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STRATEGIES FOR Information Technology AND Intellectual Capital

Challenges and Opportunities

LUIZ ANTONIO JOIA

Strategies for Information Technology and Intellectual Capital:
Challenges and Opportunities

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Summary: "This book presents efficient ways for executives to understand the impact of IT on the intellectual capital of their firms, and searches for a new mandate for management that takes into consideration the pervasive role of IT on competitive boundaries. It provides a synopsis of the history, origin, taxonomies, ontologies, measurement models, and dynamics of intellectual capital"--Provided by publisher.

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(tangible or intangible) asset-driven core competencies and non-asset driven core competencies. These are in turn classified according to the intellectual capital categories they drive. The method proposed is based on the assumption that the value of a company's intangibles is to be found essentially in its core competencies. Financial valuation models based largely on the cash flow generated by the company and on real options valuation are proposed as a means of identifying and quantifying a company's intangibles in monetary terms, taking the earnings they are capable of generating into account. This method is suitable for valuing the intangibles of large companies and smaller businesses where large databases are not available.

The aim of this chapter is to examine how firms measure and report their knowledge-based resources. The first section of the chapter analyzes the intellectual capital construct and its sub-constructs. In the second section, the authors review basic models for measuring intellectual capital. The third section examines guidelines for measuring and reporting intellectual capital. Based on the analysis of intellectual capital statements published by 28 pioneering firms from Europe and India, section four explores key issues on building this innovative report. Finally, major conclusions and implications for management are presented.

Section II
Intellectual Capital and Information Technology

In this theoretical chapter, the authors examine the contribution of IT systems and tools to the emergence and use of different types of knowledge in a firm. They divide knowledge to explicit, tacit and potential and argue that these three types of knowledge characterize firms' three main functions—operational effectiveness, gradual development, and innovation—respectively. On the basis of their examination, they conclude that the main part of IT applications serves dissemination, storing and acquisition of explicit knowledge. However, there are also some tools that serve the elicitation of tacit and potential knowledge and the conversions between tacit and explicit knowledge. The end of the chapter evaluates more generally the potential provided by IT.

Networked collaboration, which spans functional, formal and hierarchical boundaries, has become increasingly important for all types of organizations. With the spread and evolution of information technologies,

among the parties involved in the ERP (SAP R/3) system implementation project in a Brazilian Higher Education Institution, as well as the analysis of how this sharing influenced the project in question. Data was collected in semi-structured interviews, open questionnaires and from documentary analysis. The research enabled the authors to verify that the factors which influenced knowledge sharing and, consequently, the project itself, can be related to the context and dynamics of the institution in which the system was installed, to the way in which the project was planned and conducted, and also to the individual characteristics of the participants.

This chapter seeks answers to two questions: what types of intellectual capital are affected by IT and how can IT affect these types of intellectual capital? An analysis of intellectual capital indicators of the banking industry using an input-process-output model reveals that the process mediator variables, namely management capabilities, are highly affected by information technology. These management capabilities include risk management, quality management, taking advantage of new opportunities, product development and delivery, marketing management, and fulfilling customer needs. Information technology plays a key role in supporting decision-making, making possible business innovations and tightening controls of various processes through its tracking, informational, dissemination, analytical, simulative, and detection capabilities. Moreover, disintermediation is possible because of information technology.

This chapter analyzes the impacts of Intranet quality on organizational capital practices. The chapter describes a research model empirically tested in 98 large Brazilian organizations. The variables proposed by the TAM (technology acceptance model) and the TTF (task technology fit) were converted into portal's context, emphasizing the importance of leveraging classical information science and information system studies to understand better the portal phenomenon. Furthermore, the knowing organization model was applied in order to offer a theoretical support for the intellectual capital-based variables. The results give evidence that the portal quality has more influence on knowledge creation than on sense-making and decision-making.

The emergence of radio frequency devices associated with smart tags—in what is called radio frequency identification (RFID) technology—has been widely discussed in the logistics field, mainly with respect to the implications accrued from this technology in the improvement of organizational efficiency and the creation of strategic ecosystems. However, very little research is available regarding the benefits of

this technology in leveraging the relationship of firms with their customers, especially in the retailing arena. Hence, the purpose of this chapter is to analyze the potential of RFID technology with respect to the relationship between retailers and their clients, in order to understand how this technology is capable of increasing a firm's customer capital, in line with intellectual capital taxonomy. Lastly, from this study, prospective scenarios are elaborated concerning the use of this technology to increase a firm's customer capital.

Foreword

We feel certain that you will enjoy reading the many thought-provoking chapters in this book, contributed by a selection of inspired authors. They will clarify the latest developments in the sector under scrutiny and give you some valuable contributions and in-depth insights into intellectual capital (IC) for the future.

It is now over ten years ago since we began to investigate this fascinating subject, starting with various practical studies. We have now adopted the recent tendency in academia of using a generic framework to interest a broader reading public, with a selection of shorter works by authors from different disciplines. In line with this trend, this book highlights several interesting applications related to both information technology (IT) and the cultural context of the world today.

For many years, the key focus was on the measurement of intellectual capital in order to provide a quantitative map of IC, such as, the IC Navigator introduced in Skandia in 1992[1]. This also resulted in the growing taxonomy surrounding IC, like the IC tree presented in 1993, with its major components defined as human capital, structural capital and relational capital[2]. In 1994, Skandia released the world's first IC report. This resulted in a global movement of IC statements and IC reporting.

Nowadays, the countries leading research on the subject are Germany and Japan, as witnessed by the pioneering work over the past few years carried out by BundesMinisterium fur Wirtschaft unt Arbeit in Germany[3], and METI in Japan[4]. Both of these approaches start from the Knowing Organization pointing to a more systematized intelligence for handling the invisible and intangible assets both in SMEs (small and medium-sized enterprises) in Germany, as well as in major companies in Japan.

More on the subject of IC reporting can be found in a recent High Level Expert Group report to the European Commission, called RICARDIS – *Reporting Intellectual Capital to Augment Research, Development and Innovation in SMEs* (2006)[5]. Another interesting approach is the 3R model for intellectual capital statements[6].

In order to leverage IC, it became evident at an early stage that we needed to leverage the human potential by using structural capital. The *IC multiplier* concept was coined for this[7]. It shows how to multiply human potential with structural capital, such as IT, for example. This is where numbers can help us to assess productivity in value creation as well as value extraction.

As can be seen in one of the chapters, we are now also studying how to use technological advances, in the form of RFIDs (radio frequency identification tags), to monitor the customer's relational capital. Many more knowledge tools are being developed in addition to IC forecasting for companies, as well as for regions and nations. Consequently, the strategic core will be IC Navigation, or put more simply, ensuring that the strategic challenges and opportunities are well covered. The opportunity cost of not doing so at this juncture would represent a tremendous IC liability that could handicap future generations. Thus, the corporate and social responsibility required of leadership today is to assess the opportunities and visualize this journey through intangibles as an attempt to chart an intellectual capital map.

Moreover, the core meaning of IC and the leadership challenge is future earnings potential. In this perspective, we witness a growing focus shift not only to intangibles but also to relational capital dimen-

sions. This is increasingly evident if we look at the entertainment and sport sectors, which are systematically taking advantage of the value of its customers, user clubs, fan clubs and supporter clubs. At the same time, these sectors supplement this with IT by broadcasting football games as well as converting cell phones into handheld mobile entertainment stations. This is the core aspect for brand value or intellectual property dimensions.

So, the most challenging dimension for the rapidly evolving future will be that of attempting to keep pace with and predict innovations that are up ahead, in other words, in the *ignorance space*. This book will undoubtedly provide you with some insights on new developments you were unaware of in the field of IC and thereby give you added value for broadening your knowledge.

For the above reasons, this book published by Luiz Antonio Joia represents a further step forward in the study of intellectual capital and its strategic implications with relation to the competitiveness of companies and organizations. The selected chapters of this book will enable readers—academics, practitioners, or those interested in understanding more about the complex field of intellectual capital research—to delve more deeply into the study of intellectual capital and the main challenges it presents for the future.

We heartily congratulate Luiz Antonio Joia on his initiative and efforts to bring together in this book a collection of varied and interesting chapters that throw light upon the complexities involved in analyzing knowledge-based resources.

Read and enjoy!

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ENDNOTES

1 Edvinsson, L. (1997). Developing intellectual capital at Skandia. *Long Range Planning*, *30*(3), 366-373.
2 Edvinsson, L., & Malone, M. (1997). *Intellectual capital: The proven way to establish your company's real value by measuring its hidden brain power.* London: Piatkus.
3 See www.akwissensbilanz.org.
4 See www.meti.go.jp/press/20060329003/20060329003.html.
5 See http://execupery.eu/dokumente/RICARDIS report version March 2006.pdf.
6 Ordóñez de Pablos, P. (2004). A guideline for building the intellectual capital statement: The 3R model. *International Journal of Learning and Intellectual Capital*, *1*(1), 3-18.
7 See www.intellectualcapital.se.

Preface

THE GENESIS OF THE INTELLECTUAL CAPITAL THEORY

The consolidation of intellectual capital as a fully-fledged knowledge field is still in progress. It should be borne in mind that it was only fifty years or so ago that some pioneering thinkers foresaw the importance of intangible assets for a company, thereby laying down the initial foundations for this very recent discipline.

In 1945, Frederick Hayek presented research about the importance of knowledge in society (Hayek, 1945). Then, in a seminal work, Fritz Machlup, from Princeton University, produced an eight-volume work in 1962, under the general title *Knowledge: Its Creation, Distribution, and Economic Significance* (Machlup cited in Stewart, 1997, p. 11). In this work, using data gathered in 1958, it was established that 34.5% of the gross national product of the United States could be ascribed to the information sector. In 1993, Peter Drucker analyzed the new knowledge economy and its consequences (Drucker, 1993). Subsequently, academics, researchers and practitioners have increasingly highlighted the importance of the intangible assets of a corporation and even those of both countries and organizations, including non-profit entities (Dragonetti & Roos, 1998; Bontis, 2004).

A watershed was reached in July 1994, when a meeting took place in Mill Valley with a view to establishing how the knowledge of an organization could be adequately measured. Knowledge may be intangible, but that does not mean that it cannot be measured. Markets do precisely that when they value the stock of highly knowledge-intensive companies way above their book value.

In 1995, Skandia—the largest insurance and financial services company in Scandinavia—released its Intellectual Capital Annual Report, based on its Navigator framework (Edvinsson & Malone, 1997). Some other companies, such as Dow Chemical, the Canadian Imperial Bank of Commerce, Posco, and so forth, to name but a few, also entered this new era.

Several research articles have been published and timely *praxis* has been developed to measure the Intellectual Capital of an enterprise: Sveiby (1997); Roos et al. (1997); Bontis et al. (2000); Petty and Guthrie (2000); Low (2000); Sánchez et al. (2000); Joia (2000); Guthrie (2001); St Leon (2002); Rodov and Leliaert (2002); and Hunt (2003), among others.

THE IMPETUS BEHIND THE INTELLECTUAL CAPITAL THEORY

There is no single definition for intellectual capital (IC). Kaufmann and Schneider (2004), for instance, analyzed several definitions for this construct. Most of them are associated with the definition of intangible assets and knowledge resources, as stated by Rastogi (2003, p. 230): "*IC may properly be viewed as the holistic or meta-level capability of an enterprise to co-ordinate, orchestrate, and deploy its knowledge resources towards creating value in pursuit of its future vision.*" In line with this, Petty and Guthrie (2000, p. 158) define IC as "*the economic value of the intangible assets of a corporation.*"

According to Edvinsson and Malone (1997), Roos et al. (1997), Sveiby (1997), Stewart (1997) and Joia (2000), the impetus for the development of a theory of intellectual capital derives from the increasing value of the ratio between the market and the book (M/B) values of organizations. Indeed, some authors, such as Ordóñez

de Pablos (2003, p. 63) not only agree with this, but also support the claim that a firm's intellectual capital is the difference between its market (M) and book (B) values.

Some might say that different depreciation policies can influence the book value (B) calculation. It is a valid point, and is the reason why Tobin (1969) suggests the use of replacement cost, defining q as (market value)/(replacement cost of the assets). The replacement cost concept was developed in order to circumvent the differing depreciation policies used by accountants world-wide. If q is greater than 1, the asset is worth more than the cost of replacing it, thus it is likely the company will seek to acquire more assets of this kind. However, this reasoning has no longer been able to explain the recent increases in M/B values.

At this point, a very important question needs to be asked, namely: why should firms value or measure their intellectual capital? According to Andriessen (2004, pp. 232-233), this should be done for six reasons:

a. What gets measured gets managed;
b. To improve the management of intangible resources;
c. To monitor effects caused by actions;
d. To translate the organization's strategy into action;
e. To weigh up possible courses of action; and
f. To enhance the management of the organization as a whole.

In addition to this, Marr et al. (2003, p. 443) reveal five main reasons why firms value their intellectual capital, as presented below:

a. To help organizations formulate their strategy;
b. To assess strategy execution;
c. To assist in diversification and expansion decisions;
d. To use these as a basis for compensation; and finally,
e. To communicate measures to external stakeholders.

This is proof of the pressing need impinging upon organizations to evaluate their intellectual capital in order to improve their managerial *praxis*, as well as to achieve better outcomes.

In line with this, the intellectual capital theory purports to enable firms to understand their hidden assets better (Rastogi, 2003, p. 230). In this regard, it is important to understand the components of an organization's intellectual capital, namely human, organizational, and relationship, as well as innovation, renewal and social, capital.

LINKING INFORMATION TECHNOLOGY AND INTELLECTUAL CAPITAL

On the other hand, a movement was fomented by academics and executives since the early 1980s to use information technology (IT) not only as a tool for processing data more rapidly, but also as a powerful strategic weapon. The need to use IT as an enabler to reformulate old processes, rather than simply automate existing practices was perceived by these academics and executives (see, for instance, Davenport & Short, 1990, and Venkatraman, 1994).

As Internet technology became more readily available, the reformulation of productive processes in the business arena became a reality, leading most companies to strive for greater efficiency, efficacy and accountability in their relationship with their stakeholders.

Hence, this book draws on the fusion of these two former mainstreams, namely information technology and the strategic role of intellectual capital in firms.

In line with this, the main scope of this book is to show how information technology (IT) is linked to the intellectual capital of a firm, that is, to establish what the role of IT really represents in the human, organizational,

relationship, innovation, renewal and social capital of a company, namely the components of its intellectual capital. In other words, the purpose of this book is to analyze how IT has created a new mandate for management in a knowledge economy, in order to develop new business models and frameworks. Thus, a specific chapter will show the role and impact of IT on a firm's human capital, as well as new models to be used, while another will do the same for the company's relationship capital, and so forth. In this way, we can grasp the massive transformation IT has wrought on the way corporations need to be managed and propose new models based on the pervasive role IT plays in the current business arena.

THE STRUCTURE OF THE BOOK

This book contains 15 chapters, gathered under two section headings. Section I, *Intellectual Capital: Origins and Future Prospects*, analyzes the main facets of intellectual capital theory per se, in order to make it easier for the reader to grasp the potential of this new knowledge field.

Section II, *Intellectual Capital and Information Technology*, goes on to link the intellectual capital theory with information technology, revealing how the latter can impact the former in the business realm.

In Section I, there are seven chapters, as summarized below.

Chapter I outlines how intellectual capital as a theme has evolved in different academic disciplines and discusses inter-disciplinary views on intellectual capital. The author also outlines some of the major issues to be addressed as well as some possible avenues on how to take this important field forward.

Chapter II analyzes the concept of intellectual capital in strategic management research. The authors offer a comprehensive view of the key pillars and concepts formulated over the past twenty years in strategic management literature, thereby laying down the grounds for intellectual capital constructs and related components.

Chapter III establishes what the main components or building blocks of an intellectual capital balance sheet are, taking the three most common components of intellectual capital (human capital, structural capital, and relational capital) and testing empirically if this grouping of intangible assets is supported by the evidence obtained from a sample of knowledge-intensive firms from Boston's Route 128. According to the authors, the findings suggest a classification of intellectual capital according to four categories: human capital, structural capital, relational business capital, and strategic alliances.

Chapter IV provides an alternative method for measuring and reporting human capital items in financial statements. The authors explain the need for disclosing human capital information adequately in financial statements. They show the results from an empirical study they performed to test the validity of the human capital architecture and its relationship with a firm's performance.

Chapter V presents a comparative evaluation of some of the most commonly used intellectual capital (IC) measurement models. These models include Skandia's IC Navigator, the Intellectual Capital Services' ICIndex™, the Technology Broker's IC Audit, Sveiby's intangible asset monitor (IAM), citation-weighted patents, and real option theory. According to the author, each model is classified using dimensions of temporal orientation, system dynamics and causal direction.

Chapter VI proposes a method for the financial valuation of intangibles based on specific taxonomy that distinguishes between intangible assets and core competencies, while classifying the latter into (tangible or intangible) asset-driven core competencies and non asset-driven core competencies. According to the authors, this method is suitable for valuing the intangibles of large companies and smaller businesses where large databases are not available.

Chapter VII examines how firms measure and report their knowledge-based resources. Based on the analysis of intellectual capital statements published by 28 pioneering firms from Europe and India, the authors explore key issues on drafting this innovative report. At the end of the chapter, the authors present major conclusions and implications for management.

In Section II, there are eight chapters, as summarized below.

Chapter VIII examines the contribution of IT systems and tools to the emergence and use of different types of knowledge in a firm. The authors conclude that the bulk of IT applications assist in the dissemination, storage and acquisition of explicit knowledge. However, there are also some tools that serve to elicit tacit and potential knowledge and facilitate the conversion from tacit to explicit knowledge. At the end of the chapter, the authors evaluate the potential provided by IT in more general terms.

Chapter IX examines how different types of virtual communities function as platforms for the formation of social capital, which in turn foster the production of new intellectual capital. The authors propose information technology-enabled social capital as a framework for understanding how organizations generate intellectual wealth. Specifically, the authors claim that social capital in physically-based virtual communities improves the incremental continuous development of existing intellectual capital, while in Internet-based communities it facilitates the generation of new intellectual capital through radical innovations and paradigmatic change.

Chapter X discusses and introduces a quantitative method for aligning information technology resources with the knowledge management of an organization, the purpose of which is to quantify the intensity of the available software functions, so as to maximize the benefits and minimize the costs of the knowledge management process. According to the authors, the most important thing to emphasize about the method proposed here is its capacity for aligning investments in information technology resources with the organization's knowledge management process. Other advantages include the capacity for defining priorities for investments in software functions and the creation of adequate algorithms for knowledge management.

Chapter XI describes which information and communication technologies (ICT) can help in the process of managing knowledge and intellectual capital in organizations. The authors classify all of them according to their utility in assisting in knowledge management and intellectual capital management, and in which of the processes needed in organizations for managing knowledge and intellectual capital they can be used.

Chapter XII analyzes the influence of knowledge-sharing in the context of IT project management. The research made it possible to establish that the factors that influenced knowledge-sharing and consequently the project itself can be related to the context and dynamics of the institution in which the system was implemented, to the way in which the project was planned and conducted, and also to the individual characteristics of the participants.

Chapter XIII seeks answers to two questions, namely what types of intellectual capital are affected by IT and how IT can affect these types of intellectual capital? An analysis of intellectual capital indicators of the banking industry using an input-process-output model reveals that the process mediator variables, namely management capabilities, are highly affected by information technology. According to the author, information technology plays a key role in supporting decision-making, making business innovations possible and tightening controls of various processes through its tracking, information, dissemination, analytical, simulative, and detection capabilities.

Chapter XIV analyzes the impacts of Intranet quality on organizational capital practices. The authors describe a research model empirically tested in 98 large Brazilian organizations. The variables proposed by the TAM (*technology acceptance model*) and the TTF (*task technology fit*) were converted into portal context, emphasizing the importance of leveraging classic information science and information system studies to understand the portal phenomenon better. Furthermore, the *knowing organization* model was applied in order to offer a theoretical backing for the intellectual capital-based variables. According to the authors, the results revealed evidence that portal quality has more influence on knowledge creation than on "sense-making" and decision-making.

Chapter XV analyzes the potential of RFID technology with respect to the relationship between retailers and their clients, in order to understand how this technology is capable of increasing a firm's customer capital, in line with intellectual capital taxonomy. Prospective scenarios are elaborated by the author concerning the use of this technology to enhance the relationship between retailers and their customers in order to increase a firm's customer capital—which is an intangible asset.

FINAL REMARKS

This book sets out to straddle two very important, albeit still separate knowledge fields, namely information technology (IT) and intellectual capital (IC). In a knowledge and network economy, such as the business environment is becoming today, it is of paramount importance to understand how information technology can enable the creation and leveraging of valuable intangible assets within a firm. Most resources that are considered sources of sustained competitive advantage are nowadays intangibles, accruing from the human, relationship, organizational, as well as renewal, development and social capital of a firm, namely the components of the intellectual capital of a company. Moreover, these capitals can also be strategically fostered through the use of information technology and the processes enabled by it, in order to lead the firm to a position of superior performance.

By the same token, information technology projects can also be assessed through the use of the intellectual capital theory, as most of the outcomes accrued from them are intangibles.

In conclusion, this book seeks to analyze this former virtuous circle, namely intellectual capital and information technology. By doing so, it sets out to enable the readers—academics, graduate students and practitioners alike—to understand more clearly how information technology can place the market value of a firm far above its book value, which is a phenomenon that industrial management *praxis* is as yet unable to explain.

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Luiz Antonio Joia, DSc
Editor
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Section I
Intellectual Capital: Origins and Future Prospects

In the seven chapters of this section, the origins, characteristics and main features of the intellectual capital theory are addressed. The impetus behind the development of the intellectual capital theory and the rationale behind it are explained. Several taxonomies associated with intellectual capital and measurement models to evaluate the intangible assets of a company are also presented. The relationship of intellectual capital with other knowledge fields, such as strategic management, is also addressed and, lastly, some challenges facing this approach are outlined.

Chapter I
What is Intellectual Capital?[1]

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ABSTRACT

Today, intellectual capital is widely acknowledged as a principal driver of performance and a core differentiator for both private enterprises and governments. This interest in the topic has caused a flurry of activities across many disciplines from accountants, to HR professionals, to strategists. Where this has raised the profile of intellectual capital, it has also caused significant confusion about what intellectual capital is. What is often not clearly understood is that intellectual capital is a truly multidisciplinary field. This chapter outlines how intellectual capital as a theme has evolved in different academic disciplines and discusses inter-disciplinary views on intellectual capital. It also outlines some of the major issues to be addressed as well as some possible avenues of how to take this important field forward.

INTELLECTUAL CAPITAL TODAY

Today, many executives recognize the importance of intellectual capital as a principal driver of firm performance and a core differentiator (see, e.g., Marr, 2006; Carlucci et al., 2004; Marr, 2004b). But not only enterprises are seeing the value in intellectual capital; governments are also recognizing the importance of it (Marr, 2004c). The European Union, for example, aims for their membership countries to invest a minimum of three percent of their GDP into research and development initiatives in order to grow their intellectual capital and become more competitive in the knowledge economy. In the United Kingdom, for example, Prime Minister Tony Blair wrote in a recent Government White Paper that creativity and inventiveness is the greatest source of economic success but that too many firms have failed to put enough emphasis on R&D and developing skills. Patricia Hewitt, the UK's Secretary of State for Trade and Industry, added in a recent report that increasingly it is the

intangible factors that underpin innovation and the best-performing businesses.

An increasing number of firms start to report more of the intangible aspects of their business, even without the force of regulations. This trend is especially observable in Europe with various initiatives by the European Commission (e.g., projects such as METITUM, E*KNOW NET, PRISM). Another example is presented by the Danish Department of Trade and Industry, which produced guidelines of how companies can produce intellectual capital reports. In Austria the government has passed a law that all universities have to report on their intellectual capital, in the UK companies will be forced to produce an Operating and Financial Review outlining many intangible elements of their business, and countries as diverse as Iceland, Germany, and Spain have started their own initiatives.

At the same time accounting guidelines are being amended and standards are being questioned and reviewed to reflect the growing importance on intangible elements. With the introduction of the International Accounting Standards more emphasis will be placed on accounting for intangible components and stricter compliance rules force companies to report on other intangible aspects of their performance. Leading software companies such as SAP, Hyperion, Oracle, 4GHI and Peoplesoft are developing applications to address this, and even governments are beginning to measure the intellectual capital of cities, regions, and countries.

Also, many consulting companies have discovered different areas of this increasing awareness and interest in intellectual capital and now offer their services. *PricewaterhouseCoopers*, for example, offer their services to help companies in their value reporting initiatives to increase transparency in corporate reporting, while *WatsonWyatt* offer human capital audits. In recent reports or marketing material from different consulting firms this trend is apparent: *Accenture* writes that today's economy depends on the ability of companies to create, capture, and leverage intellectual capital faster than the competition. *Cap Gemini Ernst and Youn*g believes that intangibles are the key drivers for competitive advantage and *KPMG* states that most general business risks derive from intangibles and organizations therefore need to manage their intangibles very carefully. *PricewaterhouseCoopers* writes that, in a globalized world, the intellectual capital in any organization becomes essential and its correct distribution at all organizational levels requires the best strategy, integrated solutions, processes and technology.

Even though the leading management consulting firms recognize the importance of intellectual capital, they seem to suffer from the same predicament as the field as a whole. Intellectual capital is defined differently and the concept is often fuzzy (see, e.g., Marr & Adams, 2004). As a result, many firms provide point solutions only addressing particular isolated aspects of a firm's intellectual capital such as:

- help with implementing accounting for some intangibles,
- legal advice of how to protect intellectual property such as patents, copyrights, and so forth
- guidance on building customer or stakeholder relationships
- improved stakeholder dialogue and value reporting
- human capital or capabilities assessments
- solutions for valuing brands

Even though these are all important areas, the danger is that organizations are missing out on the big picture. What is often not clearly understood is that intellectual capital is a truly multidisciplinary field. Next, we will expand on this problem.

