent the means μ of the item. The ranges indicate the interval $[\mu\text{-}\sigma; \mu+\sigma]$ using the standard deviation σ.

one or multiple subjects, to review contributions to that subject or to answer questions within a given time (e.g., 24 hours).

However, one organization also experimented with objective criteria like the number of articles published in the corporate Intranet. Within a year they abandoned this practice as it only led to a flood of articles of questionable quality, but neglected other important KM goals like the reuse of existing knowledge. Thus, it seems very important to design the reward system around the KM goals and to ensure that the system is understood by the participants.

The immaterial rewards for cooperative behavior ranged in the middle of the scale. So far, it seems that in many organizations to be a helpful and cooperative organizational member was not strongly credited, neither in terms of recognition, nor in terms of financial profit or advancements in the career.

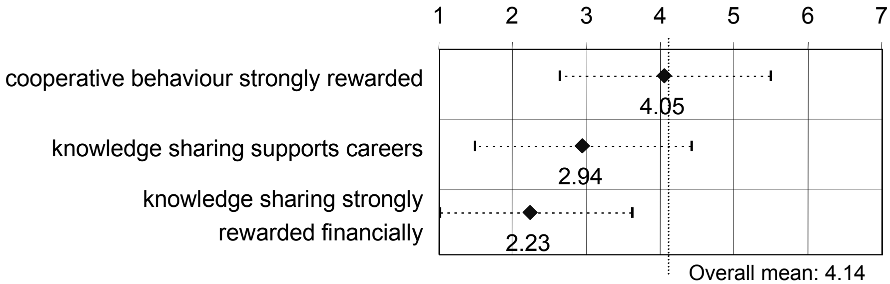

FIGURE C-14. Factor 3: rewards for knowledge sharing[69]

Organizations questioned in the ILOI study reported quite similar results. 17% of the organizations had a reward system for holders of key knowledge and only 11% had measures in place to give material incentives to employees according to the knowledge transferred or shared (ILOI 1997, 16). Similarly, in the 1998 KPMG study, a total of 23% of the organizations with KM initiatives gave incentives and/ or rewards for knowledge-related activities and 14% were planning to establish a system (KPMG 1998, 13). 36% of the very innovative organizations studied by the APQC, rewarded employee behavior supporting effective KM. Especially those organizations that focused the individual employee's responsibility for knowledge development and sharing, monitored KM related activities as part of their professional and career development programs (APQC 1996, 50).

Factor 4: knowledge sharing outside the workspace. The fourth factor shows to what extent organizational members meet outside their work environment and normal work hours to exchange ideas. Some organizations invested considerably to create opportunities for their employees to spend their leisure time together, e.g., at company events, company-specific sports clubs or sports facilities, or even holi-

69. Diamonds represent the means μ of the item. The ranges indicate the interval $[\mu-\sigma; \mu+\sigma]$ using the standard deviation σ.

days organized by the company or at company-owned facilities. Figure C-15 shows that this kind of knowledge sharing was more the exception than the rule in big German organizations. However, the ranges of answers were wide showing that there were some organizations for which this kind of knowledge sharing was very important whereas others did not pay much attention to these activities.

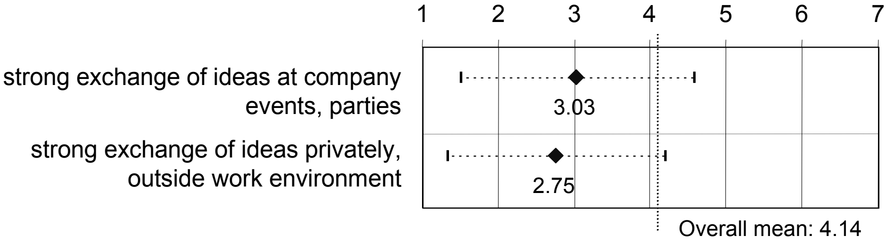

FIGURE C-15. Factor 4: knowledge sharing outside the workspace[70]

In the following, the relationships between willingness to share knowledge and factors describing the existence of a systematic KM initiative as well as access to KM-related systems will be investigated. Table C-39 shows the statistical results of the correlations.

TABLE C-39. Summary of correlations with willingness to share knowledge[a]

		factors			
correlated variables	**statistics**	**1. inter-group OL atmosphere**	**2. work-space OL atmosphere**	**3. rewards for k. sharing**	**4. k. shar-ing outside workspace**
systematic KM	Spearman's rho	0.011	-0.154	0.013	**-0.338**
	significance	0.930	0.209	0.919	**0.005**
	n	68	68	68	**68**
share of employ-ees with access to Groupware	Spearman's rho	0.272	0.311	0.289	0.098
	significance	0.138	0.089	0.115	0.599
	n	31	31	31	31
share of employ-ees with access to KMS	Spearman's rho	-0.021	0.188	0.358	-0.146
	significance	0.939	0.485	0.173	0.589
	n	16	16	16	16

a. k.=knowledge, OL=organizational learning

A correlation matrix of 4 X 3 was tested with 4 factors describing willingness to share knowledge and 3 variables describing whether KM was systematically implemented and describing the share of employees with access to Groupware or

70. Diamonds represent the means μ of the item. The ranges indicate the interval [μ-σ; μ+σ] using the standard deviation σ.

KMS. Thus, the adjusted significance level using a Bonferroni type correction was 0.008[71].

The existence of a *systematic knowledge management* in an organization correlates with factor 4—knowledge sharing outside the workspace. The negative sign means that respondents who indicated that their organization had implemented a systematic KM initiative estimated a higher level of knowledge sharing outside the workspace than organizations without such an initiative. The correlation with factor 2 also showed the expected negative sign, but was not significant. In the case of reward systems, both, the quantitative data obtained in the survey as well as the qualitative results gained in the interviews suggest that neither organizations with nor without a systematic KM initiative were actively engaged in the design and implementation of a reward systems for KM (see also above).

The existence of systematic KM so far seems to have the most profound effect on the most informal knowledge sharing outside the traditional workspace. Hypothesis 12: 'In organizations with systematic knowledge management, willingness to share knowledge is improved' was therefore supported. One explanation for these findings might be that organizational culture is an organizational phenomenon which changes rather slowly and systematic KM has not been around for long enough in most organizations to already show profound effects on employees' willingness to share knowledge.

The correlations with the *share of employees with access to Groupware systems* all showed the expected positive sign meaning that organizations with a higher share of employees with access to Groupware also experience a higher willingness to share knowledge[72]. However, none of the correlations was significant. A more detailed analysis correlating the individual variables of the factor with the highest correlation coefficient, factor 2—workspace-related OL atmosphere, revealed a significant positive correlation with a *strong exchange of ideas in, before and after meetings*[73]. Thus, Hypothesis 22: 'The more employees have access to Groupware and/or KMS, the more they are willing to share knowledge' was supported for Groupware systems. The more employees have access to Groupware systems, the more they exchange ideas in, before and after meetings.

The correlations between the *share of employees with access to knowledge management systems* and willingness to share knowledge were statistically insignificant. Correlations with factor 1—inter-group organizational learning atmosphere and factor 4—willingness to share knowledge outside workspace even showed a negative sign. Hypothesis 22: 'The more employees have access to Groupware

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71. See section 'Statistical analysis." on page 455 for an explanation of the Bonferroni type correction.
72. The results of the investigations on access to Groupware systems, KMS and other KM-related systems were presented in section 13.1.1 - "Scope" on page 482.
73. The adjusted significance level after a Bonferroni type correction for this extension of the test to include all 17 individual items (17 X 3 matrix) was 0.0019. The correlation analysis with the item *strong exchange of knowledge in, before and after meetings* produced a Spearman's rho correlation coefficient of 0.520 and a significance of 0.00163 (n=34). Detailed results can be found in URL: http://iwi.uibk.ac.at/maier/kms/.

and/or KMS, the more they are willing to share knowledge' was not supported for KMS. This might be partly due to the fact that the number of respondents with KMS is much lower than the number of respondents with Groupware systems. Another explanation might be that it takes time until platforms and systems are rolled out and really used in daily operations so that employees' willingness to share knowledge might be positively influenced from an increased ability to share knowledge. Groupware platforms have been installed in most organizations for quite a while whereas KMS are a recent development.

13.2.2 Turnover in employees

Turnover in employees was measured with two questions reflecting the percentage of newly recruited employees and the percentage of employees leaving the organization per year. Categorical variables were used as it was expected that most of the respondents would not have real figures. Figure C-16 shows the absolute number of organizations with the percentage of employees leaving the organization per year. Four in five organizations (54 respondents, 80.6%) had a low or moderate rate at which they lost people with less than 10% of employees leaving per year.

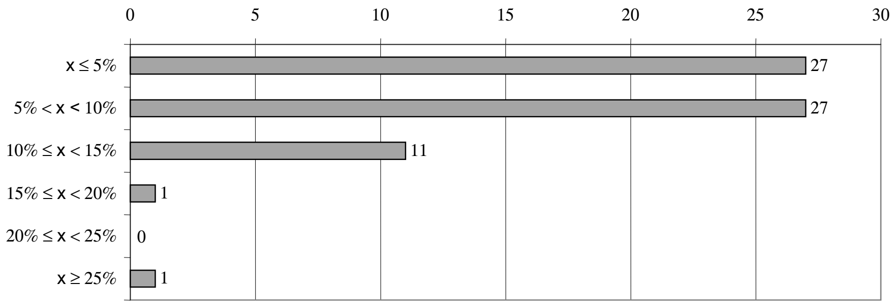

FIGURE C-16. Share of employees leaving the organization per year[74]

Figure C-17 shows the distribution of organizations according to the percentage of newly recruited employees per year. Again, almost three quarters of the organizations (48 respondents, 72.7%) had a low or moderate rate at which they hired new people with less than 10% of newly recruited employees per year. However, 18 organizations (27.3%) had a high rate of growth of 10% or more and four of these organizations (6.1%) grew at a fast pace with 15% or more newly recruited employees per year.

As expected the correlation between the two variables was highly significant (Spearman's rho: 0.589, significance: 0.000001, n=66) which means that the more employees left an organization, the more these organizations recruited new members. A detailed investigation reveals that 45 out of 66 organizations (68.2%) indi-

74. As percentage of total number of employees, absolute numbers of organizations, n=67.

cated the same categories for both questions. Nine organizations (= 13.6%) seemed to downsize whereas another 12 organizations (18.2%) grew. Four organizations (= 6.1%) reported that their rate of newly recruited was two or three categories higher than their rate of employees leaving the organization.

In the following, the relationships between fluctuation and willingness to share knowledge will be investigated.

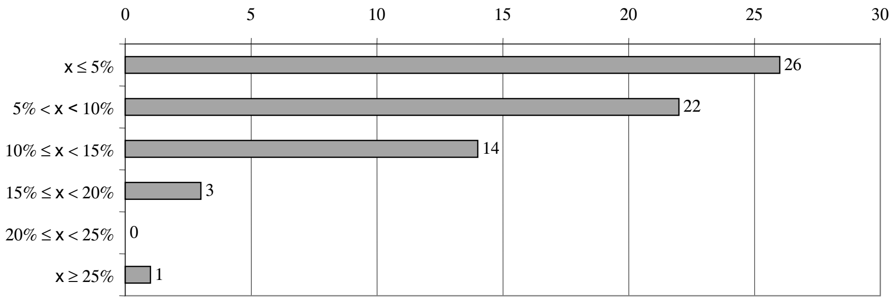

FIGURE C-17. Share of newly recruited employees per year[75]

Table C-40 shows the statistical results of the correlations. A correlation matrix of 4 X 2 had to be tested with 4 factors describing willingness to share knowledge and the 2 variables of fluctuation. Thus, the adjusted significance level using a Bonferroni type correction was 0.0125[76].

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TABLE C-40. Summary of correlations between fluctuation and willingness to share knowledge

		factors			
correlated variables	**statistics**	**1. inter-group OL atmosphere**	**2. work-space OL atmosphere**	**3. rewards for k. sharing**	**4. k. sharing outside workspace**
share of newly recruited employees	Spearman's rho significance n	0.124 0.336 62	-0.058 0.653 62	0.191 0.137 62	0.197 0.126 62
share of employees leaving organization	Spearman's rho significance n	-0.125 0.334 62	-0.118 0.359 62	-0.063 0.628 62	-0.065 0.614 62

None of the correlations was significant. Thus, Hypothesis 10: 'The higher the share of newly recruited employees is, the more knowledge exchange is taking

75. As percentage of total number of employees, absolute numbers of organizations, n=66.
76. See section 'Statistical analysis." on page 455 for an explanation of the Bonferroni type correction.

place outside traditional work environments' was not supported. The positive signs for the correlations between the share of newly recruited and factors 1, 3 and 4 show a tendency that organizations with a higher share of newly recruited in the sample experienced an increased willingness to share knowledge. According to the interviews, the level of recruitment in an organization is a crucial factor that strongly impacts organizational culture. It is often the newly recruited employees who are most open to knowledge sharing between work groups and also outside the work environment (also Swan 2001).

Willingness to share knowledge, particularly parts of the inter-group organizational learning atmosphere, supposedly suffer in those organizations that experience a high share of employees leaving the organization. The corresponding correlations all showed the expected negative sign, but no correlation was significant. Hypothesis 11: 'A high share of employees leaving the organization negatively affects willingness to share knowledge between groups and teams' was therefore not supported.

13.2.3 Résumé

Once again, it must be noted that results concerning organizational culture generally have to be interpreted carefully. The item measured here, willingness to share knowledge, not only carries the well-known conceptual problems as reported in the literature (e.g., Drumm 1991). The measurement of this item also lacks representativeness as only one member of the organization was asked to judge this organizations' willingness to share knowledge. However, the construct was included in the questionnaire for two reasons:

1. The person responsible for KM supposedly had a good overview of that part of his or her organization for which he or she was responsible. Pretests also revealed that knowledge managers considered organizational culture as one of the most important factors in KM and thus watched it carefully. Many had also initiated representative culture analyses (some had undergone this process several times) supporting that their judgements might be more adequate than one might expect at a first glance.
2. Willingness to share knowledge certainly varies between groups and teams and even within one group from individual to individual. However, the variables of interest here were aggregate measures of all the estimations of individuals at an organization-wide level. As the whole questionnaire was directed exclusively at the knowledge manager, all answers reflect the perspective on the implementation of the KM initiative he or she takes. Thus, the judgement of the organizational culture completed the "picture" which knowledge managers paint of their initiatives and activities.

Four factors were extracted to reduce the sixteen items describing willingness to share knowledge. *Workspace-related organizational learning atmosphere* seems to be easier to achieve than *inter-group organizational learning atmosphere*. The other two factors, *rewards for knowledge sharing* and *knowledge sharing outside* *the workspace* showed lower ratings than the two factors describing the organizational learning atmosphere.

These four factors were correlated to variables describing the fluctuation, systematic KM and the penetration of the organizations with Groupware platforms and KMS. Turnover in employees was in the majority of the organizations low to medium. However, one in five organizations grew rapidly whereas fewer than one in seven organizations shrunk.

Systematic KM is positively correlated with high knowledge sharing outside the workspace. Also, in organizations in which more employees have access to Groupware platforms, there is a strong exchange of ideas in, before and after meetings. The correlations showed a stronger tendency for Groupware to positively influence willingness to share knowledge than in the case of KMS. This might be because cultural changes take some time and employees in many organizations might have been exposed to Groupware platforms for a much longer time than to KMS. The rest of the correlations was not significant.

However, the interviews showed that many knowledge managers consider the rate of newly recruited employees as one of the most critical factors in KM. Newly recruited employees often seem to be more open to adapt new ideas, to learn from their colleagues and to share knowledge outside traditional work environments. Additionally, knowledge islands might be connected with the help of new employees bridging previously isolated "clans" or "knowledge families".

The four factors describing willingness to share knowledge will be correlated with business goals in section 15.2.4 - "Correlations with goals" on page 575. The next chapter is devoted to the results about systems applied to KM initiatives.

14 Systems

This chapter will focus ICT instruments supporting a KM initiative[77]. Section 14.1 will study to what extent organizations applied Groupware and Intranet platforms as well as KMS. Then section 14.2 will focus on the contents of the KMS, their type, size, media used and their structure. Finally, section 14.3 will investigate the state of practice of KMS in detail with respect to KMS functions implemented and the frequency with which they were used in the organizations.

14.1 Platforms and systems

This section will investigate which information and communication systems were used by the organizations to support KM. Firstly, section 14.1.1 will study the Groupware platforms which provide basic functionality for communication and for team- or work group-oriented publication, structuring, storing as well as retrieval and distribution of knowledge elements. Secondly, section 14.1.2 will investigate to what extent organizations used integrated KMS solutions[78] in the sense of KM suites or organization-specific, comprehensive KMS solutions.

Knowledge-based or expert systems (KBS or XPS) were not included into the study. This is due to the observation that these technologies are regularly only used for specialized applications which are not part of organizations' KM initiatives and therefore do not support KM[79]. However, the corresponding technologies used in KBS or XPS are also used within a number of KMS or business intelligence tools, e.g., for the semantic analysis of texts, text or Web mining, case-based reasoning, or for the analysis of access paths or patterns (e.g., Grothe/Gentsch 2000, 98ff and 233ff). At least from a theoretical viewpoint, there seems to be a potential for the application of AI- or KBS-specific methods and techniques to the field of KMS which is reflected by many AI- or KBS-related research institutions, journals and conferences that recently have extended their focus to include KMS (e.g., the German research institute for artificial intelligence, DFKI–Deutsches Forschungsinstitut für Künstliche Intelligenz)[80].

77. See also Klosa 2001 who analyzed platforms, KMS, contents and functions in a more restricted research model focusing exclusively on the relations between contents and individual functions which do not play an equally important role here.
78. For a definition and a detailed discussion of the term knowledge management system see section 4.3 - "Knowledge management systems" on page 82. An integrated KMS like the ones presented in the questionnaire comprises an integrated set of functionality spanning the middle layers of the KM architecture, particularly the integration services, knowledge services as well as personalization services. Groupware and/or Intranet platforms provide the underlying layers, especially the infrastructure layer, as well as more general functions on the access layer (see section 7.3.3 - "Integrating architectures for KMS" on page 311).
79. In the Fraunhofer Stuttgart study expert systems were considered the least important of a list of technologies supporting KM (Bullinger et al. 1997, 22).
80. See also section 7.1 - "Technological roots" on page 273.

14.1.1 Groupware platforms

Figure C-18 shows which Groupware platforms were installed in the organizations. Multiple responses were possible. Respondents were asked not to report test installations as these would not be in use by a significant part of the employees of the respective organization. The three favorite platforms used were Microsoft Exchange with 63.2% of respondents), Intranet Server (e.g., Netscape Suite)[81] with 51.5% and Lotus Notes with 47.1%. The other platforms used were in three cases organization-specific Groupware platforms, e.g., on the basis of an Intranet or a workflow management system. One responding organization used a Banyan solution[82] and one respondent did not describe what other solution was used in his or her organization.

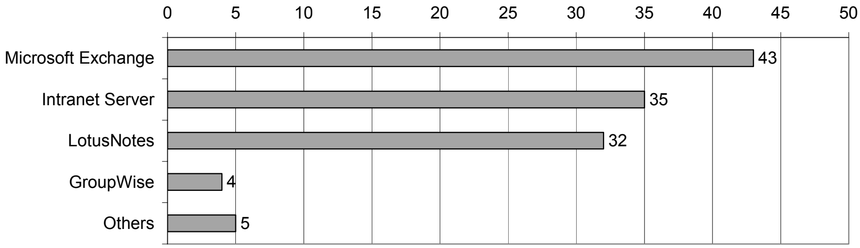

FIGURE C-18. Groupware platforms used in the organizations[83]

Almost two thirds of the respondents (41 respondents, 60.3%) had more than one Groupware platform in place with 42.6% having two (= 29 respondents) and 17.6% (= 12 respondents) having three different Groupware platforms installed in their organizations.

These results might be explained by the many mergers and acquisitions that had taken place in big, especially multinational organizations. These organizational transactions might have brought together organizations with distinctive information and communication infrastructure which had not (yet) been integrated. Another explanation might be that even without mergers and acquisitions different parts of the organization rely on different Groupware platforms, e.g., sales and marketing versus production or administration. Also, organizations might have had e.g., a Lotus Notes Groupware platform in place and then might have decided to additionally develop an Intranet solution, thus leaving them with two parallel information and communication infrastructures.

81. In the case of Intranet platforms there were a multitude of vendors that offered solutions and the market was not as consolidated as in the case of the Groupware platforms. Only the category Intranet server with the example Netscape Suite was included in the questionnaire due to the tight space limits and because it does not matter what actual Intranet server solutions the organizations used.
82. For links to the vendors see the support Web site for this book http://iwi.uibk.ac.at/maier/kms/.
83. Multiple responses possible, absolute numbers, n=68.

In general, 66 out of 68 organizations responding to that question (= 97.1%) had either a Groupware platform or an Intranet platform and 64 organizations (94.1%) had a Groupware platform in place, although there was a large variety to what extent that platform was actually used extending from a basic information and communication platform to sophisticated KM functionality[84]. This result is supported by the telephone survey of non-responding organizations. 57 out of 64 organizations (89.1%) answering said that they had an Intranet in place. The number of employees with access to these platforms in the telephone interviews ranged from 70 to over 10,000 which again shows how widely organizations vary with respect to the rate of participation[85].

Compared with previous studies, the share of organizations using Groupware rose substantially. In the APQC study, 81.8% of the organizations used Groupware and 65.9% used an Intranet (APQC 1996, 55). Also, 20.5% of these organizations considered themselves to be ineffective at using Groupware as a tool for knowledge sharing, whereas 43.2% thought they were effectively using Groupware for knowledge sharing. The rest was undecided (APQC 1996, 58). In the 1998 KPMG study, 66% of the organizations said they had an Intranet and 49% said they had a Groupware platform implemented. However, only 41% said they had the Intranet implemented for KM or with KM as the primary focus and only 28% reported the same about their Groupware platform (KPMG 1998, 11).

These results once again show that only a portion of the organizations which had an Intranet or Groupware platform actually used it effectively for knowledge management. The APQC's results were obtained in 1996 and the KPMG results in 1998 and the adoption of Groupware platforms as well as the conceptual exploitation of these infrastructures has certainly improved since then. Hypothesis 6: 'Compared to earlier studies significantly more organizations use ICT in general and knowledge management systems in particular to support their KM activities' was supported for Groupware platforms[86].

14.1.2 Knowledge management systems

Recently, the market for KMS has been a very dynamic one and many vendors of e.g., document management systems, content management systems, e-learning systems, Groupware and Web server systems as well as business intelligence tools attempt to build KMS functions into these systems[87]. The market has been quite intransparent, though some vendors moved a step further and integrated a diverse set of KM-related functions into a comprehensive KMS solution, a KM suite. This set of functions consists of e.g., functions for content management, collaboration, visualization & aggregation and information retrieval (Seifried/Eppler 2000, 31).

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84. See section 14.3 - "Functions" on page 548.
85. See also section 13.1.1 - "Scope" on page 482.
86. The corresponding t-test comparing the results presented here with the share of 81.8% of organizations with a Groupware platform obtained in the APQC study produced a mean difference of -0.1232, a t-value of -4.285 and a significance of 0.00006 (n=68).

Additionally, functions for context building and management, profiling, personalization and advanced electronic communication might also be included[88].

Figure C-19 shows those integrated KMS solutions that were implemented and used in at least one responding organization[89]. 41.2% of the respondents indicated that their organization used an integrated KMS solution, a KM suite (28 out of 68 organizations responding to that question). 24 had one KMS, two organizations had two and another two respondents reported the use of three KMS in their organizations. This result is supported by the follow-up study of the FH Cologne who found in 2001 a share of 43% of organizations with KMS (Döring-Katerkamp/Trojan 2001, 4).

In almost two thirds of the cases (18 out of 28, 64.3%) the organizations implemented their own KM solutions. These were in most cases combinations of several tools and systems with organization-specific extensions. In the other cases, the organization-specific solution was developed on top of a Groupware platform like Lotus Notes or an Intranet server solution. Additionally, eleven different KMS available on the market were used.

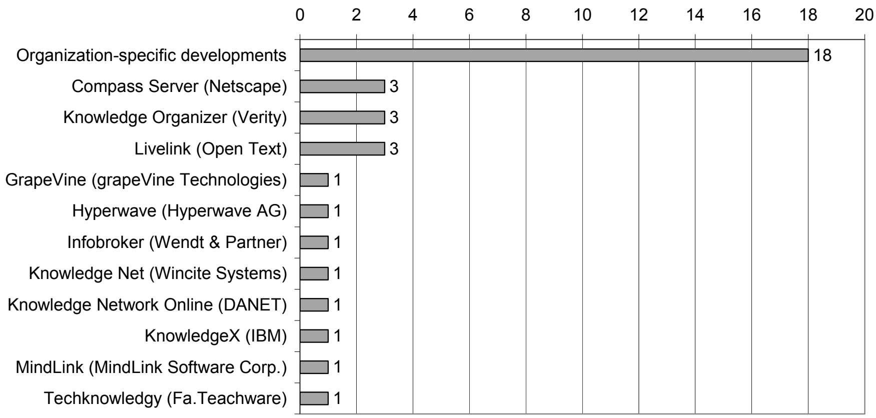

FIGURE C-19. Knowledge management systems used in organizations[90]

In four cases, KMS bought on the market were used in conjunction with organization-specific developments. There were significantly more organizations using

87. See also the list of KMS and KM tools provided on the support Web site for this book http://iwi.uibk.ac.at/maier/kms/. Recently, hardly any vendor does not stress the KM competence of the offered document or content management systems, e-learning platforms, business intelligence tools, Groupware or advanced electronic communication tools. Additionally, several vendors offer new KM tools, such as knowledge visualization tools, profiling, personalization and recommendation tools and new integrative systems, such as enterprise portals.
88. See section 7.4 - "Centralized architecture" on page 318 for a detailed description of KMS functions.
89. Respondents were asked not to report test installations.
90. Absolute numbers, multiple responses possible, n=68.

an organization-specific KMS solution than there were organizations with exclusively KMS bought on the market[91]. Therefore, Hypothesis 20: 'The majority of organizations apply organization-specific KMS developments or a combination of organization-specific developments and KMS tools rather than just KMS available on the market' was supported.

This result shows that the market for KMS had not been consolidated. There were still a large number of vendors competing for the fast growing market for KMS[92]. Only Netscape's (or iplanet's respectively) Compass server, Verity's Knowledge Organizer and Open Text's Livelink were used more than once. Still, even these three KMS were not used significantly more frequently than the rest of the tools[93].

As expected, KMS were used most frequently in organizations with systematic KM initiatives that had been established for more than a year. Of these organizations, 13 used KMS whereas 5 had not implemented integrated KMS solutions (yet). The majority of organizations without a systematic and established KM initiative did not apply KMS. 15 of those organizations had a KMS in place and 35 had no such system installed. Table C-41 gives an overview of the shares of organizations with and without systematic KM as well as KMS.

TABLE C-41. Cross-tabulation of established, systematic KM initiative and the use of KMS

	use of KMS		
systematic, established KM	**yes**	**no**	**total**
yes	13 (72.2%)	5 (27.8%)	18 (100.0%)
no	15 (30.0%)	35 (70.0%)	50 (100.0%)
total	28 (41.2%)	40 (58.8%)	68 (100.0%)

More than two thirds of the organizations with an established, systematic KM had also a KMS in place and thus applied a holistic approach to KM comprising organizational and advanced ICT instruments. The corresponding correlation was significant (Spearman's rho: 0.378, significance: 0.001, n=68). Thus, Hypothesis 4: 'Organizations with systematic knowledge management that has been established for at least one year are more likely to have installed KMS than organizations without systematic knowledge management' was supported.

91. A t-test comparing the means of the use of organization-specific solutions to the means of KMS bought on the market produced a mean difference of -0.28, a t-value of -3.067 and a significance of 0.005 (n=28).
92. For a list of vendors of KMS see the support Web site for this book http://iwi.uibk.ac.at/maier/kms/.
93. A t-test comparing the means of the most frequently used KMS against the average of the means of all KMS produced a mean difference of -0.0782, a t-value of -1.314 and a significance of 0.200 (n=28).

Also, the number of organizations using specialized KMS is likely to rise (Delphi 1997, 19). Despite the fact that on average smaller and less KM experienced organizations participated in the FH Cologne study conducted half a year after the study presented here, already 51.1% of the organizations reported to use "specific KM software" (Döring-Katerkamp/Trojan 2000, 9).

Many organizations used document management systems which can be considered as one of the technological predecessors of KMS[94]. In the 1998 KPMG study, more than two thirds of the organizations (68%) used document management systems and still 46% said they were using these systems with KM as the primary focus (see KPMG 1998, 11). Moreover, many vendors of document management systems have extended their systems to include KM functionality so that it is hard to judge how many organizations really used KM functionality by exclusively looking at the systems that were implemented. This will be analyed with an investigation of the frequency with which specific KMS functions were used[95]. This analysis will be independent of what type of systems supported these functions.

Beforehand, it will be investigated how well the various KM platforms and systems were integrated in the organizations. Figure C-20 shows the *level of integration* between KMS. Almost a third of the organizations responding to this question (16 out of 49 respondents, 32.7%) had all KMS functions either integrated within a single system or at least within one single user interface, e.g., a Web browser. About half of the organizations (25 out of 49 respondents, 51%) had a medium level of integration with either one main KMS from which other (sub-) systems can be called one-sidedly or multiple systems between which easy data transfer is possible (e.g., via drag&drop or copy&paste). There were still 16.3% of the respondents who had several KMS in place between which not even data transfer was possible.

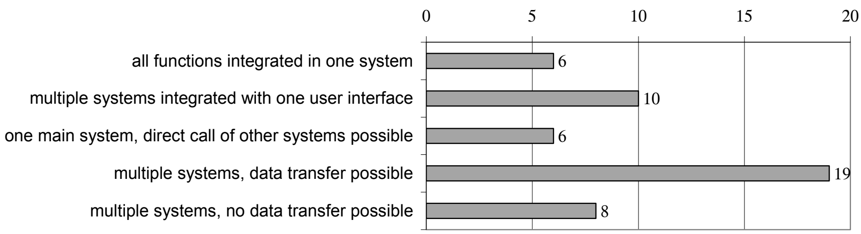

FIGURE C-20. Level of integration of information and communication systems related to KM[96]

Some respondents marked multiple categories even though the ordinal scale was originally intended to be exclusive. This was especially true for *multiple systems integrated with one user interface* (category 4) on the one hand and *one main sys-*

94. See also section 7.1 - "Technological roots" on page 273.
95. See section 14.3 - "Functions" on page 548.
96. Absolute numbers, n=49.

tem, direct call of other systems possible (category 3) or *multiple systems, data transfer possible* (category 2) on the other hand. In these cases organizations supposedly had many different systems in place, some of which were more integrated than others. Some might have been integrated within an Intranet environment and might have been accessible with the help of a Web browser while others might not have been integrated into this environment.

The lowest level of integration was taken as the common denominator because the question asked for the level of integration of the whole set of KMS or KM-related systems in an organization. Thus, if an organization marked categories four and three, category three was the correct answer for this question. The case was clearer if *all functions integrated in one system* (category 5) was one of multiple answers to this question. In this case it was clear that the lower level of integration was the correct answer as every category lower than five assumed more than one system which contradicted category five. Again, the lower level of integration was the correct answer.

It was also expected that especially KMS bought on the market should contribute to a better integration. These systems integrate a large amount of functionality and also regularly provide access to a variety of systems and media. Table C-42 shows a comparison of the mean level of integration for organizations using KMS and more specifically using organization-specific KMS and KMS bought on the market and the means of organizations without KMS. Thus, the mean for organizations with KMS bought on the market is slightly lower as the mean of organizations without KMS or with organization-specific developments.

TABLE C-42. Comparison of mean levels of integration for organizations with or without KMS

group of organizations	n	mean[a]	std.dev.
organizations without KMS	23	3.30	1.43
organizations with KMS	25	3.20	1.22
KMS bought on the market	12	3.00	1.35
organization-specific developments	16	3.31	1.20

a. A lower mean value means a higher level of integration.

However, the correlations are statistically insignificant (Spearman's rho: 0.112, significance: 0.450, n=48). Thus, Hypothesis 19: 'KMS functions in organizations with KMS bought on the market are more integrated than KMS functions in organizations without KMS' was not supported.

14.1.3 Résumé

During the past couple of years, organizations have busily implemented a modern information and communication infrastructure spanning in most cases a large part of the organization, if not the whole organization. A presentation of the organizations in the Internet, mostly, the WWW, has been deemed necessary by most organizations and has also fueled the use of this medium within the organization. Corporate Intranet solutions have been implemented to connect employees, to support the easy sharing of electronic documents and easy access to company information. Also, after a first round of office management systems focusing on the individual (PCs and office management tools) and the management of shared resources, such as printers, file servers and the like (LANs and network operating systems), organizations have installed Groupware tools in order to support teams and to master the increasing complexity of organizational structures and processes along with its advanced information and communication needs.