MISUNDERSTANDING INTELLECTUAL CAPITAL AS A BARRIER FOR CONVERGENCE

The multidimensional nature of intellectual capital, as defined by many members of the community, is often not well understood, which means definitions are not always very clear and neither are the boundaries of what people mean when they talk about intellectual capital. In a recent book to address exactly the multidimensional nature of intellectual capital, I outline that it could happen that when one talks to accountants they might refer to intangibles as 'non-financial fixed assets that do not have physical substance but are identifiable and controlled by the entity through custody and legal rights" as defined by the Accounting Standards Board in FRS 10, their main standard for reporting intangibles and goodwill. Such a stringent definition excludes many commonly accepted intangibles like customer satisfaction and knowledge and skills of employees, as they cannot be controlled by the firm in an "accounting" sense. If one then went to a HR manager she might refer to intellectual capital as skills, knowledge, and attitude of employees. A marketing manager might argue that intellectual capital such as brand recognition and customer satisfaction are at the heart of business success, whereas the IT manager might view key intangibles as being software applications and network capabilities.

Furthermore, different words are being used to describe very similar constructs from different perspectives, which add to the confusion. In accounting, most people would refer to *intangible assets* to explain the non-financial and non-physical drivers of success. In Economics the phrase *knowledge assets* is often used to describe similar ideas, and in strategic management they use intellectual or *intangible resources* or *capabilities*. The potential power of the field of intellectual capital is to create a truly inter-disciplinary view of these different constructs and ideas.

When intellectual capital is defined by members of the intellectual capital community, it is often divided into various components, which refer to the skills and competencies of people in the organisations (*human capital*), then components referring to relationships with customers or other stakeholders (*relationship capital*), and components referring to organisational culture, routines and practices, or intellectual property (*organisational* or *structural capital*). Even though these components are often defined or bundled slightly differently, it shows how broad the scope of the concept of intellectual capital really is.

One key role of members of this community is to make the concept of intellectual capital more accessible to the different fields that often clearly recognise the importance of intellectual capital components, but miss out the big picture and therefore the interdependencies and interconnections between the different elements. Much emphasis has recently been placed on the interactions and interdependencies of different intellectual capital components. Firms are now realising that, for example, by valuing their brands companies only get a partial view of the truth since their brand value is linked to other crucial aspects, such as their processes that produce high-quality products and services, their relationship, the reputation, and the competencies of their employees. Examples such as Arthur Andersen show how quickly a well-recognised brand can disappear overnight if some of the other organizational components are missing. What the field of intellectual capital has to offer is a more comprehensive view of the organizational elements and how they deliver value and competitive advantage. By converging some of the point solutions into a more strategic overall package, consulting firms would be able offer their clients truer and more insightful help. The current misunderstandings and the isolated point solutions offered by many, mostly major firms, does seriously make one question the thought leadership claimed in much of their mar-

keting material. There is a huge opportunity here for scholars to bring together different strands of research to form a more complete picture of intellectual capital management.

EVOLUTION OF INTELLECTUAL CAPITAL AS A THEME

When we look at the way the theme of intellectual capital has evolved over time it is interesting to note that, against many common beliefs, the concept is not a new phenomenon—in fact the economist Nassau William Senior mentions "intellectual capital" as an important production factor in his book published more than 150 years ago in 1836. Economists and scholars in the strategy field have long discussed the importance of knowledge-based assets.

Also interesting to note is that intellectual capital is often referred to as a "practitioner driven concept." It is often argued that the concept of intellectual capital was developed by visionary companies such as Skandia or Dow Chemical, which started to measure and to report their intellectual capital in the 1990s. There has indeed been a strong practitioner driven movement in the middle of the 1990s towards tools and approaches for measuring, managing, and reporting intellectual capital. Many of these practitioner books propose classification frameworks of intellectual capital and approaches to measure and manage it. This triggered a seemingly separate intellectual capital movement that was primarily concerned with practical applications. Most of these approaches were based on initial experiences of firms and were to a large extent developed in isolation from any academic work done previously.

The first to discuss the topic academically were economists who highlighted the importance of intellectual capital as a production factor and the different behavior of intellectual capital in comparison to traditional economic assets. A long stream of publications reached its pinnacle in the development of *The New Growth Theory* developed by Raul Romer, of the University of Stanford, who proves that economic growth is based on knowledge. The theory is in strong opposition to the classical economic theory and is based in many respects on the works of the Nobel Prize winner Robert Solow. While the parts of the economic model of Solow are capital, technology and labour, Romer has added also knowledge as a superior part that directs the use of capital, technological development and quality of labour.

Some of these developments in economics were picked up in the strategic management field. The development of the *resource-based theory* in the 1980s and the *knowledge-based theory* in the 1990s challenged the traditional market-based theories. It is argued that a sustainable competitive advantage results from the possession of resources that are inimitable, not substitutable, tacit in nature, and synergistic. With this newly developed emphasis on internal resources, special attention was placed on competencies, capabilities, and knowledge-based assets (Marr, 2004a; Spender & Marr, 2006). It is interesting to note that in the strategic management literature the terminology intellectual capital is rarely used, but the same constructs are referred to.

In parallel there were activities in the field of accounting, with attempts of the major accounting bodies around the world to develop approaches to account for intellectual capital. This was to provide a better picture of firms in which intellectual capital are major assets but where stringent accounting principles would prevent recognition of such assets. This debate has been discussed since the 1970s and new guidelines for accounting of intangible assets have emerged regularly. Interesting to note is that accountants also rarely refer to intellectual capital, as they seem to prefer the term intangible assets. The theme of intangible assets has become a major subject matter in the accounting field and conferences, as well as special issues of journals fueling the ongoing debate on the topic.

Accounting takes a statutory inside-out view of the firm in order to externally disclose performance data in a standardized format driven by accounting rules. However, there has also been a movement to better *value intellectual capital* from an outside-in perspective. On the one hand, financial analysts, banks, and other investors looked for ways to better understand the potential value for firms; on the other hand, firms wanted to better understand the financial value of their investments in intellectual capital. This need was highlighted with the burst of the dot-com bubble. With the absence of reliable tools to value intellectual capital, speculation led to many firms being over-valued. However, after the return to reality, many innovative start-up firms, even with a sound business case, still find it hard today to secure funding. Approaches discussed in this perspective include EVA™, Discounted Cash Flow, and Real Options Models.

Related to the discussion in accounting and finance has been the work of a separate group of researchers that is concerned with the external *reporting* of intellectual capital. Surrendering to the thought that the rigid postulates of accounting will not allow the deserved treatment of intellectual capital, they associated themselves with the more practitioner-orientated management accounting field. The efforts of firms such as Skandia in the 1990s to externally disclose information on their intellectual capital has fueled this debate. This movement has resulted in various initiatives in Europe to design guidelines for firms to create intellectual capital reports, most notably an initiative in Denmark where many companies have experimented with producing and disclosing information on their intellectual capital.

When it comes to *marketing* it seems that intellectual capital and much of the above outlined research is often ignored. The term intellectual capital is rarely used; however, customer relationships and brands are often classified as intellectual capital and definitely represent important intangible assets for firms. One of the issues in marketing is the drive towards demonstrating the importance of investments into building assets such as brands or relationships with customers. The same issue applies to *human resource management*. However, here the topic of intellectual capital is addressed but more from a personal perspective—how do we assess the knowledge and capabilities of individuals? It seems that in both of these fields accounting and finance driven models have hindered developments. External valuations of brands or *Human Resource Accounting* were brought into the disciplines from other, maybe more financially and measurement driven perspectives.

Another view on intellectual capital developed in complete isolation is provided by the *legal perspective*. Work in this perspective is primarily concerned with how to legally protect intellectual capital such as patents, trademarks, or copyrights. These are generally referred to as intellectual property. With an exception of maybe the pharmaceutical industry, this topic has rarely been discussed outside legal departments. However, many recent publications are trying to raise awareness among executives about the strategic importance of intellectual property.

Above I have summarized how intellectual capital as a theme has evolved in different academic disciplines. Many of these disciplines have developed the intellectual capital theme in isolation and with little awareness of developments in other fields. The second part of this chapter includes inter-disciplinary views on intellectual capital. These establish starting points for cross-disciplinary knowledge transfer, open new research streams, or provide views that could add insights to new developments.

One interesting development outlined is lifting the level of analysis from an individual or firm level towards an inter-firm or even regional or national level of analysis. Closer supply chain integrations and more inter-firm collaborations mean that intellectual capital issues between firms need to be addressed. On an even higher

level is the question of whether we are developing the right intellectual capital in cities, regions, counties, and countries. These are exciting new avenues for future research.

Other interesting insights can be gained from philosophy and epistemology—the oldest disciplines to influence the theme of intellectual capital. Intellectual capital is related to knowledge and the debate about what knowledge means goes back to Plato (427-347 BC), who defined knowledge as "justified true belief," which trigged an unremitting epistemological discussion throughout the evolution of philosophy among philosophers including Descartes, Locke, Kant, Hegel, Wittgenstein, and Heidegger, to name just a few. The way we perceive the world and our role in it influences our view of intellectual capital. These insights open up interesting research opportunities and offer new insights into the way intellectual capital is managed, measured, and reported.

TOWARDS CONVERGENCE: SOME POSSIBLE WAYS FORWARD

The multi-dimensional and diverse nature of thinking on the topic of intellectual capital is appealing; however, as a consequence there is no cohesive body of literature on intellectual capital. The developments of specialist publications such as the *Journal of Intellectual Capital* (established in 2000) and the *International Journal of Learning and Intellectual Capital* (established in 2004) are attempts to channel diverse thinking into single outlets. However, these journals are still in the process of finding their acknowledged position and have not yet managed to bridge all the disciplinary silos. The diverse nature of thinking on intellectual capital poses many challenges as well as immense opportunities for inter-disciplinary and cross-functional learning. Below I outline some of the major issues to be addressed as well as some possible avenues of how to take this important field forward.

Terminology and Definitions

The construct of "intellectual capital" has existed in management research for many years. However, different terminology used in different disciplines and different taxonomies of the same constructs have caused significant confusion and have restricted the potential for generalization and comparability of application and research in this area. To date there is no commonly agreed terminology or definition for the construct "intellectual capital."

Every discipline has different assumptions; every definition (whether made explicit or not) is linked to specific roles of intellectual capital, which in turn are often linked to the disciplinary assumptions. It is important to note that there is no right or wrong definitions of intellectual capital, however, what does exist are adequate and inadequate definitions of intellectual capital. The least adequate case is when authors fail to define intellectual capital at all and leave it to the reader to interpret the construct. This chapter has hopefully highlighted the differences in interpretations and therefore the resulting risk of misinterpretation due to a lack of adequate clarification.

It is therefore important that whenever we use terms such as intellectual capital, intangible assets, or knowledge resources, we explain what we mean by them. In addition, it would be useful to explain the perspective from which the topic is discussed (for more information see Marr & Moustaghfir, 2005).

Interdisciplinary Research

The field of intellectual capital seems to offer immense room for knowledge transfer between the individual perspectives and functions outlined in this chapter. It seems that the theories and insights developed in the economist and strategy perspectives provide a good grounding for other "less developed" intellectual capital perspectives. Theories such as the new growth theory

and the resource-based theory could inform the thinking in disciplines such as marketing, HR, and accounting.

This chapter has provided a comprehensive overview to the complex and interdisciplinary research and practice on the management, measurement, and reporting of intellectual capital. It is now up to managers and researchers to take the insights from the many perspectives and apply them to further our understanding across disciplines and between academia and practice. I would call for more interdisciplinary research projects and more collaboration between academics and managers.

Methodological Implications

It seems that there are different implications for different disciplines and research streams. Below I outline some implications offering future opportunities.

One opportunity seems to be to empirically test some of the practitioner driven frameworks. As outlined above, in the middle of the 1990s many classification and reporting frameworks were developed from experience of sometimes one or a very small number of firms and sometimes only based on anecdotal evidence. Many of those frameworks have never been subject to rigorous empirical tests. This offers great opportunities for researchers to test the wider applicability of some of those frameworks.

Another opportunity is to ground some of the practical frameworks in theory. Many theoretical foundations outlined in this chapter should offer an excellent starting point. Much of the academic work published on intellectual capital is of theoretical nature and often attempts to build theory. There is immense room for convergence here, the theories developed in academia can be used to ground the practical work; and the practical experience can be used to support or reject theories.

Economics and strategy are the disciplines with the longest track record of research on intellectual capital. However, theory testing research in these disciplines is traditionally performed using quantitative and large sample methodologies, often using secondary sources of data. It is important that we produce some of those studies, however, with the developments of new theories in strategy; for example, these traditional positivistic methods have been questioned. Rouse and Daellenbach (2002, 1999) for instance, argue in their influential article that research based on the resource-based view must be done not only on organizations but also in organizations, since the research methodologies traditionally used in strategy research will not unambiguously uncover the sources of sustainable advantage. Rouse and Daellenbach continue to argue that uniqueness springing from intangible resources (perhaps especially forms of knowledge) should form the focus of research. Thus, generalizable codifiable knowledge available from secondary sources is probably irrelevant to the core research agenda of the resource-based view (Rouse & Daellenbach, 2002).

What we need is rigorous and theoretically grounded empirical research not only provided by classical large sample, cross-sectional research projects but complemented by rich, longitudinal case studies that will allow us to understand the specific context which seems to be critical for the analysis of intellectual capital (Marr & Chatzkel, 2004). Research methods such as ethnography, participant observation, and other more phenomenological approaches might be appropriate.

The Level of Analysis

Most publications on intellectual capital have concentrated on the firm level and reported on issues related to the management, measurement, and reporting of intellectual capital (Marr et al., 2004; Pike et al., 2005; Marr & Spender, 2004).

More recently we have seen that the level of analysis has been raised. Contributions in this chapter have outlined some attempts to address intellectual capital on an inter-firm level and on a national or regional level. On the other hand, research on epistemology, for example, is often conducted on a personal level and rarely discussed on an organizational level.

Moving between these different levels of analysis offers exciting new avenues for future research and application. An interesting question that needs further exploration is how applicable are the insights, approaches, and tools developed on a firm level to a regional or national level? On the other side it would be interesting to apply and test the insights from epistemology and the way we handle and process knowledge on an individual level when looking at higher levels of analysis such as organizations, cities, regions, and nations.

Theme vs. Field

Maybe instead of a field, as often referred to by many practitioners, it might be better to talk about the intellectual capital theme or even a lens that allows us to gain new insights in different disciplines and fields. The challenge here is to learn from each other's insights and develop a bigger understanding of intellectual capital without re-inventing the wheel all over. I hope that this chapter has provided both managers and academics with a richer insight into the multi-dimensional nature of intellectual capital as an important construct in today's business context. It is now up to all of us to take the ideas and insights and utilize them for rigorous research and practical applications.

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ENDNOTE

[1] This chapter is based on the book *Perspectives on intellectual capital: Multidisciplinary insights into management, measurement, and reporting* (Marr, B., 2005, Elsevier) as well as other recent articles by the author (see References).

Chapter II
Exploring Intellectual Capital Concept in Strategic Management Research

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ABSTRACT

This chapter analyses the concept of intellectual capital in strategic management research. It offers a comprehensive view of the key pillar concepts formulated, in the last twenty years, in the strategic management literature grounding intellectual capital (IC) construct and related components. In the last years, IC has emerged as a key concept for the identification and assessment of company's intangible assets and knowledge resources. In this chapter it is argued that IC is an umbrella concept for understanding and integrating four fundamental categories of firm's resources: human capital, social capital, structural capital, and stakeholder capital. The authors believe that a clear understanding of the IC concept provides benefits for both theoretical and practical purposes. In order to develop a theory and/or theoretical implications about the role and the relevance of IC, it is necessary a clear understanding of the concept, which represents the fundamental unit and share of analysis.

INTRODUCTION

In the last several decades the emphasis on knowledge resources, on organisational competencies and, more generally, on firm-specific factors, has strongly contributed in creating a wide acknowledgement of the strategic role of intangible resources for a firm's success. A number of theoretical and practical contributions, outlining the centrality of knowledge and intangible resources for firm's performance improvement, have been produced.

Analysing the strategic literature it arises that a lot of terms, frequently interchangeable, with

definitions ambiguous as well as a juxtaposition of their meanings, have been coined to refer to and analyse cognitive and/or intangible resources of firm.

In particular, focusing on the concepts introduced over the last years in strategic management studies it is possible to incur a number of alternative and overlapping conceptual constructs, such as invisible assets (Itami, 1987), intangible assets (see e.g., Hall, 1992, 1993), intangible elements (see e.g., Carmeli & Tishler, 2004), knowledge assets (see e.g., Spender & Grant, 1996; Teece, 1998; Winter, 1987), and knowledge-based resources (see e.g., Wiklund & Shepert, 2003), as well as social capital (see e.g., Inkpen & Tsang, 2005; Nahapiet & Goshal, 1998; Yli-Renko, 2001), human capital (see e.g., Hitt et al., 2001), and so on.

More recently on the basis of such numerous and relevant interpretations and in an attempt to synthesise them into a more holistic and manageable construct, the concept of intellectual capital (IC) has been introduced and developed as a new interpretative category of such resources. It can be considered as a conceptualisation that better answers to the managers' need to have an operative notion of the firm's cognitive and intangible resources.

In particular, whereas constructs such as human capital or social capital focus on specific features concerned with a firm's intangible dimension (i.e., respectively, human and relational features), IC appears as an umbrella concept embracing the whole features and dimensions of intangible resources.

Furthermore, it allows one to group and represent the overall intangible assets that are not included in the traditional balance sheets, as well as allows one to assess the differences between the market value and book value of today's knowledge intensive firms. However, over the last years, the economic and management literature concerning IC has introduced different and often not shared definitions and characterisations.

The ambiguity of the formulated conceptualisations of IC and its components has been encouraged by practitioners' attention (see e.g., Edvinsson & Sullivan, 1996; Sveiby, 1997). This has involved that, although researchers and practitioners are nowadays using the same concept (i.e., IC), they have different views and interpretations due to their diverse background and experience. In other words, it is missing a common platform for analysing IC. This is a shortcoming for research as well as for practice. In fact, in order to develop a theory and/or theoretical implications about the role and the relevance of IC, it is necessary to ground the studies on a clear understanding of the concept, which represents the fundamental unit and share of analysis.

The clarification of the IC concept is useful not only for theoretical reasons, but mostly because a better understanding of the roots, components and nature of IC is at the basis of management actions. Managers perceive competitive context and define their actions also on the base of their mental models, schemes, beliefs and points of view about the internal and external firm's success factors. The way to conceive intangible resources or capital especially affects the way by which managers develop and deploy this kind of resource in defining and performing the firm's strategy.

In such a prospect, based on the results of a literature review, this chapter explores the concept of IC, tracking back its origin to other concepts adopted into the strategic management literature dealing with the analysis of a firm's intangible resources.

The chapter begins by reviewing some of the most relevant concepts coined and analysed during the last decades in the strategic management literature and concerning firms' cognitive and intangible resources. In particular, the review has been performed by analysing the contributions that appeared in strategic management journals published in the last twenty years. Then, taking into account the main insights that emerged from

the close investigation of literature, we analyse the construct of IC by clarifying its meaning and exploring its components.

On the basis of the results of the analysis we introduce a framework, theoretically founded on the main insights arisen from literature, directed to interpret IC concept and to disclose its components, according to a strategic management perspective. The proposed framework especially represents a conceptual structure for identifying IC components as well as for driving and supporting management in the evaluation and strategic deployment of an organisation's IC.

Finally, we summarise the main contributions of the chapter and suggest some future prospects for the research agenda.

THEORY FOUNDATION OF INTELLECTUAL CAPITAL

The concept of IC has its origins in the key idea concerned with the importance of some specific resources for company's competitiveness that has been sustained by new theories of strategic management such as resource-based view, competence and capabilities-based view and knowledge-based theory. According to these theories, a firm's success is largely determined by the resources owned and controlled by an organisation. In particular, the resource-based view argues that firm's resources can be important factors of sustainable competitive advantage that drive superior business performance when they posses certain special characteristics (Barney, 1991). A firm's sustainable competitive advantage results from the possession of resources that are hard to transfer and accumulate, inimitable, not substitutable, tacit in nature, synergistic (Barney, 1991; Rumelt, 1984; Teece et al., 1997; Wernerfelt, 1984) and not consumable because of their use (Davenport & Prusak, 1998). In fact, by acquiring, stocking, deploying and continuously nurturing those resources a company can maintain and achieve its competitive advantage (Barney, 1991; Collins & Montgomery, 1995; Peteraf, 1993; Rumelt, 1984; Wernerfelt, 1984). More specifically, a company strategically differentiates from its rivals both by the imperfect imitability and substitutability of its specific resources and by its capabilities, that is, the ways of combining and deploying those resources (Amit & Schoemaker, 1993; Grant, 1996; Prahalad & Hamel, 1990; Teece et al., 1997).

Value comes mainly from capabilities which are strictly idiosyncratic and accumulated over time (Dierickx & Cool, 1989). Capabilities are founded on knowledge and learning process taking place within organisation (Iansiti & Clark, 1994; Leonard Barton, 1995). The concepts of competencies and capabilities are mainly stressed in the mainstreams of competence-based view and capabilities-based view (Prahalad & Hamel, 1990; Stalk et al., 1992; Vickers-Koch & Long, 1995), which consider the company's ability to recognise, create, strengthen and increase its "core competencies" as the source of a sound competitive advantage. The competence-based view, particularly, conceives the company as a portfolio of competencies and its competitiveness is based on the creation and development of core competencies and on the realisation of a strategy able to create an integration between aims, resources and competencies (Prahalad & Hamel, 1990, 1993). Capabilities and competencies have their foundation in knowledge. Around this belief more recently the knowledge-based theory (Grant, 1998; Spender & Grant, 1996; Sveiby, 2001) has been formalised. This theory sustains that knowledge is a key resource for a company's success and the main concern of any organisation has to be protecting, developing and integrating the organisational knowledge to create value.

In the last decades, grafting on the theoretical foundation of the above mentioned research mainstreams, several conceptualisations for company's strategic resources have been developed, such as intangible assets, knowledge capital, social capital

and so on. This has generated a large amount of concepts and characterisations related to intangible organisational resources.

EXPLORING THE CONCEPT OF INTELLECTUAL CAPITAL

Through a systematic literature review of strategic management literature we have explored the concept of IC.

A step-by-step process has been implemented; it has included the following main phases: (i) planning of the review process by defining a review protocol; (ii) identification and evaluation of significant articles (by conducting a systematic research and an evaluation of articles); (iii) extraction and synthesis of data; (iv) reporting of the findings.

The literature review process has started from the research question "What are the theoretical foundations of the IC concept and how it can be interpreted, identifying its main components, in the light of the strategic management literature?" This research question has driven the definition of the factors at the basis of the literature review, such as the disciplinary perspective to be adopted, the searching keywords and the quality of the research sources. Figure 1 and Table 1 depict the keywords and the inclusion criteria adopted along the review process. The keywords for the selection of papers were defined on the basis of the experience of the research team as well as by consulting other academics. In particular, the investigation of the literature has been performed assuming a distinction between the following concepts: resource, asset and capital. It is considered that resource is any factors tangible or intangible that a firm can use in its value chain processes. Asset stands for a company's resource which is strategically relevant to acquire or to produce economic benefits for an organisational system. While capital indicates a stock of assets that are attributed to an organisation and most significantly contribute to sustain or improve its competitive position. For the purpose of the research we have focused our attention on the concept of capital. We have especially investigated the various forms of capital identified in the literature and related to the IC construct by means of a review of the key outlets for scholarly research in the strategic management field (see MacMillan & Stern, 1987; MacMillan, 1989, 1991, 1994) (see Table 2). In particular only scholarly articles published from 1985 to june 2005 were included for the review process.

Enabled by electronic search tools, we used keywords and search strings to identify relevant papers. These papers have been imported into a reference manager database and downloaded in full-text format. Each article was analysed. The results of this analysis were stored into the reference manager database in accordance with specific workform. The analysis of the selected papers have been carried out on the base of the following investigation items:

1. Analysis of the core definition used to build up an understanding of the constructs;
2. Identification of the sub-components of the constructs;
3. Understanding of the links between the constructs and company's value.

Summarising the results of the literature review the following "pillar concepts" emerged as key ones: human capital, social capital, organi-

Figure 1. Search keywords

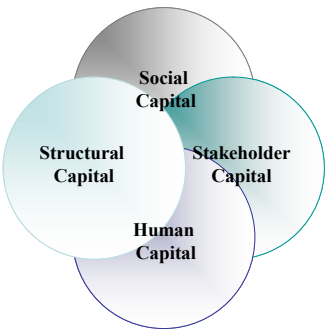

Table 1. Inclusion criteria

	Inclusion criteria	**Reason for inclusion**
1	Published papers/articles since 01/01/1985	The main contributions to the theoretical concepts that we intend explore started to be published after 1985
2	Papers/articles in the English language	The language in which the main scholarly business journals are published in English
3	Papers/articles that aim to understand each of the analysed constructs in terms of meaning and/or components	This matches with the objective of this review, that is, a better understanding of the meaning and/or components of each of the studied constructs
4	Paper/articles that address strategy issues and are published in the top strategic management journals	The main theoretical contributions related to the analysed concepts have been made by strategic management scholars in top journals
5	Scholarly published paper/articles	To provide more rigorous arguments and theoretical foundations for the proposition and assumptions that the review intends to develop

Table 2. List of journals

Journals (*Source: MacMillan, 1994)*
1. Strategic Management Journal
2. Administrative Science Quarterly
3. Academy of Management Journal
4. Academy of Management Review
5. Management Science
6. Rand Journal of Economics
7. Harvard Business Review
8. Organisation Science
9. Sloan Management Review
10. California Management Review
11. Organisation Studies
12. Journal of Management
13. Journal of Management Studies
14. Organisational Dynamics
15. Academy of Management Executive
16. Decision Science

sational capital, structural capital, customer and stakeholder capital.

Human Capital

The concept of human capital (HC) has emerged in human management theory as formulated by Becker (1964) and Schultz (1961). However, the inclusion of HC as an important factor influencing economic growth has been addressed by the development of the growth theory by Solow (1956, 1957) in the 1950s.

According to human management theory it is possible to apply economic logic to the study of people's decisions dealing with their work, the improvement of their skills and knowledge and, more generally, each occurrence of lifetimes. This in turn means that HC construct can be defined and analysed mainly according to an unit of analysis which is the individual. This is aligned with most of theoretical contributions related to HC. For example, most definitions of HC stress clearly the individual nature of this construct. For instance, Leana and Van Buren III (1999) define HC as people's knowledge and technical ability. DeFilippi and Arthur (1998) describe HC as people's skills. Dess and Picken (2000) and Youndt et al. (2004) state that HC consists of the individual's capabilities, knowledge, skills and the experience of the company's employees and managers, as they are relevant to the task at hand, as well as of the capacity to create a reservoir of knowledge, skills, and experience through individual learning.

Pennings et al. (1998) argue that the HC of a firm is the knowledge and skills of its professionals aimed to produce professional services. Bolino et al. (2002) declare that HC is reflected by education, training, or experience of people. Adopting an etiologic perspective, Burt (1997) interprets HC as the quality of individuals. Therefore the individualistic perspective is the primary view of HC.

However, it is important to highlight that some authors also include in HC some components of social nature. According to Nonaka and Takeuchi (1995), the social nature of HC allows one to better understand, on the one hand, how this kind of capital can be developed and, on the other hand, how this capital contributes to create higher value for the firm. In fact, some skills and knowledge can be developed only in an organisational context and embodied in a team of employees. In addition, the creation of new knowledge and/or the improvement of existing knowledge depend on the interaction and relationships among people. To this regard Lengnick-Hall and Lengnick-Hall, (2003) outline that high-quality HC has to take into account the social components in order to drive the acquisition of competitive advantages in the knowledge economy. In particular, they focus their attention on the relevance of the relationships among people and claim that, within a company, the human resources department's role has to be that of facilitator and coach in identifying, encouraging, and supporting the establishment of relationships that are useful and valuable for the organisation, and in putting formal and informal systems in place that nudge these relationships in the right direction.

Summarising the alternative interpretations of HC it seems possible to conceive of HC as the knowledge, skills, intellect, relationship attitude, talent and behaviour of employees.

In accordance with this interpretation HC is an holistic concept which denotes the organisation resources and assets related to a firm's people.

From the literature analysis it raises that the most important components of HC are: knowledge of people; know-how of people; expertise of people; skills of people; problem solving capability of people; innovation capacity of people; teamwork capacity of people; productivity of people; formal training of people; learning capacity of people; education of people; leadership and management ability; and ability of people to manage change.

Those resources and assets define the value of the firm, from a static point of view, as well as represent key critical operative factors to support and drive value creation dynamics over the time. Particulary, to this last regard, HC theorists (e.g., Becker, 1964; Schultz, 1961) stress that HC contributes to create value because an increase in worker skills, knowledge, and abilities most likely translates into increased organisational performance. When people possess high levels of knowledge and skills they generate new ideas and techniques that can be embodied in production equipment and processes; they initiate changes in production and service delivery methods; and they improve the links between employees, managers, and customers (Berg, 1969). For example, Dutta et al. (2002), exploring pricing capability, state that:

An effective pricing process can't be run on automatic pilot. It requires well-trained people who understand the company in all its complexities - its strategy, range of products or services, customers, suppliers and competitors. Companies can meet this requirement by training existing employees and by hiring business school graduates or seasoned executives who bring pricing expertise with them. (p. 64)

HC doesn't operate in isolation but it is integrated with other forms of resources and assets. Burt (1997) argued that an organisation has to leverage the skills and capabilities of its employees by encouraging individual and organisational learning as well as creating a supportive environment where knowledge can be created, shared and applied. Such a consideration leads to a crucial issue: the development and the effective utilisation for an organisation of its HC depends on investment in people skills and expertise, but also on the right relationships among people and a supportive structure. In other words, the concept and perspective of HC engage with other kinds of capital and particularly with social capital.

Social Capital

The term social capital (SC) was originally used by social theorists to describe and highlight the central importance of the relational resources, embedded in cross-cutting personal ties for the development of individuals over time in community social organisations (e.g., Jacobs, 1961; Loury, 1977).

The concept was popularised by Putnam (1993), who described SC as the combination of local institutions and trust relationships among economic actors that evolve from local cultures. According to this interpretation, SC is a networks of civic engagement that, increased over time, contributes to improve economic performance of an organisation system.

Recently, the concept has been applied to elucidate a broader range of social phenomena, including relations inside and outside the family (Coleman, 1988), relations within and beyond the firm (Burt, 1992), the organisation-market interface (Baker, 1990), and public life in contemporary societies (Putnam, 1993, 1995). Likewise, several definitions have been proposed by a number of researchers facing different units of analysis, such as individuals (e.g., Baron & Markman, 2000; Oh et al., 2004; McFadyen & Cannella, 2004; Belliveau et al., 1996; Starbuck, 1992); groups (e.g., Baker, 2000; Lengnick-Hall & Lengnick-Hall, 2003; Oh et al., 2004; Bhappu, 2000; Adler & Kwon, 2002; Levin & Cross, 2004; Senge & Carstedt, 2001); organisations (e.g., Anand et al., 2002; Cohen & Prusak, 2001; Fischer & Pollock, 2004; Dess & Shaw, 2001; Koka & Prescott, 2002); and communities and societies (Bolino et al., 2002; Rob, 2002).

In particular, according to an individual and group perspective, Tsai (2000) defines SC as the relational resources attainable by individual actors through networks of social relationships; while Baron and Markman (2000) state that SC refers to the actual and potential resources individuals obtain from knowing others, being part of a social network with them, or merely from being known to them and having a good reputation.

Nahapaiet and Goshal (1998) define SC as the:

Sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit. Social capital thus comprises both the network and the assets that may be mobilised through that network. (p. 243)

Focusing on the firm, Leana and Van Buren III (1999) conceptualise SC "as a resource reflecting the character of social relations within the firm. Organisational social capital is realised through members' levels of collective goal orientation and shared trust, which create value by facilitating successful collective action. Organisational social capital is an asset that can benefit both the organisation (e.g., creating value for shareholders) and its members (e.g., enhancing employee skills)" (p. 538).

Looking outside the firm, Pennings et al. (1998) define SC in terms of supporting relationships with other economic actors, most notably potential customers. Such relationships can be made in many different ways: mutual schooling, family and other personal connections, overlapping memberships, interfirm mobility, joint ventures or other collaborative arrangements, and more. Referring to a Silicon Valley context, Choen and Fields (1999) outline the importance of social relationships for longer term innovation, since they contribute to enrich knowledge and information exchange.

Besides the research contributions aimed to formalise the concept of SC and analyse its strategic relevance, the strategic management literature has been popularised with studies directed to investigate and understand the contents, properties and components of SC. Three main

theoretical approaches emerge as particularly significant: (i) weak tie theory; (ii) structural holes; (iii) social resources.

The first approach, the weak tie theory (Granovetter, 1973), focuses on the strength of the social tie used by a person in the process of finding a job. Granovetter (1973) formulates this theory by looking at the weak ties, which are more likely than strong ties, the source of information about job openings.

The second approach to SC is the structural holes theory (Burt, 1992). This approach focuses on the pattern relations among people in a social network. A structural hole is said to exist between two individuals who are not connected to each other. According to structural holes theory, it is advantageous for an individual to be connected to many people who are themselves unconnected. According to Burt's theory (1992, 1997), an individual, controlling a network rich in structural holes, can achieve three primary benefits:(i) more unique and timely access to information; (ii) greater bargaining power and thus control over resources and outcomes; (iii) and greater visibility and career opportunities throughout the social system.

The third theoretical approach to SC is the social resources theory (e.g., Lin et al., 1981a; 1981b). This approach focuses on the nature of the resources embedded within a network. In such an interpretative perspective, SC is the sum of the actual and potential resources that social actors can mobilise for achieving their goals and that are available to the actors because of their social relationships with others.

Recognising the main insights of the above three approaches: weak tie theory, focused on the nature of ties; structural holes theory, focused on the pattern of the ties among alters; and social resource theory, focused on the characteristics of the alters contacted; Seibert et al. (2001) propose an integration of the three theories. They sustain that:

The key to this integration is to recognise an analytical distinction between the structural properties of networks and the nature of the social resources embedded in networks and to thus draw a distinction between their form and their content. Weak tie theory and structural holes theory each focuses on the structure of a network. Social resources theory focuses on the content of a network. (p. 222)

More recently, Fischer and Pollock (2004), in an attempt to identify some elements of integration concerning with the various SC definitions, argue that the different conceptualisations share two common elements:

(I) Social capital arises from the structure of relations between and among actors in a network and (2) An actor has the ability to access these network, or social-structural, benefits. (p. 468)

From the analysis of the different interpretations emerges that SC is a meta-concept which has been characterised on the base of different perspective of analysis.

In an attempt to summarise its main facets, it seems possible to conceive SC as a set of assets involving two main dimensions: the network of relationships beetween and among actors and the content of these relationships. It is an "invisible force" embedded in relationships of individuals, organisations, communities or economic actors which support growth.

SC can include a number of components. Leana and Van Buren III (1999), focusing on organisation, identify such as primary components of organisational SC the associability, that is the willingness and ability of participants in an organisation to subordinate individual goals and associated actions to collective goals and actions; and the trust which is necessary for people to work together on common projects, even if only to the extent that all parties believe they will be compensated in full and on time.

Rob (2002) cites networks, norms and social trust that facilitate coordination and cooperation for mutual benefit within an organisation as components of SC.

Other scholars (Bolino et al., 2002; Burt, 1997; Nahapiet & Ghoshal, 1998), analysing the components of SC, have identified three main perspectives:

1. **Structural Perspective:** Focuses the attention on structural components of SC referring to the overall pattern of connections between actors; that is, who you reach and how you reach them; those connections provide people with the access to information and specific resources. The most important components of this perspective are: network ties; network configuration; appropriable organisation, that is, the existence of networks created for one purpose that may be used by another;
2. **Relational Perspective:** Refers to those assets created and leveraged through relationships. It comprises trust, trustworthiness, norms and sanctions, obligations and expectations, identity and identification.
3. **Cognitive Perspective:** Refers to those resources providing shared representations, interpretations, and systems of meaning among parties. It includes shared codes and language as well as shared narrative.

Adopting the above perspectives of analysis it seems possible to split the many components of SC, arising from the literature review, as follows:

1. *Structural perspective*, includes mainly components such as network ties; network configuration; position in the network and appropriable organisation;
2. *Relational perspective*, includes trust (e.g., goodwill trust); trustworthiness; social trust; norms and sanctions; obligations and expectations (e.g., expectations of reciprocity); identity and identification;
3. *Cognitive perspective*, includes shared vision; shared codes and language; shared narrative; shared experiences; associability and collective goal orientation.

SC, as a set of assets, plays a fundamental role in defining and creating the value of any organisation system. To this regard Anand et al. (2002) argue that the role of SC for company's value creation has increased especially in the last years. According to the authors, several factors have contributed to this increase.

First, in current business environments, managers are faced with increasing knowledge density, a term referring to the amount of knowledge that a manager must have in order to make organisational decisions [...]. At the same time, organisations are becoming leaner and reducing their number of managers [...]. Second, past knowledge and experiences of organisational employees are less useful today because their firms are increasingly faced with novel and unexpected situations [...]. Third, social capital is also increasing in importance because of the large number of high-technology industries where knowledge is being created rapidly and is unevenly distributed among several small firms. For firms to survive in such industries, they need to depend on external knowledge and be capable of accessing it. (pp. 88-89)

About the ways in which SC contributes to value creation dynamics, Tsai (2000) asserts that SC, as a multidimensional construct, can contribute in many ways to the creation of new value for an organisation.

Leana and Van Buren III (1999) sustain that there are four primary ways in which SC can lead to beneficial outcomes. It justifies individual commitment to the collective good (1), facilitates

a more flexible work organisation (2), serves as a mechanism for managing collective action (3), and facilitates the development of intellectual capital in the firm (4).

Nahapiet and Ghoshal (1998) argue SC increases the efficiency of action. For example, networks of social relations, particularly those characterised by weak ties or structural holes increase the efficiency of information diffusion through minimising redundancy. Furthermore, SC encourages cooperative behaviour, thereby facilitating the development of new forms of association and innovative organisation. The concept, therefore, is central to the understanding of institutional dynamics, innovation, and value creation. However, the same authors outline that SC is not an universally beneficial resource. For example, the strong norms and mutual identification that may use a powerful positive influence on group performance can, at the same time, limit its openness to information and to alternative ways of doing things; producing forms of collective blindness that sometimes have disastrous consequences. Finally, Nahapiet and Ghoshal (1998) sustain that:

Social Capital facilitates the development of intellectual capital by affecting the conditions necessary for exchange and combination to occur. (p. 250)

Koka and Prescott (2002) describe SC as a multidimensional construct that yields three distinctly different information benefits in the form of information volume, information diversity, and information richness.

Kostova and Roth (2003), adopting the SC's characterisation as private or public good conceptualised by social network theorists, distinguish the benefits derived from this capital, in according to the view of private or public good. In particular, the authors outline that SC as a *private good*, is an asset that individuals can "spend" to better their own situations; while as a *public good*, is a feature of successful communities, reflected in trust, reciprocity, and strong social norms that facilitate integration and cooperation as well as provide effective regulation of social behaviour. SC in this form creates benefits both for the individual members and the community as a whole and it is accessible to all within the community.

Reviewing benefits of SC, Adler and Kwon (2002) argue SC influences career success and executive compensation; helps workers find jobs and creates a richer pool of recruits for firms; facilitates interunit resource exchange and product innovation, the creation of intellectual capital, and cross-functional team effectiveness; reduces turnover rates and organisational dissolution rates; facilitates entrepreneurship and the formation of start-up companies; strengthens supplier relations, regional production networks, and interfirm learning.

Therefore SC is a strategic lever that, developed and exploited, can generate a wide variety of benefits, which range from an individual level to a system level and concern with the development of the individual (Coleman, 1988; Loury, 1977, 1987), the improvement of firms' economic performance (Baker, 1990) and business operations (e.g., Baker, 1990; Burt, 1992; Coleman, 1990), the development of economic-production system, such as local systems and regions (Putnam, 1993, 1995), as well as nations (Fukuyama, 1995).

Organisational and Structural Capital

Organisational capital (OC) and structural capital (StC) are analysed in the literature as interchangeable concepts.

Bontis (1998) refers to StC as all mechanisms and structures that can help employee to better deploy their cognitive resources and then improve company's performance. According to other authors (Ambrosini & Bowman, 2002; Nelson & Winter, 1982) StC consists of organisational know-how which is incorporated in routine or rules,

embedding tacit knowledge as well as culture. In particular, routines act as the glue for organisations and contribute to enhance cooperative working and the development of new knowledge (Rumelt, 1984). While culture identifies the "way of doing things" within an organisation. It constitutes the beliefs, knowledge, attitudes of mind and customs to which individuals are exposed in an organisation, as a result of which they acquire a language, values, habits of behaviour and thoughts (Hall, 1992) and it is an important driver of innovation, since it supports and affects the learning mechanisms of an organisation (Bontis, 1998).

Winter (1987) refers to StC as "intellect of the organisation."

Stewart (1997) describes OC in terms of technology, process descriptions, manuals, and networks, which allow one to structure and package competencies to ensure that the knowledge and competencies will remain with the company when the employees go home.

Youndt et al. (2004) state OC represents institutionalised knowledge and codified experience stored in databases, routines, patents, manuals, structures, and the like. The authors sustain that OC is knowledge endowment that an organisation actually owns. It is made up of knowledge, skills, and information that stay behind when an organisation's people go home at night, that is, patents and licenses as a way to store knowledge, manuals, databases, culture, valuable ideas, ways of doing business, systems, processes and so on.

In the light of the analysed interpretations, OC and StC can be considered as the overall organisation's tangible and intangible infrastructures that enable a firm to perform its business processes.

They mainly include: routines, procedures and rules; artefacts embedding knowledge like patents and licenses; organisational and reporting structures; operating systems; procedures and task design; information and communication infrastructures; resource acquisition, development and allocation systems; decision processes and information flows; incentives, controls and performance measurement systems; organisational culture, value and leaderships; ways of doing business; and organisation processes.

The role of this capital in value creation is mainly related to the fact that it is a primary means through which an organisation can rapidly learn, manage and apply knowledge. In this regard Stewart (1997) states that OC reduces lead times between learning and knowledge sharing and, therefore, allows to firm to gain a sustained, collective growth. StC and OC are the essential drivers in converting knowledge embedded in individuals and organisation into value.

Moreover, this form of capital represents the essential substratum for the growth and right exploitation both of HC and SC.

Stakeholder Capital

Stakeholder capital (StkC) collects different subset of SC, such as relational capital (Ireland et al., 2002), customer capital (Pennings et al., 1998), and external social capital (Fischer & Pollock, 2004). It is about some forms of SC that, due to their importance for firm's success, have been adressed separately from the broader concept of SC.

As underlined by Fischer and Pollock (2004), as well as by Adler and Kwon (2002), an important dimension of SC is whether the firm's network of relations are internal or external to an organisation. This is related to the functions of the relationship, that is, if it is aimed to facilitate either the actors' actions within a social structure of a firm, or the links between a firm and its external stakeholders. In particular when relations develop inside firm, SC is an "internal SC," while when relations develop outside firm, SC is an "external social capital."

Addressing the relations with customers, Pennings et al. (1998) define an organisation's SC as the aggregate of firm members' connectedness with potential customers; while Ireland et al.

(2002), Koka and Prescott (2002), and Chung et al. (2000) outline that SC is an important component of successful strategic alliances and trust is the foundation through which SC can be leveraged to achieve alliance success.

Bontis (1998), looking at a firm's relationships with external, introduces the concept of customer capital to refer to the potential an organisation has due to exfirm intangibles which include knowledge embedded in customers, suppliers, government and other related industry association.

In the light of the several interpretations provided for this form of capital, StkC can be conceptualised as relationships that an organisation develops with its internal and external stakeholders, as well as knowledge embedded and transferred in those relationships.

The components of this form of capital are relationships between firm and its customers as well as, consistent with stakeholder theory (Donaldson & Preston, 1995; Jawahar & McLaughlin, 2001), the firm and its stakeholders.

The role of this capital to value creation is mainly related to the fact this specific form of SC is a primary means through which organisations import external knowledge into the firm. In this regard, Anand et al. (2002) argue:

Knowledge acquired from a firm's social capital impacts the firm's internal knowledge in two ways. First, as new external knowledge comes into the firm, it can be combined with the firm's existing internal knowledge. Second, comparing new external and existing internal knowledge can highlight inconsistencies that can identify weaknesses in the firm's existing internal knowledge. The kind of knowledge a firm retains internally determines the benefits that a firm can derive from social capital. (p. 88)

In addition, the degree to which firms can use external relationships for knowledge acquisition and exploitation is regulated by the amount of SC embedded in such relationships (Yli-Renko et al., 2001).

INTELLECTUAL CAPITAL: AN UMBRELLA CONCEPT

In the last decade the concept of IC has emerged as a key interpretation for revealing the firm's intangible resources. This interpretation has acquired a significant relevance both in the research and in the practical arena. From its analysis it seems possible to state that IC represents an umbrella concept for synthesising and assessing those organisation resources which are intangible in nature. It answers, in a better way, to the managerial needs to have interpretative and operative notion for the understanding, identification and evaluation of the firm's intangible resources that determine the value of a firm as well as drive the value creation dynamics.

However, even if in the last years the concept has been largely used in the mangement literature, it seems that there is still a lack of clarity surrounding IC mainly due to numerous definitions abounding (e.g., Ulrich, 1998; Nahapiet & Ghoshal, 1998; Youndt et al., 2004).

From the analysis of the different interpretations of IC provided in the strategic literature, it seems relevant to underline a common central assumption, that is, IC is embedded and made of people and systems, and integrates as well as combines all various forms of human, social, structural and stakeholder capital.

The IC is a bundle of firm's intangible resources. The interaction between these resources allows both the growth of each of them as well as the development of the overall firm's IC. To this regard, DeFilippi and Arthur (1998), reflecting on the interactions among various forms of organisation capital, stress the interplay relationships between HC and SC. People reputation, for instance, may be viewed as an estimate of HC

conveyed in SC channels. While, in relation to the link between IC and specific forms of capital, Nahapiet and Ghoshal (1998) describe how SC can facilitate the development of IC within the firm by providing a suitable environment for the combination and exchange of information and knowledge. For example, social relations can provide a vehicle for accessing and disseminating information that is often more efficient and less costly than more formal mechanisms.

Over the last years the IC concept has been widely spread due to the fact that it, such as an umbrella concept, offers a broader view about organisational resources as well as allows to better understand the potential patterns of coexistence among the subcategories of IC. To this regard Youndt et al. (2004) notice even if treating human, social, structural and stakeholder capital as discrete, unidimensional phenomena tends to simplify reality, in order to fully understand how IC develops and drives performance:

It may be helpful to look at an organisation's overall profile of intellectual capital in the aggregate rather than independently focusing on individual parts. (p. 336)

IC is an holistic concept which allows one to synthesise the overall intangible and cognitive resources of firms. It is made up by different components.

The starting point in explaining IC components involves a clarification of their common nature. From literature review it emerges that frequently IC, as whole of different forms of capital, has been used to refer to the knowledge and knowing capability of an organisation, as well as to denote the valuable cognitive resources and a capability for action based in knowledge and knowing. Therefore knowledge represents the fertile soil where all IC components are rooted.

Acknowledged the cognitive nature as a common feature of all forms of capital dealing with IC, it seems possible conceptualise the components of IC as knowledge assets which represent any organisation resource made of or incorporating knowledge which provides an ability to carry out a process or an activity aimed to create and/or deliver value. In other words, the knowledge asset is a resource, both tangible and intangible, that has a knowledge nature and most significantly drives organisation value creation mechanisms for targeted company key stakeholders.

The adoption of the concept of knowledge asset to explain IC components allows one to stress the common foundations of IC components as well as their strategic role to perform the business activities and to gain competitive advantages. Additionally, it allows one to overcome the limitation of several recent models of IC mainly oriented to evaluate only the intangible components of the organisation and disregarding the possibility to consider the tangible resources as knowledge assets at the basis of the organisational competences (i.e., structural capital). To this regard, it is important to highlight that the value of intangible resources is often related to their interactions and integrations with organisation tangible resources. In a such a way, this equals to state that the know is between resources and not just within.

In short, IC embraces all the tangible and intangible resources embodying knowledge and created by individual or collective actions, which integrating with each other define and build over time the competence and the skills that are essential in value creation and delivering of any organisation system.

Taking into account the main insights that emerged from the close investigation of literature, it seems possible distinguish two main kind of knowledge assets shaping IC: the knowledge assets related to the firm's stakeholders —called *stakeholder knowledge assets*—and the knowledge assets related to the tangible and intangible infrastructures of an organisation—called *structural knowledge assets*.

This distinction denotes the two main components of an organisation reflected in the different

forms of capital: its actors and its relationships, both internal and external (i.e., human, social and stakeholder capital) and its structural components, such as all those elements at the basis of the processes of an organisation (i.e., structural/organisational capital). Both the main components can be further divided in other sub-components: *Wetware* and *Netware* for the stakeholders knowledge assets and *Hardware* and *Software* for the structural knowledge assets. They represent the key building blocks of an interpretative map of strategic resources dealing with IC.

The *Wetware* denotes human capital of an organisation and comprises both the know-how characterising the different specialist figures operating within the organisations and the knowledge, the level of general culture, the attitudes and the behaviours that marked each person. The Wetware, then, denotes all that knowledge that is at the basis and influences the behaviour of the human resources.

The *Netware* denotes social capital and stakeholder capital. It indicates the group of the cognitive resources linked to the relationships characterising the organisational system referred both to internal and external context.

The *Hardware* includes that part of structural/organisational capital, that is all those assets tangible in nature, relevant for the development, acquisition, management and diffusion of knowledge as well as all the components linked to structural features of an organisation. Within this category it is possible to consider two subcategories: the *physical infrastructures* and the *virtual infrastructures*.

The *physical infrastructures* include all organisation's infrastructures which can be tangible, such as structural layout and ICT like computers, servers and physical networks, which support knowledge development and management.

The *virtual infrastructures* comprise intellectual property like patents, copyrights, trademarks, brands, registered design, and trade secrets; that is, assets whose ownership is granted to the company by law, as well as virtual networks, operating systems, processes and task design, decision processes and information flows, incentives, controls and performance measurement systems.

Finally, the *Software* comprises the structural/organisational capital having a soft nature such as routines, internal practices, procedures and rules, organisational culture, value and leaderships, ways of doing business, procedures, corporate culture and management philosophies.

As stressed above, each IC component plays a strategic role in business success. However it seems important to underline that in order to effectively and efficiently deploy these assets in conducting business all the IC components have to be considered inextricably combined and leveraged together. This means that at the heart of value creation there is the dynamic interaction of the different "knowledge assets" composing IC.