By now, almost every big organization like the ones in the sample has installed an Intranet and/or a Groupware solution which can be considered the basic ICT infrastructure for KM. Many organizations apply multiple platforms, e.g., Lotus Notes and Intranet server. Due to the integration capabilities of the Web technologies, it is technically feasible to integrate the platforms, use a combination of those functions of each platform that are needed and to hide this added complexity from the participants.

These platforms together with a multitude of extensions and add-on tools provide good KM functionality. Almost two thirds of the organizations have developed their own KMS solutions based regularly on a bundle of tools. It is not surprising that in most of the organizations KM functionality is spread over many systems with a varying degree of integration. However, about a third of the organizations reported a high degree of integration with all functions at least integrated within one single user interface or fully integrated within one system.

Specific KMS or KM suites are intended to provide exactly this organization-wide integration between KM-related information and communication functions. This kind of systems, however, was used to a lesser extent. The reasons for this result might be that

- Many organizations have undergone large projects installing advanced Intranet technologies and/or Groupware platforms, so that they first want to fully exploit the capabilities of these systems before they might want to install just another platform. This reasoning was confirmed by the interviews with organizations that had developed their own solutions.
- KM suites have been quite expensive tools the implementation of which is a complex project. At the same time some organizations had programmer capacity freed from completed large projects, for example of ERP installations or of the Y2K-problem, thus leading to a preference for in-house development of KMS solutions;
- The market for KMS has been intransparent and has not yet been consolidated. Therefore a large number of relatively small vendors provide solutions that evolve very dynamically. A “standard” set of functions has yet to be defined or found by the market forces.

- Organizations view the handling of knowledge as their core competence and are reluctant to apply standard solutions for their core business. In the case of large, multinational, knowledge-intensive companies such as the "big five" professional services companies, KMS are viewed as an important source of strategic advantage over the competition.

These explanations reflect the situation in the end of 1999. However, since then the market for KMS has evolved and sophisticated solutions are now available by a small group of leading vendors (e.g., Hyperwave, IBM/Lotus, OpenText) so that the share of organizations using KM suites is likely to rise in the near future.

14.2 Contents

14.2.1 Types of contents

The types of contents of KMS used in organizations was investigated in two steps. Firstly, contents of KMS were classified into the four groups (1) internal, formal knowledge, (2) internal, informal knowledge, (3) external knowledge and (4) private knowledge. Respondents had to estimate what share of the total contents of KMS belonged to each of these groups. Secondly, these four groups were detailed using a list of 16 items describing typical KMS contents. Figure C-21 shows the means and standard deviations of the percentages the respondents reported.

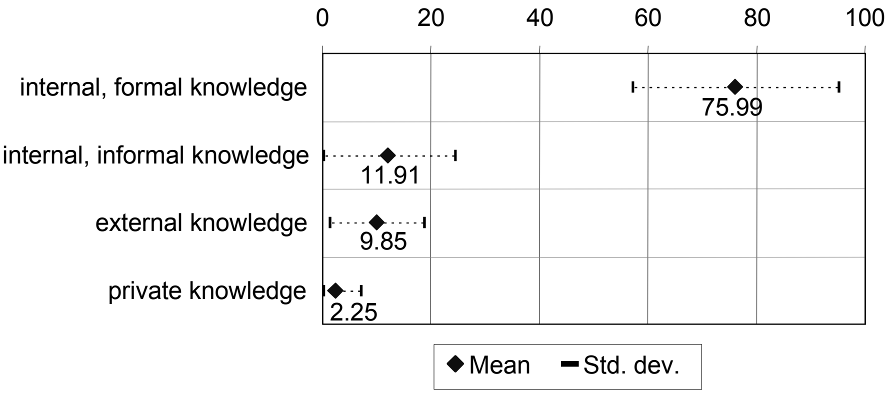

FIGURE C-21. Types of contents of knowledge management systems[97]

The majority of respondents reported a share of *internal, formal knowledge* of 80 or more percent (23 out of 39 respondents, 59%). Ten organizations (= 25.6%) had between 60 and 80 percent, five organizations (= 12.8%) had between 40 and 60 percent and one organization reported the lowest share at 33%. Thus, KMS contained primarily enhanced, reformatted, structured, contextualized and linked offi-

97. Means and ranges show percentages, n=39.

cial, formal documents most of which had already been stored in different systems before, such as document management systems or file servers.

There were eight organizations (= 20.5%) that reported not to have any *internal, informal knowledge* in their KMS. At the opposite end, there were five organizations (= 12.8%) that reported a share of 30 or more percent with a maximum of 50 percent. However, most organizations had a share of internal, informal knowledge between 2 and around 20 percent with a peak around 10 percent. Thus, organizations could be classified into three groups. Approximately every fifth organization had none at all, two thirds had a medium and every seventh organization had a high share of internal, informal knowledge.

Eleven organizations (= 28.2%) reported no *external knowledge* in their KMS. Eight organizations (= 20.5%) had 20 or more percent with a maximum of 30 percent. The majority of organizations could be found once again between 2 and 20 percent with two peaks at 5 and at 10 percent. Thus, external knowledge played different roles in different organizations. Almost a third of the organizations were exclusively inward-oriented whereas there were also organizations with a high share of external knowledge.

Private knowledge was not part of the KMS in more than two thirds of the organizations (27 respondents, 69.2%). Of those organizations that allowed this type of knowledge seven organizations (= 17.9%) had below 10 percent and five organizations (= 12.8%) had a share of 10 or more percent.

This basic classification along the dimensions *formality* (formal—informal) and *relation to the organization* (internal—external) could be extended according to different dimensions such as *time* (historic knowledge—knowledge relating to the future), *type of knowledge* (e.g., descriptive—exploratory), *security* with regard to competition (secured—unsecured), *topic* (e.g., people—methods/instruments/procedures) and the like[98].

16 items were used in order to get a more detailed picture about what types of knowledge were part of the organizations' KMS. Figure C-22 shows the shares of the responding organizations in which these items were part of the KMS. In the following, the results to each of the items will be discussed and compared to related empirical studies.

As Figure C-22 shows more than three quarters of the organizations answering this question (77.1%) said that *knowledge about organization/processes* was part of their KMS. This share is significantly up from the 63% of organizations that indicated to use handbooks and internal instructions as a KM instrument in the ILOI study (ILOI 1997, 16, t-test of mean differences: t-value: 2.297, significance: 0.026, n=48) and also significantly higher than the 57% of organizations storing knowledge about organizational methods and processes electronically in the 1998 KPMG study (KPMG 1998, 9). Knowledge about methods or processes was also the single most important category of knowledge objects found in the Fraunhofer

98. See also section 4.2.2 - "Types and classes of knowledge" on page 66 and section 7.2.1 - "Types of contents" on page 282.

Berlin study with 78% of the respondents thinking it was important (Heisig/Vorbeck 1998, 7).

Still two thirds or more of the organizations had *internal communication* (68.8%) and *knowledge about business partners* (66.7%) in their KMS. The latter value is higher compared to the 60% of respondents indicating to store knowledge about customers in the 1998 KPMG study (KPMG 1998, 9) and also higher than the 56.8% of innovative organizations which used customer management systems as part of their set of technologies supporting KM found in the APQC study (APQC 1996, 55). In the Fraunhofer Berlin study, knowledge about customers was ranked third of all categories of knowledge objects and 41% of respondents repored it to be important (Heisig/Vorbeck 1998, 7).

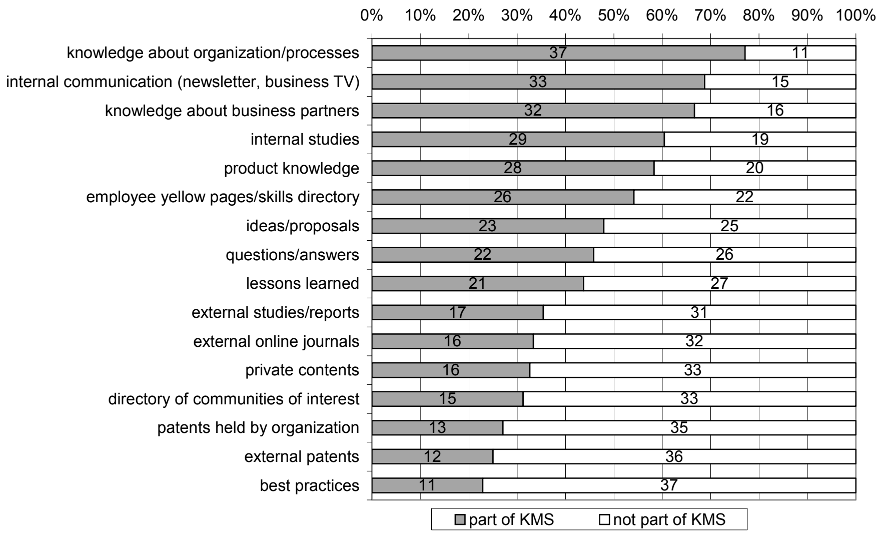

FIGURE C-22. Contents of knowledge management systems[99]

These were followed by *internal studies* (60.4%) and *product knowledge* (58.3%). The latter result is about the same as the share of 60% found in the 1998 KPMG study (KPMG 1998, 9). In the Fraunhofer Berlin study 51% of the respondents thought product knowledge was important (Heisig/Vorbeck 1998, 7).

The first item reflecting a KM-specific content was *employee yellow pages* or *skills directories* which were part of the KMS in more than half of the organizations (54.2%). This result is backed by the 52.3% of organizations having skill inventory systems or yellow pages found in the APQC study (APQC 1996, 55) and by the 50% of organizations storing information about employee skills electronically found in the 1998 KPMG study. It is substantially up from the 9% of organi-

99. $48 \leq n \leq 49$.

zations that reported in the same study that everyone had access to this knowledge (KPMG 1998, 9). It is also significantly up from the 29% of organizations that reported to have knowledge directories in the ILOI study (ILOI 1997, 16, t-test of mean differences: t-value: 3.463, significance: 0.001, n=48) and the 20.8% of organizations that had yellow pages for organization-internal specialists in the Jäger/Straub (1999) study.

Employee yellow pages were followed by *ideas and proposals* (47.9%), *questions and answers* (frequently asked questions, FAQ, 45.8%) and *lessons learned* (43.8%), three more types of contents which have become very popular instruments for organization-internal sharing of knowledge or experiences. Exactly half of the organizations surveyed by the APQC thought they were effectively using lessons learned for knowledge sharing, whereas only 6.8% said they were ineffective (APQC 1996, 58). Respondents of the Fraunhofer Stuttgart study also thought that data bases holding experiences (with an average value of 3.74 on a scale from 1=not important to 5=very important) and especially data bases holding customer knowledge (4.12) were important technologies for KM (Bullinger et al. 1997, 22). However, the same study also indicated that best practices or lessons learned were identified primarily with the help of informal talks between colleagues or the formal communication with experts and supervisors whereas information and communication technologies were used substantially less frequently (Bullinger et al. 1997, 27).

The Fraunhofer Stuttgart study also revealed that about three quarters of the German organizations (73.6%) used a so-called “organizational proposal system” (Betriebliches Vorschlagswesen) in which employees can submit ideas and proposals which are then evaluated, a result backed by the 70.8% of HR managers indicating that they used this instrument in the study done by Jäger/Straub (1999). Employees get financial rewards, if the proposals are implemented. In almost half of the organizations (44.6%) this proposal system was implemented throughout the organization, in the rest it was restricted, in most cases to construction, production or marketing/customer service (Bullinger et al. 1997, 28). It seems that this system could provide a good basis from where an electronic equivalent could start. Thus, it is not surprising that almost half of the organizations surveyed in the study presented here had ideas and proposals as part of their KMS.

External studies (35.4%) and *external on-line journals* (33.3%) were each used as part of the KMS by about a third of the organizations. These results are substantially lower than the 57% of organizations which reported to use “technical storage media” (e.g., CD-ROMs, data bases, online-data bases, etc.) for the acquisition and retention of external knowledge in the ILOI study (ILOI 1997, 25). It seems that the degree of integration of external knowledge, even if stored on electronic media, with the organization-specific KMS was low. Contents of KMS seemed to be focused more on the internal side of knowledge than on the external side.

About a quarter of the organizations used *patents held by the organization* (27.1%) or *external patents* (25%) as part of their KMS. The latter result compares to the 29% of organizations which reported in the ILOI study to use immaterial, legally secured external knowledge (licences, franchising, ILOI 1997, 25, 27). However, this share is substantially higher than the mere 6% of respondents who thought patents were important knowledge objects in the Fraunhofer Berlin study (Heisig/Vorbeck 1998, 7).

Finally, *best practices* were used by only a minority of organizations (22.9%). Best practices seemed to be viewed as a much more specific instrument when compared to other instruments such as lessons learned and the like.

In addition to the types of contents found here, KPMG reported a share of 32% of the organizations electronically storing knowledge about regulatory environments and 37% about competitors, the two lowest values in the study (KPMG 1998, 9). Knowledge about competitors was rated important by 27% of the respondents in the Fraunhofer Berlin study (Heisig/Vorbeck 1998, 7).

All in all, it seems that only recently the organizations have made more and more contents available online for most if not all of their employees[100]. However, there still remains a substantial part of organizations with a quite restrictive Intranet or KMS with respect to the type of contents.

In order to support the development of scenarios of the use of KMS this list of items was investigated in more detail. The statistical method *factor analysis* was used to get a picture of what underlying factors could be used to describe the types of knowledge in the organizations' KMS[101]. The factors shall be interpreted as types of knowledge used in the organizations' KMS. The method used for factor extraction was *principal components*. The criterion used to determine the number of factors is a minimum *Eigenvalue > 1*. The application of this criterion lead to a six-factor solution[102]. The six factors together explain 69.4% of the total variance. In order to ease the interpretation of factors the initial solution was rotated according to Kaiser's Varimax method of factor rotation. Missing values were excluded listwise. Table C-43 shows the rotated factor matrix[103].

In the following, the six factors are described and their importance for the organizations is investigated using Figure C-22.

The type of knowledge describing the first factor can be called **formally approved, institutionalized knowledge** and comprises the contents *external studies and reports*, *internal communication* and *questions and answers*. Questions and answers can be imagined as formally approved lists of frequently asked questions which are very common within the IT sector. The item *questions and answers* thus must not be misunderstood as informal, unapproved discussion lists with contributions to various topics like the item *ideas and proposals* (see below). More than two thirds of the organizations (68.8%) reported to have formal internal communi-

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100. See also section 13.1.1 - "Scope" on page 482.
101. For a short explanation of factor analysis see also section 13.2.1 - "Willingness to share knowledge" on page 512; for a detailed description of factor analysis e.g., Backhaus et al. 1996.
102. The Scree-test also leads to a six-factor solution (see URL: http://iwi.uibk.ac.at/maier/kms/).
103. See URL: http://iwi.uibk.ac.at/maier/kms/ for detailed results.

cation in their KMS. Almost half of the organizations (45.8%) had questions and answers and about one third (35.4%) had external studies and reports. Thus, formally approved knowledge was well represented in the KMS of most of the organizations.

TABLE C-43. Rotated component matrix of the variables describing contents of KMS

variables	factor 1	factor 2	factor 3	factor 4	factor 5	factor 6
external studies/reports	<u>0.78633</u>	0.23363	0.05976	0.11568	-0.18829	0.15996
internal communication (newsletter, business TV)	<u>0.75977</u>	0.09942	0.07021	-0.10639	0.28216	0.13956
questions/answers	<u>0.60221</u>	0.01296	0.45209	-0.06766	0.21675	0.02943
external online journals	<u>0.53991</u>	<u>0.58065</u>	0.01875	-0.35897	-0.01368	-0.11806
lessons learned	0.09671	<u>0.79358</u>	-0.09851	0.02490	0.17935	0.10459
best practices	0.11780	<u>0.76330</u>	0.33994	0.17806	0.03697	-0.15754
employee yellow pages/ skills directory	0.06665	<u>0.56705</u>	0.26982	0.27128	-0.01900	0.14543
knowledge about business partners	-0.06966	0.16999	<u>0.80483</u>	-0.07493	-0.19833	-0.00749
directory of communities	0.21526	0.12095	<u>0.69235</u>	0.04497	0.23099	0.12063
ideas/proposals	0.48457	-0.02487	<u>0.60885</u>	0.29549	0.05079	0.04879
external patents	0.18674	0.06279	0.11880	<u>0.83910</u>	-0.08827	-0.21208
patents held by organization	-0.23075	0.15029	-0.04495	<u>0.78336</u>	0.03229	0.08597
private contents	0.13744	0.11279	-0.03342	-0.04416	<u>0.85034</u>	-0.10992
knowledge about organization/processes	-0.02536	0.09360	0.28855	0.06246	<u>0.55225</u>	<u>0.55461</u>
product knowledge	0.14991	-0.11249	0.04145	-0.32648	-0.23144	<u>0.72842</u>
internal studies	0.31076	0.24577	-0.00861	0.33610	0.10627	<u>0.51859</u>

The second factor describes **experiences/expertise** and contains the contents *lessons learned*, *best practices*, *employee yellow pages / skills directory* and *external online journals*. The latter also loads almost equally strong to factor 1—formally approved knowledge. Online journals as a type of knowledge content rather describe a medium than a type of knowledge. Different types of journals can contain different types of knowledge. More than half of the organizations (54.2%) had expert or skills directories. Lessons learned (43.8%), external online journals (33.3%) and especially best practices (22.9%) were part of the KMS in only a minority of the organizations. These more advanced contents were only present in organizations which had already undergone a more advanced KM approach.

Factor three can be called **unapproved contributions in knowledge networks** and is reflected by the items *knowledge about business partners* (customer and supplier relationship knowledge), a *directory of communities* and *ideas and proposals*. The knowledge described by this factor can be characterized as formally unapproved ideas for the development of new knowledge. These ideas are contributed to communities, teams and workgroups and lead to knowledge networking within the organization and with business partners. Knowledge about business partners was one of the three most reported items in this study with a share of two thirds of the organizations (66.7%). As communities were at the point of the study not a wide-spread organizational phenomenon, it is not surprising that only about a third of the organizations had directories of communities in place (31.3%). In about half of the organizations (47.9%) ideas and proposals were part of the KMS.

Factor four can be called **secured inventions** and is devoted to precisely defined knowledge products which are secured from being used by the competition. It comprises the items *external patents* and *patents held by the organization*. As patents play a much more important role in the industry sector than in the service sector (Spearman's rho: 0.372, significance: 0.009, n=48 for internal patents, Spearman's rho: 0.338, significance: 0.019, n=48 for external patents), it is not surprising that only about a quarter of the organizations had patents in their KMS. The two items were highly correlated which means that if an organization handled patents, it stored both, internal and external patents (Spearman's rho: 0.514, significance: 0.00018, n=48).

The fifth factor can be called **personal contents**. It comprises contents that are related to private, out of workspace interest of the employees which is reflected by the item *private contents* held by about one third of the organizations (32.7%). The item *knowledge about the organization and processes* loads partly on this factor, too, which might be explained as describing the individual employees' relationship to the organization. The factor does not necessarily describe knowledge in a narrow sense, as private homepages or contact platforms (e.g., to find sport partners) all fall into this category.

It was supposed that the question whether personal contents are allowed into a corporate KMS correlates with an open organizational culture encouraging knowledge sharing among employees, even outside the traditional work environment. The corresponding correlations between the factor personal contents and the four factors of willingness to share knowledge[104] all showed the expected negative sign. This means that knowledge sharing outside the workspace tended to be higher for organizations that allowed private contents as part of their KMS. However, the correlations were not significant[105]. Hypothesis 14: 'If an organization allows private contents as part of their knowledge management systems, willingness to share knowledge is higher' was not supported.

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104. See section 13.2.1 - "Willingness to share knowledge" on page 512.

The sixth and last factor can be called **organization-specific descriptive knowledge**. In addition to the item *knowledge about organization and processes* as mentioned above it contains the items *product knowledge* and *internal studies*. All three items were part of KMS in most of the organizations. More than three quarters (77.1%) had knowledge about organization and processes stored in their KMS and about three in five organizations having product knowledge (58.3%) and internal studies (60.4%) in their KMS. Thus, organization-specific descriptive knowledge was the most prevalent type of knowledge in the organizations' KMS.

Each of the six factors represents a different type of knowledge, although some factors are closer to each other than others. Examples are *experiences/expertise* and *unapproved contributions in knowledge networks* which both represent unapproved knowledge in the sense that there has not been a formal approval before this type of knowledge is published in the organization, or the factors *formally approved knowledge*, *secured inventions* and *organization-specific descriptive knowledge* which all represent formal knowledge approved within the organization.

It is well worth to go beyond this basic classification and attempt to integrate the factors into the theoretical model of the tasks and flows in knowledge management[106]. This will help to understand the underlying processes in organizations that transform knowledge of one type into knowledge of another type and that can be used to bring the six factors into a logical order. The theoretical basis for the ordering is the knowledge life cycle that is part of the model of KM tasks and flows (see Figure C-23). The knowledge life cycle describes the flow of knowledge and the changes to the types of knowledge used in organizational learning processes.

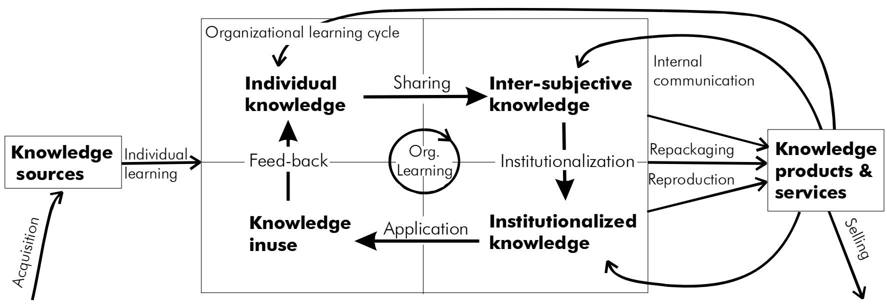

FIGURE C-23. Knowledge life cycle portion of the model of KM tasks and flows

105. Correlations to factor 1: inter-group OL atmosphere: Spearman's rho: -0.151, significance: 0.329, n=44; factor 2: workspace-related OL atmosphere: Spearman's rho: -0.015, significance: 0.922, n=44; factor 3: rewards for knowledge sharing: Spearman's rho: -0.183, significance: 0.236, n=44; factor 4: knowledge sharing outside workspace: Spearman's rho: -0.086, significance: 0.581, n=44.

106. For a detailed discussion of the model see chapter 6 - "Organization" on page 153; see also Figure C-8 on page 499 for the application of the model in the empirical study to investigate KM tasks.

The knowledge life cycle in the model basically consists of *knowledge sources*, of the four types of knowledge that are part of the organizational learning cycle—*individual knowledge*, *inter-subjective knowledge*, *institutionalized knowledge* and *knowledge in use*—and finally of *knowledge products and services*. The differences between these types of knowledge can be described as changes in the degree of sharing, of linking and structuring, of formal approval and of institutionalization with respect to the organizational power relationships (e.g., approval by a project manager versus approval by senior management).

The six factors extracted here can now be assigned to the types of knowledge in the model of KM tasks and flows and ordered according to the knowledge life cycle as follows:

1. **Personal contents:** *individual knowledge*, no direct relation to the business- or business process-oriented part of the organizational knowledge life cycle,
2. **Unapproved contributions in knowledge networks:** *inter-subjective knowledge*, knowledge ready-to-share,
3. **Experiences/expertise:** *inter-subjective knowledge* that has been verified, linked, classified, represented, is physically and intellectually accessible and contains links back to individual knowledge,
4. **Formally approved knowledge:** *institutionalized knowledge*, *internal communication*,
5. **Organization-specific descriptive knowledge:** *institutionalized knowledge*, *internal communication*, *knowledge products & services*,
6. **Secured inventions:** *knowledge products & services, knowledge in use.*

As expected, organizations with a systematic KM targeted different contents than organizations without such an initiative. The differences were significant concerning the factors *experiences/expertise* (Spearman's rho: 0.442, significance: 0.002, n=48) and *secured inventions* (Spearman's rho: 0.377, significance: 0.008, n=48). Thus, Hypothesis 13: 'Organizations with systematic knowledge management target different contents than organizations without such an initiative' was supported. Organizations with systematic KM were more likely to have experiences and expertise, particularly best practices, lessons learned or employee yellow pages/skills directories in their knowledge bases. Organizations with a systematic KM were also significantly more likely to handle patents, thus showing that organizations where secured knowledge undoubtedly creates business value, are more aware of knowledge management.

14.2.2 Size and media used

It is quite difficult to measure the size of the contents of KMS as opposed to measure the size of e.g., relational data base systems. In the case of relational data base systems size is quite easily measured as the number of rows of a table times the number of bytes in every row. The sum total of all tables is the total size of a data base system. Alternatively, the size of the data base file managed by a DBMS or a set of files in the case of distributed data base systems gives the size of the data base system. However, a "knowledge base" in most cases consists of a large number of semi-structured files that are dispersed over a number of servers and often also client PCs which not only contain files that are part of the KMS, but also more traditional documents which might also be managed with the help of a KMS. Thus, measuring the size of a KMS is a non-trivial problem and hardly any respondent or interviewee could answer the questions easily, if at all.

Moreover, terminology is still in its infancy, so the simple (sounding) question "How many knowledge elements does knowledge management handle?" was answered by just nine out of 73 respondents (12.3%). The reported numbers ranged between 0 and 120 knowledge elements with eight organizations reporting up to 10 knowledge elements. These answers show that the question was clearly misunderstood. Thus, the data obtained in this question cannot be interpreted. The closest proxies of knowledge elements in traditional information systems are documents, files or parts of a hypertext document. Certainly, organizations of the size like the ones in this sample were expected to have many more knowledge elements and telephone calls to several respondents showed that this was the case.

The interviewees also had difficulties to estimate the size of their KMS and particularly the number of knowledge elements and were not sure what types of electronic data[107] they should count as knowledge elements. Estimates, though, ranged between tens of thousands up to several millions of knowledge elements. This shows once again that KM is a decentral approach where the contents of KMS are not "managed" in the sense that a central unit is in control of all the contents.

The second measure was storage capacity used by knowledge elements. Respondents (and interviewees) in most cases again had problems to estimate this figure, though it seemed that they found it easier to answer this question than the question about the number of knowledge elements. As mentioned above, the difficulties are due to the fact that knowledge elements are spread over a number of servers and even client PCs so that a central unit cannot easily obtain the total size of knowledge elements "woven" into a knowledge net. However, fourteen organizations (19.2%) answered the question.

Table C-44 shows the distribution of responding organizations according to the size of contents of KMS. The amount of content managed by a KM unit can be quite considerable. The figures vary widely with a minimum of 25 MB and a maximum indicated by one organization at 1.5 Terabyte of data managed. The variation in the size of the contents was not correlated with the size of the organization.

Correlation analysis is statistically not possible neither with the number of knowledge elements nor with the size of contents. This is due to the misinterpretation of the question in the case of the number of knowledge elements and due to the small number of organizations that could answer the questions in the case of the size of the contents. Not surprisingly, the correlations with the existence of a sys-

107. In the end, every knowledge element stored electronically is data. The interviewees were uncertain about to count data sources towards KMS, e.g., customer relationship data, contributions in newsgroups, data in data warehouses, experience, lessons learned, best practice data bases, CBT modules, email messages.

tematic KM initiative were insignificant. Hypothesis 15: 'Organizations with systematic KM handle a larger knowledge base than organizations without such an initiative' was not supported.

TABLE C-44. Size of contents of KMS

x = storage capacity used (in MB)	frequency	percent
x < 1,000	4	28.57
1,000 ≤ x < 10,000	3	21.43
10,000 ≤ x < 100,000	4	28.57
x ≥ 100,000	3	21.43
total	14	100.00

Figure C-24 gives an overview of the types of media used in the responding organizations' KMS. The numbers in the figure represent the average share of the types of media.

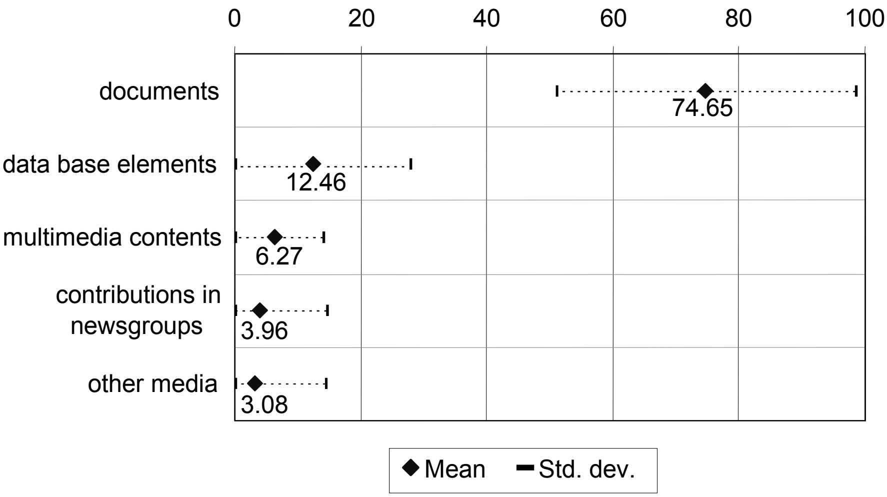

FIGURE C-24. Types of media used in knowledge management systems[108]

Documents are stored in varying formats[109]. In most organizations documents were the most important type of format used in KMS. More than four in five organizations (31 out of 38 organizations, 81.6%) had KMS with more than 50% docu-

108. Means and ranges show percentages, $37 \leq n \leq 38$.
109. See section 7.2.3 - "Size and media used" on page 296 for a brief description of document formats as well as the formats discussed in the following categories and for links to the literature.

ments and in about two thirds of the organizations (63.2%) documents made up 80 or more percent of their KMS with four organizations (10.5%) having KMS made up of 100% documents. Four organizations (10.5%) had 30 or less percent of documents in their KMS.

Data base elements, are stored in conventional data base systems (e.g., hierarchical, relational, object-oriented DBMS) and data warehouses. About a third of the organizations did not consider data base elements as part of their KMS (12 out of 37 organizations, 32.4%). Seven organizations (= 18.9%) had less than 10 percent, five organizations (= 13.5%) had between 10 and 20% and 13 organizations (= 35.1%) had a share of data base elements in their KMS of 20 or more percent with a maximum of 70%. The APQC reported that 77.3% of the innovative organizations questioned in 1996 used data bases for "institutional knowledge" (APQC 1996, 55) which is higher than the 67.6% found here.

Multimedia contents could be *audio files*, *video files*, *vector graphs* or *pictures*. All these multimedia contents could also be part of hypertext documents. Almost half of the organizations had no multimedia contents in their KMS at all (16 out of 37 organizations, 43.2%). 15 organizations (40.5%) had up to 10 percent and six organizations (16.2%) had more than 10 percent of multimedia contents in their KMS with a maximum of 30 percent.

Almost two thirds of the responding organizations did not handle any *contributions to newsgroups* within their KMS (24 out of 37 organizations, 64.9%). Ten organizations had 10 or less percent, two had 20% and one organization reported a share of contributions to newsgroups of 60%.

Five out of 37 organizations (= 13.5%) reported the use of *other media*. The percentages ranged between 4 and 64.8%. Only one organization specified the type of other media. This organization additionally handled email messages and other internal electronic communication in their KMS.

It seems that most organizations still do not pay a lot of attention to the more interactive side of knowledge management. Contents of KMS are mostly focused on the explicit, descriptive side with documents representing the lion's share and data base elements ranking second. Multimedia elements and contributions to newsgroups are less commonly found in KMS.

Organizations with a systematic KM initiative differ, though, from organizations without such an initiative with respect to the types of media used in their knowledge bases. Having a KM initiative, organizations on average have a significantly higher share of data base elements, multimedia elements and contributions to newsgroups combined (Spearman's rho: -0.413, significance: 0.011, n=37[110]) and consequently a significantly lower share of documents (Spearman's rho: 0.321, significance: 0.049, n=38) than organizations without such an initiative. Thus, Hypothesis 16: 'Organizations with systematic KM handle a higher share of multi-

110. The negative sign means there is a positive correlation between having a KM initiative and the share of the type of media tested.

media elements, contributions to newsgroups and data base elements in their KMS than organizations without such an initiative' was supported.

A detailed analysis reveals that the relationship is strong with respect to data base elements and insignificant with respect to contributions to newsgroups and multimedia elements. The latter even shows a slightly lower share for organizations with a KM initiative. Table C-45 compares the means of organizations with and without a systematic KM initiative with respect to the types of media used.

TABLE C-45. Comparison of means of the shares of different media with/without systematic KM

systematic KM	measure[a]	documents	data base elements	contributions to newsgroups	multimedia elements
yes	mean	64.23	22.92	7.31	4.39
	n	13	13	13	13
	std.dev.	27.75	19.33	16.79	7.52
no	mean	80.07	6.79	2.15	7.29
	n	25	24	24	24
	std.dev.	19.78	8.84	4.56	7.81
total	mean	74.65	12.46	3.96	6.27
	n	38	37	37	37
	std.dev.	23.70	15.35	10.65	7.74

a. The means do not add up to 100% as there are other media used. Other media were excluded from this consideration, because only a small portion of the respondents reported other media.

14.2.3 Structuring of contents

Structuring and organizing contents of KMS are supposed to be key tasks in knowledge management. The structure of knowledge elements supposedly strongly influences the usefulness of a KMS. Structure not only determines how quick a participant can navigate to the knowledge elements needed, but also influences the mental models which participants have of the organizational knowledge base. Thus, structure has a descriptive and a normative component influencing the way of thinking of the members of the organization.

Almost three quarters of the respondents (71.7%) indicated that they did not know the number of knowledge areas or clusters in their organization and still more than half of the respondents (60.7%) did not know whether their knowledge areas or clusters were structured hierarchically or according to a network structure. Table C-46 shows the distribution of organizations according to the number of knowledge areas or clusters.

Of those organizations that actually provided figures, more than half (58.8%) had fewer than 10 knowledge areas or clusters suggesting that only the first level of the knowledge structure was defined at the point of time of this empirical study. Most of the remaining organizations had between 10 and 20 knowledge clusters and two respondents reported very detailed structures with 90 and a maximum of 1,000 knowledge areas.

TABLE C-46. Number of knowledge areas or knowledge clusters

number of knowledge areas/clusters	frequency	percent	valid percent
< 5	4	6.67	23.53
5 - 9	6	10.00	35.29
10 - 49	5	8.33	29.41
50 - 99	1	1.67	5.88
≥ 100	1	1.67	5.88
valid total	17	28.33	100.00
do not know	43	71.67	
total	60	100.00	

There are two different possible explanations for the surprising lack of knowledge about the structuring of the organizations' knowledge bases. Firstly, some organizations apply a very decentralized approach to structuring and allow participants to update the structure by e.g., creating new knowledge areas. In these cases, the number of knowledge areas grows without a central authority approving it, thus making it harder to judge the actual number of knowledge areas. This is especially true if KMS have a decentralized architecture and are spread over many servers and workstations. The explanation is backed by the finding that five of those organizations that could not provide the number of knowledge areas reported the number of hierarchical levels within their knowledge structure (see Table C-48 below). This group of organizations had on average four hierarchical levels which was higher than the average of three levels reported by those four organizations that provided the number of knowledge areas.

Secondly, many organizations experienced major difficulties in structuring their knowledge base. Many interviewees found that structuring the contents of KMS was one of the most difficult decisions they had to take during the implementation of KMS. Due to the fact that this structure receives visibility (e.g., the first and second levels of the structure of an organization's Intranet), in most cases many senior managers or middle managers had to be involved who often had contradicting mental models about the importance of certain knowledge areas. The resulting compromises were rarely considered optimal solutions, but rather reflected the organizations' struggle with bringing together varying perspectives of different executives or managers.

As difficult as this process is, as much does it help to develop a joint understanding of what knowledge is important for an organization. Thus, one can conclude that those organizations that do not structure their contents appropriately, might miss out on the potentials of common mental models in their organizations, e.g., a clear guideline for knowledge publication, quicker search for knowledge elements, accelerated understanding of documented knowledge, shared context for knowledge elements, improved communication by common mental models, clarified context for communities.

Additionally, the questionnaire asked for what mode of structuring organizations applied in their knowledge organization, hierarchy or network. Table C-47 shows a cross-tabulation of the number of organizations with a hierarchical versus a network structure of their knowledge areas.

TABLE C-47. Hierarchical versus network structure of knowledge areas

	network structure		
hierarchical structure	**yes**	**no**	**total**
yes	2	8	10
no	12	0	12
total	14	8	22

The number of organizations with a network structure of knowledge areas was higher than the number of organizations with a hierarchical structure. The corresponding t-test was not significant, though (t-test of mean differences: t-value: 1.775, significance: 0.090, n=22). Thus, Hypothesis 17: ’There are more organizations which apply a network structure to their knowledge areas than organizations with a hierarchical structure of knowledge areas’ was not supported. Two organizations (9.1%) had both, a hierarchical and a network structure.

Table C-48 shows the number of hierarchical levels within the knowledge structure.

TABLE C-48. Number of hierarchical levels in the knowledge structure

number of hierarchical levels	**frequency**	**percent**
2	1	11.11
3	4	44.44
4	2	22.22
5	2	22.22
total	9	100.00

Only nine respondents indicated an average number of hierarchical levels of 3.56. As mentioned above, those organizations that provided numbers of knowledge areas, reported fewer hierarchical levels than those organizations which did not indicate the number of knowledge areas. The correlation is not significant, though.

14.2.4 Résumé

There is still considerable uncertainty in many organizations about what is or what should be considered a "knowledge element" in a KMS. This uncertainty is reflected most openly in the findings that less than a fifth of the respondents could report the number of knowledge elements or the size of the organization's knowledge base. Moreover, almost three quarters of the respondents indicated that they did not know how their organizations' knowledge was structured or organized. Most of the other organizations confined the structure to the first level of their knowledge base. Combined with the results obtained in the interviews it seems that a systematic structuring and organization of an organization's knowledge base is a key task in knowledge management, although a difficult and largely unsupported one. In the literature, there are typologies of knowledge in abundance which unfortunately seem to be as diverse as definitions of knowledge are. What is needed in the organizations is a pragmatic, but comprehensive definition as well as a classification of knowledge—a knowledge typology—and experiences about what to include into KMS and how to structure and organize the contents of KMS. AI approaches towards corporate ontologies, particularly on the basis of business process models, are promising developments in this area[111].

A basic *classification* of knowledge along the dimensions *formality* and *relation to the organization* was used in order to shed some light on the variety of types of knowledge stored in KMS. The predominant type of knowledge was internal, formal knowledge followed by internal, informal knowledge. Most organizations focused (almost) exclusively on the organization-internal knowledge. They possibly missed the benefits of a joint consideration of internal and external knowledge. Only a minority of organizations allowed their employees to include private contents into their knowledge base reflecting a more open organizational culture.

Sixteen items were used detailing this basic classification of knowledge. Generally, more organizations handled a larger variety of knowledge contents when compared to previous studies. About half of the organizations used modern KM contents, like employee yellow pages, skills directories, idea and proposal systems and lessons learned. Recently, compared to earlier empirical studies[112] organizations seemed to have extended the scope of their KMS to include more types of internal knowledge previously unavailable to a larger group of employees. One of the biggest potentials now seems to lie in the integration of external knowledge which, although deemed important, supposedly is not managed systematically in the majority of the organizations.

111. See also section 7.2.4 - "Structuring of contents" on page 298.
112. APQC 1996, Bullinger et al. 1997, ILOI 1997, KPMG 1998

The sixteen items were reduced to *six factors* ordered along the knowledge life cycle in the model of tasks and flows of knowledge from informal, unapproved and unsecured knowledge to formal, approved, secured and applied knowledge: personal contents, unapproved contributions in knowledge networks, experiences/ expertise, formally approved knowledge, organization-specific descriptive knowledge and secured inventions.

Most organizations had organization-specific descriptive knowledge on the one hand and unapproved contributions to knowledge networks on the other hand as part of their knowledge base. These two types reflect the integrative and interactive architecture of KMS and the codification versus the personalization KM strategy. Not surprisingly, secured inventions were used by only a minority of organizations as the service sector does not depend as much on this type of knowledge than the industry sector. The biggest *potentials*, however, seem to lie in:

- *experiences and expertise* which could be seen as the most important type of content bridging the gap between organization-specific descriptive knowledge and unapproved contributions in knowledge networks and
- *external knowledge* bridging the gap between the organization and its environment, business partners, competitors, innovators and research institutions as well as the regulatory environment.

An analysis of the size of KMS showed that it is hard to judge the number of knowledge elements or the storage capacity used by this type of systems. This is due to the observation that KMS regularly have a very decentral architecture, are (almost) self-organizing, extensively growing, dynamic systems with documents spread over an often large number of networked servers, workstations and PCs. Those figures that were provided show that KMS store large amounts of data in the range of tens or hundreds of Gigabytes or even Terabytes.

The bulk of contents of KMS was stored in documents followed by data base elements. In most organizations, interactive contents, such as contributions in newsgroups up to now still do not play an important role. The same is true for multimedia contents. Many organizations are challenged by the high requirements for storage capacity and bandwidth that multimedia contents have. This is especially true for multinational organizations which have subsidiaries in regions with a heavily challenged network infrastructure.

14.3 Functions

In the following, KM-related systems will be investigated in detail. It will be analyzed to what extent KM functionality was used in the organizations in order to support the contents as described above. Additionally, the findings will be compared to the results of related empirical studies, particularly in order to see whether the usage of KM functionality has changed over time.

The list used in this study contains a *set of 62 KMS functions* which represent all functional areas of KMS discussed in part B[113]. A substantial portion of these functions comprising all functional areas has to be integrated and actually used by a number of participants in order for the ICT system in that organization to qualify as a comprehensive KMS solution[114]. These functions do not have to be realized by one single KM suite. In most cases, organizations combined a number of ICT tools and systems in order to realize a (more or less) integrated KMS solution.

The naming of the functions had to be adapted as the pretests had shown that many of the more advanced functions were not very well known or defined and different vendors of KMS called several functions differently. The list of 62 functions was presented in the questionnaire split into *seven groups of functions* in order to ease their interpretation:

- knowledge search,
- knowledge presentation,
- knowledge publication, structuring and linking,
- knowledge acquisition,
- knowledge communication and cooperation,
- computer-based training and tele-learning,
- administration of KMS.

For each of the functions respondents were asked to indicate whether or not this function was supported by the KMS in their organization. If the function was implemented, they were asked to estimate the frequency with which this function was used on the ordinal scale never, rarely, sometimes, often or always. For each of the groups of functions respondents could add other functions that they used. Only three respondents indicated other functions. One was a function that was asked for later on in the list. One reported to use "Intranet-based manuals", a description of a type of content for which Intranet functions were used in that particular organization, and thus was omitted. Only one respondent stated a function not in the list: "Web-based training" in the category *computer-based teaching and learning*. Thus, it can be concluded that the list of functions as presented in the questionnaire was a quite exhaustive list of KMS functions as implemented and used in German organizations at the time of the study[115].

In the following, the state of usage of these KMS functions is discussed in detail. The functions are classified using an extension of Zack's differentiation into[116]:

- integrative KMS functions,
- interactive KMS functions,
- bridging functions.

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113. See sections 7.4 - "Centralized architecture" on page 318 and 7.8 - "Résumé" on page 390; see also Klosa 2001, 184ff who used the same raw data on functions, but in a different grouping. He investigated traditional versus more advanced KMS functions and tested detailed correlations to the use of KMS and to contents in KMS not considered here.
114. See section 4.3.2 - "Definition" on page 86.
115. Due to space limitations, the numerous functions provided by e-learning suites were not included in detail, though.
116. See Zack 1999a, see also section 7.6.1 - "Knowledge Tools" on page 361.

The differentiation also reflects Hansen's classification of KM strategies into personalization and codification strategies where interactive KMS functions support the personalization strategy and integrative KMS functions support the codification strategy[117]. Some functions cannot be classified into one of these categories because their very intent is to close the gap between these two types of systems. They are discussed as functions bridging integrative and interactive KMS. This differentiation is used to study whether organizations primarily have implemented systems to support the handling of codified knowledge, to what extent they aim at bringing together experts to collaborate and share knowledge or jointly target a codified and personalized knowledge strategy by KMS functions bridging the gap. The state of implementation and frequency of usage for these three classes of KMS functions will be correlated with the achievement of business goals[118].

14.3.1 Integrative functions

Figure C-25 shows the 28 functions that can be attributed to an integrative KMS architecture. The functions generally support the handling of knowledge elements in the sense of an asynchronous transfer of explicit knowledge between participants. They fall into the four groups:

- knowledge search and presentation,
- knowledge acquisition, publication and organization,
- computer-based training and
- administration.

Within these four groups the functions are ordered according to the number of organizations that have implemented the function (descending, first criterion) and, in case two functions are used by the same number of organizations, the number of organizations always using the function (descending, second criterion), often using the function (descending, third criterion) and so on. In the following, the results will be discussed in detail.

Knowledge search and presentation. Generally, the functions for knowledge search and presentation fall into two groups:

- More traditional functions are supported by document management systems and Web browsers such as *keyword search*, *presentation of full texts*, *presentation of new/unread documents* and *navigation*. These functions were used by about two thirds of the organizations and more;
- Advanced functions usually require either a modern document or content management system, a KM suite or added functionality to more traditional systems either bought on the market as tools or extensions to existing systems or implemented by the organizations themselves, such as a *meta-search system*, *informa-*

117. See Hansen et al. 1999, see also section 5.2.3 - "Generic knowledge management strategies" on page 129.
118. See section 15.2.4 - "Correlations with goals" on page 575.

tion subscriptions, *ranking of knowledge elements*. This type of functions was used by between 24 and 47.5% of the organizations. The most recent additions to the field of visualization, such as the visualization of *semantic closeness between knowledge elements* and *three-dimensional visualization* (hyperbolic browsers) were implemented in fewer than a sixth of the organizations and generally not heavily used.

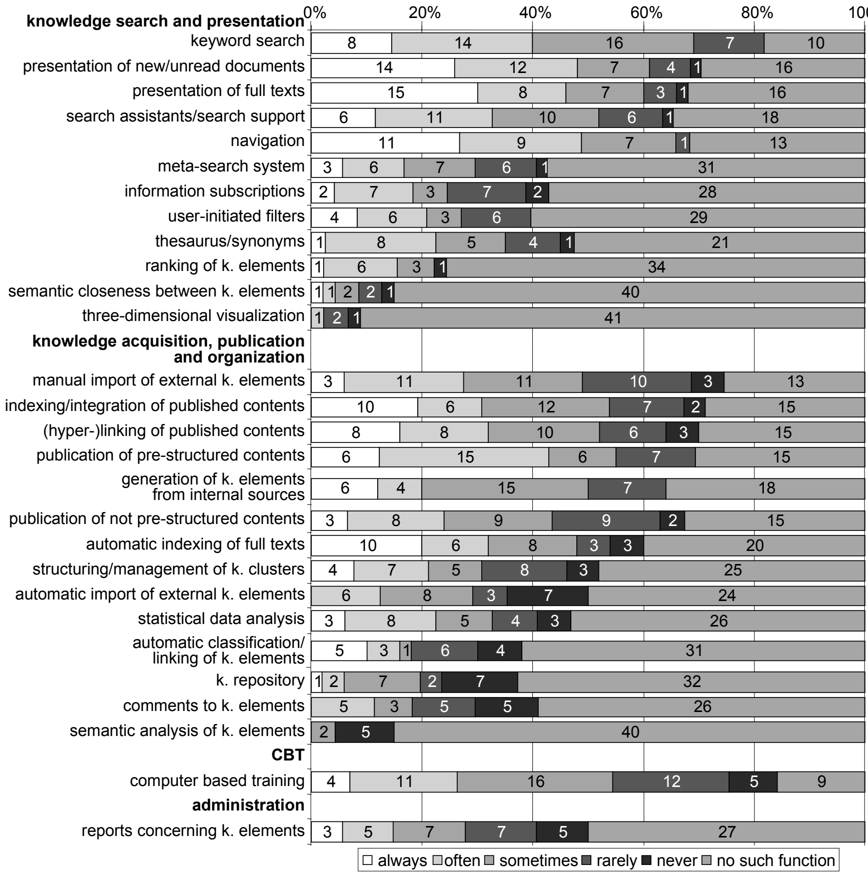

FIGURE C-25. KMS functions for integrative KM

With the exception of the most basic functions *keyword search*, *presentation of new/unread documents*, *presentation of full texts* and *navigation*, no function was used strongly (i.e., always or often) by more than 40% of the organizations. The more advanced functions supporting knowledge search and presentation were not heavily used, although implemented in the organizations. This result might be explained by the observation made in the interviews that in many organizations employees so far have not been trained in the use of these functions. The corresponding KM projects still have to overcome basic technical and organizational difficulties before the systems can be used easily.

One knowledge manager of a big German industry organization said that the technical infrastructure (the LANs and the Internet connections) simply could not cope with the high loads resulting from a heavy use of their networks for the transfer of documents and multimedia elements. The network capacity in some regions of the world has been too low to transport multimedia data on top of the enterprise-resource planning data and computer-aided design data that is already exchanged on a large scale. Thus, this organization does not propagate the heavy use of KMS functions yet. For example in the case of interactive functions, the participants must not use desktop videoconferencing tools and Web-based training files yet.

Knowledge acquisition, publication and organization. Most organizations used functions for publication, indexing and linking of knowledge elements and for the manual import of external knowledge elements. The function *publication of not pre-structured contents* was less frequently used than the *publication of pre-structured contents* although not significantly (difference between means: 0.42, t-value: 1.479, significance: 0.153, n=24). Both questions required that participants could publish knowledge elements autonomously. This explains why the values were lower than those of indexing, linking and the manual import of external knowledge elements. These results differ from the findings of the Fraunhofer Stuttgart study. Respondents of that study stated to use non-standardized documentation substantially more frequently than standardized documentation for the systematic identification and preparation of expert knowledge (Bullinger et al. 1997, 36). One might assume that the longer an organization uses an Intranet, Groupware or KMS solution, the more it standardizes or structures its contents as organization and structuring might ease the interpretation of the knowledge presented.

With the exception of *automatic indexing of full texts* which was used by quite a lot of organizations, functions automatizing the import of external knowledge elements or the classification/linking of knowledge elements as well as functions automatically analyzing knowledge elements (*statistical data analysis*, *semantic analysis of knowledge elements*) were used a lot less frequently. This result is consistent with a share of only 26% of respondents surveyed in the Delphi study who felt that “smart” tools which aid decision-making were a valuable feature of KMS (Delphi 1997, 15).

Computer-based training. 84.2% of the organizations had *computer based training* software in place which was used strongly (= always or often) by only about a quarter of the organizations (26.3%).

Administration. Exactly half of the organizations had functions for the generation of *reports concerning knowledge elements* (e.g., the number of accesses to a knowledge element). 14.8% of the organizations frequently used reports (always or often) about knowledge elements.

Most organizations used at least the more traditional integrative KMS functions for knowledge publication, organization, search and presentation. 91.1% of the organizations (51 out of 56) used at least one of these traditional functions. The more advanced functions which employ technology previously known under the label artificial intelligence technology, such as *intelligent agents*[119], presentation of *semantic closeness between knowledge elements*, *automatic indexing of full texts*, *automatic classification or linking of knowledge elements* or *semantic analysis of knowledge elements* were used by fewer organizations. 68.5% of the organizations (37 out of 54) used at least one of these AI functions. This value is significantly up from the 49% of organizations that indicated to use this type of systems in the ILOI study (ILOI 1997, 16, 22f, t-test of mean differences: t-value: 3.06, significance: 0.003, n=54).

The 2001 KPMG study showed that two years after the study presented here most organizations still relied heavily on rather traditional ICT support for integrative KM functionality, such as Intranet integration (56%), document management (50%), integrated access to contents in the Internet (45%), access to internal systems (39%) and content management (36%). The same study found that AI technologies were used in the KMS of only 4% of the organizations, but search systems to discover contents which often apply AI technology were implemented in 24% of the responding organizations (KPMG 2001, 19). Therefore, it might be that many respondents in the 2001 KPMG study did not attribute functions like the ones cited above as AI functionality and thus the "real" share of organizations using these functions might well be higher.

14.3.2 Interactive functions

Figure C-26 shows the 20 interactive KMS functions. Interactive KMS focus direct knowledge sharing or joint development of knowledge between experts and/or knowledge workers or between knowledge providers and knowledge seekers. They can be divided into the three groups:

- knowledge communication and cooperation,
- tele-learning and
- administration.

Within these three groups, the functions are ordered in the same way than in the case of integrative KMS functions (see above).

Knowledge communication and cooperation. Electronic mail had become a standard form of communication in almost every organization. 89.7% and 82.8% of the organizations answering used *email* or *email distribution lists* strongly (always or often). Still more than half of the organizations used richer synchronous communication tools like *point-to-point videoconference* and *audioconference*. These results are backed by the APQC study, in which more than three quarters of

119. See section 14.3.3 - "Bridging functions" on page 555; see also section 7.1 - "Technological roots" on page 273.

the organizations used videoconferences and nearly 100% used email (APQC 1996, 55). In the Fraunhofer Stuttgart study, most respondents agreed on the high importance of email as an instrument for KM. However, in that study it turned out that the single most important tool supporting knowledge communication and cooperation still was conventional communication technology: the telephone followed by the telefax (Bullinger et al. 1997, 22). One might assume, though, that the importance of conventional communication technology will decrease with the advent of easy-to-use readily available synchronous electronic communication and cooperation technology integrated with the personal electronic work environment.

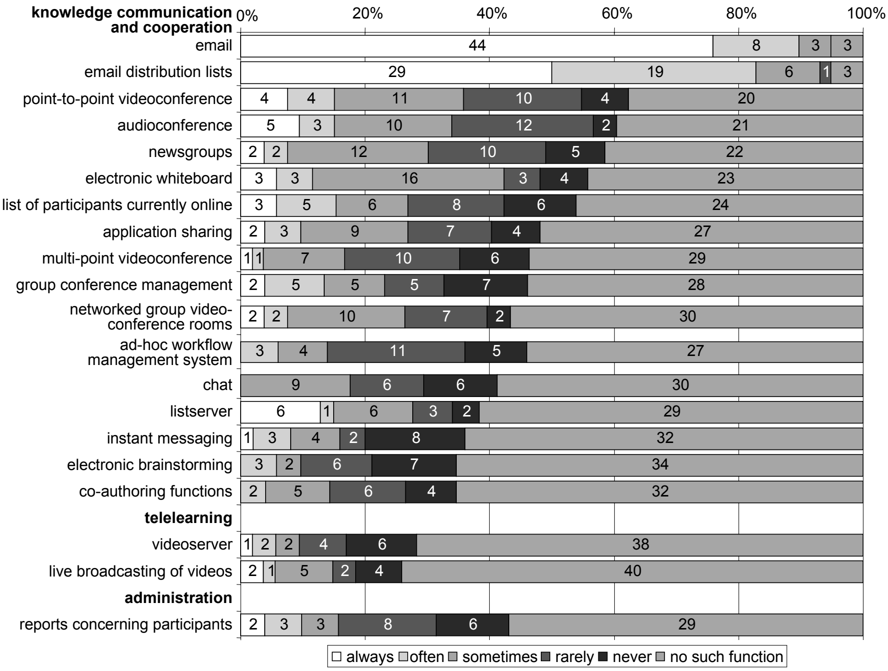

FIGURE C-26. KMS functions for interactive KM

Between 40% and 50% of the organizations actually used more advanced collective communication functions, such as *newsgroups*, *electronic whiteboards*, *multi-point videoconference*, *networked group videoconference rooms*, *chat* and *listserver*. The latter was the most frequently used tool of these, especially when compared to *chat*, the most infrequently used of this type of tools implemented in the organizations. *Newsgroups*, *electronic whiteboards*, *chat* and *listserver* might also be viewed as functions supporting platforms for discussions, a KM instrument used by 57% of the respondents in the ILOI study (ILOI 1997, 16). In the study presented here, 70.9% of the organizations (39 out of the 55 organizations answering at least one of these questions) used at least one of these functions which is a significantly higher share than in the ILOI study (t-test of mean differences: t-value: 2.25, significance: 0.029, n=55).

Of the tools supporting cooperation, *application sharing* was used most frequently, followed by *co-authoring functions*, *ad-hoc workflow management systems* and the least frequently used function *electronic brainstorming*. On the whole, asynchronous electronic communication dominates synchronous electronic communication. The reason could again be the bandwidth problem, especially for the lower use of richer, multimedia communication functions.

Tele-learning. Tele-learning functions like *videoserver* or especially *live broadcasting of videos* are only marginally used in the organizations. Once again, the reason might be the bandwidth problem as mentioned above.

Administration. Reports concerning participants were used by about a third of the organizations (31.4% used this function at least rarely). This function was less frequently used than reports concerning knowledge elements (difference between means: 0.35, t-value: 1.789, significance: 0.090, n=20). One possible explanation for this finding is that the German data privacy law and the German "Mitbestimmungspflicht"[120] which gives employees the right to participate in important organizational decisions together prevent many organizations from using reports tracking the employees' behavior with respect to KMS. This is certainly the case concerning reports for individual employees' behavior, but might also hinder organizations to use aggregated functions not to disturb good relations to the workers' associations or unions which traditionally are not in favor of any kind of worker "surveillance".

On the whole, with the exception of the standard functions *email* and *email distribution lists*, interactive KMS functions were used less frequently than integrative KMS functions showing a tendency of the organizations to focus on the codification of knowledge elements[121]. This result is confirmed by the 2001 KPMG study in which still Groupware (34%) was used by substantially fewer organizations than the integrative KMS systems with email/messaging (74%) being the most frequently used technology for KMS.

14.3.3 Bridging functions

Figure C-27 shows the 14 functions bridging integrative and interactive KMS. Overall goals of these functions are on the one hand to link knowledge elements to knowledge networks and on the other hand to enrich the context for searching and presenting knowledge by considering participants' and groups' patterns of usage of

120. literally translated "right of co-determination", the right of participation of workers in business decisions

121. The average values of all means for interactive KMS functions without *email* and *email distribution lists* versus for integrative KMS functions were 2.54 versus 3.12. The average values of medians were 2.50 versus 3.09. The average shares of organizations having implemented functions were 44.68% versus 53.03%; for a comparison of the figures for all three categories see section 14.3.4 - "Extension and intensity of KMS use" on page 558.

the (integrative) KMS functions. Functions bridging integrative and interactive KMS broadly fall into the three categories:

- knowledge search and presentation,
- knowledge acquisition, publication and organization,
- administration.

The order of the functions as presented in Figure C-27 is the same as in the two sections before.

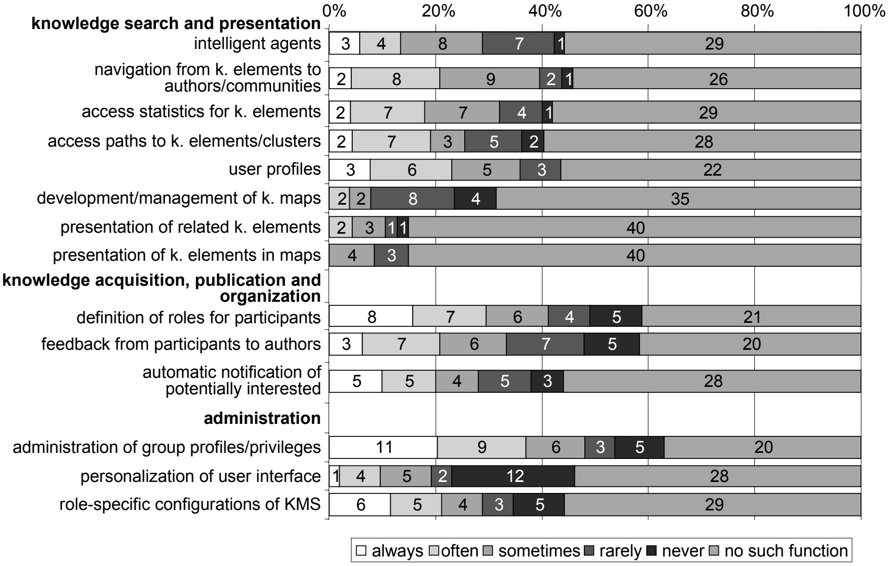

FIGURE C-27. KMS functions bridging integrative and interactive KM

Knowledge search and presentation. Generally, bridging functions supporting knowledge search and presentation were implemented in a minority of the organizations. On average, only about a third of the organizations (34.6%) had implemented this type of functions. However, of those organizations which actually had implemented these functions, usage was quite high (average of all means: 2.98, average of all medians: 3.00). This is especially true for functions supporting the link between knowledge elements and their use by participants, such as *navigation from knowledge elements to authors/communities* (mean: 3.36, median: 3.00), *access statistics for knowledge elements* (mean: 3.24, median: 3.00), *access paths to knowledge elements/clusters* (mean: 3.11, median: 3.00) as well as for *user profiles* (mean: 3.53, median: 4.00). User profiles support a personalization of a participant's search domain or strategy. *Intelligent agents* were implemented most frequently of all the search and presentation functions bridging integrative and interactive KM, but in two thirds of the cases (65.2%) they were only used sometimes or rarely at all.

Visualization of relationships between knowledge elements on the one hand and participants and/or experts on the other hand can be found in knowledge maps (function *presentation of knowledge elements in maps*) or complex search assisting functions such as *presentation of related knowledge elements* which take into account search goals and strategies of participants ("who looked for X might also look for Y"). These functions were hardly used at all. Fewer than half of those organizations (37.5%) that had knowledge maps (function *development/management of knowledge maps*) actually used the maps for a presentation of knowledge elements. It seems that in many cases knowledge maps were exclusively used for management functions rather than to support the search for and presentation of knowledge elements. Still, only 23.5% of the organizations answering this question developed or managed knowledge maps, almost exactly the same share as reported in the ILOI study (23%, ILOI 1997, 16). There might still be considerable untapped benefits from using knowledge maps in the organizations.

Knowledge acquisition, publication and organization. The functions in this group were implemented in substantially more organizations than the functions supporting knowledge search and presentation. On average, more than half of the organizations had this type of functions (53.7%). The *definition of roles for participants* (mean: 3.30, median: 3.50) and the *automatic notification of potentially interested* participants (mean: 3.18, median: 3.00) were used quite strongly. *Feedback from participants to authors* which should support direct interaction between knowledge providers and knowledge seekers was used to a lesser extent (mean: 2.86, median: 3.00). This might be due to the slow transition from users only passively absorbing information provided by unknown authors to participants who strongly interact with knowledge providers to help improve the knowledge elements presented in the systems.

Administration. Generally, all three functions for administration should support the personalization of KMS, in various ways: (1) by using group, team or community membership to define privileges, e.g., search domains, (2) by using an individuals' own preferences, or (3) by using the individuals' organizational role(s), e.g., different functional areas like marketing, production, purchasing or administration as well as different career steps, such as newly recruited/trainee, administrative, manager, senior manager, functional expert or top manager. All three functions were implemented in at least 44.2% of the organizations. The *administration of group profiles/privileges* was used quite frequently (20 out of 34 organizations used this function always or often, mean: 3.53, median: 4.00). This shows that the concept of groups was used widely as an important organizational unit to which privileges and profiles for an adaptation of KMS were attributed to. However, the function *personalization of user interfaces* was hardly used at all. Even though this function was implemented in almost half of the organizations (46.2%), only five organizations used it always or often. The function was used significantly less frequently than the average of all KMS functions (difference between means: -0.81, t-value: -2.942, significance: 0.007, n=24).

14.3.4 Extension and intensity of KMS use

The large number of KMS functions were aggregated to the two measures extension and intensity of the usage of KMS functions:

$$extension(g(KMS)) = \sum_{i=1}^{n} \frac{implement(i)}{n}$$

g(KMS) = group of [integrative; interactive; bridging] KMS functions
n = number of [integrative; interactive; bridging] KMS functions
implement(i) := 1 if function i is implemented
implement(i) := 0 if function i is not implemented

$$intensity(g(KMS)) = \sum_{i=1}^{n} \frac{frequent(i)}{n}$$

g(KMS) = group of [integrative; interactive; bridging] KMS functions
n = number of [integrative; interactive; bridging] KMS functions
frequent(i) := 1 if function i is used "often" or "always"
frequent(i) := 0 if function i is either not implemented or used less frequently

Extension of KMS usage was measured per group of KMS functions—integrative, interactive and bridging functions—as the number of implemented functions. *Intensity of KMS usage* was also measured per group of KMS functions as the number of frequently used functions (often or always used). These measures will be used for the analysis of the relationship between the usage of KMS functions on the one hand and the achievement of business goals on the other hand[122].

KMS functions in organizations were used in a variety of ways. First of all, most organizations used basic functions for information retrieval and communication, like keyword search, navigation, email and email distribution lists. The use of more advanced functions, however, was preserved for a much smaller group of organizations. Integrative KMS functions were used widely and frequently, especially to support knowledge acquisition and publication and to a somewhat lesser extent knowledge organization. Generally, interactive KMS functions were used less frequently than integrative KMS functions. Thus, even though the use of interactive functions was up when compared to previous studies, organizations at least until 1999 did not predominantly use communication-oriented functions as was hypothesized by Blackler (1995). Hypothesis 5: 'Organizations converge in their use of ICT and increasingly use communication-oriented functions of knowledge management systems' therefore was not supported.

The reason for this might be attributed to the problem of bandwidth preventing especially multinational organizations from a substantial organizational effort to boost the use of bandwidth-intensive functions, such as videoconferencing or

122. See section 15.2.4 - "Correlations with goals" on page 575.

advanced tele-learning applications like live broadcasting of videos or video server. This might change in the near future, though, as investment in network infrastructure is considerable, though not at the same pace throughout the world. This means that especially large multinational organizations will encounter bandwidth problems in certain parts of the world even in the longer run. This is especially true for their operations in countries with infrastructure that is still challenged by the large gap between supply and demand if they try to install KM programs that should discriminate some of their subsidiaries, e.g., in the third world.