This statement has important practical implications, often not followed by organisations. To this regard Youndt et al. (2004), using data collected from 208 organisations, have examined how human, social, and organisational capital coexist to form distinct IC profiles across organisations and how organisations invest in them. Results indicate that of most firms, a relatively small group of superior performing organisations exhibit high levels of human, social, and organisational capital. Most firms, however, tend to focus primarily on only one form of IC, and a small group of underperforming organisations have very low levels of all three types of IC. The authors argue that several factors may explain this predominately narrow focus. For example, some organisations may view the different forms of IC as substitutes and consider the development of multiple forms of IC as redundant and wasteful. Additionally, it may be a very difficult and complex task to develop multiple types of IC. As such, only a relatively small number of organisations ever reach high levels of all three types of IC. In such a prospect, it seems very interesting to study in-depth the interactions among the different forms of capital

in order to explore interaction amongst knowledge assets that is complementary in that the value of one element is increased by the presence of other elements (Carmeli & Tishler, 2004).

FINAL REMARKS

The main aim of the chapter is to explore the IC concept in strategic management research, in order to identify its key conceptual pillars.

The use of the IC concept by academics and practitioners has resulted in the proliferation of a number of definitions often ambiguous and used in an interchangeable way. The authors have analysed the strategic management literature aiming to clarify the IC concept as well as identify its main components. Human Capital, Social Capital, Structural/Organisational Capital and Stakeholder Capital have been identified as fundamental components of the IC of an organisation. Each of these forms of capital has been analysed focusing mainly on related definitions, components and strategic role. The literature review has been developed by a thematic analysis of research papers produced in strategic management field in the last twenty years. To this regard it is important to outline some main limitations of the review presented here. The disciplinary boundaries which have been adopted are focused only on strategic management research stream. This involves that other complementary perspectives could be adopted such accounting, marketing, law and so on. Additionally, we focused only on top journals published in the strategic arena. Obviously this has affected the kind and number of the selected and reviewed papers.

The literature review has represented the conceptual base for defining an interpretative framework providing a comprehensive view of the IC's components. The framework has been formulated taking into account the main insights concerning meanings, components, role in value creation and cognitive nature of each component of IC as emerged from the literature review. The concept of knowledge asset especially has been introduced to characterise and disentangle the main building blocks of IC.

The framework provides a possible guide for theoretical research and practical actions on IC.

In particular, from a theoretical point of view, the map represents a suitable starting point to explore the interaction between and among IC building blocks as well as for understanding the role of IC in a firm's competencies building. While from a practical point of view, the framework represents a possible tool for the identification, mapping and classification of a firm's resources which are at base of business performance. In particular, it provides guidelines for measuring IC by adopting suitable metrics and indicators.

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Chapter III
Intellectual Capital in Knowledge-Intensive Firms: Exploring the Concept and Main Components in Boston's Route 128

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ABSTRACT

During more than a decade, the literature has provided several intellectual capital models. Nevertheless, empirical evidence is still necessary in the field, and empirically supported models for classification and measurement of intellectual capital are not very common. This work finds the main components or building blocks of an intellectual capital balance sheet, taking the three most common components of intellectual capital (human capital, structural capital, and relational capital) and testing empirically if this grouping of intangible assets is supported by the evidence obtained from a sample of knowledge-intensive firms from Boston's Route 128. Findings suggest a classification of intellectual capital according to four categories: human capital, structural capital, relational business capital, and strategic alliances.

INTRODUCTION

More than a decade has passed since the publication of the first proposals about the concept and measurement of intellectual capital. Until now, literature has provided several intellectual capital models (Brooking, 1996; Bueno, 1998; CIC, 2003; Edvinsson & Malone, 1997; Kaplan & Norton, 1996; among others). Nevertheless, the need for adapting theoretical and empirical models to the new social and economic trends justifies an effort in improving previous proposals. Empirical

evidence is still necessary, and empirically supported models for classification and measurement of intellectual capital are not very common.

At the international level it is accepted that there are three basic components of intellectual capital: human capital, structural capital, and relational capital. In a wide sense, these represent all expressions of firm's knowledge stocks. This triple nature of intellectual assets is being revisited by different lines of research, which are trying to reconcile the concept of intellectual capital (CIC, 2003).

In this chapter, an empirical research about knowledge-intensive firms is presented, based on the dominant stream of the theoretical proposals of intellectual capital, thus adopting these basic three components:

Human capital, which includes values and attitudes, aptitudes and know-how Structural capital, which contains both organizational and technological elements that pursue integration and coordination within the firm Relational capital, which gathers the value of the relationships that the firm maintains with external agents (close to business activity or with other more distant social agents).

The purpose of this empirical research is to test the previously extant models, and provide a configurative definition of intellectual capital from the different components that it comprises.

BACKGROUND: MAIN COMPONENTS OF INTELLECTUAL CAPITAL AND COMPETITIVE ADVANTAGE

Although for a long time it has been recognized that economic wealth comes from knowledge assets—intellectual capital—and its useful application (Teece, 1998), the emphasis on it is relatively new. Managing the intellectual capital of the firm has become one of the main tasks in the executive agenda. Nevertheless, this work is especially difficult because of the problems involved in its identification, measurement and strategic assessment. In this situation, the models of intellectual capital become highly relevant, because they not only allow one to understand the nature of these assets, but also to carry out their measurement.

The term intellectual capital is used as a synonym for intangible or knowledge assets since the work by Stewart (1991). The fact of calling it "capital" makes reference to its economic roots, because it was described in 1969 by the economist Galbraith as a process of value creation and as a bundle of assets at the same time. The definition by Bueno-Campos (1998, p. 221), "basic competencies of intangible character that allow to create and maintain competitive advantage," argues how we can tie intellectual capital to the resource-based view (RBV).

A joint perspective for intellectual capital (understood as strategic resources and capabilities) led to us to raise its assessment in order to state its own consistency. The different types of intellectual capital represent different types of intangible resources and capabilities. Nevertheless, in spite of their strategic nature, all of these assets would not have the same value for the firm, as it seems to suggest in the works of Hall (1992, 1993), Itami and Roehl (1987), Aaker (1989), or Prahalad & Hamel (1990) that emphasize the importance of certain intangibles. Setting this kind of difference can be considered as a useful help for strategic management. They can help in making decisions about the actions that the firm must perform and about the implementation of programs that allow it to protect, maintain or develop those more valuable intangible assets. Nevertheless, in order to explore the relation between any specific kind of intellectual asset and competitive advantage, a clear identification of the main components of intellectual capital is required.

In this way, several contributions have provided different frameworks for classifying the different components of intellectual capital, as well as for establishing series of indicators for intellectual capital measurement. Thus, according to most of the theoretical proposals, in a first step, three main components can be found: (i) human capital; (ii) structural capital; and (iii) customer or relational capital (Kaplan & Norton, 1992; Bontis, 1996; Saint-Onge, 1996; Sveiby, 1997; Edvinsson & Malone, 1997).

Nevertheless, a more detailed classification is needed in order to reach a better understanding. In this sense, Brooking (1996) highlights the differences between intellectual property assets–focused on technological knowledge—and infrastructure assets – focused on organizational knowledge— and gives a broader concept of market assets—that include customer assets.

Following the identification and classification of intellectual capital assets, during 2002 and 2003 a group of academics—including the authors—and expert practitioners developed a series of workshops at the Spanish Knowledge Society Research Center in Madrid. In those workshops, based on previous literature as well as on professional experience, a model of intellectual capital—called Intellectus (CIC, 2003)—was developed. It includes five components:

- Human capital (makes reference to the tacit or explicit knowledge which people possess, as well as their ability to generate it, which is useful for the mission of the organization and includes values and attitudes, aptitudes and know-how),
- Technological capital (refers to the combination of knowledge directly linked to the development of the activities and functions of the technical system of the organization, responsible for obtaining products and services),
- Organizational capital (as the combination of explicit and implicit, formal and informal knowledge, which in an effective and efficient way structure and develop the organizational activity of the firm, that includes culture—implicit and informal knowledge, structure—explicit and formal knowledge, and organizational learning—implicit and explicit, formal and informal renewal knowledge processes),
- Business capital (refers to the value to the organization of the relationships which it maintains with the main agents connected with its basic business processes—customers, suppliers, allies, and so forth),
- Social capital (as the value to the organization of the relationships which it maintains with other social agents and its surroundings).

As it can be seen, due to its heterogeneous nature, structural capital was divided into technological and organizational capital. In the same way, relational capital was divided into business and social ones. This more detailed classification allows a better understanding of these types of organizational factors. The Intellectus Model (CIC, 2003) is a good example that theoretical proposals about intellectual capital are becoming more complex and detailed every day. This encourages analytical reflection among managers and chief knowledge officers, but it can also be seen as a too extensive proliferation of criteria and categories of intangible assets.

This way, empirical evidence is needed in order to determine the level of aggregation that intellectual capital components must adopt in practice. This is the purpose of this work: to find out the main components or building blocks of an intellectual capital balance sheet. Bearing this aim in mind, we take the three most common components of intellectual capital (namely human capital, structural capital, and relational capital) and test empirically if this grouping of intangible assets is supported by the evidence obtained from a sample of knowledge intensive firms.

SAMPLE AND METHOD

Taking into account the previously mentioned theoretical proposal, we empirically test the presented simple model of intellectual capital in knowledge-intensive firms. With this purpose, we have carried out a survey in firms operating within NAICS 334 (Computer and Electronic Product Manufacturing), 516 (Internet Publishing and Broadcasting), 517 (Telecommunications) and 518 (Internet Service Providers, Web Search Portals, and Data Processing Services) from Boston's Route 128 (Massachusetts, U.S.) during 2005. The selection of industries was guided by the purpose to have a homogeneous sample (Rouse & Daellenbach, 1999).

From a population of 422 firms, 52 firms took part in our survey, so we reached a response rate of 12.32 % (see Figure 1 for a general description of the fieldwork).

The questionnaire employed for the survey included 12 items for measuring different intellectual capital aspects according to the three main constructs that it involves. Four items were devoted to report human capital (HC), three addressed structural capital (SC), and five tried to analyze relational capital (RC). Firms had to answer in a seven positions Likert-style scale, showing their level of agreement about the sentences present in the survey. The 12 items employed in the questionnaire were taken from general insights about the pre-defined components of intellectual capital taken into account (see Figure 2). The items were ungrouped in the questionnaire, and one of them was reversely written ("our relations with suppliers are sporadic and punctual"). These facts granted attention and sense-making from the respondent. Assessing the intellectual capital in a homogeneous scale is not very easy to do; nevertheless, the survey allows one to perform these comparison applying a same framework for assessment from each respondent.

RESULTS

A factor analysis was developed in order to identify the main dimensions of intellectual capital for these type of industries as well as their main elements and variables, although in the following paragraphs, as a preliminary approach to the data analysis performed after data gathering, a comment on the descriptive statistics about the items of the questionnaire is provided. This analysis allows us to detect the most and less common aspects of intellectual capital that firms possess (see Figure 2).

Figure 1. Research resume

Research focus	Knowledge Creation Processes
Criteria defining sample	Knowledge-intensive firms From industries NAICS 334, 516, 517 & 518 Placed on "Route 128" (Massachusetts, U.S.) 50 employees or bigger Included in CareerSearch Database
Sample	422 firms
Response rate	52 firms (12.32%)
Method for data gathering	Survey
Process for data gathering	Ordinary mail Follow up on the phone Backup with second ordinary mail, FAX, Web page and e-mail
Statistical software used	SPSS 12.0S for Windows (version 12.0.1)

Figure 2. Intellectual capital elements: Descriptive statistic

Questionnaire items	Mean	Standard Deviation
HC2 - Our employees are among the most experienced in the industry	5.92	1.074
HC1 - Our employees develop new ideas and knowledge	5.81	1.049
HC4 - Our employees have a long experience in the firm	5.67	1.232
HC3 - Our employees do team work	5.67	1.098
RC5 - Our firm is recognized by the external agents (customers, suppliers, competitors, and the general public) as one of the best firms in the industry	5.61	1.297
RC2 - Our customers are highly loyal to our firm	5.35	1.341
RC4 - Our collaboration agreements are held during long periods of time	5.19	1.394
SC1 - Our efforts in creating and sustaining an organizational culture are among the highest in our industry	5.02	1.651
SC2 - Our firm develops more ideas and products than any other firm in our industry	4.75	1.671
SC3 - We perform a lot of actions to spread our corporate values and beliefs	3.96	1.703
RC3 - Our relations with suppliers are sporadic and punctual (R)	3.81 (R)	1.313
RC1 - Our firm devotes an important part of its budget to funding community and green actions	2.60	1.796

(R) Reversed item. Un-reversed mean would be 4.19. Standard deviation remains the same.

As it can be seen, the items related to human capital show the higher means (close to 6 in a scale with 7 as the maximum value). This reports that firms operating in the chosen industries are highly focused on having a strong human capital. And these data are quite robust, as the low standard deviation figures show. Almost every firm values so strongly its human capital. Employees with high experience in the industry, ability to develop new ideas and knowledge, as well as experience within the firm and the involving in teamwork appear as key assets for competing in the industries analysed.

The surveyed firms agree considerably (reduced standard deviations) about recognizing as next important in the list of intellectual strengths and assets the renown among customers, suppliers, competitors and the general public, the effective customer loyalty, and the long-lasting collaboration agreements sealed by the firm. All of these issues are tied to relational capital in the fashion of reputation-based and operationally based relationships with the environment.

The item "our relations with suppliers are sporadic and punctual" (RC3) deserves special attention. Its right mean will place it as an intermediate power asset. This is consistent with the literature, which confers less relevance to the relation with the suppliers in respect to other external agents as customers or allies. This is backed by the obtained results, because the items devoted to these agents show higher values as firm strengths than relations with the suppliers.

When firms assessed their intellectual capital positions, the issues tied to structural capital ranked among the less common element. Organizational culture emerges as the most employed element of internal coherence, but firms differ considerably among them about this issue (see the standard deviation figure). The effective flow of ideas and products delivered to the market is a slightly common asset, but we must take into account that it has been posed in industrial-competition terms. Finally, the relevance of actions for spreading and reinforcing corporate values and beliefs differ considerably for each particular firm (see standard deviations in Figure 2).

In order to end this preliminary descriptive analysis of our results, we must highlight that there are very few firms in the studied industries investing in community and green actions. Funding these actions was posed as an indicator for relational capital focused on community, social and green care agents. The average position in this kind of relation is actually low.

After descriptive statistics, an exploratory factor analysis was carried out in order to identify the factors or latent phenomena that lie in the data about intellectual capital provided by the studied firms.

For deciding if factor analysis is an appropriate technique in this case, several preliminary tests are needed: the analysis of correlations and communalities, the Bartlett test, and the Kaiser-Meyer-Olkin. Figures 3, 4 and 5 show the results of them for the set of items contained in the questionnaire employed in the research.

As it can be seen in those figures, the tests advise to perform the factor analysis, rejecting the null hypothesis that the correlation matrix is an identity matrix (there are several correlations among the considered variables). Besides, the KMO index is above 0.6, so it can be considered

Figure 3. Correlation matrix (a)

		SC1	**RC1**	**SC2**	**SC3**	**RC2**	**RC3**	**RC4**	**HC1**	**HC2**	**HC3**	**HC4**	**RC5**
Correlation	SC1	1.000	.387	.318	.596	.074	.070	-.101	.153	.400	.331	.581	.410
	RC1	.387	1,000	.249	.600	-.039	-.030	.043	-.178	-.024	.079	.273	.140
	SC2	.318	.249	1.000	.375	.241	.277	.021	.296	.404	.082	.153	.419
	SC3	.596	.600	.375	1.000	.067	.025	.050	-.003	.057	.094	.448	.296
	RC2	.074	-.039	.241	.067	1.000	.250	.227	.280	.271	.150	.378	.312
	RC3	.070	-.030	.277	.025	.250	1.000	.192	.081	.065	-.128	.111	.063
	RC4	-.101	.043	.021	.050	.227	.192	1.000	.373	.130	.031	.071	.285
	HC1	.153	-.178	.296	-.003	.280	.081	.373	1.000	.528	.319	.446	.713
	HC2	.400	-.024	.404	.057	.271	.065	.130	.528	1.000	.566	.422	.540
	HC3	.331	.079	.082	.094	.150	-.128	.031	.319	.566	1.000	.254	.445
	HC4	.581	.273	.153	.448	.378	.111	.071	.446	.422	.254	1.000	.522
	RC5	.410	.140	.419	.296	.312	.063	.285	.713	.540	.445	.522	1.000
Sig.	SC1		.006	.020	.000	.321	.331	.263	.167	.004	.016	.000	.003
(Unilat.)	RC1	.006		.056	.000	.402	.425	.392	.130	.439	.310	.040	.188
	SC2	.020	.056		.007	.062	.038	.447	.029	.004	.303	.167	.003
	SC3	.000	.000	.007		.336	.437	.376	.494	.360	.277	.001	.029
	RC2	.321	.402	.062	.336		.055	.074	.036	.041	.171	.007	.022
	RC3	.331	.425	.038	.437	.055		.111	.305	.342	.209	.243	.347
	RC4	.263	.392	.447	.376	.074	.111		.007	.206	.423	.328	.034
	HC1	.167	.130	.029	.494	.036	.305	.007		.000	.020	.002	.000
	HC2	.004	.439	.004	.360	.041	.342	.206	.000		.000	.003	.000
	HC3	.016	.310	.303	.277	.171	.209	.423	.020	.000		.052	.002
	HC4	.000	.040	.167	.001	.007	.243	.328	.002	.003	.052		.000
	RC5	.003	.188	.003	.029	.022	.347	.034	.000	.000	.002	.000	

a Determinant = .005

Figure 4. Communalities

	Initial	Extraction
SC1	1,000	.734
RC1	1,000	.728
SC2	1,000	.627
SC3	1,000	.811
RC2	1,000	.433
RC3	1,000	.705
RC4	1,000	.826
HC1	1,000	.761
HC2	1,000	.752
HC3	1,000	.634
HC4	1,000	.583
RC5	1,000	.752

Extraction Method: Main Components Analysis

Figure 5. KMO and Bartlett tests

Kaiser-Meyer-Olkin index		.618
Bartlett's Test	Aprox. Chi-squared	191.200
	FD	66
	Sig.	.000

Extraction Method: Main Components Analysis

acceptable for exploratory studies (as this), and the factor analysis becomes appropriate.

From the factor analysis we obtained four components of intellectual capital. Jointly they explained almost a 70% of the total variance contained in the original data (see Figure 6).

The first component found was labeled as "human capital" because it gathered all the items originally developed for measuring this construct, as well as one of the elements initially designed for relational capital. The five items included in this component explained the 25% of the total intellectual capital of the firm. The element that better characterizes "human capital" is the experience in the industry that employees hold. Nevertheless, the experience in the firm also presents important factorial weight. Besides, this component of intellectual capital includes the abilities of the employees for developing ideas and new knowledge, and for team-working, as well as the recognition as a leading firm by the external agents (see Figure 7 for factorial loadings).

The second component found in the factor analysis represents 20% of the intellectual capital of the firm and includes three elements. The most

Figure 6. Explained variance

Component	Inicial Autovalues			Sum of saturation at extraction squared			Sum of sturation at rotation squared		
	Total	% of variance	Acumul. %	Total	% of variance	Acumul. %	Total	% of variance	Acumul. %
1	3.921	32.674	32.674	3.921	32.674	32.674	3.009	25.078	25.078
2	2.003	16.688	49.363	2.003	16.688	49.363	2.400	20.000	45.078
3	1.408	11.736	61.099	1.408	11.736	61.099	1.587	13.224	58.302
4	1.014	8.451	69.550	1.014	8.451	69.550	1.350	11.248	69.550
5	.880	7.331	76.881						
6	.708	5.903	82.784						
7	.677	5.643	88.427						
8	.412	3.431	91.858						
9	.392	3.265	95.123						
10	.260	2.168	97.292						
11	.193	1.609	98.901						
12	.132	1.099	100.000						

important of them is the set of actions devoted to spread corporate values and beliefs. Due to the fact that this item was clearly representing structural capital, and because this component of intellectual capital includes two of the three items originally designed for structural capital it was named "structural capital." The other two items that appear within this component are the investments on community and green initiatives, as well as the efforts that the firm makes for creating and sustaining its organizational culture.

The third component of intellectual capital found weighted at 13% of the total variance contained in the original data and it was shaped by three items. The strongest of them was representing the relations with suppliers, showing content clearly tied to relational capital. In this vein, this component also included the relations with the customers. The factorial loadings of two relational capital items in this component, as well as the clear dominance of one of them led us to label it simply as "relational capital," although it also contained one of the items originally designed for structural capital (see the composition of this component through the factorial loadings shown in Figure 7).

Figure 7. Rotated components matrix (a)

	Component			
	1	2	3	4
HC2	.836			
HC3	.760			
RC5	.739			
HC1	.716			.448
HC4	.527	.500		
SC3		.892		
RC1		.844		
SC1	.446	.681		
RC3			.821	
SC2			.660	
RC2			.507	
RC4				.903

Extraction method: Main components analysis
Rotation method: Normalization Varimax with Kaiser
(a) Rotation has converged after 5 iterations

The last component of intellectual capital that provided the factor analysis was designated "strategic alliances" because it contained only one item, initially developed for measuring relational capital along with the collaboration agreements held by the firm. This component emerged as an own entity, representing the 11% of the intellectual capital of the firm (see *Figure 6*), which highlights the relevance that special partners can have for a firm of the industries analyzed.

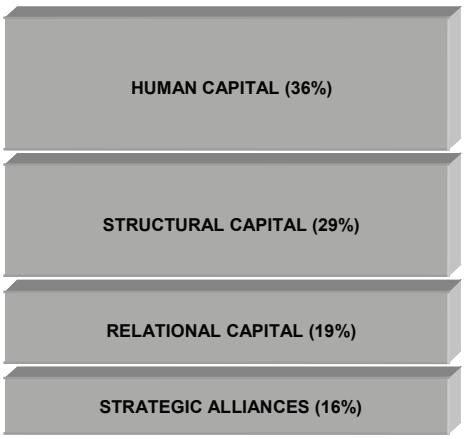
FINDINGS AND FUTURE TRENDS

According to the obtained data, the average balance sheet of intellectual capital that could be found in a firm of the knowledge-intensive industries of computer and electronic product manufacturing, Internet publishing and broadcasting, telecommunications, and Internet service providers, Web search portals, and data processing services operating in Boston's Route 128 at the beginnings of 2005 would show something similar to Figure 8.

In this configuration of intellectual capital, human capital appears as the most influential component. It includes the experience, creativity and teamwork of the employees, but when the firm holds a strong position in these areas, an image of leading firm is projected towards the external agents (customers, suppliers, competitors, and the general public) present in the environmental setting. Thus, the quality of the workforce seems to be the main indicator of leadership in the industry. Probably, due to the important knowledge base of the studied industries, the role of key engineers or experts could determine that "the best people make the best firm."

Structural capital represents almost a 30% of the total intellectual capital of a typical firm. The purpose of structural capital is to provide an

Figure 8. Components of intellectual capital obtained from the empirical research



appropriate context for communication, cooperation, adhesion and identity (Kogut & Zander, 1996). Issues related to organizational culture, values and beliefs are gathered within the label of structural capital, although we have found that investments on green care or community initiatives hold a strong relation to corporate culture and structural capital. This is nothing strange, because when a positive mission and values are stated for the company, probably the best way to legitimize them is with subsequent actions that reinforce the declared principles. Respect for the natural environment and the active involvement in the community life are two of the most common aspects that can be included in the documents about organizational mission, vision and values, and this explains the configuration obtained for structural capital.

Nevertheless, one of the most appealing findings of this research has been the fact that relational capital did not appeared as initially supposed. Although according to the literature we expected to found grouped all the relations with external agents (customers, suppliers, allies, competitor…), two components of intellectual capital were found in regard to these issues: the one that we have named "relational capital" and the one that has been labeled "strategic alliances."

Our block of relational capital includes the relations with customers and suppliers, as well as the capability of the firm to deliver ideas and products in its industrial setting. Although this characteristic was originally planned as an indicator of structural capital, the development process of ideas and products appears intertwined with its industrial environment, involving external aspects because it has been written with a comparison to the rest of competitors of the firm. This way, the factor named relational capital represents the set of general relations that a firm holds in its industrial setting, taking into account the interconnections with customers, suppliers and competitors. These agents are very close to the business activities, and it can be compared easily to the concept of "business capital" that can be found in other models (CIC, 2003).

The rising of and independent relational component of intellectual capital for allies and partners of the firm points out that certain collaboration agreements deserve a special interest. The presence of strategic partners could make the management and nature of this component considerably different from the management of the rest of the relations with the environmental agents. Although we have taken into account firms from different industries, or even from different

sectors, there are common patterns about the possible interactions with key partners. Thus, firms born in a certain industry can learn to operate in another one with the help of an appropriate ally, or simply form alliance networks (Kogut, 2000) to reinforce its competitive position.

It is not strange to find a computer manufacturer partnering with a firm that develops and updates contents for manuals, or distributing its product with the Web-searching software of other firm, or providing special reduced conditions for accessing the Internet through a specific company, which surely will need communication equipment for undertaking its operations. These are some examples of how strategic alliances can strengthen the competitive position in the firm's own industry, thanks to the ties with firms from other industries. This kind of alliances can be a key for success and require specialized management, so that is what the results reveal when "strategic alliances" appear as an independent component of intellectual capital.

Further research is needed in order to improve knowledge about any of these building blocks of intellectual capital, bridging the extant advances in the fields of human resource management, organization theory and design, supply chain management or collaborative agreements, with the literature of intellectual capital. With empirical researches as the one presented in this chapter, managers can discover the components of intellectual capital that can be found in their industry. Then, they must apply the strategies and advice already developed for other fields of management research in order to develop and strengthen each kind of capital. Research efforts are welcome: (a) in analyzing the configuration of intellectual capital for different industries, building models from empirical findings, so theoretical proposals in the field could be supported or improved, and (b) in providing guidance for practitioners in the complex process of reinforcing the intangible endowments of the firm, improving each of the different components of intellectual capital.