Only a small portion of the list of KMS functions could be compared to the more superficial analysis of KMS functions performed in previous studies. The share of organizations that used functions that actually could be compared, did not rise with respect to previous studies. Hypothesis 6: 'Compared to earlier studies significantly more organizations use ICT in general and knowledge management systems in particular to support their KM activities' was not supported for KMS functions. However, according to the interviews it seems that organizations have implemented a number of advanced KMS functions only recently so that the use of these functions might well be on the rise.

Table C-49 gives an overview of the results for the different KMS architectures. The aggregation of means for ordinary scaled variables cannot be interpreted seriously. The numbers are meant to give a general indication of which categories of functions were used by what share of organizations and in what frequency[123].

TABLE C-49. Aggregated comparison of KMS functions according to KMS architectures

KMS architecture	number of functions	average number of KMS functions per organization	average share of organizations with KMS functions	mean frequency of usage of KMS functions
integrative	28	10.03 (35.82%)	53.04%	3.12
interactive	20	7.21 (36.05%)	50.24%	2.74
bridging integrative and interactive	14	4.01 (28.64%)	42.59%	3.00
total	62	21.25 (34.27%)	49.77%	2.97

The *average number of functions per organization* was calculated as the mean of the number of integrative, interactive and bridging KMS functions implemented per organization. The *average share of organizations with functions* was computed using the following formula:

123. The mean over means and the mean over medians differ only marginally, though, and the general picture has been confirmed in the interviews, so that the results all point in the same direction.

$$avgorg(g(KMS)) = \sum_{i=1}^{kms} \frac{n_{implement}(i)}{n_{total}(i)}$$

avgorg = average share of organizations with KMS functions
g(KMS) = group of [integrative; interactive; bridging] KMS functions
kms = number of [integrative; interactive; bridging] KMS functions
$n_{implement}(i)$ = number of organizations that have implemented KMS function i
$n_{total}(i)$ = total number of organizations that have responded to the question about KMS function i

The *mean frequency of usage of functions* was calculated aggregating the mean values for each function to the groups integrative, interactive and bridging KMS functions:

$$\mu_{freq}(g(KMS)) = \sum_{i=1}^{n} \frac{\mu(i)}{n}$$

μ_{freq} = mean frequency with which KMS functions were used
g(KMS) = group of [integrative; interactive; bridging] KMS functions
n = number of [integrative; interactive; bridging] KMS functions
$\mu(i)$ = mean frequency with which function i is used

Functions bridging integrative and interactive KMS were used in substantially fewer organizations than functions of the two other groups, integrative and interactive KMS functions. Those organizations that actually had implemented bridging functions used them in about the same frequency than functions belonging to the other two groups. In the case of interactive KMS functions, removing the two functions email and email distribution lists revealed that the more advanced interactive KMS functions were implemented and especially used substantially less frequently than integrative KMS functions[124].

Extension and intensity of usage were also compared for organizations with or without KMS. The adjusted significance level using a Bonferroni type correction was 0.0166[125]. Table C-50 shows the corresponding statistical results.

As expected, organizations with KMS had more KMS functions implemented and were also using these functions more intensively than organizations without KMS[126]. With the exception of the extension of interactive functions all correlations were significant. Hypothesis 18: 'Organizations with KMS have a larger number of KMS functions than organizations without KMS' was supported. The

124. The values for interactive KMS without email and email distribution lists were as follows: an average number of KMS functions of 5.70 (31.67%), an average share of 44.68% and a mean frequency of 2.54.
125. See section 'Statistical analysis." on page 455 for an explanation of the Bonferroni type correction.
126. All correlations showed the expected negative sign meaning that organizations with KMS were using KMS functions more extensively and more intensively.

relationships were stronger for integrative and bridging functions than for interactive functions. One might conclude that the KMS used in the organizations currently primarily target integrative and interactive functions.

TABLE C-50. Correlations between use of KMS and use of KMS functions

aggregated measure for KMS functions	Spearman's rho	significance	n
extension (integrative functions)	-.408	0.000555	68
extension (interactive functions)	-.284	0.019028	68
extension (bridging functions)	-.408	0.000553	68
intensity (integrative functions)	-.498	0.000015	68
intensity (interactive functions)	-.380	0.001407	68
intensity (bridging functions)	-.528	0.000004	68

In the following, these results showing the actual use of KMS functions are compared to estimates of the potentials of these technologies or expectancies about KMS functionality. These were studied in the related empirical studies.

In the Fraunhofer Stuttgart study, respondents had to estimate the potentials of modern ICT in the context of KM (Bullinger et al. 1997, 20f). An efficient access to information was considered to carry the highest potentials which would require primarily integrative KMS functions. The support of the identification of experts (yellow pages) was not seen as a promising technology. Respondents believed that their organizations relied on personal networks for the identification of experts rather than on links and electronically accessible information.

Similar results were obtained in the Delphi study. Most respondents of that study (63%) thought the organization of existing corporate knowledge and thus integrative KMS functions were a valuable feature of KMS. A much lower share of organizations (39%) felt that KMS could provide new ways to share tacit knowledge and thus require interactive functions (Delphi 1997, 15). However, sharing tacit knowledge was ranked higher in that survey than sharing explicit knowledge (29%) and the support for research and knowledge generation (31%).

In the 2001 KPMG study, organizations also ranked integrative KMS functions as the most important parts of a KMS with an emphasis on knowledge search and publication: development/updating of contents (1.32[127]), management of existing knowledge (1.48), keyword search (1.62), full text search (1.79). Interactive KMS functions such as determination of contact persons (2.17) or collaboration (2.95) were considered less important (KPMG 2001, 18).

The results of the follow-up study on knowledge management by the FH Cologne performed in 2001 seem to point in the same direction. Respondents esti-

127. The scale extended from 1—very high importance to 5—very low importance of the function.

mated the highest potentials for KM tools in the areas *integration and consolidation of informations* (81% said this area is *important* or *very important*), *exploitation of existing information* (80%), *communication between employees* (73%), a *higher transparency* (68%) and *improved collaboration* (68%) whereas *document management* on average was found less important (56%, Döring-Katerkamp/Trojan 2001, 3f). The latter result might already suggest a trend towards the more advanced KMS functions which define traditional document management as a solid basis, but not a focus of KM.

Bullinger et al. conclude, though, that many organizations might underestimate the potentials of KMS to support networks of employees and their sharing of knowledge (Bullinger et al. 1997, 21). One reason might be that advanced functions bridging integrative and interactive KMS are comparatively new and not yet well known in the organizations. Thus, organizations might view the simpler integrative KMS functions as more promising in the first place whereas a successful application of the more advanced functions bridging integrative and interactive KMS requires a more sophisticated KM approach. Another reason might be that the larger organizations were, the more respondents felt that their IT infrastructure was unsuited for a support of KM (Bullinger et al. 1997, 40). Additionally, larger organizations seemed to suffer more under a lack of visibility of knowledge and knowledge demand and under bureaucracy and hierarchical structures (Bullinger et al. 1997, 40), which might make it even harder for this group of respondents to envision a successful use of KMS.

14.3.5 Résumé

As studied above, ICT infrastructure offering basic KM-related functionality is already implemented in almost all large organizations. Examples are Groupware platforms and Intranet solutions that are in many cases used organization-wide. Therefore, in most organizations a considerable number of KMS functions are available and ready-to-use. However, in many cases these functions are not used intensively. This is partly due to technical restrictions, e.g., lack of bandwidth or lack of multimedia components, partly due to organizational problems, such as a missing integration into the business processes or a missing assignment of responsibility for certain knowledge-related tasks or simply a lack of user privileges for the active participation in an organization's KMS, and last but not least partly due to individual barriers, a lack of time, motivation or capability to use the KMS functions offered.

Organizational KMS implementations regularly show a bias towards integrative KMS functions. Interactive KMS functions are implemented and used substantially less frequently except for the two basic communication functions email and email distribution lists. Functions bridging integrative and interactive KMS are implemented in only a minority of organizations. Those organizations that actually have implemented these functions use them frequently, though. These results are confirmed in the interviews and also in a number of other empirical studies which all seem to show an emphasis on integrative KMS functions.

Even in the case of integrative functions, the potentials of ICT to support KM initiatives still seem to be high as the more advanced and "intelligent" functions, such as semantic analysis, automatic classification or linking of knowledge elements, ranking of knowledge elements, presentation of semantic closeness between knowledge elements or three-dimensional visualization are not implemented widely yet. The highest potentials, however, seem to lie in a combination of integrative and interactive functions, in the personalization of contents that makes heavy use of intelligent functions to analyze and structure knowledge elements and to profile participants. These are important in order to avoid the "more is better" trap that leads to information overload or "lost in cyberspace" phenomena which result from the enormous amounts of documents and data electronically available.

According to the results of the empirical study and especially the interviews with organizations pioneering the implementation of KMS, there seems to be the following general pattern that describes the sequence or phases of implementation of KMS functions in organizations:

1. **Basic KM-related functionality:**
   Groupware platforms and Intranet solutions provide basic interactive functionality (email, email distribution lists) and integrative functionality (publishing, search and retrieval of documents) which is used intensively.
2. **Integrative KMS:**
   Advanced KM functionality is implemented to support the codification of knowledge and search and retrieval as well as the administration of knowledge repositories and the organization of knowledge structures.
3. **Interactive KMS:**
   Sophisticated KM functionality supports the location of experts, their communication and collaboration, provides shared homespaces for communities, and modern e-learning instruments.
4. **Bridging KMS:**
   Finally, integrative and interactive KMS are combined to provide highly contextualized knowledge repositories which also focus on linking knowledge seekers and providers, match participants with similar profiles, make recommendations, filter and present knowledge elements and links in a personalized way.

Not surprisingly, most organizations surveyed are still in the first two phases of KMS implementations. Many critics of using ICT to support KM also only consider functions of these two phases and might not be aware of the potentials of the functions of the higher phases. Many newer organizational KM instruments would be better supported by KMS functions of phases three and four. It is precisely the more advanced integrative, the interactive and particularly the bridging KMS functionality that overcome the problems of the document-oriented, technical KMS solutions that do not fit organizational instruments and the human-oriented KM approaches.

15 Economics

To determine the economics of a KM initiative is a challenging task. In the following, some results will be presented that shed some light on the expenses and estimated benefits of KM initiatives. In general, the situation in German companies by the time of the study can be described as follows[128]:

Most organizations do not track benefits in the sense that objective measures are in place which are regularly reviewed. At best, the organizations collect “success stories” or “quick wins” that describe specific benefits of a KM initiative gained in a particular business case. The situation is no different from previous attempts to measure the costs and benefits of the application of information and communication technology which result in organizational redesign, such as data warehousing, workflow management, Groupware or Intranet technology just to name a few.

However, it is still interesting to see to what extent organizations invest in KM and what benefits they think they gained out of such an initiative.

15.1 Funding

15.1.1 Expenses

Table C-51 gives an overview of the amount of money the responding organizations invested in KM.

TABLE C-51. Total expenses for KM excluding salaries

x = KM expenses (in 1,000 German marks)	frequency	percent
do not know	6	28.6
$x < 50$	6	28.6
$50 \leq x < 100$	2	9.5
$100 \leq x < 500$	4	19.0
$500 \leq x < 1{,}000$	1	4.8
$1{,}000 \leq x < 5{,}000$	1	4.8
$5{,}000 \leq x < 10{,}000$	0	0.0
$x \geq 10{,}000$	1	4.8
total	21	100.0

Respondents were asked not to include salaries or other personnel-related expenses. More than a quarter of the organizations responding to this question (6 respondents, 28.6%) did not know the figures. One might assume that at least some of them might not have been willing or might not have had the permission to hand

128. See also section 12.2.3 - “Documentation and evaluation” on page 477.

out these figures. Another explanation might be that some KM initiatives were informal in nature and thus had no formal budget at all[129].

Of those organizations which actually provided their figures, more than half of the KM initiatives (8 out of 15 respondents, 53.3%) had spent less than 100,000 German marks (DM). Three KM initiatives (20%) crossed the 500,000 German mark line. One might conclude that most of the KM initiatives in the sample were rather small in size. However, in many cases organizations supposedly did not keep track of a substantial portion of KM-related expenses as part of a KM budget, but as part of the budgets of other initiatives. Examples are budgets for projects implementing organization-wide information and communication infrastructure, e.g., hardware and software expenses of an Intranet project, or the ordinary budgets of the organizational units involved in KM, e.g., travelling expenses as part of the work groups' or teams' ordinary budgets.

These results are supported by the findings of the follow-up study of the FH Cologne. In 2001, 39% of the responding organizations said that they spent less than 50,000 German marks for KM software, 11% reported between 50,000 and 250,000 German marks and 11% reported more than 250,000 marks (Döring-Katerkamp/Trojan 2001, 5). Once again, more than a third of the organizations (39%) did not provide their figures. In the 1998 KPMG study, a third of the organizations said they had no budget allocated to the KM initiative (KPMG 1998, 14).

These figures are much lower than the figures found in the ILOI study which asked for the expenses organizations would be willing to take, not what organizations actually had spent on knowledge management (ILOI 1997, 14). Also, these studies asked for overall KM expenses including human resources whereas the study presented here asked not to include expenses for human resources and the FH Cologne only considered expenses for software. In the ILOI study, organizations with more than 5,000 employees said that they would be willing to spend between 10 and 30 million German marks. Even organizations with between 500 and 5,000 employees said they would spend between 200,000 and 4 million German marks and finally organizations with fewer than 500 employees indicated expenses between 20,000 and 200,000 German marks. The picture might be biased, though, as the ILOI asked for a percentage of the turnover and computed these figures and did not ask for actual figures. Still, one can conclude that the investments which organizations are willing to take for KM activities seem to be considerable.

Figure C-28 shows the second component of KM expenses, the *number of KM staff*[130]. On average, those organizations that responded to this question had 7.5 employees working for KM. In more than three quarters of the organizations the KM initiative consisted of a small to medium group of employees ranging between 0 and 10 persons (13 out of 17 organizations responding to this question, 76.5%). Two respondents reported large investments with 20 and 30 KM employees.

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129. See also section 12.1.2 - "Organizational structure" on page 470.

130. Respondents were asked to count part-time employees and employees only partially working for KM appropriately.

The range which is shown here is quite large and can be explained by the different approaches organizations followed with their KM initiative. As mentioned earlier[131], the number of KM staff supposedly depends on the form of implementation with a new informal initiative at the low end of the numbers, a new formal initiative in the middle and the extension an existing organizational unit at the high end. In the latter case some organizations reported a number of KM staff of 400 and more. Examples were the Ernst & Young Center for Business Knowledge (according to the interview with an E&Y knowledge manager, see also Madey/Muzumdar 1997), or Siemens (according to the interview with a Siemens KM professional).

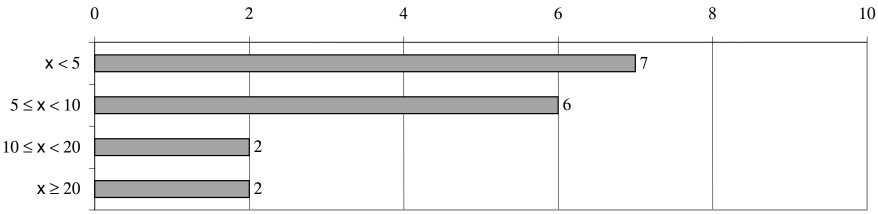

FIGURE C-28. Size of KM initiative in terms of KM staff members[132]

Correspondingly, the correlations between type of organizational design and the two variables describing the KM expenses were significant (correlation between type of organizational design and number of KM staff: Spearman's rho: -0.466, significance: 0.059, n=17, correlation between the type of the organizational design and KM expenses: Spearman's rho: -0.592, significance: 0.026, n=14; the negative signs mean that the more formal the type of organization design, the higher the number of KM staff and the KM expenses; see also Table C-52). Hypothesis 8: 'The more formal the organizational design of a knowledge management initiative, the higher are the expenses for knowledge management' was supported.

TABLE C-52. Average KM expenses according to organizational designs of KM function

organizational design of KM function	**∅ number of KM staff**		**∅ KM expenses excl. salaries**	
	mean	**n**	**median category**	**n**
separate organizational unit	10.2	5	100 ≤ x < 500	3
project	7.4	9	x < 50; 50 ≤ x < 100	8
no separate organizational unit	3.3	3	x < 50	3
total	7.5	17	50 ≤ x < 100	14

131. See section 13.1.2 - "Structural organization" on page 492.
132. n= 17.

Table C-52 compares the average number of KM staff and the median category assigned for KM expenses according to the various organizational design alternatives for the KM function. In the case of a project, the median for KM expenses is split into two categories.

Both variables describing the expenses of a KM initiative, KM expenses and the number of KM staff, were not correlated with the size of the organizations and the industry sector the organizations belonged to[133]. Smaller organizations with a KM initiative seemed to invest quite as much into knowledge management as bigger organizations[134].

15.1.2 Type of funding

Additionally, respondents were asked how the KM initiatives were funded. The following three alternatives of funding were given in the questionnaire:

- a *separate budget* for the KM initiative,
- *internal accounting or internal "selling"* of KM services,
- *external "selling" of KM services,* e.g., through licenses, concepts.

Respondents had to indicate what percentages of each of these alternatives funded their KM initiative. 17 out of 19 organizations responding to this question (3 checked the "do not know" box) funded 100% of their KM initiatives through a separate budget. Only two organizations funded their KM initiative through 50% internal accounting or selling of KM services and 50% through a separate budget. As the interviews showed the separate budgets were financed by a variety of sources. In the 1998 KPMG study, 30% of the organizations said KM expenses were spread over all departments. If the source was identified, it was in most cases either the IT department (17%), R&D (6%), sales or marketing (6%), finance (5%) or HRM (4%). However, 28% did not know where the budgets came from (KPMG 1998, 15).

Moreover, as KM usually is a decentralized initiative, one might assume that a large part of the efforts for this initiative is brought up by members of the organization other than KM personnel. Thus, organizations seem to apply a "fragmented approach" to the funding of KM (KPMG 1998, 15) and the "real" expenses (including expenses for information and communication infrastructure and travelling) might be much higher than indicated above[135].

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133. Correlation analysis of KM expenses with the number of employees produced: Spearman's rho: -0.039, significance: 0.894, n=14, with turnover produced: Spearman's rho: 0.152, significance: 0.656, n=11 and with industry sector produced: Spearman's rho: 0.055, significance: 0.847, n=15. Correlation analysis of the number of KM staff with the total number of employees produced: Spearman's rho: 0.207, significance: 0.425, n=17, with turnover produced: Spearman's rho: 0.166, significance: 0.588, n=13 and with industry sector produced: Spearman's rho: -0.026, significance: 0.920, n=17.

134. The sample consisted of the TOP 500 German organizations and the TOP 50 banks and insurance companies so there were no really small organizations in the sample. However, the sizes of the organizations still varied considerably (see section 11.4 - "Respondents and response rate" on page 461).

135. See section 15.1.1 - "Expenses" on page 564.

15.1.3 Résumé

As noted earlier, KM is mostly a quite decentral approach, thus expenses tracked and budgeted for KM are low, especially when compared to the willingness to invest in KM analyzed in the ILOI study. Three groups of approaches can be identified:

- *small, informal KM initiatives* with anywhere from zero to five employees responsible for KM and less than 50,000 German marks total KM-related expenses,
- *medium, project-based KM initiatives* with around 7.5 employees assigned to KM and mostly between 50,000 and 100,000 German marks spent,
- *large KM initiatives assigned to a separate organizational unit* with 10 or more employees and more than 100,000 German marks spent.

The vast majority of organizations has separate budgets for KM. As it is hard to determine and value KM services, it is not surprising that only two organizations used internal accounting to spread their KM expenses to those organizational units that (supposedly) profit most from the approach. However, the "real" expenses taken for KM might be much higher than indicated here as respondents might not have included e.g., expenses taken by decentral units and expenses for the implementation of KM platforms (Groupware, Intranet) as part of the KM budgets they reported.

15.2 Benefits

One of the most difficult research questions in the MIS discipline is the measurement of success of complex organizational initiatives involving the application of information and communication technologies. There have been numerous variables, models and approaches suggested which claim to guide organizations in the assessment of the benefits they get from such initiatives[136].

This section discusses the subjective assessments of the respondents concerning the benefits of their KM initiatives in support of important business goals. Additionally, the results of related empirical studies about success factors and barriers of KM initiatives will be reviewed. Then, the measures for success of KMS will be analyzed. The first group of measures deals with the use of knowledge management systems and services. The second group investigates what effects selected factors describing the organizational design, contents and systems as well as the funding of a KM initiative had on the support of business goals as described above.

15.2.1 Support of business goals

The primary success measure used in this study was to what extent a KM initiative supported the business goals of an organization. Apart from the summarizing vari-

136. See chapter 8 - "Economics" on page 395.

able general support of business goals the following list of ten particular business goals was presented (the italic parts refer to the wording in Figure C-29)[137]:

- *improve growth of the organization*,
- *improve productivity*,
- *improve speed of innovation*,
- *improve product quality*,
- *improve customer satisfaction* and/or service quality,
- *improve scheduling*, reduce throughput/running time / improve the meeting of deadlines,
- *develop new business fields* or topics,
- *reduce business risks*, improve the ability to react to environmental changes,
- *reduce costs*, e.g., through reduced travelling, costs for acquisition of knowledge, the use of commercial knowledge sources etc.,
- *improve employee satisfaction* and motivation.

Figure C-29 gives an overview of the relationship between knowledge management and business goals showing the mean values of respondents' estimation of how much their KM initiative supported their business goals. In the figure, the means of the estimations and the interval $[\mu-\sigma; \mu+\sigma]$ which is one standard deviation to the left and to the right of the means and the number of respondents are shown for each individual business goal and for the general support of business goals at the end of the figure. The individual business goals are ordered by descending means (first criterion) and ascending standard deviations (second criterion). Additionally, the overall mean encompassing the set of ten particular business goals excluding the general goal is shown in Figure C-29. At 4.92 it is significantly offset to the right side of the scale. Detailed results can be found in the appendix[138].

With the exception of *improve productivity* the highest benefits were estimated to be in the rather "soft" areas like *improve customer satisfaction*, *improve speed of innovation* or *improve employee satisfaction*, whereas the "hard criteria" did not achieve equally high estimates (e.g., *reduce costs*, *improve growth of organization*).

The three highest ranked goals—*improve customer satisfaction*, *improve productivity*, *improve scheduling*—are also typical business process reengineering goals. Thus, it seems that organizations tried to use KM instruments to continue the orientation towards customer needs and the reduction of throughput times, business goals originating or highly aimed at in BPR projects.

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137. A more thorough analysis of the relationship between organizational design alternatives and their impact on business goals needs more detailed data which can only be obtained by a comprehensive field study. The results of this study can be used as a basis for the design of such a field study with the help of a list of business goals and (preliminary tested) hypotheses about the relationships between variables describing the design of the KM initiative and these business goals.
138. See URL: http://iwi.uibk.ac.at/maier/kms/.

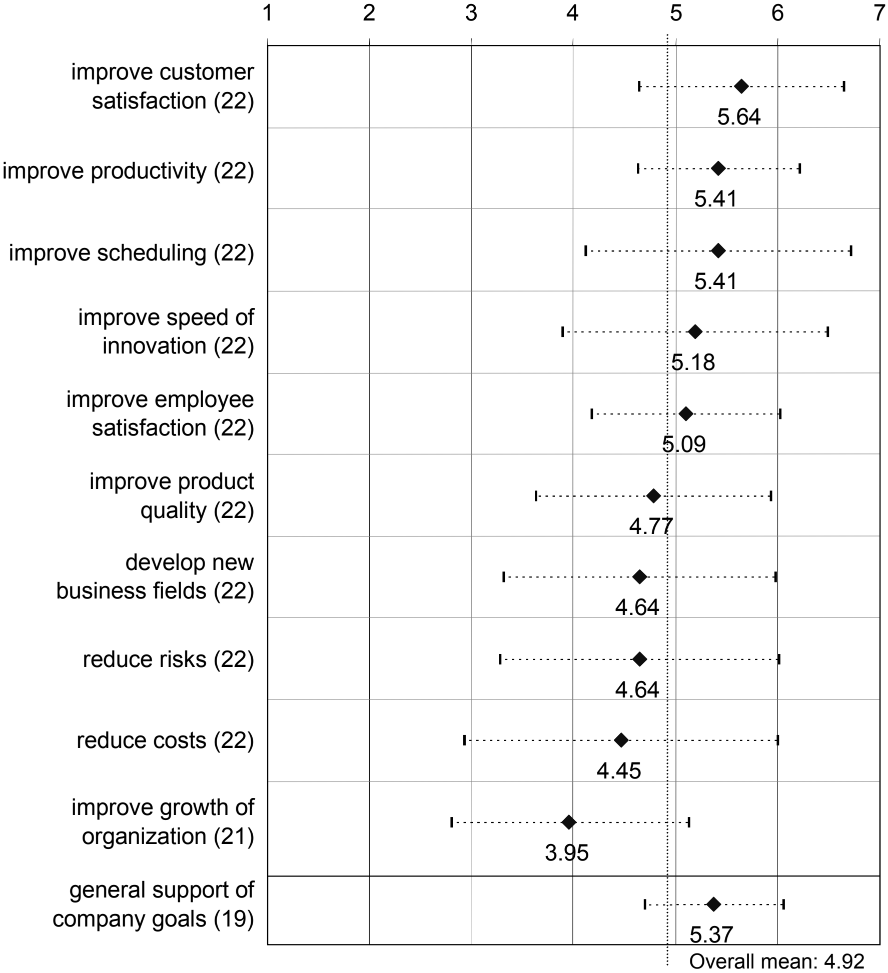

FIGURE C-29. Support of business goals through KM projects[139]

These results can be compared to the expectations of an improved handling of knowledge that respondents of the Fraunhofer Stuttgart study and of the 2001 KPMG study reported (Bullinger et al. 1997, 17, KPMG 2001, 15) and to the estimations of benefits gained by a KM initiative reported in the 1998 KPMG survey (KPMG 1998, 18f). Respondents of the Fraunhofer Stuttgart study expected high-

139. The number of respondents is given in parenthesis. Legend: goal supported: 1=not/very low, 2=low, 3=rather low, 4=medium, 5=rather high, 6=high, 7=very high. Diamonds represent the means μ of the item. The ranges indicate the interval $[\mu-\sigma; \mu+\sigma]$ using the standard deviation σ.

est returns with respect to the three goals *improve product quality*, *improve speed of innovation* and *improve customer satisfaction or closeness* whereas *improve productivity* and *reduce costs* ranked in the middle of the list and *improve growth of organization* and *improve scheduling* had lowest expectations. In the 1998 KPMG study, most organizations thought they benefited by a *better decision making* (86% of the organizations with a KM initiative), *reducing costs* (70%), by *improving productivity* (67%) and a *faster response to key issues* (67%). When compared to the study presented here, the two goals *better decision making* and *faster response to key issues* certainly contributed to *speed of innovation*. *Developing new business fields* (58%), and an *increase of profit* (53%) ranked in the middle whereas *improving growth* (42%), *better staff attraction/retention* (42%) and *increased share price* (23%) were least achieved. In the 2001 KPMG study, most organizations expected an *improved productivity* (72%), *reduced costs* (65%), a *better decision making* (62%) and an *improved customer service* (46%). *Developing new business fields* (20%) and *improving growth* (37%) were least expected (KPMG 2001, 15).

All in all, *improve speed of innovation* was a highly recognized goal in all four studies, whereas *improve growth of organization* was ranked lowly in either one of the studies. Organizations also seem to consistently profit or expect benefits in terms of an *increase in productivity*. There is a lot of ambivalence with respect to the goal *reduce costs*. On the one hand, many organizations might think that KM has potentials to reduce costs. On the other hand, reducing costs is certainly not the main focus in most KM initiatives as additional KM expenses might have to be taken in order to improve other measures, like the *speed of innovation*, *productivity* or *customer satisfaction*. Generally, one can conclude, though, that in most cases organizations try to judge the success of KM initiatives using financial measures, although most organizations have difficulties to decide on how to measure the impact of KM[140].

Finally, respondents estimated that the *general support of business goals* by KM was rather high. 89.5% of the organizations (17 out of 19) said that their KM efforts supported their business goals either "rather highly" or "highly". These findings are backed by the results obtained in the APQC study where 83% of the organizations said their business performance was strongly improved through KM (APQC 1996, 62). On average, organizations responding to the Fraunhofer Stuttgart study estimated that productivity could potentially be improved by 25% with the help of KM measures (Bullinger et al. 1997, 18). However, only 20% of the organizations surveyed by the APQC calculated the ROI of their KM initiative (APQC 1996, 63). Thus, the organizations seemed to be convinced that KM had a significant positive impact on the achievement of their business goals, although it was difficult for them to back this conviction with hard data. One must be careful with the interpretation of these results as the three samples are different in terms of

140. See also section 12.2.3 - "Documentation and evaluation" on page 477.

size or geographical location of the organizations, even though the Fraunhofer Stuttgart study reported no significant differences in the expectations of large versus small enterprises.

In order to determine whether growing organizations also successfully used KM, the rate of growth was calculated as a measure for success by subtracting the measure for employees leaving an organization from the measure for newly recruited employees[141]. The rate of growth then was correlated with the estimations of how successfully KM supported the ten business goals as mentioned above. 8 out of 10 correlations showed the expected positive sign, although none of the correlations was significant. Also, the rate of growth was correlated with the estimations of the KM goals achieved[142]. All correlations except for the goal *generate additional turnover* showed the expected positive sign meaning the more an organization grew in terms of the number of employees the more successfully it achieved its KM goals. The correlations were not significant, though, possibly due to the small number of respondents answering all of these questions.

Bullinger et al. found similar results. Those organizations that were growing in terms of revenues and in terms of number of employees used significantly more instruments for knowledge management, especially for:

- the development of organizational networks,
- the multiplication of knowledge taught in courses and seminars,
- the transfer of best practices and
- a systematic development of knowledge, e.g., the use of instruments such as benchmarking or cooperations with business partners or Universities (Bullinger et al. 1997, 39).

15.2.2 Success factors and barriers

The Fraunhofer Berlin study identified *success factors for knowledge management* (Heisig/Vorbeck 1998, 9). Single most important factor was a *corporate culture* supportive of KM (44% of the respondents), followed by *structural factors, external requirements* (24%), *information technology* (23%), *employees' motivation and qualification* (18%) and *senior management support* (18%). Interestingly, 11% mentioned to be *under pressure to be successful* as a success factor. Thus, it seems that although organizations experienced difficulties in assessing success of KM initiatives, many felt that (financial) reasoning and legitimation of the expenses were important drivers for success.

Several empirical studies also analyzed *barriers to knowledge management* which might hinder organizations from implementing a systematic KM approach[143]. More than two thirds of the respondents in the Fraunhofer Stuttgart study thought that *scarcity of time* (70.1%) or a *lack of awareness about KM*

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141. See section 13.2.2 - "Turnover in employees" on page 520.
142. See section 12.2.2 - "Achieved goals" on page 475.
143. Bullinger et al. 1997, 31, Delphi 1997, 20, KPMG 1998, 16, Jäger/Straub 1999, 23, Döring-Katerkamp/Trojan 2000, 8, KPMG 2001, 17.

(67.7%) were the most important barriers to KM (Bullinger et al. 1997). In the 1998 KPMG study respondents also felt that *lack of time* (49% strongly or somewhat agreeing), *lack of understanding of KM and benefits* (40%), *lack of funding* (24%) and *lack of senior management support* (24%) were important barriers to effective KM (KPMG 1998, 16). In the Jäger/Straub (1999) study, *scarcity of time* (47.6% thought this barrier was highly important), *lack of awareness* (45.8%) and *lack of management support* (44.0%) were the most important barriers to KM whereas *employees consciously holding back knowledge* (20.0%) and *too highly specialized employees* (4.8%) were the least important barriers.

The Delphi study showed that *immature technology* (20%), *cost* (9%) or *lack of need* (3%) were only minor obstacles to KM when compared to *culture* which was named by more than half of the organizations (53%) as the most important barrier (Delphi 1997, 20). This is a similar finding than in the FH Cologne study which found that more than half of the responding organizations (50.4%) had *problems with employees accepting KM* (Döring-Katerkamp/Trojan 2000, 8). 25.1% encountered *problems with selecting the "right" (software) components* to support KM, however, only 11.2% experienced *problems with implementing or installing these components* in their organization. In the 2001 KPMG study *lack of time* (65%), the *sharing of one's "own" knowledge* (62%), an *unclear strategy* (47%), *weaknesses of the ICT support* (44%) and *unclear information demand* (38%) were cited as the most important barriers to effective KM (KPMG 2001, 17).

Thus, it seems that from a technological perspective KM can be well supported by sophisticated KMS if organizations succeed in convincing participants of the advantages of knowledge sharing and organizing knowledge in a way that improves usability of the systems. In a substantial part of the organizations, the existing ICT infrastructure seems to be not well prepared to handle the increased requirements of a KM initiative, though.

There are substantial differences between the studies concerning two common prejudices about reasons hampering KM: Only 16% of the respondents surveyed by KPMG UK (1998) and only 20% of the HR managers in the Jäger/Straub (1999) study felt that *employees were unwilling to share knowledge* whereas in the 2001 KPMG study it was the second most frequently cited barrier. 62% said that the willingness to share knowledge created a barrier to KM (KPMG 2001, 17). In the latter study, only frequencies were investigated, though, and thus no statement can be made concerning the importance of this barrier. Additionally, in the same study only 35% said that employees were *unwilling to accept foreign knowledge* and only 26% thought that there was a *lack of trust* in the knowledge presented (KPMG 2001, 17). As for the second commonly held prejudice—information overload—only 14% of the respondents in the 1998 KPMG study and only 4.8% of the HR managers in the Jäger/Straub study said that there was *too much knowledge* (KPMG 1998, 17, Jäger/Straub 1999, 23).

Table C-53 summarizes the most important barriers to KM and shows the corresponding values found in the various studies. However, the results cannot be compared with each other e.g., to reveal trends due to the fact that the samples and questions differed substantially from each other.

Most of the answers seem to suggest the paradox that those organizational variables are unsuited for KM which should be changed or implemented with the help of a KM approach: e.g., lack of visibility of existing knowledge and knowledge needed, lack of skills in KM techniques, lack of reward systems, lack of an information and communication infrastructure suitable for KM, lack of a supportive corporate culture or unsuited organizational structures.

TABLE C-53. Summary of empirical results about barriers to KM

barrier	Bullinger et al. 1997	Delphi 1997	KPMG 1998[a]	Jäger/ Straub 1999	Döring/ Trojan 2000	KPMG 2001
scarcity of time	70.1%		49.0%	h[b]: 47.6% m: 47.6%		65%
lack of awareness/understanding of need of KM	67.7%		40.0%	h: 45.8% m: 33.3%		
organizational culture/ employees do not accept KM		53.0%			50.4%	31%
lack of (senior) management support			24.0%	h: 44.0% m: 40.0%		28%
too much effort/lack of funding		9.0%	24.0%	h: 29.2% m: 50.0%		
organization's ICT infrastructure unsuited				h: 26.1% m: 52.2%		44%
immature ICT/problems in selecting ICT		20.0%			25.1%	
employees unable/unwilling to share knowledge			16.0%	h: 20.0% m: 56.0%		62%
too much knowledge/too much specialization			14.0%	h: 4.8% m: 62.4%		

a. strongly/somewhat agree
b. h means highly important; m refers to medium important

All in all, it seems that there is a definite need for instruments improving the organizations' way of handling knowledge. However, many respondents doubt that KM will be successful in this respect. Reasons for these doubts might be that

- there is too much emphasis on technical rather than personal issues in KM initiatives,
- substantial benefits can only be expected in the long run,

- knowledge about KM is not wide-spread and confusing with many uncertainties concerning the "right" approach to implementation and a controversial discussion in the practitioners' literature and
- measurement of success is difficult, thus it is hard to justify KM investments.

15.2.3 Usage of KMS and services

As discussed in part B[144], usage of information and communication systems in general and of KMS in particular is a necessary prerequisite for an impact on individual or organizational performance and, together with other measures, is used to assess success of KMS. As KMS are still in their infancy, respondents were asked for usage figures of quite basic functions of KMS and knowledge services. Figure C-30 shows the medians of these usage figures.

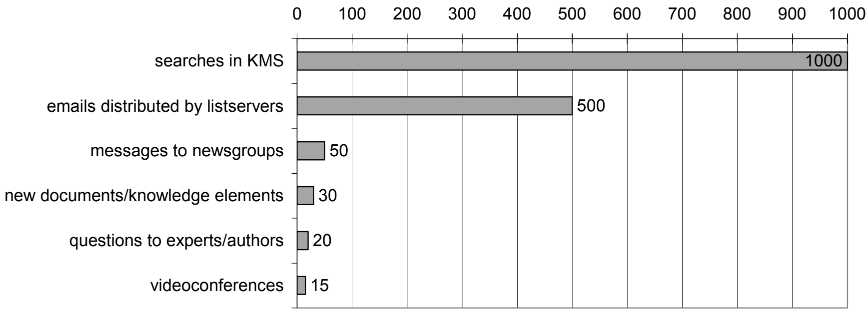

FIGURE C-30. Usage of KMS and KM services per month[145]

26 respondents (35.6%) were able or willing to answer any one of the questions. It seemed that in most organizations the usage of KMS and KM related services either was not tracked at all or the information was not easily available. As the interviews showed, there were usually at least two different organizational units involved in KM-related activities[146]. This is on the one hand the IT unit which was responsible for the implementation of the relevant technology and on the other hand the KM unit which was responsible for the development and internal pushing of the KM vision, the organizational design, training and education of employees. Thus, in many cases usage figures might be unknown for the KM unit which would explain the low number of respondents answering this question.

15.2.4 Correlations with goals

In the following, the estimated general support of business goals (dependent variable) will be correlated with factors describing the organizational design of the KM initiative and the willingness to share knowledge, the use of KM systems and func-

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144. See section 8.4 - "Success of knowledge management systems" on page 410.
145. Median, $17 \leq n \leq 26$.
146. See also section 13.1.2 - "Structural organization" on page 492.

tions and the handling of types of contents as well as the funding of KM (independent variables). As mentioned above[147], there is not much knowledge about these relationships yet. Thus, the relationships will be explored in order to generate some propositions which can be tested in subsequent studies.

Table C-54 shows a summary of correlation analysis of the variables describing a KM initiative with the estimation of success, measured as the estimated general support of business goals. The correlation coefficient, the significance and the number of cases included in the statistical test (n) are shown for every variable. All in all, 24 correlation tests were performed. The adjusted significance level using a Bonferroni type correction was 0.0042[148].

Generally, none of the relationships between variables assessing the *organizational design* of a KM initiative or the *organizational culture* were found significant on the adjusted significance level. This can be at least partly attributed to the small set of organizations that had responded to all the questions involved. However, the correlation coefficients were quite high, especially in the case of the rate of KM activity, and suggest that the influences of the organizational design on the success of a KM initiative should be tested in a bigger sample of organizations. In the following, the tendencies suggested by the signs of the correlation analysis will be discussed. These tendencies are limited to the sample of organizations tested here and thus cannot be generalized.

Organizations with a *formal organizational design* for KM showed the expected tendency to estimate the general support of business goals by KM higher than organizations with an informal design. The results concerning the relationship between the reporting level of the head of KM and the support of business goals in the sample contradict the suggestion that the higher the head of KM is institutionalized in the organization's hierarchy, the more business goals are supported.

One explanation for this tendency in the sample might be that the higher-ranked heads of KM were closer to the process of developing business goals in their organizations. Thus, they might have been more critical in their judgements of the impact of KM on business goals. Once again, it has to be noted, though, that the results only show tendencies, but are not statistically significant.

Organizations with a higher *level of decentrality* of KM[149] estimated on average a higher positive impact of KM on business goals. Thus, those responding organizations with a decentral design of their KM function seemed to profit more directly with respect to business goals. One explanation might be that a decentral assignment of responsibility leads to KM activities that are closely tied to serve real business needs.

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147. See section 8.5 - "Résumé" on page 428.

148. See section 'Statistical analysis." on page 455 for an explanation of the Bonferroni type correction. Correlations were limited to the general support of business goals because a correlation of all individual goals would have given a matrix of 24 X 11. The number of cases would have been much too low to provide for any statistically significant results.

149. For a definition see section 13.1.3 - "Knowledge management tasks and roles" on page 498.

TABLE C-54. Summary of correlations with general support of business goals

area	correlated variables	expected sign	Spearman's rho	significance	n
organizational design	formal organizational design	-	-0.422	0.081	18
	decentral vs. central KM tasks	+	0.445	0.096	15
	relative KM reporting level	+	-0.396	0.144	15
	$\frac{active - participants}{participants}$	+	0.845	0.008	8
	$\frac{communities}{employees}$	+	0.866	0.333	3
willingness to share knowledge	inter-group OL atmosphere	+	-0.200	0.427	18
	workspace-related OL atmosphere	+	0.181	0.471	18
	rewards for knowledge sharing	+	-0.050	0.843	18
	knowledge sharing outside workspace	+	0.025	0.921	18
knowledge management systems	use of KMS bought on the market	-	-0.383	0.116	18
integrative KMS functions	extension	+	0.276	0.252	19
	intensity	+	0.070	0.776	19
interactive KMS functions	extension	+	0.019	0.937	19
	intensity	+	-0.187	0.443	19
bridging KMS functions	extension	+	0.270	0.263	19
	intensity	+	-0.055	0.824	19
contents	institutionalized knowledge	-	-0.071	0.794	16
	expertise	-	-0.309	0.245	16
	unapproved contributions	-	-0.271	0.311	16
	secured inventions	-	-0.040	0.884	16
	personal content	-	-0.160	0.554	16
	organization-specific descriptive knowledge	-	-0.322	0.224	16
funding	$\frac{KMexpenses}{participants}$	+	**0.867**	**0.002**	**9**
	$\frac{KMemployees}{employees}$	+	0.825	0.006	9

A higher *rate of KM activity* of participants, measured as the number of active participants divided by the number of participants, showed also a tendency for more successful KM initiatives. This variable and especially the number of communities divided by the number of employees targeted suffered particularly from the low numbers of cases.

Willingness to share knowledge was correlated with the general support of business goals with the help of the four factors extracted above[150]. Only the correlations of the two factors workspace related organizational learning atmosphere and knowledge sharing outside the workspace showed the expected positive sign. The two factors inter-group organizational learning atmosphere and rewards for knowledge sharing were negatively correlated with the general support of business goals. As opposed to organizational design, these correlations are far from being significant, though.

The use of ICT to support KM initiatives, especially *knowledge management systems*, might also have a positive influence on the perceived success of such an initiative. All correlations showed the expected signs. None was significant, though. Respondents of organizations in the sample that used KMS bought on the market estimated the general support of business goals by their KM initiatives higher than respondents in organizations that had no such systems.

Extension and intensity of KMS functions were measured as the number of integrative, interactive and bridging functions implemented (extension) and used often or always (intensity) in an organization[151]. The correlations with the extension of KMS functions all showed the expected sign. The correlations were insignificant, though. In the case of intensity, two correlations even showed a negative sign. Thus, it is not possible to suggest any tendencies from this sample.

In the case of *contents* the six factors were used that describe different types of contents of KMS as extracted above[152]. Once again, all the correlations showed the expected sign, but were far from being significant. The data suggests a tendency for *expertise*, *unapproved contributions* and *organization-specific descriptive knowledge* as the three factors that should be investigated in more detail.

Finally, the relationship between *funding* of a KM initiative and the support of business goals was tested. Generally, the more an organization invests in KM, the more it benefits from this approach. Business goals were correlated with the investments in KM per participant which were measured as:

$$\frac{\text{KM expenses}}{\text{number of participants}}$$

and as:

$$\frac{\text{number of KM employees}}{\text{number of participants}}$$

150. See section 13.2.1 - “Willingness to share knowledge” on page 512.
151. The variables were defined in section 14.3.4 - “Extension and intensity of KMS use” on page 558.
152. See section 14.2.1 - “Types of contents” on page 532.

The relationship between KM expenses per participant and the estimated general support of business goals was the only significant correlation in the comprehensive correlation analysis as depicted in Table C-54. The more the organizations spent on KM, the more they estimated that this initiative positively affected business goals. The second measure, the number of KM staff also showed the expected positive sign and came close to the significance level. The corresponding Hypothesis 23: 'The more rigorously knowledge management is established in an organization, the more business goals are achieved in that organization' was supported.

All in all, the data presented shows a tendency that the organizational design influences perception about the support of a KM initiative with respect to business goals most when compared to systems or types of contents managed. However, we must not forget that the interpretation of these tendencies is limited to the sample and needs to be tested in a larger sample in order to be sure about the possible correlations as suggested here.

15.2.5 Résumé

Many organizations have difficulties to assess success of their KM initiatives. In many cases, senior executives and skeptics have to be convinced by success stories, plausible arguments and hints that the competition is engaged in similar initiatives rather than hard data that investment in KM pays off.

Most organizations seem not to keep track of figures concerning the use of KMS and KM-related services. Even in those cases in which usage figures are evaluated, it would be difficult to judge whether the users of KMS actually found and could apply the knowledge that they looked for. Therefore, the focus is on the estimations of the support of business goals as the primary success measure in this study.

Consistently with other KM studies, *improve speed of innovation* is an important business goal supported by KM. In addition to this rather KM-specific goal, organizations seem to primarily target the same business goals as used in BPR or process management projects: *improve customer satisfaction*, *improve productivity* and *improve scheduling*. Improve growth of organization was ranked lowly in all KM studies reflecting once again the internal focus of most KM initiatives already mentioned[153]. KM initiatives attempt to improve primarily the organizations internal way of handling knowledge in order to achieve traditional business goals oriented towards value creation rather than environment-oriented goals such as *improve growth*, *reduce risks* and *develop new business fields*.

The general support of business goals with the help of KM, however, was rated highly by almost all respondents, showing that respondents were convinced of the positive, if not directly measurable, impact of their KM initiatives on business performance. This result is supported by the finding that KM expenses per participant were positively correlated with estimations of general support of business goals by KM initiatives.

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153. See section 14.2 - "Contents" on page 532.

Apart from this finding, only tendencies could be shown and the following proposition could be generated which can be tested in subsequent studies: KM initiatives with a formal organizational design, but a decentral assignment of responsibility might be more successful than organizations with an informal design and a central assignment of responsibility.

The relatively obvious tendencies in the case of the organizational design compare with a more uncertain picture in the case of KMS. It seems that KMS or KMS functions have to be combined with organizational instruments in order to be successful. However, the empirical study does not provide enough data in order to test hypotheses about possible fits between KMS functions, organizational instruments and types of contents targeted with a KM initiative. In the case of contents, a subsequent study might direct its attention to the more informal factors expertise and unapproved contributions as well as organization-specific descriptive knowledge.

Organizational culture was analyzed with the help of four factors describing willingness to share knowledge. The only factor showing a minor tendency towards supporting general business goals was the workspace-related organizational learning atmosphere. Thus, it is difficult to hypothesize about which factors are most important for a KM initiative to support business goals.

To sum up, assessing benefits of a KM initiative still is a tough endeavour. Even though comprehensive evaluation systems that support the assessment of KM programs have been around for some time[154], most organizations still hesitate to implement these instruments. One explanation for this result might be that the successful installation of e.g., an intellectual capital navigator or a balanced scorecard approach in many cases requires a fundamental refocusing of management instruments, style and culture. However, the interviews showed that in many organizations this shift already takes place or corresponding instruments are at least evaluated in pilot projects, so there might be a substantial change in this respect in the near future.

154. See chapter 8 - “Economics” on page 395.

16 Summary and Critical Reflection

This chapter summarizes the results of part C. First, Table C-55 gives an overview of the results for all the hypotheses tested. Then the most important findings will be distilled as theses about the state of practice of KMS supported KM initiatives.

TABLE C-55. Summary of hypotheses tested

hypotheses	**support**	**section**
H-1: The share of organizations with a KM initiative has increased compared to earlier studies	supported	11.4, p. 461ff
H-2: Service organizations have a higher share of employees with access to KM-related systems than industry organizations	supported	13.1.1, p. 482ff
H-3: Knowledge management activities span business processes rather than focusing on exclusively one business process	supported	13.1.1, p. 482ff
H-4: Organizations with systematic knowledge management that has been established for at least one year are more likely to have installed KMS than organizations without systematic knowledge management	supported	14.1.2, p. 526ff
H-5: Organizations converge in their use of ICT and increasingly use communication-oriented functions of knowledge management systems	not supported	14.3.5, p. 562ff
H-6: Compared to earlier studies significantly more organizations use ICT in general and knowledge management systems in particular to support their KM activities	supported for Groupware, not supported for KMS	14.1.1, p. 525ff (Groupware); 14.3.5, p. 562ff (KMS functions)
H-7: The majority of organizations strongly aim at more than half of the KM goals (>7 goals) at the same time	supported	12.2.1, p. 472ff
H-8: The more formal the organizational design of a knowledge management initiative, the higher are the expenses for knowledge management	supported	15.1, p. 564ff
H-9: Employees are more willing to share knowledge within than outside their work environment (group or team)	supported	13.2.1, p. 512ff
H-10: The higher the share of newly recruited employees is, the more knowledge exchange is taking place outside traditional work environments	not supported	13.2.2, p. 520ff
H-11: A high share of employees leaving the organization negatively affects willingness to share knowledge between groups and teams	not supported	13.2.2, p. 520ff

TABLE C-55. Summary of hypotheses tested

hypotheses	support	section
H-12: In organizations with systematic knowledge management, willingness to share knowledge is improved	supported	13.2.1, p. 512ff
H-13: Organizations with systematic knowledge management target different contents than organizations without such an initiative	supported	14.2.1, p. 532ff
H-14: If an organization allows private contents as part of their knowledge management systems, willingness to share knowledge is higher	not supported	14.2.1, p. 532ff
H-15: Organizations with systematic KM handle a larger knowledge base than organizations without such an initiative	not supported	14.2.2, p. 540ff
H-16: Organizations with systematic KM handle a higher share of multimedia elements, contributions to newsgroups and data base elements in their KMS than organizations without such an initiative	supported	14.2.2, p. 540ff
H-17: There are more organizations which apply a network structure to their knowledge areas than organizations with a hierarchical structure of knowledge areas	not supported	14.2.3, p. 544ff
H-18: Organizations with KMS have a larger number of KMS functions than organizations without KMS	supported	14.3.4, p. 558ff
H-19: KMS functions in organizations with KMS bought on the market are more integrated than KMS functions in organizations without KMS	not supported	14.1.2, p. 526ff
H-20: The majority of organizations apply organization-specific KMS developments or a combination of organization-specific developments and KMS tools rather than just KMS available on the market	supported	14.1.2, p. 526ff
H-21: Organizations with KMS have a higher rate of KM activity than organizations without KMS	supported for KMS bought on the market	13.1.1, p. 482ff
H-22: The more employees have access to Groupware and/or KMS, the more they are willing to share knowledge	supported for Groupware, not supported for KMS	13.2.1, p. 512ff
H-23: The more rigorously knowledge management is established in an organization, the more business goals are achieved in that organization	supported	15.2.4, p. 575ff

In the following, the state of practice of KMS supported KM initiatives that has been studied in this empirical study will be summarized in the form of theses that together describe the current activities concerning KMS in German organizations. The theses are based

- on the theoretical investigation presented in part B,
- on the results obtained in the broad questionnaire which were compared to the results of related empirical studies and—last, but not least—
- on the qualitative findings that were collected in the in-depth interviews with knowledge managers in organizations who had dealt with KM for a long time.

The theses are once again organized into the four blocks strategy, organization, KMS and economics.

Strategy.

1. **KM and KMS are increasingly implemented and fairly new for most organizations.**
   About a third of the organizations have a KM initiative in place. This is a significant increase over previous empirical studies. Most of these organizations have started their KM initiatives within the last two years. As related studies have shown, there are also many organizations that plan to implement KM within the next years. So far, organizations are most successful in achieving rather basic KM goals in both, the codification and personalization side of KM, such as an improved access to existing knowledge or an improved communication and location of experts. More ambitious KM goals, such as turning implicit into explicit knowledge, or changing culture have been achieved to a much lower degree. Thus, it seems that organizations still have some way to go until they achieve the more advanced potentials that KM promises. Also, there is a strong increase in the interest, the state of implementation and the usage of KM-related ICT systems over previous studies. Most organizations have installed an advanced Intranet infrastructure during the last years which they try to extend so that KMS functions are supported. Mostly large, knowledge-intensive organizations have invested in KM. Professional services companies and a number of pioneers in a variety of industries have been leading the way. As recent related empirical studies have shown, more and more small and particularly medium-sized organizations have started to evaluate the potentials of KM.
2. **There is common agreement about the strategic relevance of KM, but the coordination between KM and business strategy is weak.**
   Most organizations agree on the potentials of KM. The initiative quickly gains high visibility. Most KM initiatives report to the two highest levels of the organizational hierarchy. In many organizations, the executive board pushes the approach[155]. Organizations have high expectations towards knowledge management and believe that the approach potentially causes high positive returns when

155. E.g., von Pierer, CEO of Siemens, has made official statements on the importance of knowledge management in general and the relevance of the Internet and the worldwide corporate Intranet for effective management of company knowledge on several occasions, see e.g., Pierer 2000.

integrated with business strategy. There is broad agreement over all empirical studies that KM is a relevant and important topic as the share of knowledge workers and knowledge-intensive business processes is constantly rising. The interviewees were also convinced about the positive effects of their KM initiative on business goals. They based their convictions on positive feedback gathered in surveys of employees and success stories, but cannot provide quantitative results. As much as organizations are convinced that the potential benefits of KM are high, as much difficulties they have in establishing clear, well-documented and measurable knowledge or KM goals. The lack of a well-defined and (empirically) proven set of KM strategies is obvious as most organizations aim at a large number of different KM goals at the same time. Many interviewees see this missing link and the measurement of the impact of KM or KMS on knowledge and business goals as the most important challenge ahead of them.

3. **KM initiatives are a multidisciplinary effort.**
   KM initiatives regularly comprise a strategically relevant combination of organizational and ICT instruments. Even though organizational instruments are the main drivers for a change in the handling of knowledge, it is often ICT implementations that play the role of an enabler, a catalyst for the changes to take place as they visibly change the work environments of the participants. Consequently, multiple disciplines are required in order to implement KM successfully. In a substantial part of the organizations KM is not embedded in a single functional area, but assigned to an interdisciplinary group. Also, many KM initiatives are split into at least two separate groups within an organization with frequently a large gap between their perspectives. These are human resources and organizational design on the one hand and the information technology department on the other hand. Regularly, marketing, R&D and strategy are also major players in the KM initiative.
4. **There is a strategic shift in many organizations from codification towards personalization and especially towards bridging the gap between these two strategies.**
   There is a shift in focus of KM initiatives from explication or codification of knowledge to a more holistic, theme-oriented approach supporting the identification and handling of existing knowledge, the documentation and distribution of knowledge on the one hand and the support of knowledge workers and experts in knowledge sharing from person to person and in networks or communities on the other hand. It is a popular starting point in many KM initiatives to improve the handling of existing knowledge that is documented in electronic form. Organizations then focus the personalization and codification strategy at the same time as in most organizations, both strategies promise benefits. It seems that by now organizations have realized that KM is not an exclusively technical or infrastructural approach, but that a combination of infrastructural, organizational and person-oriented measures promises the most benefits. As almost all organizations try to change their culture with the help of a KM initiative, it seems that organizations also recognize that a positive organizational

environment fostering willingness to share knowledge is a prerequisite for an efficient and effective use of KM measures and instruments.

5. **Most KM initiatives aim at organization-internal knowledge and neglect knowledge external to the organization.**
   Most KM initiatives have their focus on knowledge flows between organizational units or groups of employees within the organization. Much less do KM initiatives aim at knowledge that crosses organizational borders. Neither do most organizations support the acquisition of external knowledge nor do they systematically make use of knowledge developed internally by selling knowledge products or services. Also, most KM initiatives only foster organization-internal work groups, teams, networks and communities whereas those collective structures that cross organizational borders are rarely systematically supported. There are a lot of issues at hand that need to be resolved, such as the relationship to the formal organization, appropriability of the knowledge generated in cross-organizational border networks, security issues for the access to organizational ICT systems by non-members of the organization, just to name a few. Organizations have just begun to establish positions for key strategic alliance management[156] that address these challenges at least for the most important liaisons to partner organizations.

Organization.

6. **In large organizations, KM is a set of independent activities, rather than a single initiative.**
   Today, large companies have a multitude of knowledge management efforts working in parallel to tackle the problem. In many cases, several core groups start KM activities independently. Companies such as DaimlerChrysler and Siemens organized conferences where KM-related projects and other activities could be exhibited and were surprised how many activities had gone unnoticed. Thus, in some cases even the various KM groups, teams and communities do not coordinate their efforts or even exchange knowledge which gives an indication of the complexity of the challenge.
7. **Most organizations have organized their KM initiative as a project.**
   The most prevalent form of structural organizational design applied to KM, however, is the project. Projects have been established in almost half of the organizations. In more than a quarter of the organizations, KM is advanced in the organization by an informal group of employees interested in KM. As the interviews showed, many of these groups attempt to convince senior management to fund a project. Only if an organization has established a separate organizational unit assuming a role similar to KM before, it is likely that KM is organized as a group or a department. Only a minority of the organizations with a systematic KM initiative have established a separate KM unit. However, several

156. In analogy to key account managers a key strategic alliance manager oversees all transactions and communication with a partner organization.

of the projects might be turned into permanent units after the project is finished successfully.

8. **KMS supported KM initiatives are often organized as decentrally as possible with a central coordinating unit.**
   KM was implemented as a predominantly decentral approach leaving as much responsibility with decentral functions as possible. Responsibility for contents of KMS in most cases is shared between the author of a knowledge element and subject matter specialists. One of the most important goals of the implementation of KMS solutions is to increase participants' ability to actively handle ICT supported knowledge, e.g., to publish knowledge elements and information about their skills, project assignments and the like and to react to activities of other participants, e.g., to answer questions, contribute to discussions, comment, value, give feed-back to and recommend knowledge elements. KMS help to decentralize the corresponding KM tasks. A central unit, either a separate, permanent organizational unit or a project, frequently coordinates the decentral activities. Examples are the management of the organizational and ICT infrastructure, a regular reorganization of the knowledge structure, the administration of KMS and quality management for knowledge elements.
9. **The key role in KM initiatives is the subject matter specialist.**
   Most of the organizations surveyed assigned responsibility for the majority of their KM tasks to this role. Subject matter specialists are primarily responsible for KM tasks on the operational level. They take on responsibility for one subject area or topic in the organizational knowledge base, help knowledge providers to document, link and organize their experiences, refine and organize their subject area and help knowledge seekers to locate expertise and knowledge elements. Subject matter specialists also provide the "linking pins" for knowledge-related design and operational management tasks such as the update or reorganization of knowledge structure(s) or the integration of knowledge into the existing structure. In these cases, they share responsibility with knowledge managers. The strategically relevant identification of knowledge and the operational distribution of knowledge are in many organizations joint efforts with responsibility split between subject matter specialists, participants and knowledge managers.
10. **Many organizations do not assign responsibility for important KM tasks.**
   There are also several organizations in which responsibility for KM tasks is not assigned at all. About a third of the organizations just assigned responsibility for basic tasks related to the publication and distribution of knowledge, but did not pay equally high attention to what happens to the knowledge once it is documented and inserted into the organizations' knowledge bases. In a number of organizations, important tasks to keep a knowledge base relevant and useful are not systematically assigned. Examples are the actualization and refinement of existing knowledge, quality assurance, deletion and archival of knowledge. This might trigger a vicious circle in which participants use the KMS less frequently because they do not find what they are looking for. Thus, investments in KMS

are cut which deteriorates the quality of the knowledge in the KMS. This reduces trust in the knowledge and in turn negatively affects usage of the systems starting the circle over again (see also Probst et al. 1998, 309f).

Knowledge management systems.

11. **Most large organizations have an Intranet and/or a Groupware platform in place that offer basic KM functionality and a solid foundation for KMS.**
By now, almost all large organization have installed an Intranet and/or a Groupware solution which can be considered the basic ICT infrastructure for KM. These platforms together with a multitude of extensions and add-on tools provide good, basic KM functionality. During the past couple of years, corporate Intranet solutions have been implemented to connect employees, to support the easy sharing of electronic documents and to support access to company information. Also, organizations have installed Groupware tools in order to support teams and to master the increasing complexity of organizational structure and processes along with advanced information and communication needs.
12. **Many KMS functions are implemented, but not used intensively.**
Large organizations have already implemented many KM-specific functions as part of advanced Intranet infrastructures and Groupware platforms as well as more specific solutions, such as customer relationship management systems or systems that support individual business units. Many of the functions are not used intensively, in some cases due to technical problems, but mostly because they require substantial organizational changes. Therefore, there still seem to be considerable potentials when applying ICT to KM initiatives.
13. **Integrative KMS functions predominate, but interactive and bridging KMS functions catch up.**
Up to now, in most organizations there has been a strong emphasis on integrative KMS functions with a focus on explicit, documented knowledge. This is not surprising as in many cases large amounts of documents have already existed in electronic form. The improved handling of documents and the redesign of business processes to systematically capture lessons learned and to use the document base have provided for a visible improvement of the organization's knowledge base. Recently there is a trend towards more collaboration-oriented and bridging KMS functions. Organizations profit from integrative KMS functions and now seek for new forms of ICT support for their KM initiatives. Also, the technical requirements for a sophisticated support of media-rich electronic communication and collaboration can now be met at a reasonable cost due to the advancements in the ICT infrastructure in the organizations. Examples are videoconferencing, tele-teaching and tele-learning or application sharing that require large bandwidths and multimedia equipment for the PCs of the participating knowledge workers. Most organizations follow a general pattern of four phases in which they implement predominantly (1) basic KM-related functionality, (2) integrative KMS functions, (3) interactive KMS functions before they (4) finally aim at a combination and integration of the two. Most organizations are still in

the first two phases of this sequence whereas many organizational KM instruments need to be complemented by KMS functions of the third and fourth phase.

14. **KM-related ICT systems lack integration.**
In most organizations, a multitude of partial systems are developed without a common framework which could integrate them. Only recently, comprehensive and integrated KMS gain market share. They offer extensive functionality integrated within one system. Some organizations also build enterprise knowledge portals that at least integrate access to most, if not all organizational and organization-external ICT systems relevant for the KM initiative. Still, in most organizations the functionality of KM-related ICT systems is largely not integrated, e.g., messaging systems, document or content management systems, access to external systems, World Wide Web, external online data bases, data warehouses, customer relationship management systems and last but not least the organization's enterprise resource planning systems.

15. **KMS are highly complex systems.**
Comprehensive KMS are highly complex ICT systems because of (1) the *technical complexity* of the "intelligent" functions that distinguish a KMS from a more traditional system and of the large volumes of data, documents and messages as well as links, contextualization and personalization data that have to be handled, (2) the *organizational complexity* of a solution that affects business and knowledge processes as well as roles and responsibilities throughout the organization and finally (3) the *human complexity* due to the substantial change in the handling of knowledge that is required from the organization's knowledge workers as KMS have to be integrated into their work environment.

16. **Most organizations build their own KMS solutions.**
The majority of organizations relies on organization-specific developments and combinations of tools and systems rather than on standard KMS solutions available on the market. The most important explanations for this finding might be two-fold. On the one hand, the market for KMS solutions is a confusing and dynamic one. There is no leading vendor or group of vendors yet and interoperability with other KM-related systems that the organizations have in place is often difficult to realize. On the other hand, organizations might fear that they loose strategic advantages if they exchange their home-grown organization-specific KMS solutions for standard software that might not fit their needs as well.

17. **The diversity of KMS contents has increased.**
Generally, more organizations handle a larger variety of knowledge contents when compared to previous studies. About half of the organizations use modern KM contents, like employee yellow pages, skills directories, idea and proposal systems and lessons learned. Recently, organizations seem to have extended the scope of their KMS to include more types of internal knowledge previously unavailable to a larger group of employees. Most organizations have organization-specific descriptive knowledge on the one hand and unapproved contribu-

tions to knowledge networks on the other hand as part of their knowledge base. Secured inventions are used by only a minority of organizations. The biggest potentials seem to lie on the one hand in experiences and expertise that bridge the gap between organization-specific descriptive knowledge and unapproved contributions in knowledge networks. On the other hand, external knowledge bridges the gap between the organization and its environment. Many organizations do not distinguish between these KM-related contents and more traditional contents of ICT systems, such as a broad view of all documents or the entire content of the corporate Intranet, data in data warehouses or transactional and communication data about customers and business partners. There is still considerable uncertainty in many organizations about what is or what should be considered a knowledge element in an organization's KMS.

Economics.

18. **A KMS implementation is a major, long-term investment, but organizations strive for short-term profits.**
KMS are highly complex and expensive systems. The implementation of KMS, no matter whether bought on the market or developed internally, represents a major investment. A KM initiative and its support with KMS are long-term investments because they require a substantial shift in employees' roles, organizational processes and in many cases a change of the organizational culture. KMS success is dependent on network effects. The more knowledge workers participate, the more useful the KMS solution will be and the more these workers will profit from the solution. However, most companies apply KM-related ICT systems and concepts that promise a "quick-win", a quick return-on-investment and are reluctant to commit themselves to a substantially higher investment and especially to changes in work processes. Some of them have just finished a fundamental shift to an ERP system, have solved the Y2K problem and/or have installed an Intranet solution. Thus, they currently might not want to implement any revolutionary changes in their ICT landscape.