CONCLUSION

We want to highlight the contribution of our research to the field of intellectual capital, where empirical works are very scarce. This way, although several proposals about intellectual capital classification, identification and measurement can be found in the literature, this work provides an evidence-driven classification and configuration of intangible assets.

We must not forget that, although the traditional concept of relational capital has been split up, adding both obtained components, it would represent a 35% of the intellectual capital of the firm. This makes the sum of relational capital and strategic alliances as important than human capital, leaving a supporting role for structural capital. It is not difficult to find a theoretical interpretation for this. The keys or main components of intellectual capital (for the surveyed firms) are at the very heart of the organization (human capital) as well as in its "osmosis" with the environment (relational capital and strategic alliances). Structural capital provides support for leveraging human capital and designing a coherent map of interconnections with external agents.

We must highlight that the empirically driven model for classifying intellectual capital that has been obtained in this research (see Figure 8) does not differ very much from the three main components that have been traditionally and theoretically discussed. Strategic alliances emerge as an intellectual capital component probably due to its relevance in the industries of the sample. Thus, we can argue that intellectual capital is a construct shaped by four different components, two of them with an internal nature and two more devoted to relating the firm with its environment.

This way, managers face four important challenges in managing intellectual capital: (1) granting access and development of human capital as the origin of its intellectual capital; (2) providing a structure for supporting strategy, connecting properly the different elements of human capital,

and designing the desirable map of relationships and alliances needed for running business successfully; (3) relating the firm with its environmental setting and the different key agents that can be found on it (as customers or suppliers); and (4) finding and connecting properly with key partners that allow a special leverage of service, operative, and financial performance.

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Chapter IV
Human Capital Architecture and its Utilization in Accounting

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ABSTRACT

This chapter provides an alternative method of measuring and disclosing human capital items in financial statements. First, we explain the necessity of properly disclosing human capital information in financial statements. We then go on to define and classify human capital within our theoretical framework; sort out human capital investments according to cost development stages in human resources; isolate human capital from expenses; and suggest the proper method of disclosure in the financial statements. Finally, we show the results from an empirical study we performed to test the validity of the human capital architecture and its relationship with firm performance.

INTRODUCTION AND BACKGROUND

The purpose of this chapter is to provide a solution for some of the present accounting system's human capital disclosure issues; and also to investigate the relationship between human capital investment and firm performance. Research for human capital and organizational performance often discusses the relationship between a business's employees and their effect on organizational performance. However, Lepak & Snell (1999) suggest that not all employees provide equal value to firms. Companies usually establish different employment modes according to the expected contribution provided by their employees. Thus, it is necessary to clarify the relationship between human capital and organizational performance.

On the other hand, due to the limitations of the accounting database, research usually takes "salary expenses" as the only proxy of human capital. However, business's investments in human capital include expenditures such as recruiting, training, maintaining, and rewarding employees. The discussion of human capital will not be extensive enough unless the number of proxies involved in human capital can be increased.

LITERATURE REVIEW

In order to study the relationship between human capital and organizational performance, this paper follows the human capital architecture concepts of Lepak & Snell (1999) and the classified human capital expenditure of Flamholtz (1973). We visited a publicly traded company in Taiwan, analyzed its employees and divided them into two groups according to their "human capital value." The results suggest that, in the target company, the performance of employees with "high human capital value" is significantly different from the performance of employees with "low human capital value." To enhance organizational performance, companies may observe the characteristics of their employees and use different employment modes to optimize business resources.

The Necessity of Properly Disclosed Human Capital Information in Financial Statements

There is an abundant amount of research being conducted on the contribution of intangible assets and/or capital to the value of companies. Elements contributing to the value of companies are numerous, including organizational capital, customer (relations) capital, and human capital (Dzinkowski, 2000). All these factors center on humans as a foundation of the company's value. However, current accounting research on the definition, forms, and categories of human capital has been limited. It is hard to obtain statistical data on human capital from the current accounting system (let alone apply the data to managing human capital), which has become increasingly important to companies' value creation. Against this backdrop, this study aims to present an in-depth discussion of human capital.

Under the generally accepted accounting principle (GAAP), financial statements lack the proper reporting, measurement and disclosure of items in newly emerging fields such as human capital (Wintermantel et al., 1997). For example, the conservative viewpoint states that when exposure to uncertainty and risk is significant, accounting measurement and disclosure should take a cautious and prudent stance by using methods that do not overstate assets and net income. Only about one-third to one-sixth of the market valuation of firms in the United States is explained by GAAP (Westland, 2002). It is doubtful that proper decisions can be reached with the reference of financial statements unless information about human capital is sufficiently disclosed (Carme et al., 1999).

Under the current accounting system, financial statements disclose assets as important tools for companies to communicate with the public. On the balance sheet, machinery equipment is treated as an asset based on its acquisition costs and then deducted as expenses based on depreciation methods each following year. On the other hand, human capital investments such as training and education are all included in expenses. This distorts the meanings of those financial figures (for example, income increases when well trained or experienced workers are laid off) and can mislead decision makers who rely on those figures.

The Definition and Classification of Company Human Capital within a Theoretical Framework

Human capital investments are inputs made into talents and technology that benefit a company's competitive advantages. They are valuable and

unique, and should be kept out of the reach of other companies. In other words, only employees possessing these qualities are qualified as human capital. The skills of employees are a company's assets just like tangible assets are (Barney, 1991). In particular, employees with core skills are the fountain source for a company to raise its competence and profits (Porter, 1985). Therefore, investments in this kind of employee, that is, human capital investments, should be the focal point of our attention (Porter, 2001).

To explain ways of identifying companies' human capital investments, researchers have used value as the horizontal axis and uniqueness as the vertical axis to divide companies' utilization of human capital into four quadrants (Lepak & Snell, 1999). Among the four quadrants, the one representing both high value and high uniqueness denotes the proper human capital investment. This type of employee is capable of core skills, key to a company's competitiveness (barred he/she isn't being used by other companies), and very difficult to obtain by means of sourcing. Therefore, it is best that this type of employee base be developed internally by means of human capital investments. How the company forms, obtains, maintains and segregates this type of employee should translate into a quantified disclosure of human capital investments in terms of cost accounting attributes. Of course, the salary offered to these employees in exchange for services and labor in itself is not defined as a human capital investment. Salary expenditure is considered as the reward of employees' previous efforts.

Not all expenditures on employees are counted as part of human capital. Expenditures such as staff training programs are not paid out in exchange for the labor or services provided by employees. They are paid out in order to add value to their performance in the future. These so-called costs (which are actually investments) do not refer to an absolutely fixed set of accounting items but vary according to the business objectives, core skills and human attributes concerned.

Sorting Out A Company's Human Capital Investments According to Cost Development Stages in Human Resources

Traditional human capital accounting theories identify the following cost stages of human capital investments (Flamholtz, 1973): (1) formation and acquisition costs during the early stages of development; (2) learning costs during the middle stage of development; (3) replacement costs during the final stages of development. These investments represent firm inputs in different stages of human capital development.

Isolating Human Capital Costs From Expenses Pools and Suggestions for a Method of Disclosure in Financial Statements:

Chen and Lin (2003) have developed a human capital classification framework (see Figure 1).

TESTING THE VALIDITY OF HUMAN CAPITAL ARCHITECTURE

The Assumptions:

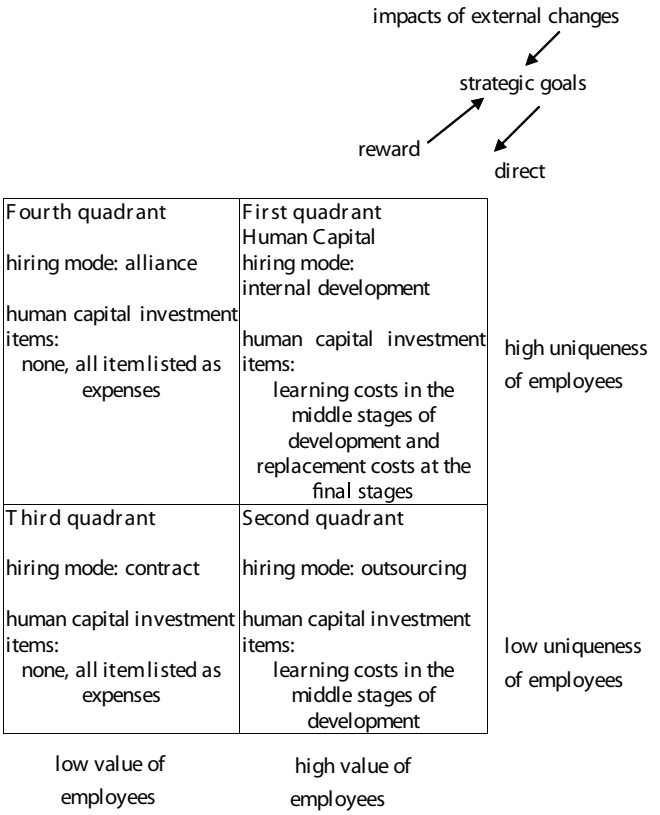
Lepak and Snell (1999) suggest that not all employees have the same contribution to firm performance. According to their theory, employees can be characterized by "uniqueness" and "value." So we made the following assumptions:

Assumption 1

The contribution to firm performance from an investment in high value employees is significantly different from an investment in low value employees.

The purpose of this assumption is to divide the employees into two groups according to their position and value, then test whether the investment of capital into those groups has a different influence

Figure 1. Framework of human capital expenditure classification



on firm performance. We used the questionnaire developed by Lepak and Snell (2002) to classify company employees into the different groups.

If the contribution to organizational performance from high value employees is significantly higher than the contribution from low value employees, the following assumption can be made:

Assumption 2
Investments in high value employees provide more of a contribution to firm performance than investments in low value employees.

The Selection of Human Capital Investment Data

Traditional human capital accounting theories identify the following stages of human capital investment (Flamholtz, 1973): (1) formation and acquisition costs during the early stages of development; (2) learning costs during the middle stage of development; (3) replacement costs during the final stages of development. These investments represent firm inputs in different human capital development stages. Through in-depth visiting, the target company provided the following data that represents different stages of human capital investment (see Table 1).

Combined with human capital architecture and human capital investment data, the following regression formulas were developed:

For Assumption 1
The contribution to firm performance from an investment in high value employees is significantly different from an investment in low value employees. Thus, regression equation 1 can be see in equation 1.

Table 1. Variables in different stages of human capital investment

Stages of development	Early stage	Middle stage	Final stage
Variables	Acquisition cost (AQR)	Training cost (TRN) Insurance cost (ISU)	Pension cost (PEN)

Equation 1.

$$ROA = \alpha_0 + \beta_1 AQR + \beta_2 TRN + \beta_3 ISU + \beta_4 PEN + \beta_5 DUMMY + \varepsilon$$

Equation 2.

$$ROA = \alpha_0 + \beta_1 AQR + \beta_2 TRN + \beta_3 ISU + \beta_4 PEN + \varepsilon'$$

Where

ROA = Return on assets in target company – Return on assets of industry average
AQR = Acquisition cost
TRN = Training cost
ISU = Insurance cost
PEN = Pension cost
DUMMY =1 high value employee
=0 low value employee

For Assumption 2
Investments in high value employees provide more contribution to firm performance than investments in low value employees. Thus, the regression equation 2 can be written as:

Where

ROA = Return on assets in target company – Return on assets of industry average
AQR = Acquisition cost
TRN = Training cost
ISU = Insurance cost
PEN = Pension cost

Those variables have passed both the "error term normality test" and the "multicollinearity test." The software used to complete our analysis was "SPSS for Windows 10.0."

The Target Company

The target company is a Taiwan-based textile corporation. It was founded in 1977 and went

Table 2. The descriptive statistics for "high value employees"

Variables	Number of Observations	Minimum	Maximum	Average	Standard Deviation
ROA	15	-0.67	4.67	1.1484	1.5187
AQR	15	22,279	2,801,751	264,380.60	703,895.52
TRN	15	0	5,024	1,752.86	1,719.49
ISU	15	71,399	223,541	146,405.47	29,543.88
PEN	15	1,625	10,295	5,835.99	1,968.30

Table 3. The descriptive statistics for "low value employees"

Variables	Number of Observations	Minimum	Maximum	Average	Standard Deviation
ROA	15	-0.67	4.67	1.1484	1.5187
AQR	15	5,570	700,438	66,095.13	175,973.95
TRN	15	0	47	14.37	16.05
ISU	15	1,934,443	9,200,459	4,732,945.13	2,115,627.65
PEN	15	4,116	6,570	5,826.43	703.01

Table 4. ANOVA table for equation 1

Source of variance	Sum of squares	Degrees of freedom	Mean squares	F-statistics
Due to regression	20.545	5	4.109	2.239*
Due to residuals	44.039	24	1.835	
Total	64.584	29		

**denotes a 10% level of significance*

Table 5. Summary of estimates of regression coefficients: Dummy variable

Variables	Parameter estimates	Standard errors	Normalized parameter estimates	t-statistics	VIF statistics
Intercept	-2.232	1.554		-1.436	
AQR	-2.392×10^{-7}	0.000	-0.082	-0.367	1.776
TRN	-3.199×10^{-4}	0.000	-0.319	-1.429	1.751
ISU	4.518×10^{-7}	0.000	0.835**	2.640	3.520
PEN	2.166×10^{-4}	0.000	0.211	1.002	1.558
DUMMY	2.674	1.032	0.911**	2.591	4.351
$R=0.564$ $R^2=0.318$ Adj $R^2=0.176$					

***denotes a 5% level of significance*

public in 2001. Its total equity is valued at about 30 million U.S. dollars. At present, there are over 2,600 employees in the company. Two thirds of all the employees are in mainland China. Our visits were made between July 2004 and February 2005. Each visit lasted around 2 to 3 hours.

The Analysis

The descriptive statistics for "high value employees" and "low value employees" are in Table 2 and Table 3.

Since equation 1 is designed for assumption 1, the result of our regression analysis can be seen in equation 1.

The R^2 reaches to 0.318, which means that the regression model is ideal. The coefficient of the dummy variable is significant ($p = 0.05$, two-tail test). The result supports the validity of our first assumption that the contribution to firm performance (ROA) from investment in high value employees is significantly different from investments in low value employees.

The more advanced test that was performed can be see in equation 2.

Based on the empirical study, we find that the regression model does not show a significant advantage for "high value employees" ($F = 1.167$, $p = 0.382$). On the contrary, investment in low value employees showed an advantage that reached the level of significance ($F = 2.848$, $p = 0.10$). The R^2 and the adjusted R^2 reached 0.533 and to 0.346 respectively. This leads to the conclusion that investment in high value employees does not provide more contribution to firm performance than investment in low value employees, which does not support assumption 2.

Discussion

These results are quite interesting. They indicate that "human capital investment" is important. However, only investments in "low value" human capital have a significant effect on firm performance. Why?

Actually these results perfectly reflect the facts found inside the target company. Through an interview with company CEO and managers, we found out that:

1. Compared to the electronics industry in Taiwan, the level of technology in the textile industry remains low and easy to achieve. The most important survival factor for the target company (or other textile companies in Taiwan) is not to develop high tech textile material such as Goltex. Rather, it is to win and maintain orders from leading

Table 6. ANOVA table for equation 2: High value employees

Source of variance	Sum of squares	Degrees of freedom	Mean sum of squares	F-statistics
Due to regression	10.277	4	2.569	1.167
Due to residuals	22.016	10	2.202	
Total	32.292	14		

**denotes a 10% level of significance*

Table 7. ANOVA table for equation 2: Low value employees

Source of variance	Sum of squares	Degrees of freedom	Mean sum of squares	F-statistics
Due to regression	17.197	4	4.299	2.848*
Due to residuals	15.095	10	1.510	
Total	32.292	14		

**denotes a 10% level of significance*

Table 8. Summary of estimates of regression coefficients: High value employees

Variables	Parameter estimates	Standard errors	Normalized parameter estimates	t-statistics	VIF statistics
Intercept	-2.313	3.147		-0.735	
AQR	1.237×10^{-7}	0.000	0.057	0.164	1.800
TRN	-1.979×10^{-4}	0.000	-0.224	-0.719	1.424
ISU	1.228×10^{-5}	0.000	0.239	0.819	1.249
PEN	3.387×10^{-4}	0.000	0.439	1.334	1.588
$R=0.564$ $R^2=0.318$ Adj $R^2=0.046$					

***denotes a 5% level of significance*

Table 9. Summary of estimates of regression coefficients: Low value employees

Variables	Parameter estimates	Standard errors	Normalized parameter estimates	t-statistics	VIF statistics
Intercept	0.999	3.758		0.266	
AQR	-2.424×10^{-6}	0.000	-0.281	-1.030	1.592
TRN	4.261×10^{-2}	0.040	0.450	1.060	3.864
ISU	$7.347E\times10^{-7}$	0.000	1.023**	2.491	3.613
PEN	-6.488×10^{-4}	0.001	-0.300	-1.137	1.493
$R=0.730$ $R^2=0.533$ Adj $R^2=0.346$					

***denotes a 5% level of significance*

brands such as Nike or Adidas. Although high value human capital is important, it cannot create firm performance without these orders. The more orders, the more "low level" labor needed, and the better the firm's performance.

2. Since having orders is the most important thing to a textile company, maintaining customer capital is the most important issue. In order to maintain this, investments in relationships with major customers are necessary. Also necessary are investments in meeting these customers' qualification requirements.
3. In order to reduce product defects and improve factory efficiency, the target company spends a lot of money on training costs and incentives given to "low value" employees (mostly first line operators). This may explain the relationship between these costs and firm performance.

CONCLUSION AND FUTURE TRENDS

This chapter has shown our most recent research into human capital. Since it was a pioneer study, we used a medium-sized but publicly traded company in order to keep the research work simple. The reason we performed a case study instead of using general data from a data bank is that the accounting standards do not require the three stages of human capital cost we used in our analysis. Since those individual costs were not shown publicly, we had to give questionnaires to the employees in order to dig out the numbers ourselves.

Using the method presented in the paper, human capital costs can be standardized under the requirement of GAAP. This would enable cross-company or cross-industry research regarding human capital investment and firm performance to be performed more easily.

There are two suggestions for further research. First, company employees can be further divided according to their "uniqueness" either by their position or by questionnaire. This would enable the relationship between human capital investment in each quadrant and firm performance to be examined. Second, the content of the "customer capital" and the relationship between customer capital and firm performance can be discussed further.

Finally, the results of this research do provide implications to the target firm's future decision making strategy. They provide an information base for the company to draw upon when deciding how to allocate limited resources. They also provide a persuasive argument for factors that connect to firm performance.

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Chapter V
Measurement Models in the Intellectual Capital Theory

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ABSTRACT

Intellectual capital in the form of intangible assets is now variously estimated to constitute 60-75 percent of corporate value, on average. Current debates about intellectual capital are part of the search for a methodology to measure the knowledge base of a firm. This is critical since a failure to properly conceptualize the nature and value of knowledge assets condemns firms and whole economies to fight competitive battles with outdated weapons and tactics. The purpose of this chapter is to present a comparative evaluation of some of the most commonly known intellectual capital (IC) measurement models. These models include Skandia's IC Navigator, Intellectual Capital Services' ICIndex™, The Technology Broker's IC Audit, Sveiby's intangible asset monitor (IAM), citation-weighted patents, and real option theory. Each model is classified along dimensions of temporal orientation, system dynamics, and causal direction.

INTRODUCTION

There are a growing number of methodologies for the measurement of intellectual capital (IC) at the firm level. The fact that the list is growing is perhaps a testament to both the difficulty of encapsulating something rather amorphous, the importance of doing so, and the tenacity with which pioneers in the field have tackled the subject. The challenge for academics is to frame the phenomenon using extant theories in order to develop a more rigorous conceptualization (Choo & Bontis, 2002). The purpose of this chapter is to compare the most commonly known IC models as a first step towards meeting that challenge. Given the recent proliferation of IC models, it is appropriate

to review the models and classify them according to their temporal orientation, system dynamics, and causal direction characteristics.

For temporal orientation, each model will be examined to determine whether it provides a historic report of performance, or a measurement designed to manage future firm performance. Future-oriented measurements are preferred over historic reports because they provide information that can be incorporated into decision-making, while the retrospective reports present no such opportunity.

For system dynamics, each model will be examined to determine whether it has a stock or resource focus versus a flow or process focus. Both stocks or balance sheet amounts, and flows affecting stocks are important to the management of a firm (Figure 1). Unfortunately, many organizations focus on primarily or exclusively on the stocks or resources because they are relatively easy to measure. According to Roos, managers must also focus on measuring the transformation process or flow, which is more complicated but also more useful. According to Roos, "There is no correlation between how much you know and how good you are at transforming that knowledge into something useful for somebody else" (Chatzkel, 2002).

The measurement of growth, or the rate of change of a flow, could also be important to the management of a firm.

For causal direction, each model will be examined to determine whether it has a cause or value-creating focus versus an effect or valuation focus. It is interesting to know both the cause and the financial-economic outcome of management decisions affecting intellectual capital. What is even more important from a scientific, business, and policy perspective is to be able to link a given effect to various causes.

BACKGROUND

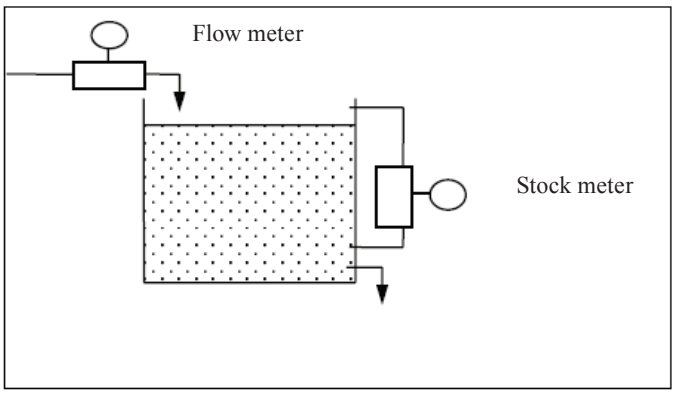
Socio-Economic Significance

Markets of all types require information in order to function. Buyers must know what sellers are offering, or transactions are not likely to occur. If they do occur, prices will be higher than they otherwise need be in order to account for the risks that buyers assume when they are not well informed.

Various estimates indicate that intangible assets currently constitute 60-75% of corporate value, on average. The socially harmful consequences of the failure to account properly for those assets, and disclose their attributes are numerous and very significant. They include (Lev, 2002):

1. Using intangibles for widespread manipulation of financial information,

Figure 1. System dynamics. Both flow and stock need to be measured.



2. Excessive gains to corporate insiders from trading the stock of their companies,
3. High volatility of stock prices, and
4. Excessive cost of capital to intangible-intensive companies, hindering innovation and growth.

Economic prosperity rests upon knowledge and its useful applications (Teece, 1998). There is much to support the assertion that IC is instrumental in the determination of enterprise value and national economic performance (Petty & Guthrie, 2000).

Significance to the Firm

Today, the nature and performance consequences of the strategies used by organizations to develop, maintain, and exploit knowledge for innovation constitute an important topic in the field of business strategy (Choo & Bontis, 2002).

Intellectual capital management has been found to be important for a company's long-term success. Firms managing their intellectual capital outperform other companies (Brennan & Connell, 2000).

Debate no longer centers on whether or not knowledge assets exist, but on their measurement. Firms need to answer such questions as: Are returns on R&D satisfactory? Are patents worth renewing? Those failing to address these questions will ultimately lose out to competitors that learn to measure, manage and leverage their knowledge assets (Mintz, 1999).

Development of the IC Concept

The development of intellectual capital reports can be traced back to the desire for individuals working with or within businesses to improve their understanding of what comprised the value of the business so as to manage better those things that generate value (Petty & Guthrie, 2000).

The formation of the discourse on intellectual capital is predicated upon the assumption that the traditional double-entry bookkeeping system does not reflect emerging realities. It is an inadequate tool for measuring the value of corporations whose value lies mainly in their intangible components (Salzer-Mörling & Yakhlef, 1999).

The limitations of the existing financial reporting system for capital markets and other stakeholders have motivated an evolving dialogue on finding new ways to measure and report on a company's intellectual capital. The product of this dialogue is a plethora of new measurement approaches that all have the aim, to a greater or lesser extent, of synthesizing the financial and non-financial value generating aspects of the company into one external report (Petty & Guthrie, 2000).

COMMONLY KNOWN IC MEASUREMENT MODELS

The plethora of theories, models, and methods advanced for understanding and measuring IC suggests that there is no generally accepted theoretical model for understanding IC (Petty & Guthrie, 2000).

The following 10 models will be examined:

- Economic value added (EVA™)
- Market value added (MVA)
- Tobin's Q ratio
- Balanced scorecard
- Skandia's IC Navigator
- Intellectual Capital Services' IC-Index™
- The Technology Broker's IC Audit
- Sveiby's intangible asset monitor (IAM)
- Real option theory
- Citation-weighted patents

While MVA, EVA™, and Tobin's Q do not directly measure IC, they may be considered early responses to the fact that book valuations of the firm as supplied by accounting were lacking in valuable information.

ECONOMIC VALUE ADDED (EVA™)

Origin

There is a long-standing financial theory that says that a business creates value only when its returns exceed its cost of debt and equity capital. The basic metric for measuring value creation is economic profit. Economic profit measures net profit after deducting a charge to account for the cost of capital utilized to generate this profit (INSEAD).