19. **Success is assessed by story-telling rather than quantitative indicators.**
The benefits of KM initiatives in general and KMS in particular so far are determined by story-telling at best. In most organizations, this is the primary justification for the budgets allocated to the KM initiative along with references to similar activities performed by the competition. The reason is that it is extremely difficult to measure knowledge directly. There are several promising approaches to the quantitative assessment of knowledge-related activities, e.g., the balanced scorecard or the intellectual capital approach. They all require a fundamental shift in the organization's management systems and in many cases organizations are as reluctant to massively change their management paradigms as they are in fundamentally changing their ICT infrastructures.

20. The organizational design of the KM initiative is crucial for a successful deployment of KMS solutions.

Generally, the higher KM expenses per participant are, the higher respondents estimate the impact of a KM initiative on business goals. KM initiatives with a formal organizational design, but a decentral assignment of responsibility, a high rate of KM activity and the systematic support of communities might be more successful than KM initiatives which apply a different organizational design. The relatively obvious tendencies in the case of the organizational design compare with a more uncertain picture in the case of KMS. The implementation of KMS alone seems to have no positive impact on business goals. They have to be combined with people-oriented and organizational instruments in order to be successful.

21. KMS supported KM initiatives aim at similar goals as BPR activities.

Consistently with other KM studies, improve speed of innovation is an important business goal supported by KM. In addition to this rather KM-specific goal, organizations primarily aim at the same business goals as targeted in BPR projects: improve customer satisfaction, improve productivity and improve scheduling. Improve growth of organization was ranked lowly in all KM studies reflecting once again the internal focus of most KM initiatives. The organizations primarily try to improve the internal way of handling knowledge in order to achieve traditional business goals oriented towards value creation rather than environment-oriented goals such as improve growth, reduce risks and develop new business fields.

Part D will now present scenarios that give a more detailed look about alternatives of KMS supported KM initiatives.

PART D *Conclusion and Outlook*

Throughout this book, every chapter was concluded with a short résumé. Part B was summarized by contrasting three major fractions of KM approaches[1]. The results of the hypotheses tested and the most important findings of the empirical study painted a comprehensive picture of the state of practice of KMS at the end of part C[2]. Thus, the following conclusion concentrates on the presentation of four typical scenarios that show the state of practice of the application of KMS.

Figure D-1 gives an overview of the organization of part D. Chapter 17 contains the four scenarios. Chapter 18 concludes the book with a short summary of recent developments, several impulses for the design of KMS and an outlook on possible developments of KMS and their application in organizations.

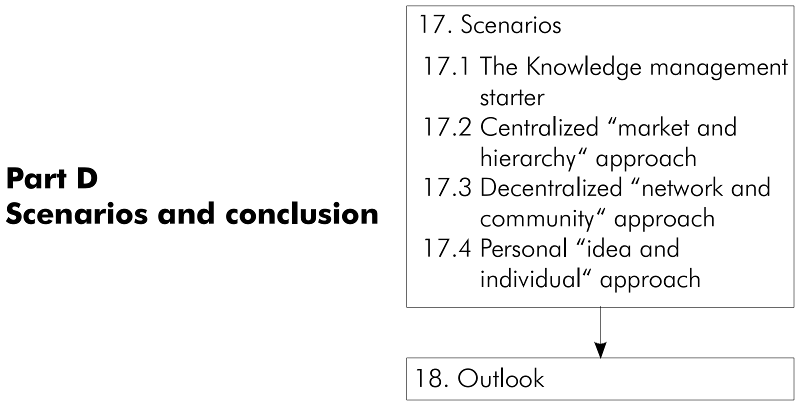

FIGURE D-1. Detailed structure of part D

1. See part B, chapter 9 - "Summary and Critical Reflection" on page 434.
2. See part C, chapter 16 - "Summary and Critical Reflection" on page 581.

17 Scenarios

Undoubtedly, knowledge management is currently a very lively and dynamic field drawing the attention of numerous research disciplines that all have their special perspective on KM. Moreover, vendors of software tools and systems happily extend their offerings to include more or less sophisticated KM functionality or simply re-badge their existing systems, e.g., business intelligence, data mining, Intranet, Groupware or content management systems, just to name a few, as knowledge management software. This situation provides for an overwhelming amount of approaches, concepts and theories in the literature, tools and systems on the market as well as Web sites focused on KM that a prospective KM user can draw from.

Unfortunately, the gap between theoretical models, such as life cycle models of knowledge management, on the one hand and concrete KM tools as well as organizational instruments on the other hand is still huge. It does not help either that researchers representing the human-oriented KM fraction sometimes simply state that ICT does not have much to offer to support KM initiatives or that its implementation even hurts the process if applied all too enthusiastically.

The solution suggested by many authors is a more holistic approach to KM, though most authors do not detail what exactly they mean by holistic KM. On the basis of the concepts and theories discussed in part B, the holistic KM approach bridging the gap between a human-oriented and a technology-oriented KM was detailed with respect to the perspective, strategy, organization, contents, KMS and economics[3].

It is not a coincidence that KM rises as a topic in a time when corresponding software platforms, especially collaboration platforms and organization-wide Intranet solutions are established in organizations and "intelligent" KM tools mushroom in the market. Organizational learning ideas have been around for quite a long time. Their application produced respectable positive results in a number of organizations. Despite that, it seems that a far bigger share of organizations recently has invested in KM concepts than there used to be organizations that implemented OL ideas beforehand. Most of these organizations with a systematic KM initiative also have implemented advanced ICT tools and platforms to support KM. Thus, it seems that ICT acts as *the* enabling technology for knowledge management.

The time seems to be right now for a rigorous implementation of KM approaches in the organizations that really makes a difference in the handling of knowledge. As discussed in detail in part B, many professional cultures both in research and in practice now engage in knowledge management. The following examples show concepts and instruments of different functional areas in organizations that contribute to a holistic understanding of KM in organizations bridging the gap between an exclusively human-oriented and a technocratic approach[4]:

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3. See chapter 9 - "Summary and Critical Reflection" on page 434.
4. For a discussion of the concepts and instruments mentioned in the following see part B and the literature cited there.

- *strategy*: knowledge strategies, strategic knowledge assets, management of (core) competencies based on the theories of the resource-based view and especially the knowledge-based view,
- *strategic alliances*: management of (complementary) competencies jointly developed in partnerships, joint ventures, strategic alliances or corporate networks,
- *finance*: instruments that assess the value of an organization's intellectual capital, balanced scorecard, controlling of KMS and KM initiatives,
- *purchasing*: purchasing alliances, networks, purchasing communities,
- *research and development*: innovation management, management of patents and licensing, learning laboratories, networks of experts,
- *engineering and production*: best practice clubs, lessons learned, networks of experts and communities,
- *quality management*: quality circles, process quality management, knowledge transfer across organizations, benchmarking, best practices,
- *marketing*: customer relationship management, customer-oriented (virtual) communities, business intelligence, personalization of products and services,
- *organizational design*: instruments for KM and organizational learning, KM tasks and roles, knowledge processes, knowledge process redesign, virtual teams, communities, hypertext organization,
- *human resources*: employee yellow pages, skills directories, personnel development, organized knowledge transfer, mentoring, organized learning, incentive systems for knowledge sharing, training and education of newly recruited,
- *information technology*: KM tools and systems, Intranet infrastructure, Groupware platforms, business intelligence, e-learning.

These concepts and instruments developed often independently in the functional areas seem to point in the same direction and view knowledge management as "the way to go". Thus, it seems that resistance to change in organizations concerning the implementation of KM concepts is at a historic low right now. The emerging cross-disciplinary networks have been called communities of knowledge practice (also Amidon 1998, 52ff).

However, the variety of particular interests also leads to an overwhelmingly big arena of thoughts and ideas not only in research, but also in practice. Consequently, it seems that organizations perform an enormously heterogeneous bundle of activities under the new label of knowledge management.

From an ICT point of view these are for example Intranet infrastructure projects, document and content management projects, Groupware projects, workflow management projects, customer relationship management projects, data mining and data warehousing projects, e-learning projects, Web shop projects, enterprise application integration projects etc.

From an organizational and HR point of view these are for example the establishment of expert networks and communities of interest, best practice groups, modern training and education measures, such as microworlds, simulations, e-learning concepts, complete organizational redesigns such as the infinitely flat, the starburst or the hypertext organization, knowledge process redesign, but also well known measures such as job rotation, job enrichment, quality circles, Lernstatt, learning laboratories etc.

In this situation, it is a difficult task to explain or even to describe what is happening in the organizations as it is hard to tell “real” KM initiatives from other approaches that apply a similar language. Thus, it is not surprising that the results presented in part C paint a diverse picture of the state of practice of KMS, the corresponding organizational design, goals and strategies. It seems inappropriate to simply state a general model that describes the application of knowledge management in organizations. Too heterogeneous are the approaches that are applied and too abundant is the list of instruments (both organizational and ICT) to choose from. Instead, it seems to be more useful to describe scenarios of potentially successful KM initiatives that apply a matching set of organizational and ICT instruments to focus a set of aspects of the handling of knowledge in organizations.

The following scenarios were formulated on the basis of the results of the empirical study and particularly the interviews with knowledge managers and discussions with practitioners in the field of KM. Starting point for the formulation of scenarios was the well-known distinction in personalization and codification strategies as suggested by Hansen et al. (1999). Management consulting companies like the ones studied by Hansen et al. seem to differentiate themselves from their competition by the very nature of their problem-solving expertise and their way of handling knowledge. The personalization fraction—represented e.g., by McKinsey and Co.—helps their clients to tackle previously unencountered, highly unstructured problems with creative solutions developed in teams of highly skilled professionals working closely together in a personalized way. The codification fraction—represented e.g., by Anderson Consulting—obviously relies more on economies of scale gained from reusing solutions and instruments and applying them to comparably well-known and similar business or management problems. In these cases, the predominant[5] application of one of the two strategies might provide orientation for the subsequent implementation of KM instruments.

The results of the empirical study presented in part C suggest that most organizations focus both, the personalization and the codification strategy, at the same time. Moreover, neither one of the interviewees could position his or her organization in exclusively or in predominantly one of the two strategies. Knowledge managers were convinced that codification and personalization instruments provided synergies in their organizations when applied in a complementary way.

One knowledge manager of a major professional services company said that his separate organizational unit for KM had developed sophisticated organizational and ICT support for the codification of knowledge. Examples were a formal sub-

5. Predominant is meant here in the sense of an 80:20 rule: 80% for one strategy and 20% for the other strategy to support the first one (see Hansen et al. 1999, 112f)

mission process and KM roles that help authors to document, organize and link their knowledge. At the same time, a lot of emphasis was put to bring together knowledge seekers and knowledge providers, to foster personal networking of employees in communities and expert networks. Communities and project teams got access to community homespaces so that they could easily share documented knowledge. Many communities took on responsibility for a subject area and played an important role in the submission process. In this case, the exclusive or predominant focus on either one side might have led to incomplete learning cycles. Thus, the organization might have missed opportunities of a holistic and complementary implementation of knowledge instruments that covers both orientations.

The codification strategy reflects a technology-oriented KM approach whereas the personalization strategy reflects a human-oriented KM approach. Particularly the technocratic approach that focuses too much on the externalization of knowledge—the codification strategy—has been criticized repeatedly[6]. The results of this empirical study suggest that both, research and practice, might be better off to focus those (parts of) KM strategies and those organizational and ICT instruments that bridge the gap between these two previously not integrated fractions of KM.

Examples are to implement KM tasks supporting an improved documentation and contextualization of experiences, ideas and lessons learned linked to an improved communication between knowledge seekers and providers or to apply KMS functions bridging the integrative and interactive KMS architecture, e.g., by integrating search, feedback and communication functions within an integrated KMS solution. The following proposition summarizes this argument:

KM strategies should aim at bridging the gap between human-oriented and technology-oriented KM, between a personalization and a codification strategy and between interactive and integrative KMS. Organizational and ICT instruments should be combined in a socio-technical perspective in knowledge processes that support the sharing of both, tacit and explicit knowledge.

Thus, organizations need new strategies which combine the handling of codified knowledge and the personal handling of knowledge in collectives of employees. The following scenarios give examples for this kind of strategies together with recommendations for an implementation of the strategies.

- scenario 1: **Knowledge management starter**,
- scenario 2: **Centralized “market and hierarchy”**,
- scenario 3: **Decentralized “network and community”**,
- scenario 4: **Personal “idea and individual”**.

The scenarios will be analyzed according to a selection of KM models and concepts that influence the application of KMS. These are integrated in the framework to support the description of the scenarios as presented in Figure D-2. The framework comprises four models that were presented and discussed before:

6. See e.g., Roehl 2000, Swan 2001, Swan/Scarbrough 2001; see also section 4.1.5 - “Critique to knowledge management” on page 58.

- The *model of the tasks and flows in knowledge management* integrates several models to describe processes of OL and KM on the operational level and the level of knowledge strategy in the scenarios (see Figure B-22 on page 154). This model guides the design of interventions that in turn influence the tasks and flows in knowledge management.
- The *model of knowledge management roles and collectives* represents the design of the structural organization of the scenarios (see Figure B-23 on page 163).
- The *classification of types of knowledge* describes the contents of KMS primarily targeted in the KM initiative (see the central part of Figure B-8 on page 78),
- the typical *architecture of a knowledge management system* represents the ICT infrastructure supporting KM initiatives as well as the KM tools and systems applied in the scenarios (see Figure B-59 on page 319).

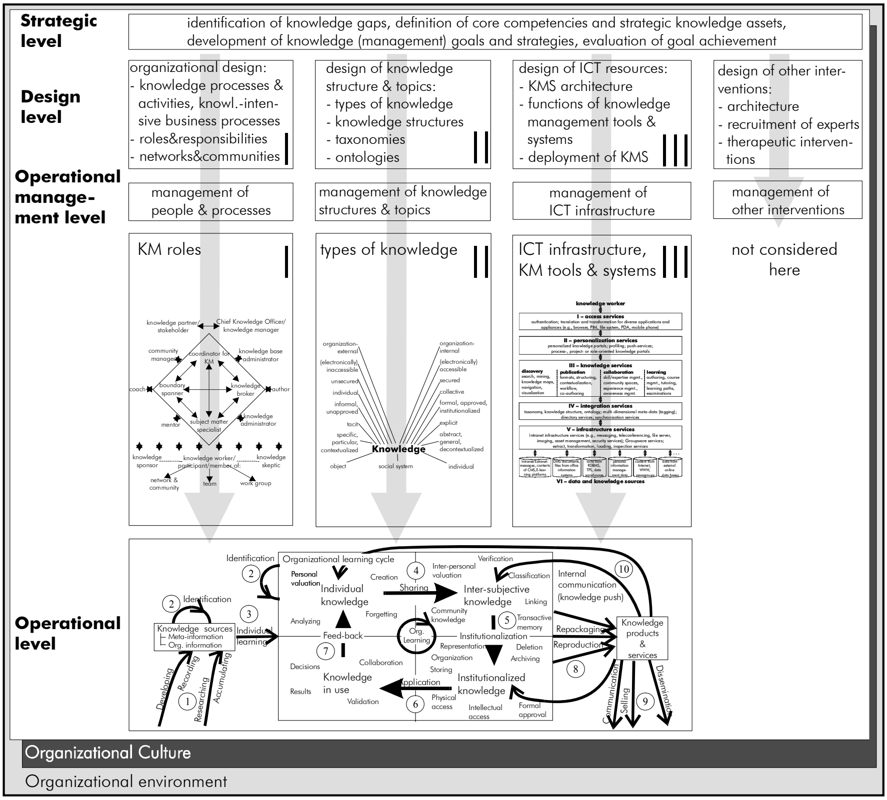

FIGURE D-2. Integrated framework to discuss the scenarios/1

The integrated framework distinguishes between a strategic, a design, an operational management and an operational level of knowledge management. These levels were discussed in detail in chapter 6 - “Organization” on page 153.

On the *strategic level*, the procedure starts with the development of a KM *strategy* which is described per scenario. The assessment of the achievement of KM and business goals as part of the strategic level reflects the *economics* of KMS and KM initiatives. The knowledge gaps identified and the knowledge goals and strategies developed are implemented with the help of four areas of design:

- organizational design (*organization*),
- design of the knowledge structure and topics (*contents*),
- design of the ICT infrastructure (*KMS*),
- design of other KM-oriented interventions.

In the following, the focus will be on the first three areas of design. The recruitment of experts is considered self-explanatory and also its positive impact on the handling of knowledge depends on factors that are independent of the scenario. The interested reader will find a host of literature about architecture stimulating the sharing of knowledge as well as therapeutic interventions that may in certain cases substantially reduce knowledge barriers in organizations[7].

Due to the enormous amount and complexity of alternatives on the *design level* and the *operational management level* the description of scenarios will concentrate on the following three main areas of concern that distinguish organizations between the scenarios most[8]:

KM roles. Firstly, it will be discussed which roles specific to KM have to be established and which forms of collectives are targeted by the different scenarios.

Types of knowledge. Then the main types of knowledge will be studied which are considered in the scenarios. This also shows the perspective taken towards the medium on which knowledge resides: individuals, objects or social systems.

ICT infrastructure, KM tools and systems. Finally, the main focus of ICT implementations in the different scenarios will be discussed. Certainly, every KMS needs the basic infrastructure services and the access services as presented in scenario 1. However, the scenarios differ with respect to what extent organizations focus the KMS functions in the middle layers—personalization services, knowledge services and integration services—that provide the "intelligence" of the KMS.

These three areas of design influence the handling of knowledge on the *operational level*. Every task and flow is affected by the design alternatives. The description of the scenarios focuses different clusters of tasks and flows that are affected substantially more than other tasks and flows. These are the primary areas targeted by the respective scenario.

7. See section 6.5 - "Other interventions" on page 230.
8. Other design alternatives can be found in part B, particularly in chapters 6 - "Organization" on page 153 and 7 - "Systems" on page 273.

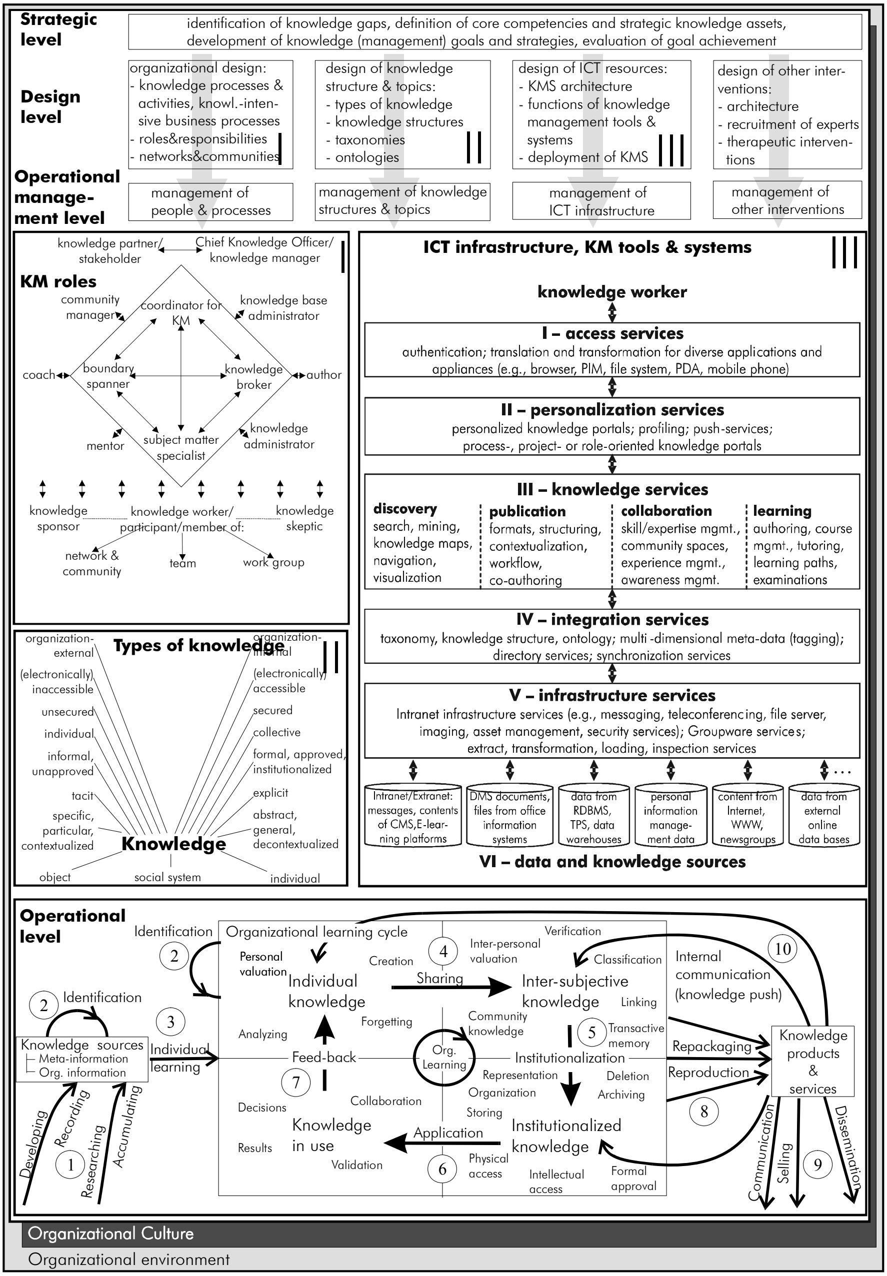

FIGURE D-3. Integrated framework to discuss the scenarios/2

The framework to describe the scenarios will be discussed in the rearranged format as shown in Figure D-3 in order to improve readability of the concepts. It is primarily the design level that has been rearranged. The roman numbers (I, II, III) link the design alternatives to the corresponding areas of design. Within each scenario, the focused concepts on the design and operational levels will be highlighted and discussed in detail[9].

17.1 Knowledge management starter

This scenario can currently be found in a large number of organizations. Within the organizations, a relatively small number of employees is aware of the potential benefits of knowledge management and has started to market the approach internally. Projects under way, e.g., the development or a new release of the corporate Intranet, are used as vehicles to establish those KM instruments that promise the most benefits from the perspectives of the people involved (e.g., an IT perspective, an HR perspective, an R&D perspective or a marketing perspective). Table D-1 characterizes this scenario.

The approach in scenario 1 is not holistic in any way, but apart from the focus on the most promising KM instruments regularly concentrates on the establishment of a common organizational and ICT infrastructure or platform to start a bigger KM initiative from. As described in Table D-1, a small core group of employees enthusiastic about KM analyzes the potentials of KM for their organization. The core group or network can either be established bottom-up fueled by the enthusiasm of the group itself, assigned by senior management or be a part of a project with a goal complementary to KM. An example for the latter might be a project to develop a corporate Intranet infrastructure, a CRM project or a post-merger integration project. This group identifies the most important knowledge barriers and knowledge gaps. The goal is to create awareness of the potentials of KM and to gain support for a consecutive implementation of a KM program or initiative. The approach taken, gaps identified and instruments considered by the organizations in this scenario vary widely depending on the background of the employees who are members of the core group.

The members might come from departments as different as strategy, R&D, HRM or IT. In many cases, the core group is a cross-functional collective with employees from different functional and/or business units. However, in the cases observed in the interviews there was always one unit that acted as the informal leader of the effort, provided most of the resources (both, in terms of people and budgets) and/or the speaker of the core group.

Consequently, even though the core group has multiple perspectives on the topic, it nevertheless concentrates on certain knowledge problems, gaps or barriers identified by the group.

9. For a detailed discussion of the concepts used to characterize the scenarios see parts B and C.

TABLE D-1. Characterizing scenario 1: KM starter

attribute	characterization
strategy	
metaphor	initiation and ignition
goals	create awareness of the potentials of knowledge management, identify the most important knowledge barriers and knowledge gaps
goal setting/strategy	mostly bottom-up approach
management support	senior managers sponsor the KM initiative
organization	
scope	core group or core network of employees interested in knowledge management
structural organization	informal organization, possibly part of a project with goals complementary to KM, e.g., the introduction of a corporate Intranet; no separate organizational unit
knowledge transfer and exchange	mainly through traditional channels and in networks that have not been systematically identified or managed
roles	knowledge enthusiast, knowledge sponsor, coordinator for knowledge management
process focus	one or a small number of selected knowledge-intensive business process(es)
organizational culture	no special focus; a culture that supports the testing of new ideas/approaches
KMS	
ICT infrastructure	basic information and communication infrastructure; Intranet functionality and Groupware platforms
KMS functions	primarily asynchronous electronic communication and basic functions for knowledge publication, search and presentation
economics	
funding	via budgets from the organizational units which the members of the core group work for or alternatively as part of projects with goals complementary to KM
measuring success	mostly qualitatively; “quick wins” shown in success stories
aspects of implementation	
getting started	a core group, either a group of people enthusiastic with KM as the starting unit or a group assigned the task to evaluate potentials of KM
enabler	self-motivated networks or communities sparking the KM initiative
critical tasks	assess the organization’s position with respect to KM; identify most important knowledge barriers and knowledge gaps as starting points; make a business case linking KM to business strategy

These knowledge problems usually provide the leading arguments to create awareness about the usefulness of the KM initiative. This approach certainly also constrains the collective mental models of the core group to a single or a handful of specific knowledge problems which this group deems urgent, but which might or might not be the most important and prevalent ones in that organization.

Apart from this focus on a special knowledge barrier, problem or gap, the core group regularly tries to design and implement an infrastructure supportive of KM. The focus is here to provide improved support for the externalization (documentation, publication, organization) and sharing of knowledge.

With respect to ICT, this means that the focus is on a secure *ICT infrastructure* accessible to as many employees as possible. This requires on the one hand the integration or the integrated access (in the sense of an enterprise knowledge portal) to the most important electronic data and knowledge sources that already exist within the organization and provides basic support for communication between the participants (cluster 1 in Figure D-4). On the other hand, the secure access to this integrated infrastructure is provided by a common access layer (cluster 2).

Knowledge in this scenario is primarily considered as an *object*, but also—frequently to a lesser extent— as being attached to *individuals.* Thus, already in scenario 1 the organizations experiment with basic forms of contextualization of knowledge elements (cluster 3). The types of knowledge targeted in this scenario are primarily *organization-internal* and *electronically accessible* as much as possible in order to reduce costs. Often, *secured* knowledge is targeted first (patents, licenses) as well as *formally approved*, *institutionalized* and therefore *explicit knowledge*. On a continuum between individual and collective knowledge the focus is primarily on the *individual* side (cluster 4).

As for *KM roles*, if any, then there is only one specific KM role established in this scenario: a *coordinator for knowledge management* (cluster 5). This can either be an individual determined by the core group or the core group altogether coordinates the approach. Regularly, there is a speaker for the core group who takes on responsibility to coordinate the KM activities in the organization. Apart from this single role, knowledge workers are focused, both as knowledge sponsors and knowledge skeptics. On the level of collectives, primarily existing teams and work groups are considered as there are no resources to identify more informal entities such as networks and communities (cluster 6).

KM initiatives in scenario 1 either have a sponsor, a senior manager supportive of KM, or still search for one. The funding of the initiative is frequently provided by the projects that have a complementary focus and create synergies when combined with the KM initiative. Additionally, it is the core group's own commitment that provides the funding so that budgets (if any) stem from the business units participating in the effort. The core groups are also often eager to present "quick wins" of their KM initiatives so that they can make a business case for KM and increase awareness and the funds attributed to the initiative.

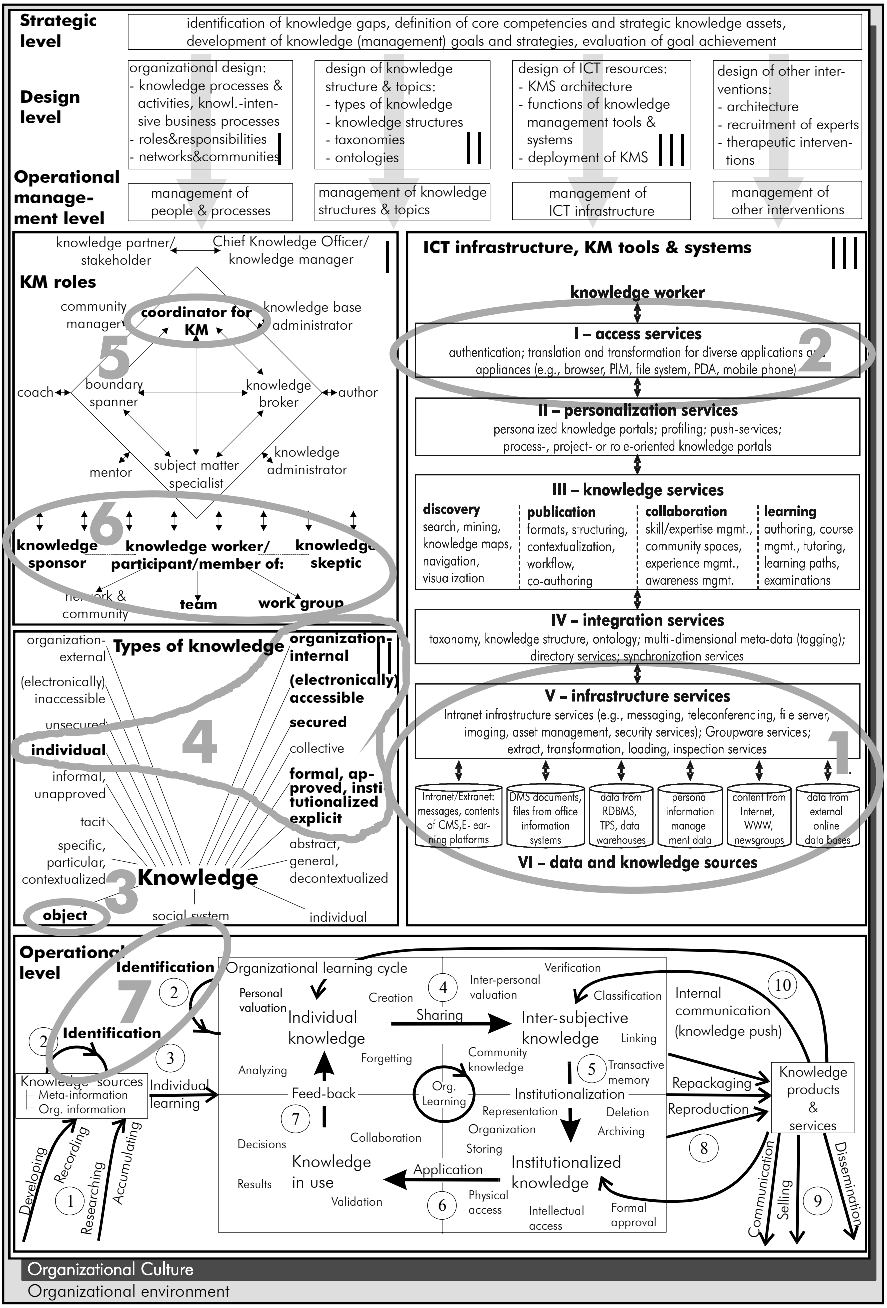

FIGURE D-4. Scenario 1: The knowledge management starter

The primary effect of all these activities on the *operational level* is more visibility about knowledge sources as well as the organizational learning cycle or KM processes in general (cluster 7 in Figure D-4).

In many organizations, state of the art ICT infrastructure such as an Intranet and the corresponding basic instruments for asynchronous and synchronous messaging and tele-conferencing as well as document or content management are marketed organization-internally as being the all-new KMS solution. Although this infrastructure undoubtedly is necessary for an implementation of more advanced KM tools and also provides a good support for easy communication and document retrieval in an organization, it is far from being a comprehensive KMS solution.

It lacks the identification of knowledge gaps and barriers which have to be addressed with an organizational design—roles, collectives, processes, tasks and flows—complementing the ICT instruments applied and the definition of knowledge structures and topics which are matched by the ICT used. A snapshot in these organizations—which currently represent the majority of KM users[10]—would certainly reveal too much emphasis on ICT and might have triggered the negative statements about ICT support for KM made by some representatives of the human-oriented KM approach. The next three scenarios will show how well ICT might fit with the organizational design.

17.2 Centralized "market and hierarchy"

Scenario 2 can primarily be found in organizations that had an established separate organizational unit before that used to be responsible for "information and documentation", "internal documentation", "document management", "market research" or "information brokering". In this scenario, the KM initiative is primarily designed as a centralized approach that develops the concepts, tools, instruments and knowledge products and services that are then applied decentrally in the business units. The knowledge itself is not centralized, but responsibility for the implementation and evaluation of a KM initiative, as well as for the organized knowledge transfer supported by codified knowledge and fostered networks and communities is attributed solely or at least primarily to a separate KM unit.