EVA™ is not a new discovery. An accounting performance measure called residual income is defined to be operating profit subtracted with capital charge. EVA™ is thus one variation of residual income with adjustments to how one calculates income and capital (Mäkeläinen, 1998).

One of the earliest to mention the residual income concept was Alfred Marshall in 1890. Marshall defined economic profit as total net gains less the interest on invested capital at the current rate (Wallace, 1997). The idea of residual income appeared first in accounting theory literature early in the last century by Church in 1917 and by Scovell in 1924, and appeared in management accounting literature in the 1960s (Dodd & Chen, 1996).

One of the best-known economic profit metrics is Stern Stewart & Company's Economic Value Added (EVA™). EVA™ is a trademarked variant of residual income that Stern Stewart & Company has marketed to be used instead of earnings or cash from operations as a measure of both internal and external performance (Biddle, Bowen, & Wallace, 1997).

The term EVA™ received little attention until a September 1993 article in *Fortune* magazine provided a detailed description of the EVA™ concept, Stern Stewart practice, and successful EVA™ adoptions by major corporations in the U.S. Similar performance measures marketed by competing firms include cash flow return on investment (CFROI) by Boston Consulting Group's HOLT Value Associates, shareholder value added (SVA) by Rappaport's Corporate Performance Systems, adjusted economic value added (AEVA) by de Villiers, refined economic value added (REVA) by Bacidore et al., discounted economic profits (EP) by Marakon Associates, and economic value management (EVM) by KPMG (Bacidore, Boquist, Milbourn, & Thakor, 1997; Biddle et al., 1997; de Villiers, 1997; Mäkeläinen, 1998).

Concepts

The EVA™ method of value measurement has its basis in traditional accounting. As defined by Stern Stewart, EVA™ is the difference between a company's net operating income after taxes and its cost of capital of both equity and debt (Chen & Dodd, 2001).

Calculating economic profit from accounting income is not easy; it requires hundreds of adjustments. For example, under traditional accounting cash disbursed for research and development (R&D) is expensed, but in arriving at economic income R&D would be capitalized since it provides a future economic benefit (Figure 2). The list of adjustments from accounting profit to economic profit is extensive (Evans, 1999).

In summary, the goal in calculating EVA™ is to arrive at earnings that are close to cash and compare this return to a capital base that is also expressed in cash equivalent terms.

MARKET VALUE ADDED (MVA)

Origin

Market value added (MVA), like EVA™, also derives its origin in the concept of economic profit as developed in the 19th century. One way of looking at MVA is to consider it the sum of initial capital invested and the economic profit or residual income or EVA™ accumulated over time.

Figure 2. EVA™ components (Chen & Dodd, 2001; Evans, 1999)

An equation for calculating EVA™

EVA™ = Residual Income (RI) + Accounting Adjustments (AcctAdj)

where:

RI = Net Operating Profits After Taxes (NOPAT) – Capital Charge (CapChg)

NOPAT = Earnings Before Extraordinary Items (EBEI) + After Tax Interest (ATInt)

EBEI = Cash Flow from Operations (CFO) + Accurals

ATInt = Net Interest Expense x (1 – Tax Rate)

CapChg = the charge for use of capital. It includes interest on the debt plus a charge for the equity capital based on a cash equivalent equity multiplied by a cost of equity.

Figure 2. One example of for calculating MVA and standardized MVA (Evans, 1999)

Example MVA and Standardized MVA Calculation

ABC Corporation has 100,000,000 shares of common stock outstanding with a market price of $25 per share. ABC has reviewed the book values of all of the debt and equity issued and adjusted it to a cash equivalent value of $2,400,000,000. In arriving at the $2,400,000,000 ABC reversed out the negative affects on equity, such as extraordinary losses. Last year ABC had a Market Value Added of $75,000,000.

Market Value of Equity = 100,000,000 x $25 = $2,500,000,000

Total Adjusted Capital = $2,400,000,000

Difference is Market Value Added = $100,000,000

Last Year's MVA = $75,000,000

Change in MVA = $25,000,000

Standardized MVA: $25,000,000 / $ 2,400,000,000 = 1.04%

Concepts

MVA is the difference between the market value of a company (both equity and debt) and the capital that lenders and shareholders have entrusted to it over the years in the form of loans, retained earnings and paid-in capital. As such, MVA is a measure of the difference between "cash in" (what investors have contributed) and "cash out" (what they could get by selling at today's prices). If MVA is positive, it means that the company has increased the value of the capital entrusted to it and thus created shareholder wealth. If MVA is negative, the company has destroyed wealth (Performance Rankings, 1999).

By maximizing the spread between the cash that a firm's investors have put into the business since the start-up of the company and the present value of the cash that they could get out of it by selling their shares, corporate managers maximize the wealth of the company's shareholders relative to other uses of capital (Bontis et al., 1999).

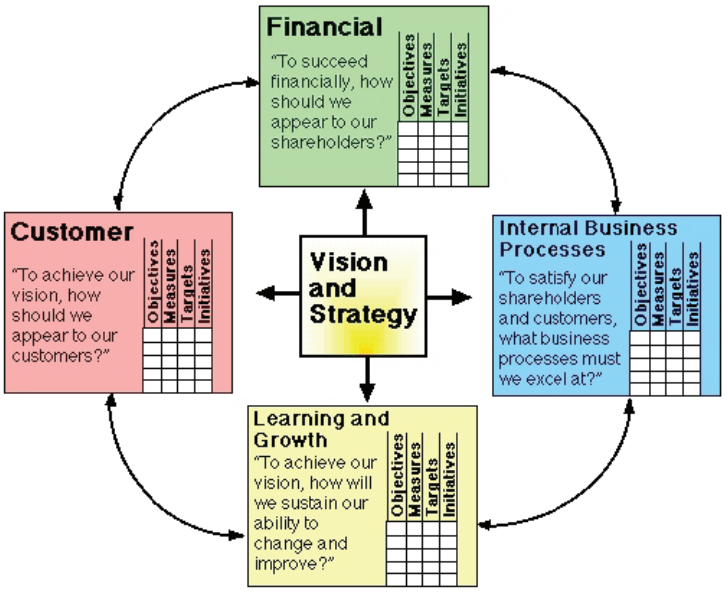
MVA = Market Value of Debt + Market Value of Equity – Total Adjusted Capital.

The total outstanding number of shares multiplied by the share price is the market value of a company's equity. Similarly, the total outstanding debt of a company multiplied by the market value of that debt is the market value of a company's debt. Total adjusted capital is the balance sheet total adjusted for a few accounting peculiarities such as LIFO reserve, notes payable, present value of operating leases, deferred taxes and the total amount of goodwill expensed to date, using both an operating and financing approach (Evans, 1999).

Figure 3. Tobin's Q ratio formula (Luthy, 1998; Mäkeläinen, 1998)

Tobin's Q Ratio
Q = Market Value / Asset Value

Figure 4. Kaplan and Norton's balanced scorecard (Kaplan & Norton, 1996)



Standardized MVA = Change in MVA for the Year/Adjusted Equity at Beginning of Year

MVA is also used as a way of benchmarking market performance between companies (Figure 4). In order to have a comparable MVA, a standardized MVA is calculated by dividing the change in MVA by the adjusted equity value at the beginning of the year (Evans).

TOBIN'S Q RATIO

Origin

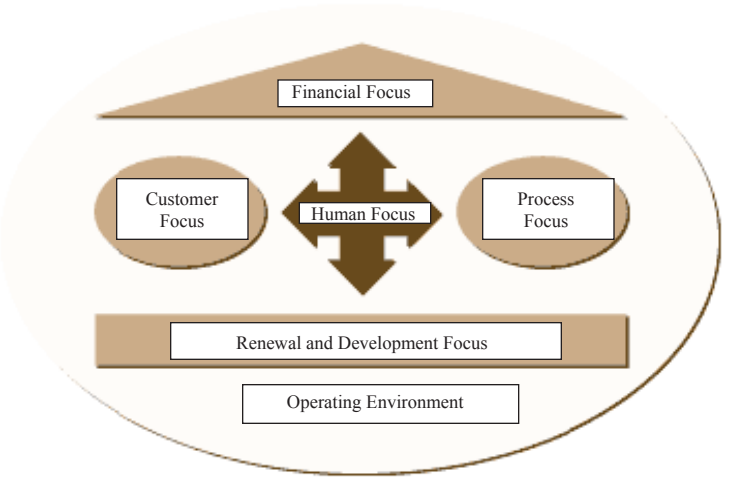
The Q ratio is the value of capital relative to its replacement cost (Tobin, 1969). Tobin, a Nobel Prize winning economist, developed it as a measure to help predict investment decisions independent of macroeconomic factors such as interest rates. Tobin's Q was not developed as a measure of intellectual capital, but Federal Reserve Chairman Alan Greenspan has noted that high Q and market-to-book ratios reflect the value of investments in technology and human capital (Stewart, 1997).

Concepts

Tobin's Q is essentially the same as the market-to-book ratio except that Tobin used replacement cost of tangible assets rather than book value of tangible assets in calculation. The use of replacement cost neutralizes many of the difficulties with the market-to-book ratio (Luthy, 1998).

A positive Q ratio value can be ascribed to the intangible value of intellectual capital, which is not captured by traditional accounting systems

Figure 5. Skandia's Navigator (Edvinsson & Malone, 1997)



(Luthy, 1998). If the Q Ratio is less than 1, an asset is worth less than the cost of replacing it, and it is unlikely that a company will buy more assets of that kind. If on the other hand, Q Ratio is greater than 1, companies are likely to invest in similar assets that are worth more than their replacement cost (Stewart, 1997).

Using Tobin's Q instead of market-to-book ratios neutralizes the effects of different depreciation policies, which vary from company to company and country to country (Roos, Roos, Edvinsson, & Dragonetti, 1998; Stewart, 1997). Tobin's Q is most revealing when like companies are compared over a period of several years (Stewart, 1997).

NORTON AND KAPLAN'S BALANCED SCORE CARD

Origin

The balanced scorecard (BSC) was created by Robert Norton and David Kaplan to provide managers with a translation of their organization's mission and strategy into a comprehensive set of performance measures that provides the framework for a strategic measurement and management system. The BSC retains an emphasis on achieving financial objectives, but also includes the performance drivers of these financial objectives. In addition to tracking financial results, the BSC simultaneously monitors the progress in the building of the capabilities and acquiring of intangible assets for future growth (Kaplan & Norton, 1996).

The BSC was developed out of recognition that the ability of a company to mobilize and exploit its tangible or invisible assets has become far more decisive than investing and managing physical, tangible assets. Managers, in their efforts to build long-range competitive capabilities, have been colliding with "the immovable object" of the historical cost-based accounting model (Kaplan & Norton, 1996).

Concepts

The balanced scorecard suggests that we view the organization from four perspectives, and to develop metrics, collect data and analyze it relative to each of these perspectives (Figure 5). The "balance" of the scorecard is between the external

Figure 6. Skandia's market value scheme (Edvinsson & Malone, 1997)

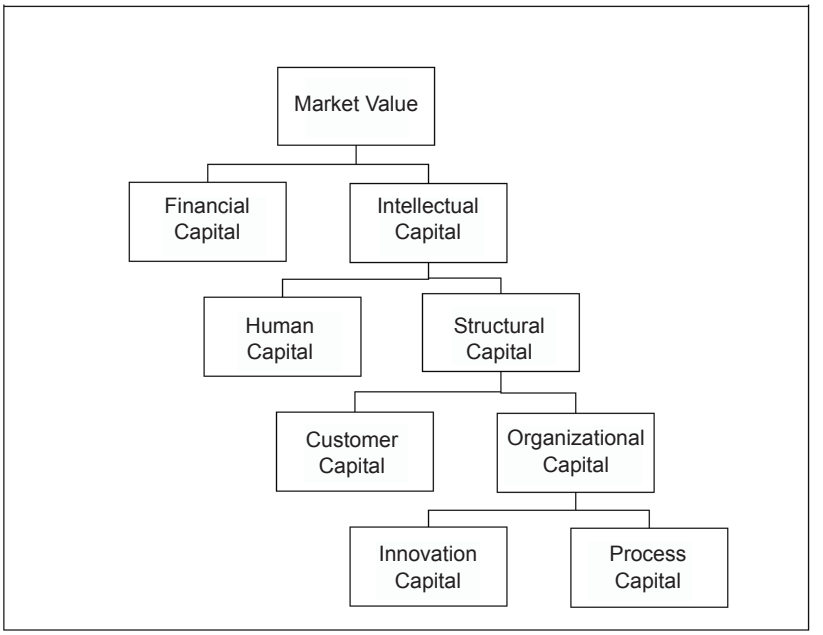
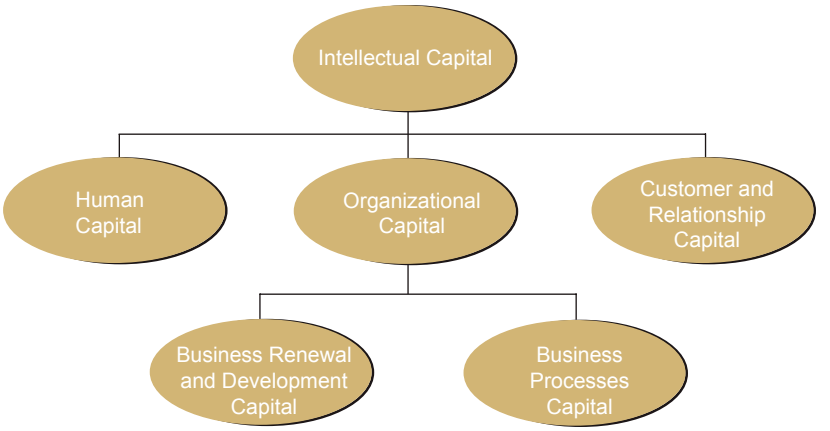


Figure 6. The intellectual capital tree used by the IC Index (Roos et al., 1998)



measures for shareholders and customers, and internal measures of critical business processes, innovation, and learning and growth. A "balance" also exists between relatively objective outcome measures and subjective, judgmental measures of performance drivers (Kaplan & Norton, 1996).

SKANDIA'S IC NAVIGATOR

Origin

The IC Navigator was developed at the Swedish financial services company Skandia by a team led by Leif Edvinsson (Edvinsson & Malone, 1997). It incorporates the presumption that intellectual capi-

tal represents the difference between market and book value of the company (Edvinsson & Malone, 1997; Luu, Wykes, Williams, & Weir, 2001).

Despite the weaknesses of Skandia's IC Navigator, most researchers agree that Skandia's considerable efforts to create a taxonomy to measure a company's intangible assets…"emboldened others to look beyond traditional assumptions of what creates value for organizations" (Bontis, 2001). Petty concludes, "Edvinsson's work was very much about the process" (Petty & Guthrie, 2000).

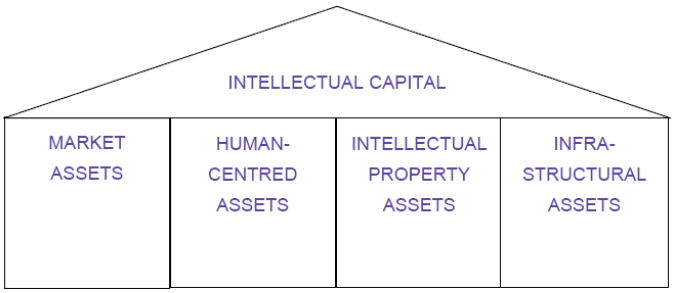
Concepts

The total market value of a firm is equal to its financial capital plus its intellectual capital. The components of IC are human capital and structural capital. Structural capital can be deconstructed into organizational capital and customer capital. Organizational capital can in turn be deconstructed into innovation capital and process capital (Edvinsson & Malone, 1997). Organizational intellectual capital is the overall common IC measure of a company. It is calculated by multiplying an efficiency coefficient, (i).

Figure 7. Hierarchy of categories in the IC Index (Roos et al., 1998)

Relationship Capital Index • Growth in number of relationships • Growth in trust • Customer retention • Distribution channels productivity and quality	Human Capital Index • Fulfilment of key success factors • Values creation per employee • Training efficiency and effectiveness
Infrastructure Capital Index • Efficiency • Effectiveness • Key success factors utilisation • Distribution efficiency	Innovation Capital Index • Ability to generate new business • Ability to generate good products • Growth • Ability to improve productivity

Figure 8. The components of intellectual capital (Brooking, 1998)



by an absolute monetary IC measure, (C). The efficiency coefficient is the arithmetic mean of the "Intellectual Capital Coefficient of Efficiency Indices," a set of percentages derived by culling out redundancies and applying some subjective judgment (Edvinsson & Malone, 1997). (However, the example given on page 188 of Edvinsson's text does not appear to be calculated in this way). The absolute monetary measure, (C), is equal to the sum of "about two dozen indices" measured in monetary terms (Edvinsson & Malone, 1997).

The Skandia Navigator approach takes into account the same set of financial, operational, and customer concerns as the Balanced Scorecard (*Figure 7*). But, it makes more explicit the need to consider the organization, its structure and processes for nurturing its employees (Shand, 1999).

INTELLECTUAL CAPITAL SERVICES' IC-INDEX™

Origin

The IC-Index model was created by Göran Roos and Johan Roos of London-based Intellectual Capital Services.

Concepts

Finding that the importance of specific components of the IC-Index Intellectual Capital Tree varied from firm to firm, Roos and Roos honed in on four high-level categories (Figure 9). Developing measures within these categories requires a three-stage process:

1. A critical review of existing indicators.
2. Development of indicators that represent the flows between different IC categories.
3. Develop a hierarchy of IC indices.

Each of these indices are in turn aggregated into a single index that can be used to compare the same unit over time, or with other business units (*The IC Index: Customer capital and the knowledge economy*, 2000).

Figure 9. Four modes of knowledge conversion (Nonaka & Takeuchi, 1995)

	tacit knowledge to explicit knowledge	
tacit knowledge	Socialization	Externalization
explicit knowledge	Internalization	Combination

THE TECHNOLOGY BROKER'S IC AUDIT

Origin

Brooking designed this model (Figure 10) to place a definitive dollar value of a firm's IC.

Concepts

Market assets consist of such things as brands, customers, distribution channels, and business collaborations. Intellectual property assets include patents, copyrights, and trade secrets. Human-centered assets include education and work-related knowledge and competencies. Infrastructure assets include management processes, information

Figure 10. Components of market value of a company (Sveiby, 1997)

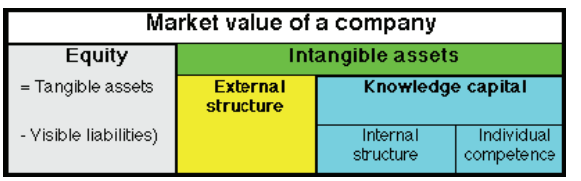


Figure 11. An example of an intangible assets monitor (Sveiby, 1997)

	External Structure	Internal Structure	Competence
Growth / Renewal	Profit/customer Growth in market share Satisfied customer index	IT investments R&D investment	Number of years' education Share of sales from competence-enhancing customers
Efficiency	Sales per professional Profit per customer	Support staff % Values	Value added/employee
Stability	% large companies Devoted customer (repeat orders)	Turnover "Rookie" ratio	Professional turnover Relative pay

technology systems, networking, and financial systems (Brooking, 1998).

It works as a diagnostic, prompting managers to develop IC indicators initially through a 20-question survey followed by a further 158 questions touching on a range of issues regarding intangible assets such as brand equity, knowledge management processes, and existing research and development (R&D) measures. The more affirmative the responses in these areas, the healthier the firm's IC focus is deemed to be. Following the survey, a dollar value for the IC is calculated using a cost approach, a market approach, or an income approach (O'Brien, 2002).

SVEIBY'S INTANGIBLE ASSET MONITOR (IAM)

Origin

Sveiby's intangible asset monitor developed out of his experience as a partner and manager of a financial weekly. While working there, he realized that the firm's traditional financial statements "were a joke" and that most of the value of the firm lay in its "invisible knowledge-based assets." Nonaka and Takeuchi's four modes of knowledge conversion (Figure 11) formed part of the intellectual underpinning of the intangible asset monitor (Sveiby, 1997).

Concepts

The total market value of a company consists of its visible equity and three kinds of intangible assets (Sveiby, 1997). The visible equity is the book value of the firm. The intangible assets are categorized as either external structure or knowledge capital. The external structure consists of brands, and customer and supplier relations. Knowledge capital is comprised of internal structure and individual competence. The internal structure is composed of the organization's management, legal structure, manual systems, attitudes, R&D, and software. Individual competence includes education and experience (Sveiby, 1997).

REAL OPTION THEORY

Origin

Real option theory provides an approach which values the opportunities arising from intellectual capital. A real option is one that is based on non-financial assets and, unlike a financial option, the underlying asset is non-tradable. It applies the same techniques and variables as the Black-Scholes model on which financial options are based, but uses non-financial inputs. The term, real option, was coined in 1977 by Stewart C. Meyers of Massachusetts Institute of Technology. Its earliest applications were in oil, gas, copper, and gold, and companies in such commodity businesses remain some of the biggest users (Luu et al., 2001). The value of the real option depends on the idea developed by the firm's R&D activity, the risk of the R&D activity, and the speed with which it is completed and introduced on the market in relation to similar actions of competitors (Johnson, Neave, & Pazderka, 2001).

Concepts

The goal of business is to direct the firm's resources to those activities that provide the highest economic value for the owners of the firm. The valuation and choice of new investments for a firm is more complicated than the capital market since within the firm there is no market for assets. With no market to provide a "fair" estimate, managers must estimate value (Phelan, 1997).

According to Simon (Beaver, 2002):

- We do not have perfect knowledge about all future states of the world;
- We do not possess the cognitive skill to determine appropriate actions for the states which we can perceive; and
- We cannot foresee all the possible consequences of actions we do eventually choose to take.

The use of real option theory provides one solution to our human inability to forecast complex or distant future events accurately (Phelan, 1997). The real options approach recognizes that the boundaries of firms are fluid with respect to adopting different kinds of projects, and attempts to value the consequences of their possible adoption (Johnson et al., 2001).

CITATION-WEIGHTED PATENTS

Origin

Schmookler and Scherer were two of the earliest researchers to use patent data in the economic analysis of technological change in the 1960s. The arrival of publicly available computerized patent information in the 1980s led to a second wave of econometric research using patent citations to increase the information content of the data (Hall, Jaffe, & Trajtenberg, 2001).

The distribution of the value of patented innovations is extremely skewed. A few patents are very valuable, but most are close to valueless. Therefore the number of patents held by a firm is not highly correlated to the sum of the value of those patents (Hall et al., 2001).

Concepts

A patent is a temporary legal monopoly granted to inventors for the commercial use of an invention. The technological antecedents of patented inventions are identified as references or citations in the patent documentation (Hall et al., 2001). Research using patent citations to measure IC is based on the following assumptions (Hall et al., 2001):

1. Stock market investors hold the rational expectation that the present value of a firm's future profits varies with its stock of knowledge,
2. Valuable technological knowledge within the firm tends to generate patents that future researchers build on and therefore cite when doing their own innovation.

The working hypothesis that flows from these assumptions is that citations are an indicator of the (private) value of the associated patent right, and are therefore correlated with the market value of the firm because investors value the firm's stock of knowledge (Hall et al., 2001).

There is considerable evidence that self-citations (citations to patents assigned to the same firm as the citing patent) are worth about twice as much as ordinary citations, especially to smaller firms. It is not clear, a priori, what interpretation to give to these self-citations. They should be less significant economically if they appear as a result of being well known within a firm or if they appear because of an inventor's desire to acknowledge colleagues. On the other hand, they may be an indication that a firm has a strong competitive

position in a particular field and is able to successfully appropriate cumulative impacts while keeping spill-over to competitors to a minimum (Hall et al., 2001).

MEASUREMENT MODEL CLASSIFICATION SUMMARY

The IC measurement models were classified along three dimensions, temporal orientation, system dynamics, and causal direction as described in the introduction. Models were examined to see if they provided a future orientation that could be incorporated into decision-making. Evidence for the measurement of flows was also sought in each model. Finally, each model was examined for empirical evidence that it was capable of linking effects to underlying causes.

Temporal Orientation

There is an implicit assumption in using EVA™ that the future value of a firm is entirely a function of historic activity. Equity valuation is ultimately the discounted present value of future equity cash flows, and EVA™ is ultimately still based on historic events (Biddle et al., 1997).

MVA measures are entirely the result of historic activity. However, it is fairly easy to obtain a current estimate for a firm whose shares and debt trade in public markets, and who have recently published financial statements.

Tobin's Q measures the result of human activity over time as expressed in the market value of a firm. Although it can be an onerous exercise to estimate the replacement cost of the tangible assets used in the denominator of the calculation, current market values a firm whose shares in public markets are relatively easy to obtain.

The balanced scorecard collects the results of human activity over time and expresses them as both internal and external measures. Since the BSC compares actual results to predetermined targets, it has a reporting or historic orientation.

The IC Navigator's Intellectual Capital Report, the IC-Index, the IC Audit, and the intangible assets monitor all have a historic orientation. The IC Report gives an account of numerous "indices" from the financial, customer, process, renewal and development, and human focuses. The IC-Index gives an account of numerous "indices" and an ultimate single index number, which can be compared from period to period. The IC Audit is designed to measure a firm's IC at a specific point in time, and makes no prediction of the future. The IAM reports on a number of financial and non-financial measures. The IAM scores a firm's ability at growth/renewal, efficiency, and stability applied across the three forms of intangible assets, external structure, internal structure, and competence.

Citation-weighted patents focus on "ancient" history. To the extent that most IC models still rely on accounting data, they are never more than 18 months out of date. However, due to the ex post nature of citations data, the usefulness of citations in estimating the current value of intangible assets is rather limited. This is because the bulk of citations occur in the range of three to ten years after a patent is granted (Shane & Klock, 1997, Hall et al., 2001)

Unlike all of the other models capturing a historic value for IC, the real option approach provides a perspective on the future.

System Dynamics

EVA™ is a measurement of a stock of value added typically over a period of one year, while MVA is by definition a measurement of a stock of value. Tobin's Q is a ratio of two stocks of value, a market valuation of a firm and the replacement value of its assets. Comparing these three measures at the end of two different periods could result in an average rate of change, but there is no rate of change or flow component built into these models.

The balanced scorecard can include stock and flow measures or both. The determination of the measures and the types used is expected to be a

function of the management's interpretation of the firm's strategy.

The IC Report is generally composed of stock measures, but does include some financial flow variables such as revenue, expense, profit, and return on assets.

The IC-Index is a stock variable that marks the IC stock at a given point in time (O'Brien, 2002). However, some flow variables are included in the derivation of the IC-Index. The IC Audit also attempts to synthesize all IC into a single stock of value measurable in a currency. The IAM is also generally composed of stock measures, but does include some flow-related variables such as growth in revenue and growth in sales per administrative staff (Sveiby, 1997).

The citation-weighted patent approach provides a measure of only one component of the total stock of IC held by a firm.

The real option approach facilitates the interchange of flows of future cash value with a stock measured in net present value.

Causal Direction

Empirical evidence does not appear to support the theory that EVA™ is linked to share value. Biddle et al. examined Stern Stewart's claim that EVA™ is superior to earnings in association with stock returns. They discovered that there is little evidence to support the Stern Stewart claims that EVA is superior to earnings in its association with stock returns or with firm values. While the charge for capital and Stern Stewart's adjustments for accounting "distortions" show some marginal evidence of being incrementally important, this difference did not appear to be economically significant (Biddle et al., 1997).

Chen and Dodd examined the value relevance of three profitability measures: operating income, residual income, and economic value added (EVA™). Their study found that all three profitability measures have little information content in terms of value-relevance. Contrary to the claim of EVA™ advocates, the data did not support the assertion that EVA™ is the best measure for valuation purposes. Results are consistent with prior studies that find accounting-based information explains little of the variation in stock returns between firms. Relatively low R2s suggest that over 90% of the variation appears to be attributable to non-earnings-based information. This suggests that if firms desire to more closely align organizational metrics with stock value, a measurement paradigm other than EVA™ will have to be developed (Chen & Dodd, 2001).

Although it could be argued that MVA provides a cumulative measure of human value-adding activity, there does not appear to be any empirical evidence linking to MVA to any underlying cause.

Despite Greenspan's assertion that high Q ratios reflect the value of investments in technology and human capital, there does not appear to be any empirical evidence linking to Tobin's Q to any underlying cause.

Since both MVA and the Q ratio are based on share prices, it would be a circular argument to claim that either is a cause of increased shareholder value.

The principal premise on which the BSC concept is based is that a business strategy can be viewed as a set of hypotheses about cause-and-effect relationships (Banker, 2000). Recent research testing the validity of the BSC's claim to be a causal model of financial performance has found mixed empirical support, in contrast with much professional literature that has given the implied relation almost unqualified support (Malina, 2001). Some of the lack of empirical support may lie in the difficulty of isolating performance driven by management's strategy-selection ability from performance based on management's ability to the select the appropriate performance measures.

The link between a number of reported IC measures and organizational and investor outcomes still requires investigation (Boudreau & Ramstad, 2001). While IC models appear intui-

Table 1. Measurement model classification summary

	Temporal Orientation		System Dynamics		Causal Direction	
Model	**Historic**	**Future**	**Stock**	**Flow**	**Cause**	**Effect**
EVA™	Year to year		✓		No	
MVA	Relatively current		✓			Coarse estimate
Tobin's Q	Relatively current		✓			Coarse estimate
BSC	✓		Can be included	Can be included	Lacking evidence	✓
IC Nav.	✓		Mostly	A few included	Lacking evidence	✓
IC-Index	✓		Single number	Used in derivation	Lacking evidence	✓
IC Audit	✓		Mostly	A few included	Lacking evidence	✓
IAM	✓		Mostly	A few included	Lacking evidence	✓
CWP	✓		✓		✓	
Real Op.		✓	Both	Both		Estimate only

tive, true empirical evidence that the use of the IC Navigator, or the IC-Index, or the IC Audit, or the Intangible Assets Monitor or Real Option valuation leads to better financial-economic performance is lacking.

However, there are some anecdotal claims that the IC-Index can predict how monetary investments in different types of capital will eventually make their way into products and sales. For example, Apion, Ltd. is reported to have established a strong correlation between its various intellectual capital investments and cash flows (Shand, 1999).

There are a small number of studies that "validate" the use of citations data to measure economic impact, by showing that citations are correlated with non-patent-based measures of value (Hall et al., 2001).

The measurement model classifications are summarized in Table 1.

CONCLUSION

Most IC measures still have a historic orientation. Only real option theory has a future orientation and only citation-weighted patents has any significant empirical support for causality. In addition, most measures still focus predominantly on stocks, with only limited incorporation of flows. This implies considerable scope for future research, especially in the development of empirically sound expectations models based on flows of IC.

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Chapter VI
The Financial Valuation of Intangibles:
A Method Grounded on an IC-Based Taxonomy

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ABSTRACT

This chapter proposes a method for the financial valuation of intangibles based on a specific taxonomy that distinguishes between intangible assets and core competencies, while classifying the latter into (tangible or intangible) asset-driven core competencies and non-asset driven core competencies. These are in turn classified according to the intellectual capital categories they drive. The method proposed is based on the assumption that the value of a company's intangibles is to be found essentially in its core competencies. Financial valuation models based largely on the cash flow generated by the company and on real options valuation are proposed as a means of identifying and quantifying a company's intangibles in monetary terms, taking the earnings they are capable of generating into account. This method is suitable for valuing the intangibles of large companies and smaller businesses where large databases are not available.

INTRODUCTION[1]

This chapter proposes a method for the financial valuation of intangibles based on a specific taxonomy that distinguishes between a company's intangible assets and core competencies as value drivers. Our approach assumes that the value of a company's intangibles lies essentially in its core competencies.

Based on a strategic analysis that identifies the firm's core competencies and assets, the proposed method also singles out the characteristics contributing most to the generation of value.

Financial valuation models based largely on the cash flow generated by the company and real options valuation are proposed as a means of measuring the value the business receives from individual intangibles. The company's financial information and the analysis and opinions of its directors are employed in implementing these models. The method is suitable for valuing the intangibles of large companies and smaller businesses where large databases are not available.

The second section looks into the basic concepts for the financial valuation of intangibles, and provides a critical survey of the approaches and models developed to perform this valuation.

The third section provides a discussion of the method's basic concepts and characteristics. The fourth section describes the initial stages of the method, designed to obtain the information needed to ascertain the value of a company's intangibles.

The fifth section shows how, in the context of this method, financial valuation models can be applied to obtain the value of a firm's intangibles.

The sixth section sets out the method's future development prospects.

The conclusions, which summarize the results obtained, are followed by a short bibliography.

BACKGROUND: THE FINANCIAL VALUATION OF INTANGIBLES

To begin with, this section looks at the basic concepts for the financial valuation of intangibles, and then provides a critical survey of the approaches and models developed to perform this valuation.

Why Value a Firm's Intangibles?

The management and valuation of companies' intangible resources and assets is undoubtedly a major preoccupation. This is particularly true of knowledge-based assets, also known as *intellectual capital* (IC) (Hussi, 2004; Kaufmann & Schneider, 2004)[2].

A company's intangible assets often account for a greater proportion of its overall total assets than its tangible assets do. However, the value of most *intangibles* does not appear on the financial statements, largely because the lack of transparency and the absence of a benchmark market make it difficult to value them (Lev & Zarowing, 1998).

Some authors see no need for explicit reports on the value of the companies' intellectual capital, arguing that the market already does this by valuing their securities. This view would be correct if the stock market were continuously efficient, but this has proven not to be the case. But the market always values the set of a firm's intangibles, which means the problem of valuing them individually persists. Furthermore, stock market valuations are not applicable to unquoted SME, comparable listed companies being hard to find.

Demands from the corporate world prompted academic research in the 1990s into ways of reflecting the value of intangibles in financial statements (García-Ayuso, Monterrey, & Pineda, 1997; Lev & Zarowin, 1998; Lev, Sarath, & Sougiannis, 1999; Lev, 2001b; Cañibano et al., 2002). Unfortunately, the problem has largely resisted efforts to find a solution.

The lack of an explicit valuation of intangible assets may encourage information asymmetries and inefficiencies on stock markets. Experience shows that when the value of intangible assets is included in the market analysis, forecasts on the future business performance improve, which highlights their importance in making the market efficient, reducing information asymmetries and thus the risk of adverse selection.

Apart from the advantages for financial market performance to be gained from fuller information about a firm's intangibles, detailed knowledge of such *intangibles* inside the company is also very important:

- For management, shareholders and workers to know the true value of their company.
- To encourage the preservation, regeneration and strengthening of the firm's intangibles, and thus help to increase present and future corporate profits.
- To show the firm's guarantees when seeking new financing, either through debt or equity. True information about the value of intangibles reduces information asymmetries, making it easier to access financial resources in better cost conditions.
- To negotiate company value in mergers or takeovers.
- Where applicable, to compare it with the stock value and check to what degree this is due to the real value of the company or to "market sentiment."

Clearly, companies increasingly need to value their intangibles.

Value Measurement and Financial Valuation

There are two general procedures for intangibles valuation: *value measurement* and *financial valuation* (Andriessen, 2004a).

Value measurement basically includes two tasks: one is identifying and placing the intangibles in a structured order, that is, discovering the type of intangibles in the company, the ones that generate basic competencies, the relationships between them and so on; the other involves looking for indicators that facilitate the development of the most important intangibles and comparing the company situation with other benchmark organizations. As these indicators are mainly ratios, the measurement of intangibles is basically non-monetary. Brooking (1996), Edvinsson and Malone (1997) (Scandia Navigator), Kaplan and Norton (1997) (Balanced Scorecard), Roos et al. (1997), Sveiby (1997) (Intangible Assets Monitor), Joia (2000), Viedma (2001) (Intellectual Capital Benchmarking System) and Bueno (2003) (Intellectus Model), have all made interesting contributions on these issues.

Financial valuation seeks to establish a monetary valuation of intangibles. As indicated below, there are several ways of arriving at this valuation. Unfortunately, they all have advantages and drawbacks, which means the search for methods and models for the financial valuation of intangibles that are both true and simple is by no means an easy task.

This chapter focuses on the latter procedure. From here on, we will be referring to the general principles of intangible financial valuation, to the characteristics determining the specific features of valuation and to the valuation approaches and methods proposed.

Future Yields and Core Competencies

To value *intangibles* financially, a company's intangibles first have to be identified and listed. In most of the works referred to above on intangibles value measurement, general models are used to identify intangibles in companies and organizations. While acknowledging the undeniable value and usefulness of such models, preparing a comprehensive list may be very difficult and ultimately unrewarding; differences in competitive capabilities would lead to differences in key intangibles from one company to another. Some important intangibles that enable the company to obtain competitive advantages will almost certainly not be individualised, being the result of combinations of a number of elements.

But of course an asset, whether tangible or intangible, only has value according to the use to which it is put; so value depends on the yields obtained from its use (Tissen et al., 2000; Cummings, 2003; Lev & Zambon, 2003; Schunder-Tatzber & Markom, 2004).

Where does the potential yield of intangible assets come from? We know that most companies

focus their endeavours and internal resources on some activities or knowledge sources, known as *core competencies*, which provide the basic competitive advantages and therefore determine value creation. Hamel & Pralahad (1994) define them as the set of skills or aptitudes developed by the company that generate significant value or benefit for the client. Therefore, as Coff & Laverty (2002) indicated, a core competence is always based on a type of knowledge or a knowledge combination.

So, in line with other authors (Andriessen & Tissen, 2000; Sullivan, 2000; Sullivan & Sullivan, 2000; Tissen et al., 2000; Viedma, 2001; Mouritsen, 2003; Andriessen, 2004b), we consider identifying a company's core competencies is an essential first step in valuing an organization's corporate intangibles.

Various aspects require evaluation to identify a firm's core competencies: its capacity to provide added value and differentiate the company from the competition, its sustainability in time and the ease with which the value generated can be appropriated.

Intangibles Financial Valuation: Approaches and Methods

It is clear from the above that the financial valuation of intangibles is a complex affair. Table 1 sum-

Table 1. Approaches and methods for the financial valuation of intangibles

Approaches	Methods	Joint valuation of all intangibles	Separate valuation of intangibles	Valuation of specific intangibles
Cost Approach	Historical cost	-	-Historical cost -Historical cost adjusted for inflation (s.a.)	-
	Present cost	-	-Reproduction cost -Replacement cost (s.a.)	-
Market Approach	Stock Market	-M/B ratio -Tobin's *q* (s.a.) -Analogical stock market valuation (Caballer & Moya, 1997)	-FiMIAM (Rodov & Leliaert, 2002)	-
Income Approach	Retrospective methods	-Goodwill (s.a.) -Calculated intangible value (Stewart, 1997)	-	-
	Prospective and mixed methods	-Intangibles scoreboard (Lev, 2001a; Gu & Lev, 2001)	-Weightless wealth toolkit -Andressen and Tissen (2000), Andriessen (2004b) -Real options approach (s.a.)	-Technology factor (Khoury, 1998)
s.a.: Several authors				

marizes the critical analysis of the approaches and methods proposed to value the set of intangibles and the isolated intangible elements.

Cost Approach

This approach takes account of several types of costs. Below is a critical review of the most frequently used.

Historical cost is the cost of an asset at the time it was acquired or constructed, less accumulated depreciation. It is not usually a good indicator of asset value, as the price may have fluctuated enormously since the time of purchase or construction. Besides, if conventional rules have been applied to record depreciation, rather than the real loss of the asset's value, deviations from the real value may increase.

Inflation-adjusted historical cost is the historical cost increased by the accumulated inflation from the moment the asset is acquired or constructed to the present, less inflation-adjusted depreciation. Although it makes a better benchmark value than non-adjusted historical cost, the fact that the general variation in prices does not have to coincide with the variation in the price of a specific asset has to be taken into account.

Reproduction cost is the estimated cost of construction, at current prices, of an exact replica of the asset in question.

Replacement cost is the estimated cost of constructing, at current prices, an asset with equivalent utility to the asset in question.

Although the last two cost types are more acceptable benchmarks for asset value, they also raise problems with regard to intangibles, particularly if they are, or contain, core competencies. This is because part of the resources used to construct them is likely to be idiosyncratic, meaning they have no market and that their current prices will be unobtainable.

Market Approach

Another group of methods for the financial valuation of intangibles is based on the hypothesis that the stock market stays close to the real value of securities issued by the company, and therefore the difference between the market value of the securities issued and the value of its tangible assets closely reflects the value of its intangibles[3].

Under this approach, one way of valuing in relative terms all a company's intangibles is through Tobin's q ratio, proposed by Nobel Prize winner James Tobin (1969). This ratio expresses the relationship between an asset's market value (MV) and its replacement cost (RC), that is, $q = MV/RC$.

If the asset is traded in an efficient market, its value on that market has to coincide with the outcome of adjusting the overall expected yields throughout its useful life to an appropriate rate. Therefore, if $q > 1$, retaining an asset adds value to the company; while if $q < 1$, the company will be worth more by getting rid of it.

If the company is considered overall as a single asset, then q expresses the relationship between the company's equity and debt market value and the replacement cost of its tangible assets. If the market for the shares and debentures issued by the company were efficient, q values over 1 would indicate that the company has intangible assets, in particular intellectual capital. The value of the intangibles would obviously correspond to the difference between q's numerator and denominator (Chung & Pruitt, 1994; Delgado et al., 2004; Villalonga, 2004).

Instead of q, a frequently used variant for its simplest calculation is the M/B ratio, which relates, for the stockholders' equity of the company, its stock market value[4] with its reported book value. This second ratio raises conceptual problems, as the accounting value, used as the denominator,

does not ensure accurate tangible asset valuations for two reasons: (1) the value awarded to these assets is usually achieved by applying accounting criteria of prudence; that is, they tend to be conservative, which means that the accounting value is usually slanted downwards; (2) asset book values already include some intangible items, including intellectual capital (Goodwill, patents, etc.), for which, furthermore, valuation is not always correct.

Another method based on the market approach is the "Financial Method of Intangible Assets Measurement" (FiMIAM), put forward by Rodov and Leliaert (2002). This method basically consists of assigning, by consensus between the company's top executives, a rating between 0 and 1 to its different intangibles, so that the sum of the ratings is equal to one. The most influential components are then identified as being the ones considered to generate the company's core competencies. Finally, these ratings are multiplied by the difference between the stock market value and the reported stockholders' equity, thus obtaining a monetary value for the core competencies.

The principal objection with respect to FiMIAM is that both the influence assigned to the intangibles' components and the selection of the "most important" are the result of subjective appreciations, based solely on the experience and knowledge of the company's top executives.

Another objection to stock market value-based methods is that they are not applicable to unlisted companies. Even so, the "Analogical Stock Market Valuation" (Caballer & Moya, 1997) may be applied to this type of companies. This method basically consists in finding an econometric model that explains the stock market value of listed companies, by means of easily accessible variables (usually taken from the financial statements themselves). This model is then applied to the values of the explicative variables in similar unlisted companies, thus obtaining their "analogical stock market value." Obviously, the same method may be used to value overall intangibles in non-listed companies.

The methods considered so far all assume that the stock market is sufficiently efficient. This is precisely where the main difficulty lies in considering them totally reliable, largely because ongoing market efficiency is not guaranteed. Furthermore, the problems the market faces in accurately valuing a company intensify as the proportion of the firm's intangibles grows. And, given the greater valuation difficulty, market inefficiency will also tend to increase (Rodríguez, 2002).

Clearly, what are needed are methods for financially valuating intangibles that are independent of stock market value, such as the ones considered below.

Income Approach: Retrospective Methods

An approach not based on stock market value is one that takes account of flows that intangibles will generate in the future. Estimations of such flows may be based on flows obtained in the past (retrospective methods) or on an estimate, not determined by the past, of future flows (prospective methods). There are also mixed methods combining the retrospective and prospective approaches. To begin with, we look at the first group of methods.

Goodwill was the first of this type to be proposed. Although various systems can be used to value Goodwill (G) (Damodaran, 2002), it is basically calculated in all of them as a multiple (M) of a firm's economic variable (EV): $G = M \times EV$.

A whole range of economic variables is used as the basis for calculation. The most common are:

- Net profit,
- Cash flow (more objective than profit as it depends less on the accounting criteria used),

- Turnover,
- "Over-profit."

Over-profit can be calculated in a number of ways, which means that Goodwill values will vary depending on the method used. Over-profit is usually calculated as the difference between net profit (NP) and the yield provided by the book value of the firm's total assets (TA), corrected to market prices, when invested at a risk-less rate of interest (r):

Over-profit = NP – r × TA

But the book value of stockholders' equity (E) can also be used in such calculations instead of total assets. In this case, G = M × (NP – r × E). Another more correct way to calculate over-profit is to identify it with the EVA (economic value added) (Stern et al., 2001)[5].

Applying multiples in order to calculate Goodwill presents serious problems. How can the value given to a multiple be economically justified? Comparable companies are normally sought, but this does not avoid the difficulty of justifying the value. On the other hand, the multiplier cannot be applied to companies that have losses or negative cash flows, as they would provide negative Goodwill values.

A simple retrospective method that does perform a strict cash flow discount is the "calculated intangible value," (CIV), proposed by Stewart (1997), which establishes the value of the intangibles by comparing the profitability of the company and that of an average competitor.

Stated formally:

$$CIV \equiv \frac{E_t(NCFe)}{s}$$

With:

$E_t(NCFe) = \frac{1}{3}\left[\sum_{k=0}^{2}\left(NCF_{t-k} - NCF^{m}_{t-k}\right)\right]$: Net cash flow, expected at moment t, which the company will obtain in excess of an average firm in industry with identical tangible assets.

NCF_{t-k}: Net cash flow obtained during the t−k period by the company.

NCF^{m}_{t-k}: Net cash flow obtained during the t−k period by an industry's average firm with identical tangible assets as the company in question.

s: industry's weighted average cost of capital.

Although this method has the advantage of simplicity, it also raises various problems:

- It does not provide an absolute value for the intangibles, but rather in relation to an industry average, which may be interesting in certain circumstances, but will be insufficient in others, as it is highly likely that the whole sector has well-used intangibles.
- It assumes that premium earnings over the industry average in the last three years will be maintained indefinitely in the future, which does not seem very realistic, given the rapid depreciation that the value of certain intangibles may undergo.
- Finally, it does not allow the value of specific intangibles to be obtained.

One defect common to all the retrospective methods is that, based as they are on the hypothesis that future performance will be the same as the past, they do not take into account the new yields and opportunities that may occur in the future. It is highly likely that it will not be identical to the past, and this is particularly true in the case of intangibles.

Income Approach: Prospective and Mixed Methods

Moving on to consider estimate-based methods, not limited to the past, of future cash flows resulting from intangibles, we look first at the "technology factor method" (TFM), developed by Khoury (1998) in the Dow Chemical Company, this being a method for specifically valuing technological intellectual property. Khoury considers that the financial value of a technology may be calculated according to the economic impact that technology has on the company to which it belongs and on the competitive setting. The challenges are: (1) to identify the contribution of a specific technology to the competitive advantage; (2) to separate the contribution due to the technology from that made by other intangible and tangible assets and (3) to quantify its financial value.

Therefore, the TFM combines a meticulous qualitative valuation of the attributes of the technology and its impact on the company, with a quantitative valuation. The financial value of the technology is obtained as the outcome of: (1) the net present value (NPV) of the incremental cash flow arising from the expected competitive advantage from the technology for the company as a whole; and (2) the estimation of a technology factor (TF) between 0 and 100% that approximates how much of the total incremental cash flow can be attributed to the specific technology.

Technology value (TV) = Δ NPV $\times$ TF

One criticism of TFM is that it calculates the value of the intellectual property as the outcome of multiplying an "income value" by the technology factor. However, as Andriessen (2004b) points out, it is not clear which part of this value is included in each of the components, or even if there are aspects that have been included twice.

One method for the joint valuation of intangibles is the "Intangibles Scoreboard," also proposed by Professor Lev and his team (Lev, 2001a, 2001b; Gu & Lev, 2001), who suggest calculating the monetary valuation of all intangible assets by means of flow discounts, but without actually breaking down the intangibles. Both past results and forecasts of future results are considered in the calculation. An interesting feature of this study is that the authors also use statistical methods in an attempt to discover the factors that drive intangibles' value in firms.

Apart from the objections shared with the previous methods, one criticism of this method is that it does not allow for separate valuations of a firm's intangibles. Nevertheless, it has been applied with certain success (DeTore et al., 2002), and estimates performed with it show great explicative, and even a certain predictive power, regarding the market performances of the analysed companies (Hurwitz et al., 2002).

A method that allows for the separate valuation of a firm's intangible resources through the identification of the core competencies and measuring their impact on operational net income is the "weightless wealth toolkit" (WWTK) (Andriessen & Tissen, 2000; Andriessen, 2004b).

WWTK offers a tool kit to help managers operate successfully in the intangible economy, considering strategy analysis and a quantitative valuation of intangibles. The tool kit consists of 20 steps grouped into the following six phases (every phase is completed with a checklist, suggestions and exercises):

1. **Do Intake:** A checklist of questions to determine whether the WWTK is appropriate for the company.
2. **Identify Intangible Resources:** A series of questions designed to give a better view of the company, that is, customers, innovation and competition. This information facilitates a list of intangible resources potentially essential to success and the task of defining the company's core competencies.
3. **Conduct Value Assessments:** The objective is to execute a value assessment of the core competencies and identify their strengths and weaknesses. The assessments involve

five checklists where added value, competitiveness, potential, sustainability and robustness of the core competencies are analyzed.

4. **Perform Financial Valuation:** Calculates the financial value of the core competencies identified using a model based on the net present value (NPV) of future earnings. The earnings are the result of combining tangible, financial and intangible resources. Then the model uses a fair return rate to subtract the returns on tangible and financial assets from total earnings. What remains is the contribution of intangible resources to the earnings. Next, the model allocates the percentage of the intangible earnings to each core competence. The core competencies value is the NPV of the forecasted intangibles earnings.
5. **Develop Management Agenda:** Designed to show the value of the core competencies can be improved by increasing added value, competitiveness, potential, sustainability and robustness.
6. **Report Value Dashboard:** Summarizes all findings into a single comprehensive report.

The proposed methodology is based on a strategic analysis of the company facilitated by the checklists proposed. After obtaining the overall value of all the firm's core competencies, the financial valuation model used then attributes this value individually to the different competencies. Although this tool has some interesting and valuable characteristics, in our view it has some major drawbacks; in particular, the method proposed for attributing individual value to core competencies is perhaps over-complex. It also fails to take account of the possibility of its synergies generating value through the combination of core competencies.

Real Options Approach

Originally designed to value options on financial assets (Black & Scholes, 1973; Merton, 1973) the options methodology has also been used to value other types of assets, including investment projects and tangible assets, leading to what are known as *real options* (Dixit & Pindyck, 1994; Kogut & Kulatilaka, 1997; Luehrman, 1998; Amram & Kulatilaka, 1999). Further, the underlying characteristics of these options can also be applied to knowledge assets, thereby facilitating their valuation as options (Bose & Oh, 2003).