Table D-2 describes this scenario. Main goal is to establish a contact unit that coordinates and surveys the handling of knowledge in the organization, identifies knowledge gaps and suggests knowledge strategies which are approved by senior management and then implemented throughout the organization. This clearly identifiable "heart of knowledge management" quickly raises awareness about KM in the organization. There is a danger that the perspective on KM is reduced to a service function and not a holistic one where the improvement of the handling of knowledge is everybody's business in an organization. The substantial support by senior management can be used to lower organizational barriers to effective knowl-

10. See also chapter 14 - "Systems" on page 524 and the results of related empirical studies discussed there (e.g., Bullinger et al. 1997).

edge sharing and redesign knowledge-intensive business processes with KM in mind. Specific KM roles are established throughout the organizations. Examples are knowledge partners and coordinators that are the linking pins between the central KM unit and the business units. Authors in the business units are assigned a publisher in the central KM unit that helps them to externalize, organize and link their knowledge.

From a process-oriented perspective, the main focus is on the design of a knowledge management process (development of knowledge goals and strategies, implementation and evaluation/controlling) and of knowledge service processes.

TABLE D-2. Characterizing scenario 2: centralized "market and hierarchy"

attribute	characterization
strategy	
metaphor	market and hierarchy
goals	make knowledge an organizational asset that is consequently and consistently administered; raise awareness of the importance of a systematic knowledge management; (re-)create or (re-)design organizational processes and structures around knowledge management; lower organizational barriers due to competition between organizational units by introducing market transactions for knowledge exchange
goal setting/strategy	top-down goal setting; knowledge goals are related to business strategy
management support	relatively high organizational position of the separate unit; clear backing of KM strategy/vision by senior management
organization	
scope	organization-wide
structural organization	stable, permanent separate organizational unit that has been around for some time
knowledge transfer and exchange	through knowledge services, planned personnel training and education as well as organized learning; via formal roles
roles	knowledge manager, knowledge broker, knowledge (base) administrator, author/publisher, knowledge partner and coordinator
process focus	knowledge management process, design of knowledge service processes, e.g., submission process, search process, knowledge push process
organizational culture	law-and-order and (preferred) market model of exchange of ideas

TABLE D-2. Characterizing scenario 2: centralized "market and hierarchy"

attribute	characterization
KMS	
ICT infrastructure	comprehensive KMS solutions, managed centrally; the emphasis is on integrative technologies combined with support for locating experts, initiation and support of communication between knowledge seekers and providers
KMS functions	administration, knowledge search and presentation, acquisition, publication, organization, communication, CBT and tele-learning
economics	
funding	initially central budget; later creation of an internal knowledge market; selling of KM services
measuring success	intellectual capital approach assessing the impact of KM initiative to business goals; balanced scorecards; measures for quality, use of and user satisfaction with KMS and KM services
aspects of implementation	
getting started	institutionalize a separate organizational unit; develop a KM strategy
enabler	there is a large body of explicit knowledge in documents or highly mobile knowledge workers who have to be coordinated
critical tasks	sophisticated reward system to help to overcome organizational barriers for knowledge sharing, such as power structures, "families" or "knowledge islands" which exchange knowledge within, but not between; access policies are important

The separate organizational unit in this view is the process owner of specific decentral knowledge processes. Examples are a submission process involving authors and subject matter specialists) and processes that offer knowledge services which can be used by the business units.

These knowledge services can also be used as vehicles to encourage a "market-oriented knowledge culture". This aims at the development of a kind of (imperfect) market for knowledge products and services throughout the organization. Business units get accustomed to view knowledge as a resource for which they have to pay the separate organizational unit and, in the long run, other business units providing knowledge products or services for them. In most cases, however, organizations are still far from having established this type of culture and the law-and-order model relying on the hierarchy and the definition of roles as the primary formal medium to organize the exchange of knowledge prevails[11].

The existence of an organizational unit that can be identified as a predecessor of a KM unit is one of the most important enablers for this scenario. Moreover, the

11. See section 6.4 - "Organizational culture" on page 221.

existence of large volumes of documents and/or of highly mobile employees working on projects whose competencies have to be recombined regularly is certainly encouraging a central coordinating unit.

Funding is frequently provided by a central budget assigned to the separate KM unit. Later on, this unit will more and more try to sell its services to its "customers", primarily the business units, but in certain cases (e.g., professional services companies) also external customers might be willing to pay for KM services (e.g., reports, consulting and knowledge brokering services, access to knowledge bases).

From an *ICT point of view* the centralized approach is in most cases supported by *integration*, *discovery* and *publication services* (cluster 1 in Figure D-5). The second important ICT pillar might be a coordinated data base of employees' skills (yellow pages) that is used to broker information about who has what competencies and is motivated to work on what kinds of assignments. The separate organizational unit develops an organizational and ICT infrastructure that aids the synchronous and/or asynchronous knowledge communication which can be direct between employees and/or mediated by documented knowledge elements, as person-to-person communication and/or communication in collectives of employees, particularly networks and communities. Consequently, the ICT support focuses primarily on knowledge mapping technologies, directory services, taxonomies, ontologies and a central knowledge repository. Additionally, *discovery* and *publication services* are primarily targeted to support the navigation and management of the large knowledge bases that regularly have to be managed in this scenario.

Due to the centralized nature of the scenario, a variety of *types of knowledge* is focused which is bound to *individuals* or treated as an *object* (cluster 2). The emphasis is on the one hand on *electronically accessible*, *secured*, *explicit*, *formal*, *approved* and *institutionalized* knowledge that is more *abstract*, *general* and *decontextualized*. The approach combines *organization-internal* and *organization-external* knowledge as the separate KM unit acts as an important and highly visible linking pin to external knowledge sources. On the other hand, *unsecured* and *individual* knowledge is focused as the second emphasis of the separate KM unit is to coordinate people with matching competencies (cluster 3).

In terms of *KM roles* the emphasis is on the explicit side with roles supporting transparency of knowledge as an object and bound to individuals, documentation, publication, standardization, organization and transfer of knowledge (cluster 4). A CKO or *knowledge manager* heads the separate unit and keeps in contact with *knowledge partners* and *stakeholders* from the business units and from outside the organization. Like already discussed in scenario 1, the KM initiative primarily targets the formal organizational structure—*teams* and *work groups*—and to a much lesser extent informal forms of collectives such as networks and communities.

Subject matter specialists, *knowledge administrators*, *authors* and *knowledge base administrators* all aid knowledge communication between knowledge workers, support the externalization of knowledge throughout the organization.

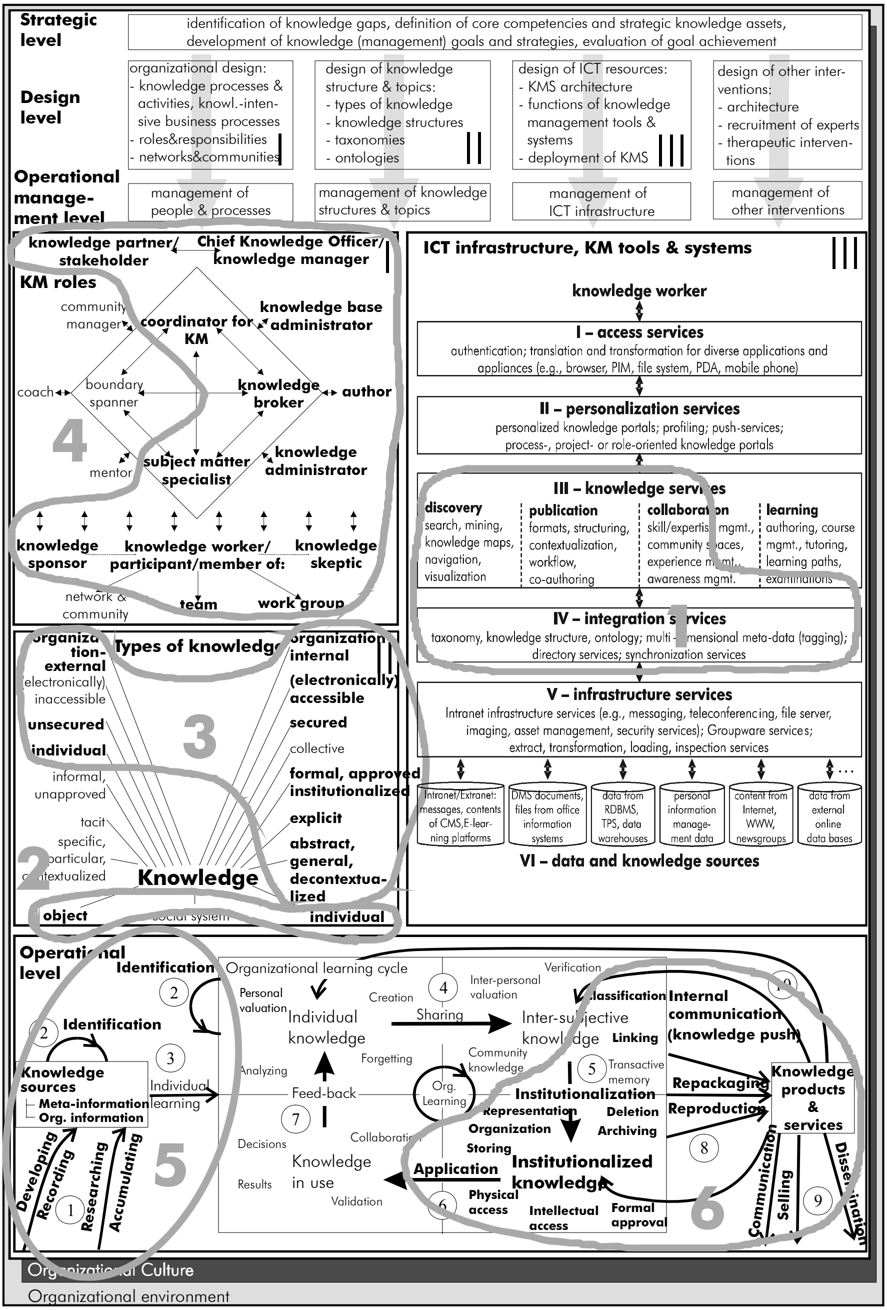

FIGURE D-5. Scenario 2: Centralized "market and hierarchy"

They provide an electronically accessible, coordinated collection of knowledge elements that are linked with experts and networks as well as participants who value and comment them. *Knowledge brokers* are appointed within the separate KM unit to perform knowledge services for the business units.

On the *operational level*, the primary focus is on the phases preceding and following the organizational learning cycle: the handling of *knowledge sources* (cluster 5) and *knowledge products and services*. Additionally, the emphasis is on *institutionalized knowledge* and on the *application of knowledge* (cluster 6).

17.3 Decentralized "network and community"

Scenario 3 has been established in organizations that want to overcome the rigidity of their structural organization by strengthening informal networks for knowledge exchange. In this scenario, KM is viewed as a decentralized approach where individual and especially collective initiatives have to be supported by knowledge sponsors or champions. Existing networks should gain visibility and thus be strengthened and new networks and communities should be founded not as part of a centralized initiative, but as a supported bottom-up initiative by interested groups of people. The scenario is described in Table D-3.

TABLE D-3. Characterizing scenario 3: decentralized "network and community"

attribute	**characterization**
strategy	
metaphor	network and community
goals	reduce barriers to (re-)use ideas of colleagues; make individuals aware of the advantages of networking; build trust between individuals; establish an informal "secondary organizational structure"; enable members of the organization to keep their personal knowledge relationships even if they take on new roles in geographically or organizationally dispersed areas
goal setting/strategy	bottom-up approach
management support	senior managers support networking and act as mentors for communities
organization	
scope	collectives of people throughout the organization
structural organization	primarily informal organization; at most a project, mostly a (steering committee); no separate organizational unit
knowledge transfer and exchange	through a network of formal and informal relationships
roles	community manager, knowledge networking officer, mentor, knowledge worker

TABLE D-3. Characterizing scenario 3: decentralized "network and community"

attribute	**characterization**
process focus	knowledge processes, e.g., community management process, knowledge asset creation process involving communities; knowledge-intensive business processes
organizational culture	family-culture model and (preferred) network/discourse model of exchange of ideas
KMS	
ICT infrastructure	sophisticated KMS infrastructure with an emphasis on communication and collaboration as well as visualization of networks, community building and support
KMS functions	communication, collaboration, knowledge search, presentation, organization, acquisition and publication
economics	
funding	support for communities (e.g., travelling, community home spaces, time) initially via budgets from the organizational units which the community members work for; communities might also take on tasks or suggest ideas and get credit for these
measuring success	quality of communication in networks and communities; use and user satisfaction with community-oriented KMS and knowledge-specific services offered decentrally (e.g., moderation, community homespaces)
aspects of implementation	
getting started	sometimes with a core group, e.g., a group of people enthusiastic with KM as the starting unit; develop communities/networks
enabler	intrinsically motivated networks or communities sparking the KM initiative
critical tasks	sponsoring/support of communities and knowledge networks; community-oriented design of knowledge and business process; support of decentral approach/politics of network support

Key enablers of this scenario are self-motivated networks or communities that can spark the KM initiative. This is especially the case if the formal structural organizational design relies all too much on the hierarchy and these networks have been in place for some time to account for communication links circumventing the rigid bureaucratic structures. Goals in this scenario are to promote networking in the organization and to build trust between different organizational units. This leads to the establishment of an informal *secondary* or, in the terms of the hypertext organization[12], an informal *tertiary organization* of networks and communities apart

12. See Nonaka 1994, 32ff, see also section 6.1 - "Structural organization" on page 158.

from the formal primary organizational structure, the hierarchy, and the formal secondary organization, the project and team organization.

The organizational support for this kind of decentralized KM initiative can be manyfold. Aspects of networks and communities can be integrated into the formal process design, e.g., by the definition of network-oriented knowledge processes. An example would be linking the publication process of knowledge elements to communities as "*subject matter specialist networks*" which evaluate, refine, organize and link the knowledge elements. Communities may also play important roles in knowledge-intensive business processes. Examples are to provide "official" sources for knowledge or to oblige process managers or all employees working on the same process tasks to participate in specialized, formally supported networks.

As opposed to scenario 2, there is no separate organizational unit responsible for KM. It is rather a kind of steering committee or a "meta-community" of key members of the networks or communities or at most a project that provides the organizational and ICT infrastructure needed to foster the decentralized growing of KM initiatives. This coordinating committee also distills best practices about the handling of knowledge in the networks and communities. Also, community moderators and boundary spanners who play an active role in several networks and communities broker knowledge between communities and identify new subject areas that could be supported by new communities.

Consequently, the goal setting procedure employs a bottom-up approach which makes sure that the knowledge needs of the networks and communities are served rather than installing "just another" top-down goal setting procedure that does not consider these needs. However, the alignment with business strategy is certainly a crucial point in this scenario which often leads to insufficient management support for the initiative.

Funding of this KM initiative might start with informal budgets provided by those formal organizational units that the members of the networks or communities come from. Later on, communities might also be funded directly by taking on assignments, offering products or services or getting credit for suggestions, ideas, success stories or measurable results.

ICT support for this scenario can be as manyfold as the organizational instruments established to foster decentralized networking. There will be a focus on functions that increase the visibility of networks and communities: knowledge maps, directory services and catalogues (cluster 1 in Figure D-6).

There will also be an emphasis on *collaboration* and *learning services*, especially for dislocated, virtual networks to support communication, coordination and cooperation between personal meetings which should still take place regularly. Community home spaces not only provide support for interactive KMS functions. These community-centered portals are a prime instrument to bridge integrative and interactive KMS functions with the help of contextualized knowledge repositories holding community-related, valued knowledge elements. These elements are linked to the individual members or sub-groups of the community who also rate the elements and give feedback about their successful or unsuccessful application.

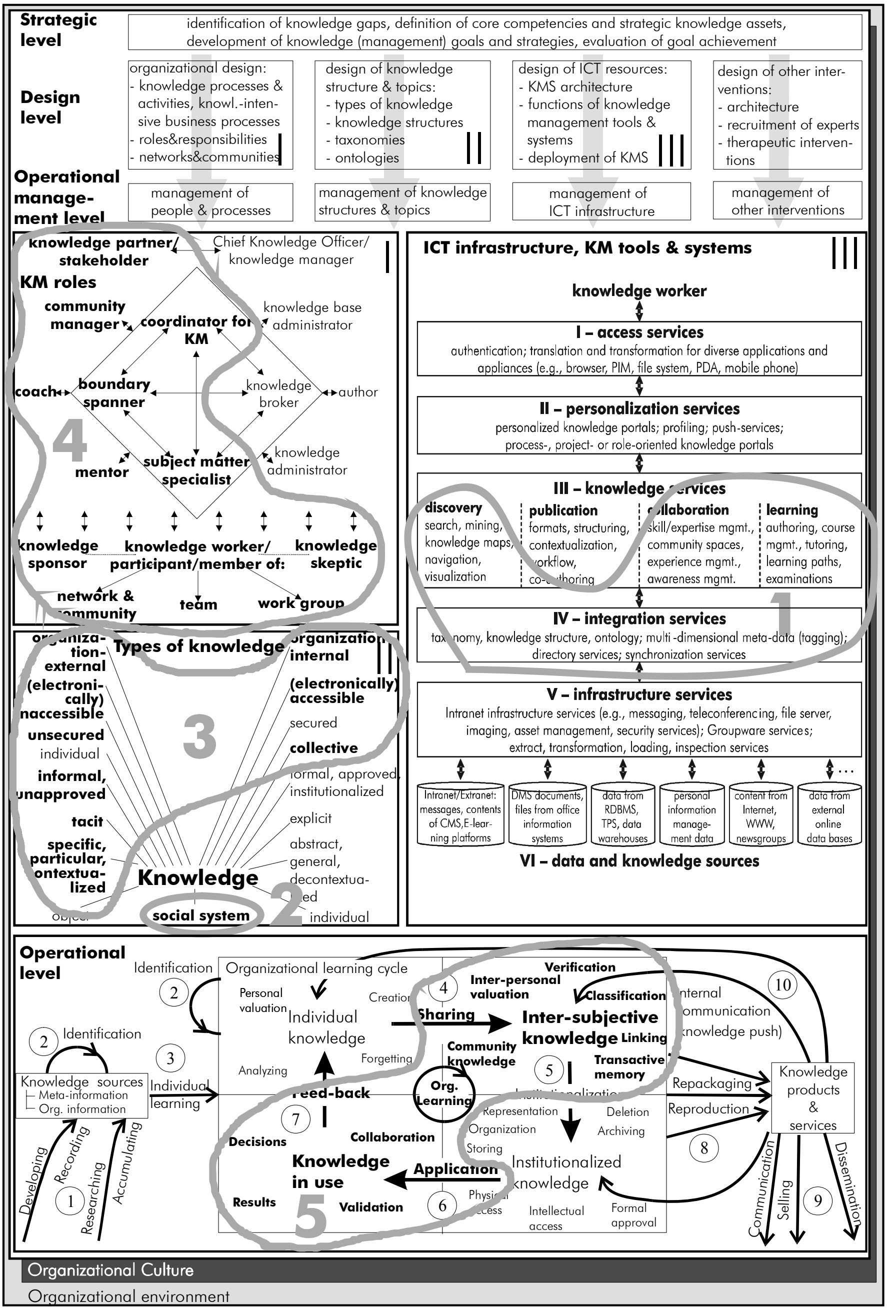

FIGURE D-6. Scenario 3: Decentralized "network and community"

Additionally, *discovery services* are applied in order to profile employees, to recommend membership in networks as well as to access homespaces of communities and networks potentially of interest for them. Also, search filters can be applied according to the networks to which the searching individual belongs and community- or network-related information can be pushed to update the knowledge of the network's members. Compared to this strong support with discovery, communication and collaboration functions, the publication services are targeted to a lesser extent. Although basic support for this group of functions is required in order to develop community homespaces and provide the knowledge elements searched for with discovery services, the support of this group is less emphasized than in scenario 2.

Consequently, knowledge is primarily viewed as bound to a *social system* (cluster 2). The main *types of knowledge* targeted are combinations of *tacit*, *electronically inaccessible* and *electronically accessible* knowledge with an emphasis on the *informal*, *unapproved*, *unsecured* side. The decentralized approach supports specific, *particular, contextualized knowledge* rather than abstract, general or decontextualized knowledge as in scenario 2. As networks and communities are not necessarily limited to the organization's boundaries, both, *organization-internal* knowledge as well as *organization-external* knowledge are targeted (cluster 3).

Concerning *KM roles*, both, formal collectives (teams, work groups) and informal collectives (networks, communities) are targeted with an emphasis on the latter ones (cluster 4). As it is a decentralized initiative there is no CKO or *knowledge manager* to oversee a corporate-wide KM program, but *knowledge partners* and *stakeholders* in the various business units participating in the effort. The specific KM roles established are primarily on the inter-personal left-hand side of the KM diamond as opposed to scenario 2's concentration on the right-hand side.

The *boundary spanner* is a key role in scenario 3 to prevent communities from the negative effects of seclusion and an exaggerated and unhealthy "we"-feeling at the cost of the "other" networks and communities. The consequence would be barriers hindering the free flow of ideas and information across networks and communities and a reinforced "Not invented here" syndrome on the level of informal networks. Boundary spanners also integrate external knowledge sources and networks into the organization in a decentralized manner. *Community moderators* or *managers* support the smooth functioning of the networks. *Mentors* integrate newcomers quickly into the "right" networks and introduce them to the communities' norms and rules. *Coaches* might help to overcome unnecessary knowledge barriers, help to integrate *knowledge skeptics* into networks, help them to build trust in these collectives and, just like boundary spanners, prevent networks from becoming too rigid (cluster 4).

On the *operational level*, the primary focus of scenario 3 is on *inter-subjective knowledge* that is shared in informal networks and communities, on *community knowledge* and inter-personal valuation of knowledge. *Transactive memory systems*[13] might serve as a strong metaphor to guide the design of organizational and ICT instruments to support this scenario. The second strong emphasis is on the *application of knowledge*, on *knowledge in use*, on collaboration and validation of knowledge as well as *feedback* which is ideally immediately shared once again in teams, work groups, networks and communities (cluster 5).

17.4 Personal "idea and individual"

Scenario 4 describes a more recent approach than the preceding scenarios and therefore cannot be found in as many organizations. Main focus of this scenario is to personalize the organization's KM efforts and to have every employee ideally responsible for his or her own handling of knowledge[14]. The organization creates an environment (organizational and ICT infrastructure, career and reward system) conducive for individuals to commit to an improved handling of knowledge and therefore increases motivation to share and reuse knowledge.

Key enablers in this scenario are highly motivated employees and a high share of experts in the organization who belong to a strong professional community. Examples are medical doctors, engineers, computer specialists, lawyers etc. Experts often have highly specialized competencies and consequently can be characterized by a highly individualized knowledge demand. Therefore, standardized knowledge supply is not likely to match the individual knowledge demand of most experts in the organization. Also, because experts often belong to a professional community, they are usually part of networks that cross the organizational boundaries. It is more difficult to make these networks visible and support them than the primarily organization-internal communities in scenario 3. Also, experts use a wide variety of knowledge sources outside the organization. Combined with the highly individualized knowledge demand, this might render a central organizational unit ineffective in the acquisition of external knowledge[15]. On the contrary, professionals often act as boundary spanners to the organization's environment themselves. Table D-4 describes this scenario in more detail.

Main goals in this scenario are to maximize flexibility of experts to gain access to the knowledge they need and to maximize support of their creative potential. This also maximizes decentralization of the KM initiative. Knowledge is personalized and can be appropriated to experts whose motivation and capability are

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13. See Wegner 1986; see also chapter 6 - "Organization" on page 153.
14. The term personalization is used here to denote the tailoring of the presentation of organizational knowledge bases to personal knowledge profiles. The provision of personal knowledge portals supports quick responses to the questions the knowledge workers pose to the KMS. The term should not be mistaken as a personalization strategy (see Hansen et al. 1999).
15. One of the interviewed professional services companies faces this problem because the knowledge demands of the various business lines differ largely from each other. Also, due to the increased dynamics in knowledge generation the central KM unit runs into the problem that it forms a bottleneck for the access of business lines to the (expensive!) external knowledge resources. Therefore, the central KM unit concentrates on the most general external liaisons (e.g., to Reuters, Gartner Group etc.) in order to profit from economies of scale. Apart from that access to external knowledge sources is not organized centrally any more.

strengthened. Organizational barriers impeding the free access to knowledge by experts are reduced. The focus thus is on the individual expert or knowledge worker in his or her operative, knowledge-intensive business processes and the professional networks to which experts belong.

TABLE D-4. Characterizing scenario 4: personal "idea and individual"

attribute	characterization
strategy	
metaphor	idea and individual
goals	strengthen the employees' ability and motivation to learn; maximize professionals' flexibility for innovation; offer access to knowledge and knowledge providers tailored to the needs of the knowledge seekers
goal setting/strategy	through business strategy which is broken down via business processes and or project processes until individual tasks and knowledge workers are reached; separate knowledge-related goals are coordinated in e.g., a committee
management support	senior managers and/or senior professionals act as sponsors for themes/topics
organization	
scope	experts/professionals throughout the organization; networks spanning the organizational border
structural organization	KM is organized around topics/themes for which subject matter specialists are responsible; these might be networked and/or supported by a central unit, but this is not a prerequisite as in the centralized scenario
knowledge transfer and exchange	knowledge workers are personally responsible for the exchange and transfer of knowledge and for networking within/across organizations
roles	subject matter specialist, boundary spanner, coach, expert/professional
process focus	knowledge-intensive business processes
organizational culture	strong professional ethics; all models of exchange of ideas with an emphasis on the network/discourse model
KMS	
ICT infrastructure	sophisticated KMS infrastructure which allows individuals to personalize their demand for knowledge and the way they enter the organizational knowledge space; infrastructure for personalized knowledge spaces, virtual workspaces, individualized knowledge portals which lead to information and communication supply

TABLE D-4. Characterizing scenario 4: personal "idea and individual"

attribute	characterization
KMS functions	profiling, personalization, contextualization, recommendation and filtering with the help of intelligent agents; knowledge acquisition, organization, communication, collaboration and publication
economics	
funding	ideally, every knowledge worker has his or her own budget for knowledge-related activities, can buy shares of knowledge projects and can buy in the knowledge supply and thus create his or her own knowledge workspace; additionally, there can be themes/topics supported by organizational units, such as departments, divisions etc. which can be subscribed for free
measuring success	as part of the instruments evaluating professionals; quality, use and user satisfaction of KMS supporting the professionals; market model with professionals in the role of shareholders in knowledge-related projects and activities
aspects of implementation	
getting started	set up steering committee; define themes/topics; evaluate demand for knowledge
enabler	intrinsically motivated professionals; high ratio of experts to participants; diverse and highly individual knowledge demand
critical tasks	knowledge maps and access policies; appropriability of knowledge; strategies for the personal handling of information and knowledge

This highly individualized approach can be supported with a theme-centered sponsorship by senior managers. This drives the collective orientation of experts and leaves the organization of knowledge creation and development up to the individual experts and their networks. Consequently, a steering committee is set up to develop a knowledge map, identify knowledge gaps and define themes or topics important to the organization. In a next step, existing knowledge sources and especially experts holding skills and competencies in the respective themes are identified and the corresponding networks are made visible. This identification function might well be centralized in the steering committee or even in a separate organizational unit, but this unit is not responsible for the KM initiative in general as in scenario 2.

After the organization-wide knowledge demand is roughly estimated, the experts and knowledge workers are assigned personal budgets for knowledge-related activities. The use of these budgets ideally is entirely left to the experts. The budgets can be spent on organization-internal as well as organization-external knowledge events, access to knowledge sources or published documents. Additionally, the reward system is extended so that employees get virtual bonuses which they can use to buy shares in topics and/or activities of project teams or networks within the organization. As a consequence, the experts will not only be interested in the progress of the topics, projects and activities keeping them up to date with the latest developments, but they will also be motivated to share knowledge with the projects from which they have bought shares to make sure that the projects will be successful.

If the project or activity succeeds, then the knowledge worker gets dividends from the returns that the organization realizes by exploiting the knowledge developed in the projects, much like an investment in the share market at the New York Stock Exchange (NYSE) or the German equivalent Deutsche Börse. Topics have to be supported by formal organizational units, e.g., work groups, departments, divisions or projects etc. in order for resources to be accountable to them. This also is the primary mechanism to integrate

- the formal organizational design focused on performing daily activities efficiently (work groups, business processes) and on improving the work processes (projects) with
- the informal secondary, and personalized knowledge organization.

Additionally, there might also as well be topics which are free to subscribe to and thus cannot be bet on as in the cases described above. The emphasis on holding employees responsible for their handling of knowledge requires that the employees are skilled in the personal handling of information and knowledge, in self-evaluation and self-motivation. As mentioned above, the key enabler is that a substantial part of employees are professionals, highly intrinsically motivated experts. The skills in personal handling of information and knowledge can be honed e.g., in workshops or with the help of coaches. This provides employees with strategies, instruments and tools to improve the goal setting, evaluation of the personal knowledge processes[16].

From an *ICT viewpoint*, the focus is on supporting personalization of the knowledge supply. Thus, the primary tools are *personalization services* through which the experts enter the organization's knowledge sources and networks. Consequently, the experts' or knowledge workers' interests have to be profiled extensively—and intelligently—and *discovery services* have to take these profiles into account. The KMS can also recommend knowledge workers with similar profiles to found a network. Generally, recommendations, ratings and valuations of knowledge sources and contents by other experts play an important role in this scenario. Personalization and discovery services are backed by *integration services*, e.g., taxonomies, ontologies, directory services and catalogues as well as *publication, collaboration and learning services*. This scenario demands the most comprehensive and sophisticated KMS solutions as tools and services on the personalization level of the KMS architecture[17] require advanced knowledge services for discovery, publication, collaboration and learning as well as tools for knowledge organization (cluster 1 in Figure D-7).

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16. A good collection of techniques and recommendations can be found in Reinmann-Rothmeier/Mandl (2000, 25ff and 99ff).
17. See section 7.3.3 - "Integrating architectures for KMS" on page 311.

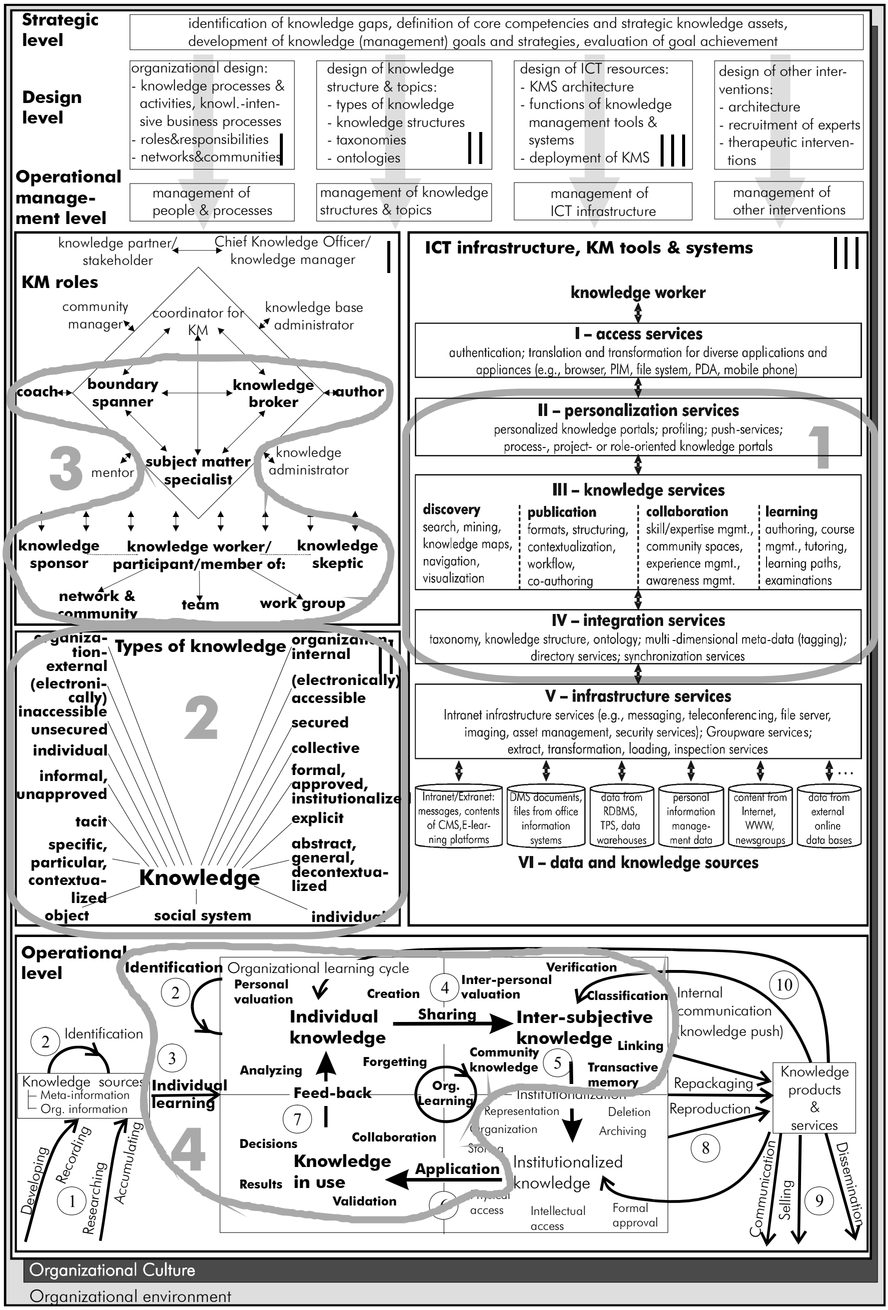

FIGURE D-7. Scenario 4: Personalized "idea and individual" approach

Concerning *types of knowledge*, there is no explicit focus as experts are ideally free in their decision about what kind of mechanisms are best to exchange knowledge (cluster 2).

As mentioned above, the primary focus considering *KM roles* is on knowledge workers, their networks, teams and work groups. All knowledge workers may and should act as *authors*, theme-oriented *boundary spanners*, *subject matter specialists* and *knowledge brokers* (cluster 3). Experts and knowledge workers "adopt" a theme or a couple of themes for which they are held responsible. *Coaches* help newly recruited professionals to quickly network with other professionals and personalize their knowledge workspaces.

On the *operational level*, the focus is on the *organizational learning cycle* with an emphasis on *individual learning*, *individual knowledge*, its *sharing* and its *application* (cluster 4). Personalization thus not only targets personal knowledge and learning. On the contrary, individual learning in groups, teams and networks is focused quite as much as experts and knowledge workers usually work and learn in these collectives. Additionally, there is a strong need for visualization of what is happening in the organizational learning cycle – what themes are deemed important and who knows what about these themes. *Identification* therefore is an important service function in this scenario.

The empirical results suggest that so far KM initiatives in most organizations can be classified as resembling scenarios 1 or 2 whereas scenarios 3 and 4 do not gain equally high attention. Figure D-8 gives an overview of a stage model that shows possible phases of KM initiatives in organizations. Many organizations had started KM in a way similar to scenario 1 and then either moved up to scenario 2 or 3. Scenario 4 presents the currently most advanced step in the organizations and was implemented either on the basis of scenario 2 or on the basis of scenario 3.

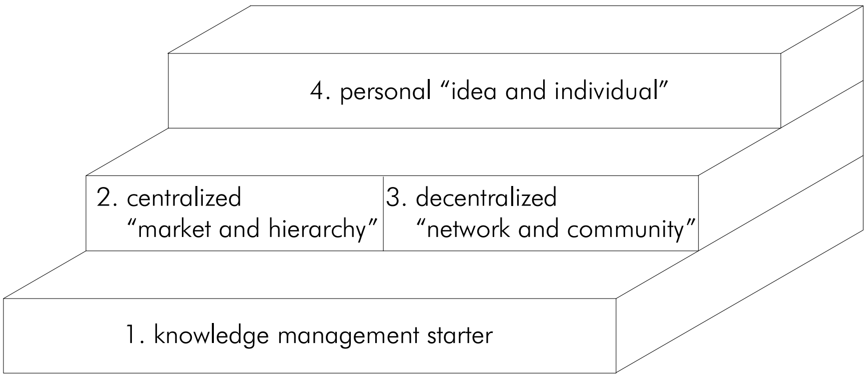

FIGURE D-8. Stage model for KMS supported KM initiatives

However, it might as well be that once organizations arrive in scenario 4, they in turn focus networks and communities as in scenario 3 and the KM pendulum visualized in Figure D-9 swings from the *person corner* back to the *collective corner*. Also, the pendulum might swing to a formal organizational design as described in scenario 2 which centrally coordinates the organizational infrastructure and KM instruments, the *organization corner*. The opposite of this scenario might be a strong focus on building knowledge alliances, fostering cross-organizational networks and communities, visualizing and integrating external knowledge sources, the *environment corner*.

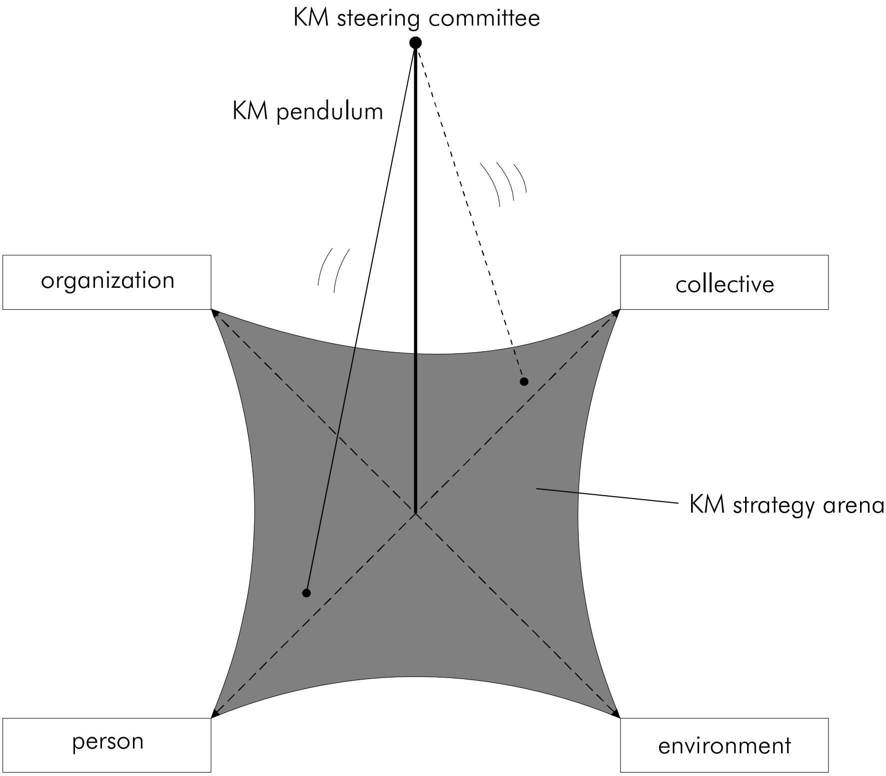

FIGURE D-9. The knowledge management pendulum

The shaded area in Figure D-9 shows the strategic KM arena. Within this arena, the KM steering committee chooses a KM strategy that provides energy for the pendulum. For example, a KM strategy that targets the network and community scenario, attempts to move the pendulum towards the *collective corner*. Depending on the direction in which the pendulum currently swings, the KM strategy's energy might boost the pendulum, slow it down or even force it to turn around. The current swing of the pendulum thus can make it easier or more difficult to achieve the goals formulated in the strategy. Thus, choosing the right KM strategy might also depend on recent developments of the organization's way of handling knowledge, the current swing of the pendulum.

The numerous attempts at integrating ideas, concepts and approaches to knowledge management from a variety of perspectives as discussed in part B, the descriptive findings presented and the hypotheses tested in part C as well as the scenarios developed in this part have addressed the research questions posed in part A. Studies of KMS require an interdisciplinary approach which combines research findings from e.g., strategy, organization science, human resource management, organizational psychology and sociology, artificial intelligence as well as computer science. The approach presented here draws from all of these disciplines and integrates selected theories and approaches developed in these disciplines. The two models depicted in Figure D-8 and Figure D-9 are meant to stimulate research that builds upon this work. The theoretical and empirical results together with the qualitative scenarios should help the reader to get a feeling about what KMS supported KM initiatives currently look like and what potentials they have to improve an organization's way of handling knowledge. In the following, this investigation is concluded with a glance to possible future developments in the field of KMS.

18 Outlook

Knowledge management systems *neither contain knowledge, nor do they manage it*. This fact has provoked substantial and partially justified critic from proponents of the human-oriented KM fraction. Despite its pragmatic foundation as an integrated set of information and communication technologies supporting knowledge management and the many unresolved questions, the term KMS seems to provide a powerful metaphor that is able to draw the attention of researchers from multiple disciplines and practitioners with diverse backgrounds alike.

The term *knowledge management system* is difficult to define. The definition of KMS given in this book distinguishes between KMS in a broad view and KMS in a narrow view. In the *broad view*, many tools and systems have been proposed as "KM enabled" or as supporting KM. The list of KMS functions presented here and the approaches to a classification show the diversity of tools and systems that are offered on the market. In this view, the term KMS generally addresses information and communication technologies used for knowledge management.

There is also a handful of software vendors that attempt to offer comprehensive, integrated platforms on which sophisticated KM solutions can be built. These platforms as well as application systems that combine and integrate a number of ICT in support of KM, no matter whether they are built with or without using these platforms, can be seen as KMS in a *narrow view*. They help knowledge workers to create, locate, acquire, reconstruct, share, integrate and apply knowledge. The integration of formerly separated solutions, the addition of "intelligent" functions and the design "with KM in mind" distinguishes KMS from more traditional systems. In this view, the term KMS denotes *platforms* or specific *application systems* to support *knowledge workers* in the *management* of *knowledge*.

What could be essential contributions to the design of strategically relevant KM initiatives that are supported by KMS? KM initiatives can be viewed as founded in a strategic approach, the resource-based view. Consequently, strategic considerations with respect to knowledge management guide the design and implementation of organizational and ICT instruments for KM whereas available KM tools and systems enable the implementation of KM instruments and thus influence KM strategies. Figure D-10 shows five essential concepts that can be used to connect KM strategies and KMS. These are:

- *assets*: the economic consideration of knowledge as intellectual capital, the analysis of an organization's (core) competencies and the embedding of this approach in the organization's management system,
- *structure*: the development of knowledge structures, taxonomies and ontologies that describe the organizational knowledge base,
- *instruments*: the introduction of KM instruments that consist of person-oriented and organizational measures as well as supporting ICT solutions,
- *processes*: the design of knowledge-intensive business processes and knowledge processes as well as

- *activities*: modeling that portion of knowledge work that cannot be modeled easily as a process, but rather consists of the description of a situation, or stance, in which certain knowledge activities and actions are performed.

The concepts *assets* and *structure* primarily target the design of (strategic) knowledge assets, contents and structures of the organizational knowledge base whereas business and knowledge *processes* and knowledge *activities* and stances primarily target persons, practices and processes, i.e. the users, situations and workflows that a KMS should support. *KM instruments* connect these two areas.

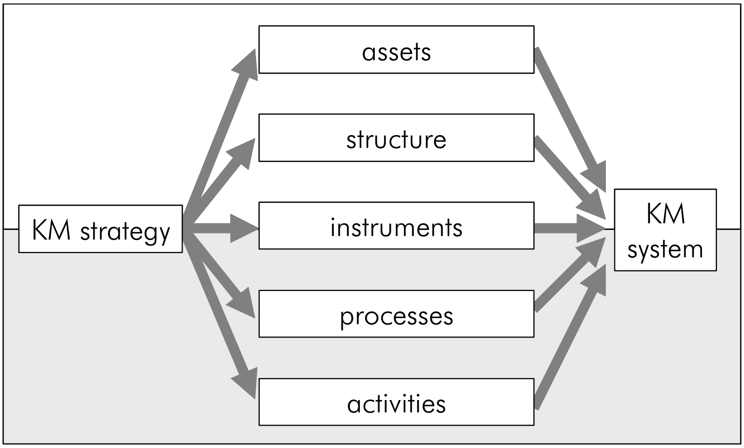

FIGURE D-10. Relationship between KM strategy and systems

Assets. The approaches to intellectual capital currently are limited to an abstract level, a high level of granularity. It remains unclear how these approaches can be operationalized and used to evaluate knowledge tasks of individual or groups of knowledge workers, supported by KMS. A combination of concepts to measure success of information systems, possibly extended by specific factors for KMS, of criteria for information quality, of the task-technology-fit and of activity-based costing might provide a comprehensive set of instruments for evaluating knowledge work in general and KMS in particular. Determining the strategically relevant intellectual capital of an organization provides the content-oriented focus of a KM initiative.

Measurement of success of KMS will not be common place until organizations fundamentally change their management methods and instruments. Instead of an exclusive focus on financial measures, management instruments and practices as well as leadership style have to integrate ideas, methods and instruments developed in the intellectual capital approach. Without this change in perspective, KM goals as well as results of KMS and KM initiatives cannot be linked to business goals.

Structure. Together with communication and activity modeling, modeling of knowledge structures is the main extension of enterprise modeling in order to be applicable for the design of KMS. Knowledge structures, taxonomies or ontologies respectively are required for a semantic integration of knowledge elements which can be seen as fine granular units of competencies or of intellectual capital. Knowledge structures connect heterogeneous, individual or group knowledge elements from decentral organizational knowledge bases that have been developed independently. This can aid search and navigation of the entire organizational knowledge base. As many knowledge processes cross boundaries of organizational units or of whole organizations, standardization of techniques to represent knowledge structures, e.g., on the basis of Semantic Web technologies, play an important role in enabling organizations to share (documented) knowledge.

Instruments. KMS implement or support KM instruments. Examples are skill management, expertise locators, workspaces of knowledge networks, semantic content management, case debriefings, lessons learned or the management of experiences. Intelligent ICT are applied to connect these instruments and consequently connect assets, contents and structures on the one hand and persons, practices and processes on the other hand. These ICT can support or even automate knowledge operations as the finest granularity of knowledge activities. Moreover, intelligent ICT can network knowledge elements, recommend operations and/or contents and provide a personalized access to the organizational knowledge base on the basis of user profiles. Still, many KM instruments are just sketched out and need further development in order to be applicable for organizations or even packaged in KMS solutions. The design of processes and practices as described in the following helps to improve the services that KMS can provide to support knowledge work.

Processes. An orientation of the design of a KM initiative on processes and the value chain guarantees that KM instruments, activities and systems always aim at adding customer value. Process orientation therefore can guide the design of strategic KM initiatives and provides starting points for the definition of knowledge goals and the subsequent implementation of organizational and ICT measures. Processes can provide a part of the context for knowledge structures, e.g., in the form of the context of creation, distribution and application of knowledge. Processes represent a major dimension of meta-data and thus aid navigation of organizational knowledge bases. Process controlling and benchmarking can finally help to identify successful knowledge-intensive business processes and knowledge processes and provide starting points for knowledge process redesign.

Activities. Process modeling is limited to relatively structured, organized work. However, knowledge practices are often weakly structured, less foreseeable, rarely repeated, creative activities. Knowledge activities and stances are concepts that help to identify patterns of knowledge work. Knowledge activities are embedded in communities with specific objectives that have specific rules and a certain division of labor that is primarily informal. It is difficult to bring knowledge activities in a sequence as the sequence often does not provide any hints for the design of supporting KMS. The identification of patterns of knowledge activities and knowledge stances, arrangements of knowledge actions and the subsequent implementation of tools and systems that support these concepts represent a promising field for research and practice. These tools and systems would primarily target the informal organizational structure that is not limited to the organizational boundaries. Thus, the metaphor of distributed or peer-to-peer KMS seems to be most suitable to describe the kind of distributed, entirely personalized, autonomous, flexible and yet seamlessly integrated tools and systems that are needed here.

When designing KMS, these concepts cannot be seen independent from each other. Figure D-11 shows that the three main concepts are interwoven and cannot be separated in the perspective of implementation of tools and systems. Types, processes and services are seen as the main levers that management can use in order to analyze, design, configure, customize, implement, change and adapt ICT solutions for their respective KM initiative's needs. Modelling efforts in KM that aim at supporting information and communication technologies have to clarify a number of questions. Some examples are:

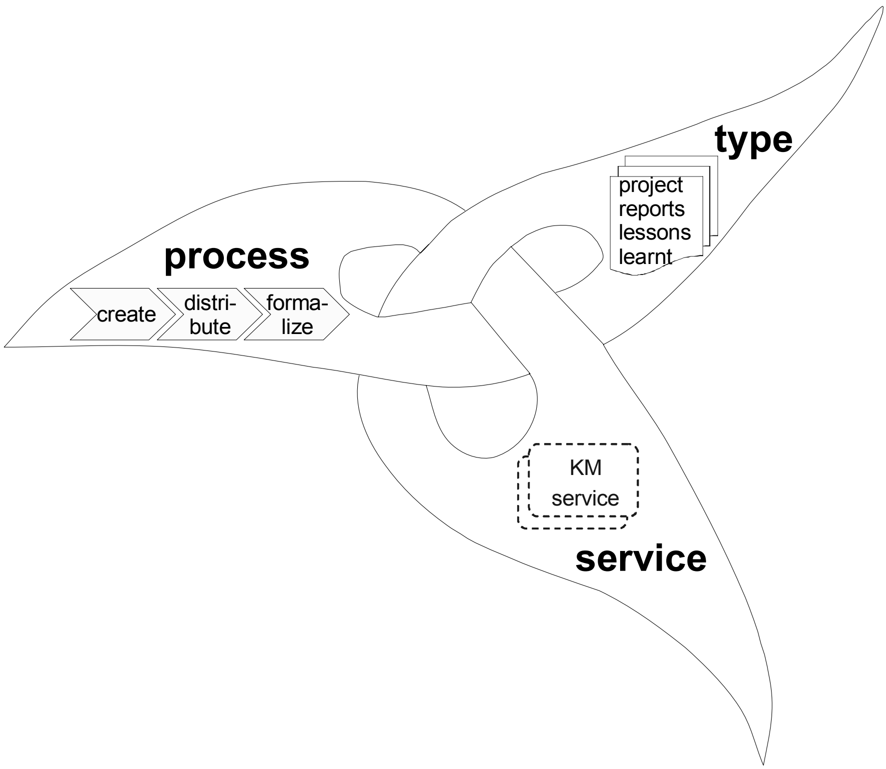

FIGURE D-11. Three main intervention levers for designing KMS[18]

- *type*: what types of knowledge elements should be supported by KMS, how can they be formalized, what meta-data are needed to describe these knowledge elements, what requirements are there for storing, versioning and archiving and what levels of maturity do they have,

- *process*: what knowledge processes are installed, who is responsible for them, what are the starting and end points of these knowledge processes with respect to business processes, how do they affect the maturity levels of knowledge elements, what resources do they require,
- *service*: what knowledge management services should be available for what steps or stances in business processes, how can they be arranged, how can they be structured, what basic services are required to compose advanced knowledge management services, how can they be semantically described, what service levels are needed and what security measures have to be taken.

In spite of all the justified warnings against a single-minded focus on technology, it is well worth observing the market for ICT solutions to support organizational and people-oriented KM instruments. Where is this market heading? In the following, some possible developments of the market for KMS will be discussed.

The term knowledge management system will continue to provide a good metaphor to look at ICT systems to support KM. Apart from *KMS platforms* or suites that offer a comprehensive, integrated combination of the most important functions, *specific KM-related tools and systems* will continue to be developed. Examples are tools for visualization, structuring and organization of the organizational knowledge base, tools for an integrated management of meta-data and for brokering meta-data, search and retrieval tools, semantic text analysis tools, recommendation engines, tools for network and communication analysis, collaboration tools, e.g., for collaborative development of networked knowledge elements such as on the basis of (semantic) Wikis, Weblogs, management of social identities and networking or collaborative tagging solutions, or personal knowledge management tools.

Knowledge management systems continue to integrate functions of *learning management systems* and vice versa forming comprehensive platforms for organized learning and organized knowledge sharing., particularly in the emerging field of professional, ad-hoc, self-managed, on-demand learning or knowledge management. The two types of systems already share an increasing number of functions. On the one hand, learning management systems more and more integrate functions to support synchronous and asynchronous interaction between teachers and learners as well as among learners. Moreover, collaborative learning solutions increasingly blur the boundaries between teachers and learners as is the case in KM with knowledge providers and seekers. Also, learning content has to be constantly updated and linked to other knowledge resources useful for learners. This is where KMS offer strong functionality. On the other hand, functions of learning management systems can provide orientation for participants of KMS. This is due to func-

18. The figure has been modelled on an ancient rune in Uppsala, Sweden, that according to legend symbolizes the inseparability of three brothers.

tions that present knowledge contents in a sequence of learning objects or modules and functions that examine the current level of expertise, the learner's profile, in order to adapt presentations to the participant's skill level.

KMS will also increasingly support the individual knowledge worker's KM needs and provide advanced methods and tools for a *personal knowledge management*. Functions for personalization, such as profiling, recommendation, contextualization and personal knowledge portals support this approach. The knowledge worker's dynamic profiles and the organizational context in the form of knowledge processes and knowledge-intensive business processes will help to navigate the organizational knowledge base.

A *personal knowledge workspace* might visualize the knowledge worker's perspective on organization-internal and organization-external competencies, networks and communities of experts and knowledge workers, knowledge elements and the relationships between these. The workspace might extend or even replace the desktop as the metaphor for the individual's interface with KMS. Routine knowledge-related tasks or operations will be supported or in some cases performed by intelligent knowledge agents. Examples are to locate expertise, both in the form of explicit and tacit knowledge, to ask questions and find answers, to exchange ideas, to jointly process and value information or to format, organize, summarize, repackage and archive knowledge elements.

Mobile access to organizational KMS will be provided for a multitude of devices, such as notebooks, PDAs, mobile phones, or in specific organizational settings wearable devices[19]. Challenges will be e.g., to decide what part of the organizational knowledge base should be accessible by mobile devices, e.g., with the help of location- and situation-based filtering, to visualize knowledge elements and particularly context, to help mobile knowledge workers to effectively and efficiently navigate the organizational knowledge base, the networks and communities so that they can exchange knowledge and access mobile experts from (almost) anywhere. It will be important for KM initiatives to pay attention to the increasing mobility of knowledge workers and particularly of experts.

In addition to these developments in the market of tools and systems with an emphasis on KM, more and more *KM-related functions will be integrated in systems not exclusively or predominantly focusing KM*. Corporate standard application software packages already profit extensively from the developments in the area of KMS and include many of the functions into their software packages that up until only recently required specialized KMS software. Examples are Intranet platforms, collaboration platforms, content management systems, office management systems, enterprise resource planning software, especially concerning enterprise portals, and even operating systems as well as more specific solutions such as software for customer relationship management, product data management, project manage-

19. Several vendors of comprehensive KMS solutions (e.g., Hyperwave) already offer basic functions for mobile access to their KMS; see also Lehner/Berger 2001, for the use of wearable devices in an emergency care setting see Röckelein et al. 2000.

ment, logistics and supply chain management or software supporting e-business solutions, particularly in the business to business as well as the business to customer area.

The majority of organizations, particularly small and medium enterprises, will probably wait for near *"out-of-the-box" KMS solutions* that offer partial support of KMS functionality and can be integrated into the existing ICT infrastructure. Enterprise portals, KMS platforms as well as KM-enhanced Intranet solutions can be seen as the most promising candidates to deliver value without huge investments to customize the solutions. However, the successful implementation of a KMS solution will always require complementary organizational measures and an effort to structure and organize the contents of the organizational knowledge base.

Some organizations, especially in knowledge-intensive industry sectors, will continue to develop their own *organization-specific KMS solutions* rather than buy comprehensive KMS solutions on the market[20]. These organizations still view KMS and KM in general as important sources for competitive advantages. Their organization-specific developments might provide advantages in the handling of knowledge over their competition. As KMS can be seen as infrastructure solutions that can be adapted to KM processes in organizations, the share of organizations that exclusively develop their own solutions is likely to continue to drop substantially.

Since the first edition of this book, the market for KMS has seen a number of *strategic alliances, mergers and acquisitions*. The market for KMS has already consolidated and many vendors of KMS have vanished from the market or their technologies have been integrated into product offerings of major software companies such as IBM/Lotus or Microsoft, or the product offerings of leading vendors of KMS, such as Open Text. Thus, the market is not as intransparent as it used to be. KMS offer reasonable support for KM. Also, quite a few useful tools have become available as open source software. As a consequence, vendors of KMS have struggled to keep the lead on the breadth and depth of integration which becomes the single most important layer in the KMS architecture distinguishing simple from sophisticated solutions. However, there are still many small companies offering innovative KMS tools that pose substantial challenges with respect to requirements such as scalability, integration with other application systems and platforms as well as security. Many innovative tools only target small groups of users or single users, e.g., in the case of some visualization tools.

Still, the main focus of standard KMS is on integrative systems, especially on powerful discovery and sharing services for explicit, documented knowledge and thus the support of a codification strategy. In order to market products as innovative, this type of systems has often been renamed as enterprise content management solutions. Systems that support a personalization strategy, e.g., skill management

20. These organizations thus will rely on individual KMS software rather than standard KMS software.

systems, expertise locators, collaborative KM solutions or workspaces for communities are frequently developed internally and only recently have also been available on the market. This is often due to the fact that there are no widely accepted standards for the naming and structuring of skills, competencies or expertise so that organizations rely on their home-grown systems. Finally, collaboration tools are still often a separate market segment that is not well integrated with the systems that focus codification of knowledge.

As with many KM-related technologies, the Internet time and again plays the important role of a forerunner for tools that are then adapted for internal use in businesses and organizations. This has been the case with e.g., email, content management systems or search engines. More recently, a number of corresponding co-developments have been termed social software.

Social software is a rather recent concept, a subset of computer-mediated communication, that covers software that is used to create and maintain social networks or virtual communities. Typically, this category of software allows for easy-to-use mechanisms to create and maintain online profiles (social identity), build relationships and reputation (social capital), stay aware of a network's activities (social presence), comment on and recommend to others (social feedback), interact with others (social interaction), organize physical meetings (social planning) and share content (social spaces) on the Internet.

Social software focuses on supporting individuals voluntarily entering networks or communities and therefore supports informal gatherings rather than formal organizational groupings in teams or workgroups which are typically focused by Groupware, project management and collaboration software. Due to this informal, self-directed nature of joining networks, it could be described as employing a peer-to-peer, bottom-up metaphor rather than a server-based, top-down metaphor (Boyd 2003). It has the potential of building larger and more effective networks.

Examples for software that can be used with this aim in mind are easy-to-use content management systems, such as text, audio and video Blogs, Wikis, fora, real-time communication, e.g., instant messaging or chat, and software platforms for rich interactions between its members that build on the friend-of-a-friend metaphor, such as the FOAF project, MSN Groups, Tribe.Net, Meetup.com or, with a business connotation, LinkedIn or Xing (formerly known as Open Business Club, OpenBC). Currently, a lot of organizations adopt these technologies and attempt to profit from them. Social software seems to be particularly promising to fill in the gap of the less supported personalization and collaboration portion of organizational KMS. However, it remains to be seen whether and how the additional challenges in business or organizational settings, particularly with respect to power distribution, incentive systems, data privacy and knowledge risks concerns, can be overcome.

Another interesting trend for the design of KMS is the integration of increasingly available geographical data into KMS solutions and thus the systematic management of the location dimension which has often been neglected so far. Again, the Internet has been the forerunner with many mash-ups on the basis of GoogleMaps that have shown applications e.g., in the areas of business service directories or real estate management. Together with increasing bandwidth ubiquitously available, many useful scenarios with enhanced context information on the location of knowledge sources, knowledge elements, experiences, knowledge- and learning-related events and experts can be thought of in businesses and organizations.

Generally, integration of data and knowledge sources and of a variety of tools poses an increasing problem to the effective handling of documented knowledge in organizations. KMS solutions need to connect to enterprise resource planning systems, document management systems, content management systems, e-learning platforms, data warehouses and business intelligence tools, product data management systems, CAD tools, project management tools, customer relationship management systems, visualization tools, Wikis, Weblogs, to personal information and knowledge management solutions etc. The problem is that most, if not all of these tools and systems implicitly attempt to play the role of the leading provider of documented knowledge within a certain context, e.g., a project, a customer contact, a product, a process, a theme, a learning situation or a knowledge worker's workspace. Specific tools are needed that broker terminology, taxonomies or ontologies back and forth between the tools and systems so that semantic integration can take place. However, semantic integration is time-consuming and costly and thus is limited to application areas where reuse of knowledge objects is highly likely to pay off.

Most KMS so far are comprehensive, server-based, organization-wide solutions that target large organizations with hundreds, if not thousands of knowledge workers. These centralized architectures are challenged by distributed or peer-to-peer architectures. The reasons for this challenge are three-fold. Firstly, substantial costs of design, implementation and maintenance of centralized KMS might be reduced, in terms of hardware, standard software as well as the often underestimated costs of designing, structuring and organizing a centralized knowledge server. Secondly, distributed KMS might reduce technical and psychological barriers of knowledge workers to actively participate and share in the benefits of a KMS by seamless integration of shared knowledge workspaces with an individual knowledge worker's personal workspace. Finally, centralized KMS often (almost) exclusively focus on organization-internal knowledge whereas many knowledge-intensive business processes and knowledge processes cross organizational boundaries. Supporting these processes requires the integration of workspaces of knowledge workers in partner organizations as well as the integration of individual messaging objects into the knowledge workspace that are rarely supported by centralized KMS. This latter scenario is also specific to small and medium enterprises in which innovation is often sparked from outside an organization and knowledge management includes considering customers, suppliers and partners with their legally, organizationally and technically separated knowledge bases.

However, on the other hand, there are still serious technical challenges that have to be overcome in peer-to-peer computing, especially concerning connectivity, security, privacy, fault-tolerance, availability, scalability and interoperability. Moreover, applying the peer-to-peer metaphor to KMS requires a substantial shift in the perspective on organizational knowledge. Executives might fear to loose control over the organization's knowledge assets if all documented knowledge is handled by autonomous knowledge workspaces. Consequently, future KMS solutions might attempt to include the "best of both worlds", i.e. the advantages of peer knowledge workspaces combined with super peers that avoid some of the shortcomings of the peer-to-peer metaphor and help to achieve the advantages of integrated and quality assured partial organizational knowledge bases. No matter which architectural paradigm will prevail in the domain of KMS, the long-term trend of moving focus from objects to networks requires a considerably more reflected handling of knowledge. KM initiatives have to not only consider chances, but also risks of knowledge management.

With respect to Drucker's claim that increasing productivity of knowledge work is the most important business aim of the 21st century, it comes as no surprise that the deployment of KMS technologies in organizations is still in its infancy. KMS already today significantly reduce some of the barriers to knowledge management that many organizations and individuals encounter in their daily work practice. KMS will increasingly help to quickly and efficiently implement KM concepts, and instruments with the help of the three layers knowledge types, processes and services. Thus, KMS will be an important cornerstone in the transformation of organizations into knowledge-intensive and knowledge-aware organizations.

List of Figures

List of Tables

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20 On-line Resources

Table D-5 presents a number of magazines, e-zines and newsletters on knowledge management and e-learning.

TABLE D-5. Magazines and e-zines

magazine	URL[a]
APQC (American Productivity and Quality Center) knowledge base on KM	http://www.apqc.org/
Electronic Journal of Knowledge Management	http://www.ejkm.com/
Journal of Intellectual Capital	http://www.emeraldinsight.com/jic.htm
Journal of Knowledge Management	http://www.emeraldinsight.com/jkm.htm
Journal of Knowledge Management Practice	http://www.tlainc.com/jkmp.htm
Knowledge and Process Management - The Journal of Corporate Transformation	http://www.interscience.wiley.com/jpages/1092-4604/
Knowledge Management Magazine	http://www.kmmagazine.com/
Knowledge Organization	http://www.isko.org/ko.html
Knowledge Management Review	http://www.km-review.com/
Wissensmanagement online	http://www.wissensmanagement.net/
@Knowledge Magazine	http://www.media-access.com/publications.html
eLearn Magazine - Education and Technology in Perspective	http://www.elearnmag.org/

a. All links were checked on 02/12/2007.

Table D-6 presents Web portals on knowledge management and related areas.

TABLE D-6. Web portals

Web portal	URL[a]
Brint.com's Knowledge Management Portal and Global Virtual Community of Practice of Brint	http://www.brint.com/km/
Buckman Laboratories Knowledge Management Web Site	http://www.knowledge-nurture.com/
Community Intelligence Labs	http://www.co-i-l.com/coil/
Community of Knowledge	http://www.community-of-knowledge.de/

TABLE D-6. Web portals

Web portal	**URL**[a]
Gesellschaft für Wissensmanagement e.V.	http://www.wissensmanagement-gesell-schaft.de/
International Center for Applied Studies on Information Technology: Collaborative Knowledge Management Repository	http://www.icasit.org/km/
Knowledge Board	http://www.knowledgeboard.com/
Know Center Graz	http://www.know-center.at/
Knowledge Management Advantage	http://www.kmadvantage.com/
Knowledge Management Consortium International (KMCI)	http://www.kmci.org/
Knowledge Management World	http://www.kmworld.com/
Knowledge Management Library of news, summaries of trends, market research and surveys, diary; links; and a KM Resources Guide of useful publications, reviews and Websites	http://www.knowledgebusiness.com/
Knowledge Research Institute, operated by Karl and Elisabeth Wiig	http://www.krii.com/
Online Community Report	http://www.OnlineCommunityReport.com/
Online Portal Knowledge Management (in German)	http://www.people-value.de/
Plattform Wissensmanagement (in German)	http://www.pwm.at/
Swiss Knowledge Management Forum	http://www.skmf.net/
Virtual Communities Portal	http://virtualcommunities.start4all.com/
Wissenskapital.de (in German)	http://www.wissenskapital.de/
Wissensmanagementforum Graz (in German)	http://www.wm-forum.org/
Yahoo Group on Knowledge Management	http://groups.yahoo.com/group/Knowledge_Management/

a. All links were checked on 02/12/2007.

Index

N

O

P

T

U

V

W

X

Y