If knowledge is considered as an asset, and given that different option categories can often be found in any type of assets, then option valuation models may also be applied to knowledge. In fact, some elements of intellectual capital have obvious option characteristics. This is the case with patents, which can be considered as call options, as they grant the right (but not the obligation) to

Table 2. Differences between financial options and knowledge options

Aspect	Financial Option	Knowledge Option
-Initial uncertainty regarding the value of full commitment (value of the underlying asset) -Value of underlying asset -Variance of value of underlying assets -Prior specification of strike price -Prior specification option's expiry date -Implications on decision to purchase option	-Increases the value of purchasing the option -Current value is known because it is traded on a competitive market -Totally determined and available for the traded securities -Fully specified in the option contract -Fully specified in the option contract -Purchase value of on options can be determined using option valuation models	-Increases the value of purchasing the option -Difficult to value because, being idiosyncratic, it lacks a market. -Poorly specified due to absence of competitive markets. -Generally unknown when establishing option -Cannot generally be specified and is flexible -No accurate valuation models
Source: prepared on the basis of Coff and Laverty (2002, p. 36)		

exploit a product commercially (Pakes, 1986: Damodaran, 2002; Bose & Oh, 2003). Yet the same can generally be said about intellectual property (Kossovsky, 2002) and even R&D processes where no result has been obtained (Mitchel & Hamilton, 1988; Newton & Pearson, 1994), or about market research (Mayor et al., 1997). "Compound options" (options on options) can likewise be found in knowledge processes[6].

The most outstanding characteristic of knowledge as an option is perhaps that its possession very often represents a capacity to obtain more knowledge, and is therefore an option on more knowledge (Kogut & Kulatilaka, 1997).

Table 2 identifies some important differences between knowledge options and financial options that need to be taken into consideration in financially valuing knowledge options.

The table shows that valuing knowledge options is much more difficult than valuing than financial options, largely due to uncertainty associated with their main features, that is, the value and volatility of the underlying asset, strike price and expiry date. This requires simulation, application of confidence intervals, fuzzy logic and so on, to be used on many occasions.

Another particularly noticeable problem when valuing options on knowledge is that the cost of the option, expiry date and other aspects can vary according to the way competitors perform. In fact, this type of option is often not the exclusive property of a company, as it is not the only one capable of exercising the option. A suitable approach in this case may be to combine the option focus with game theory (Chen, 2003).

Despite these problems, we believe that it is absolutely essential to analyze and financially value options incorporated in intangible assets and core competencies, because, as noted above, knowledge almost always includes option characteristics.

A METHOD FOR THE FINANCIAL VALUATION OF INTANGIBLES: BASIC CONCEPTS AND CHARACTERISTICS

After the previous section's critical review of the approaches and methods proposed for intangibles' financial valuation, this section covers the basic concepts and characteristics of the method we developed, prior to its full approach being discussed in the following section.

Intangibles Taxonomy and a Company's Value: Intangible Assets and Core Competencies

Under our proposed intangibles valuation method, the value of a company is determined by its tangible and intangible assets, together with the core competencies (Eustace, 2001, Mouritsen, 2003; Schunder-Tatzber & Markom, 2004). So the first sub-division of our proposed *intangibles* taxonomy refers to the difference between *intangible assets* and *core competencies*.

As these concepts are fundamental to the proposed method, we need to be sure of what they mean.

Intangible assets are taken to be those assets of a company that do not have a physical basis, and which are also "codified:" the relevant rights or the company's appropriation capacity regarding the results generated have to be established by means of a contract, a regulation or some other deed of right. Patents, concessions, trademarks, licences and so on are therefore intangible assets.

Given the characteristics of these assets, we believe the most appropriate way of obtaining their value depends on the market where they are traded. If no such market exists, the approaches that, in the light of the available information, best determine their value (replacement value, capitalised historical cost, comparative methods,

etc.) should be used. This is what we refer to as the conventional value of the *intangible assets*.

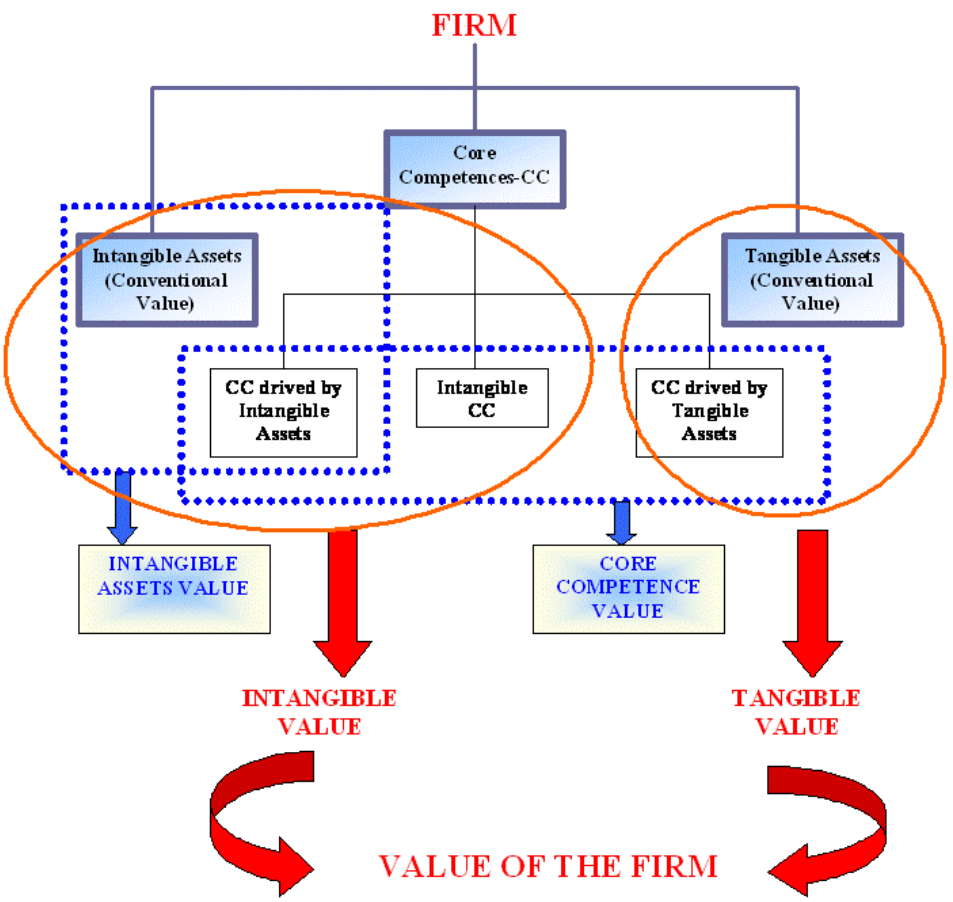
Core competencies, as we have already indicated, are those corporate characteristics or factors that give the firm a more or less sustainable competitive advantage over its competitors. We consider *core competencies* to be the main source of value in the company. The associated value depends on factors such as its sustainability and the degree of appropriability by the company of the results generated.

Core competencies may be linked to or derive from a specific tangible or intangible asset, or not be linked to a specific asset, but rather to a generally undetermined set of assets, which shall be referred to as *intangible core competencies*. They are usually associated with some knowledge category, particularly of a tacit type.

We argue that a suitable taxonomy of the core competencies should take account of the types of core competence-driven intellectual capital.

Although intellectual capital can be classified in a variety of ways (Brennan & Connell, 2000; Petty & Gutrie, 2000; Bontis, 2001; Seetharaman et al., 2002; Andriessen, 2004b; Pike & Ross, 2004), we used the classification proposed by the Intellectus Forum (Bueno, 2003), that divides *intellectual capital* into three categories: human capital, structural capital (integrated by organizational capital and technological capital) and relational capital, incorporating business capital and social capital. Human capital is de-

Figure1. Firm's value components



fined as the set of explicit and tacit knowledge of people in the organisation. Structural capital is presented as the explicit knowledge related to the organization's internal processes, and can be both organizational (the operating environment derived from the interplay between management and business processes, technology and culture) and technological (patents, licenses, proprietary software, databases and so on). Relational capital can be defined as the set of explicit and tacit knowledge concerning the way in which the organization deals with external agents, and can be broken down into business capital (understood as the basis of relations with agents linked directly to the "business": clients, suppliers, and others) and social capital (integrating the relations with agents in a broader environment, including public administrations, citizens' organisations and others).

In accordance with this classification, we propose the following taxonomy of the *intangible core competencies*:

- Human resources' competencies
- Organizational competencies
- Technological competencies
- Business relational competencies
- Social relational competencies

Finally, we believe that synergies between different core competencies in a specific organization should be explicitly taken into account in any complete valuation of intangibles.

A core competence may reside in one or various tangible assets, including fixed assets, geographical location, and so forth. Obviously, the value of that core competence cannot be computed as a value of intangible assets. Nevertheless, it must be taken into account in our method as, although not included in the final value of the intangibles, it affects the "total operating net income."

Intangible assets may not drive basic competitive advantages, although they may have value, "conventional value," as has already been indicated. So, if they represent a competitive advantage and therefore have an associated core competence, traditional methods cannot be used to value them.

Based on the differentiation between tangible assets, intangible assets and core competencies, which are either asset-driven or intangible core competencies, the basic valuation relations are established.

$$FV(IA) = FVc(IA) + FV(CC^{IA})$$

With:

FV(IA): Financial value of the intangible assets.
FVc(IA): Conventional financial value of the intangible assets.
$FV(CC^{IA})$: Financial value of intangible asset-driven core competencies.

$$FV(I) = FVc(IA) + FV(CC^{IA}) + FV(CC^{I})$$

With:

FV(I): Financial value of the set of intangibles.
$FV(CC^{I})$: Financial value of the intangible core competencies.

$$FV(CC) = FV(CC^{TA}) + FV(CC^{IA}) + FV(CC^{I})$$

With:

FV(CC): Financial value of core competencies.
$FV(CC^{TA})$: Financial value of tangible asset-driven core competencies.

Therefore, the financial value of the set of intangibles can also be expressed as:

$$FV(I) = FV(IA) + FV(CC^{I})$$

These basic valuation relations are set out in Figure 1.

The value of the company's *intangibles* therefore consists in the conventional value of the *intangible assets*, the value of the *core competencies* deriving from intangible assets and the value of *intangible core competencies*.

Core competence value is, in general, more difficult to establish than the value of intangible assets, which usually have a conventional value. The method proposed is therefore based on valuing the core competencies.

Analysis of the Core Competencies

Our approach is based on the premise that the intangibles' value is mainly found in the firm's core competencies. However, before analysing them, we should clarify what is meant by "firm."

In our view, a business unit's intangibles should be valued as a whole, as core competencies are unlikely to be easily classifiable by products, business lines, and so forth. So, when there is a clear separation between business units within a "legal" unit, that is, by divisions, geographical locations, and so forth, intangibles may be valued separately.

Once the economic unit to be valued has been defined, its core competencies need to be identified. The purpose of the chapter is not to identify and provide a detailed analysis of a firm's core competencies, but rather to value them. If the management team of the firm whose intangibles are to be valued has already identified their core competencies, they can then be valued. If not, identification should be made following the guidelines laid down in the relevant works of reference (Grant, 1991; Andriessen & Tissen, 2000; Tissen et al, 2000; Andriessen, 2004b).

Other Characteristics of the Proposed Method

Apart from applying this intangibles taxonomy and focusing on the firm's core competencies, the proposed method for the *financial valuation* of intangibles:

- Starts with a strategic analysis of the company.
- Allows the company's intangibles to be valued individually.
- Is based on discounted cash flows and real option valuation.
- Uses both standardised and objective information from the financial statements and other corporate documents, and the perceptions and opinions of the corporate directors, thereby maximizing the information available for the valuation.
- Explicitly includes the possible existence of synergies between basic competencies.
- Is appropriate for valuing the intangibles of large companies, and also small companies where large databases are not available.

SETTING OUT THE METHOD: FIRST STAGES

Our proposed method for obtaining the information necessary to determine the value of a company's intangibles follows the stages outlined below.

Identifying the Firm's Intangible Assets and Core Competencies

To begin with, we establish whether a strategic analysis of the company has identified its intangibles and core competencies. If no strategic analysis has been performed, the team of analysts focus on encouraging company directors to conduct an analysis by stressing the fundamental characteristics of the core competencies, as noted above.

Once the directors have established a map of their intangible assets and core competencies,

tables are provided to facilitate the location of other previously unidentified intangible elements.

It should be stressed that the valuation of core competencies is an important element of the proposed method. These tables therefore distinguish between intangible asset-driven core competencies and those not associated to assets (intangible core competencies). Seven tables are drawn up: the first deals with the existence of both tangible and intangible assets that generate core competencies in the company; five of the remaining six identify intangible competencies according to the intellectual capital categories driven by them, and the sixth identifies synergies between basic competencies[7].

Also requested for these tables is information on the characteristics for determining *core competence* value. The main features analysed include:

- Type of impact on present or future company results,
- Importance in the company,
- Degree of sustainability of the competitive advantage, and
- Where applicable, characteristics of the core competencies as options.

This information will allow guidelines to be established for quantifying in time and amount the impact of each of the core competencies on company results, while establishing the most suitable method or methods for their financial valuation.

Impact on Net Company Income: Basic Concepts

Once the firm's core competencies have been established, we need to estimate the "net income" (NI) they help to generate. To begin with, the part of the net income that is being generated needs to be distinguished from the part that may be generated in the future. Therefore, the management group needs to consider whether each identified competence is currently affecting the firm's net income (in which case it will be referred to as "basic project") or whether it is expected to affect income in the future positively, (in which case, it can be considered as a "real option"), or, finally, whether they are deemed to have both characteristics at the same time.

Impact on future net income should be discussed in a little more detail, as it implies that the competence in question has option characteristics on assets, competencies or future investment projects (Rodríguez & Araujo, 2005).

Given that the core competence may affect future net income by allowing other assets or competencies to be acquired or projects to be implemented, it shall always be taken to be a call option. Likewise, we shall assume that such options may only be exercised at a future date ("European options"). This is justified because, in the majority of cases, any new core competence or new fundamental investment project resulting from a current competence will only be possible at a future date.

Two components can therefore be distinguished in the core competencies value:

$$FV(CC) = FV(CC)_{BP} + FV(CC)_{RO}$$

With:

FV(CC): Financial value of core competencies.

$FV(CC)_{BP}$: Financial value of core competencies in the part currently affecting net income ("basic project" - BP).

$FV(CC)_{RO}$: Financial value of core competencies in the part expected to affect net income in the future (as "real options" – RO).

This shall be applied to each of the core competencies, both those associated and those not associated to the tangible or intangible asset:

$FV(CC^{TA}) = FV(CC^{TA})_{BP} + FV(CC^{TA})_{RO}$
$FV(CC^{IA}) = FV(CC^{IA})_{BP} + FV(CC^{IA})_{RO}$
$FV(CC^{I}) = FV(CC^{I})_{BP} + FV(CC^{I})_{RO}$

With:

$FV(CC^{TA})_{BP}$: Financial value as basic project of tangible asset-driven core competencies.
$FV(CC^{TA})_{RO}$: Financial value as real options of tangible asset-driven core competencies.
$FV(CC^{IA})_{BP}$: Financial value as basic project of intangible asset-driven core competencies.
$FV(CC^{IA})_{RO}$: Financial value as real options of intangible asset-driven core competencies.
$FV(CC^{I})_{BP}$: Financial value as basic project of intangible core competencies.
$FV(CC^{I})_{RO}$: Financial value as real options of intangible core competencies.

Therefore:

$FV(I) = FV(IA) + FV(CC^{I}) = FVc(IA) + FV(CC^{IA}) + FV(CC^{I}) = FVc(IA) + FV(CC^{IA})_{BP} + FV(CC^{IA})_{RO} + FV(CC^{I})_{BP} + FV(CC^{I})_{RO}$
$FV(CC) = FV(CC^{TA}) + FV(CC^{IA}) + FV(CC^{I}) = FV(CC^{TA})_{BP} + FV(CC^{TA})_{RO} + FV(CC^{IA})_{BP} + FV(CC^{IA})_{RO} + FV(CC^{I})_{BP} + FV(CC^{I})_{RO}$

Impact on Net Company Income: Scope and Sustainability

Scope of Impact on Current Net Income

Calculating the core competence value as the basic project is based on estimating the net income they currently generate. Net income is considered as earnings before interest and taxes (EBIT) obtained over what can be considered as a "normal" profit or minimum achievable return, given the characteristics of the company according to its size, sector, and so forth. This minimum achievable return is calculated as the amount equivalent to applying the weighted averaged cost of capital ex-taxes to the conventional value of all the firm's tangible assets.

Two alternatives are considered to quantify the impact the core competencies are already having on the company's net income and its future development and sustainability:

1. An estimate based on the direct analysis of the company's earnings account, which allows the part of net income linked to the core competence to be identified.
2. An approximate method where the management team is questioned about the percentage of the net income they consider to be associated to each core competence. Alternatively, management are questioned in terms of scales of importance, subsequently transformed into percentages.

Degree of Sustainability of the Competitive Advantage Provided by the Core Competence

Competencies deteriorate and the resulting competitive advantages tend to disappear over time. The managerial group should be asked to estimate the degree of sustainability (in years, no more than five) of each core competence detected.

Characteristics of the Asset or the Competence as Option

The other component of the financial value of core competencies [FV(CC)] is their impact on future net income [$FV(CC)_{RO}$]. To estimate this, intangible assets or competencies with real options need to be identified first.

An intangible asset or a competence includes *real options* if its holding or current availability may affect future net income, either because it allows other assets or competencies to be acquired in the future, or because it allows investment projects to be carried out in the future. In that case, the underlying assets of the assets or competencies as real options need to be established. The

assets, competencies or projects that the current holding of the assets or competencies in question will enable the company to acquire or pledge in the future have to be identified. The following aspects should be taken into account here:

- The core competencies or essential assets that may not be acquired in the future, or fundamental investment projects that may not be implemented in the future, if the company does not have the current competence in question.
- These assets, competencies of future projects, must be essential to the company if it is to maintain or increase its competitive edge.

The company's managerial group need to cooperate on establishing a series of elements that allow the assets identified to be valued as real options. Although, for simplicity's sake, the type of real options that in principle are to be considered is relatively simple—European call options—and the valuation method used is a derivation of the famous approach proposed by Black and Scholes (1973), characterising an asset or a competence as an option is no easy task. Unfortunately, estimating the parameters that facilitate its assessment as such an option is even more difficult.

The questionnaire considers the point in the future when the assets or the competence may be obtained, or the project undertaken, to be the moment when the expected impact on the firm's net income may begin. In conventional options terminology, it is the option expiry date or exercise date.

So the question to be answered is now: at what time in the future will the company be ready to acquire that asset or that competence, or to undertake the project it would not otherwise be able to acquire or undertake if it did not currently have the asset or competence in question?

Furthermore, it should be possible to estimate the degree of impact on the firm's future net income and its sustainability. In other words, the expected value, at the moment of exercising the option, has to be calculable for the new competence, the new asset or the new project (underlying asset). Therefore, an estimate is needed of its expected impact on the firm's future net cash flow and the duration, to provide, after due discount, the expected value.

Likewise, the costs involved in acquiring the asset, generating the competence or undertaking the project in the future have to be estimated. At the time of exercising the option, the acquisition of assets or competencies, or the start of a project, must have some cost or involve some payment (strike price), as otherwise the value of the option would simply be the current value of the underlying asset. Therefore, the cost or payment arising from the exercise of the option needs to be estimated.

Finally, a decisive element in the characterisation of an option is the degree of associated risk. Any uncertainty regarding the current and future value of the asset, competence or future project is one of the fundamentals of the value of the options, as has already been stated. Volatility is an essential element in valuing options, although it is not easy to estimate in the case of real options, given the nature of the underlying assets taken into consideration. Therefore, as we shall see, a qualitative answer may in many cases be more convenient.

APPLYING FINANCIAL VALUATION MODELS

After the intangible assets and core competencies have been identified, and the impact of the latter on net income has been estimated, financial valuation models are applied to obtain the value of the core competencies, together with a conventional valuation of intangible assets.

Calculating the Financial Value of Intangible Assets

Irrespective of whether or not they are linked to a core competence, a firm's intangible assets have a value associated to the asset itself or conventional value[8]. Should there be a market where the intangible asset is traded, its conventional value is calculated as the price established in that market. Where no such market exists, its conventional value is calculated by using the approach that, in the light of the available information, best determines its value. The approximate methods include asset replacement value, capitalised historical cost or the comparative method.

Financial Valuation of the Core Competencies as Basic Projects: *Discounted Cash Flow Models*

Investment theory considers that the value of an asset comes from the expectations of returns to be generated. Asset value is calculated as the current value of the yields to be generated in the future by the asset in question, discounted at a rate adjusted to the firm's characteristics and risk:

$$Value = \sum_{t=1}^{n} \frac{P_t}{(1+d)^t}$$

With:

P_t: Future yields to be obtained in period t.
d: Discount rate adjusted to risk.
n: Time horizon.

The core competencies represent the aspects that positively differentiate the company from its competitors. Thus, the value of the core competencies as basic project is calculated taking into account:

1. The operating net income obtained above what may be considered a minimum achievable return, given the characteristics of the firm.
2. The weighted average cost of capital ex-taxes as discount rate.
3. The life horizon of the competence, determined by the degree of sustainability of the competitive advantage.

Estimating Net Income

Net income (NI) refers to the net operational income coming from the firm's core competencies, and which therefore represents the income obtained above what can be considered as a minimum achievable return. Net income is calculated as the result of deducting from earnings before interest and taxes (EBIT) the amount equivalent to multiplying the weighted average cost of capital ex-taxes (WACC) by the conventional value of the firm's tangible assets [FVc(IA)][9].

The WACC is calculated as follows:

$$WACC = (\%_D \cdot K_D + \%_E \cdot K_E)/100$$[10]

With:

$\%_D$: Percentage representing long-term debt over the sum of equity and long-term debt.
$\%_E$: Percentage representing equity over the sum of equity and long-term debt.
K_D: Yield required by long-term debt.
K_E: Yield required by equity.

Net income is therefore calculated as:

Revenues − Operating expenses − Depreciation = Earnings before interest and taxes (EBIT)

Net Income (NI) = EBIT – WACC × FVc(IA)

Managers are asked about the current impact of each of the core competencies as basic project, taking into account both tangible asset-driven and intangible asset-driven core competencies, or intangible core competencies, on earnings before interest and taxes (EBIT); in other words, managers should determine the percentage of EBIT for each core competence ($\%_{CCj}$).

Therefore, net income linked to each core competence is calculated as:

$$NI_{CCk} = \%_{CCk} \times NI/100$$

with NI_{CCk} the net income linked to the k-th core competence.

Should managers have difficulty in estimating the percentage that each core competence represents in EBIT, they can be asked to rate the impact on a scale of importance from 1 to 3. These degrees of importance are then transformed into percentages as follows:

$$\%^{G}_{CC_k} = \frac{G_{CC_k}}{\sum_{j=1}^{h} G_{CCj}} \times 100$$

With:

$\%^{G}_{CCk}$: Percentage on the net income of the k-th core competence from the scale.

G_{CCk}: Degree assigned to the k-th core competence.

G_{CCj}: Degree assigned to the j-th core competence.

h: Number of core competencies that currently affect the firm's net income.

Net income linked to each core competence is therefore calculated as:

$$NI_{CCk} = \%^{G}_{CCk} \times NI/100$$

Calculating the Discount Rate

The variable used to estimate net income, EBIT, represents an economic result (corresponding to all the firm's permanent financial suppliers), an operating result (operating results only) and expressed in gross terms (before tax). Taking the above into account, the discount rate needs to reflect the opportunity cost for all capital suppliers ex-taxes, weighted by their relative contribution. This rate is the weighted average cost of capital ex-taxes (WACC), which has already been defined.

Calculating the Time Horizon

The firm's management group estimate of the degree of sustainability of each competence shall be taken as the time horizon. This value will be between 1 and 5 years.

Calculating the Financial Value of the Core Competencies as Basic Project

The financial value of the k-th core competence as basic project [$FV(CC_k)_{BP}$] is calculated using the following formula:

$$FV(CC_k)_{BP} = \sum_{t=1}^{n\leq 5} \frac{NI^{t}_{CC_k}}{(1+WACC)^{t}}$$

with NI^{t}_{CCk} being the net income associated to the core competence at the moment t.

The financial value of all core competencies currently affecting the net income [$FV(CC)_{BP}$] is calculated in-line with the previously defined magnitudes:

$$FV(CC)_{BP} = \sum_{j=1}^{h} FV(CC_j)_{BP} =$$
$$FV(CC^{TA})_{BP} + FV(CC^{IA})_{BP} + FV(CC^{I})_{BP}$$

Financial Valuation of Core Competencies as Real Options

To value the core competencies in the part expected to affect net income in the future (as "real options"), we consider one type of option only, that is, European call options on core competencies, assets or investment projects. If we consider that these competencies or assets to be possible only at some future date, they are "underlying assets" that generate no yield until the option's expiry date[11]. Therefore, to estimate the financial value of the k-th core competence as real option [$FV(CC_k)_{RO}$], we use the option valuation model proposed by Black-Scholes (1973)[12].

$FV(CC_k)_{RO}=SN(d_1)-Ee^{-rT}N(d_2)$

$$d_1 = \frac{\ln\left(\frac{S}{E}\right) + (r + \frac{\sigma^2}{2})T}{\sigma\sqrt{T}};\ d_2 = d_1 - \sigma\sqrt{T}$$

With:

S: Current value of underlying asset.
E: Strike price.
T: Option expiry time.
r: Risk-free rate of interest for maturity T (continuously compounded).
σ: Volatility of underlying asset.

Current Value of Underlying Asset (S)

In our case, the underlying asset is a competence, asset, or investment project that begins to generate income at time T. Its value in T (PV_k) will be the value of the net cash flows (CF) generated throughout a set horizon, n*, discounted to the weighted average cost of capital ex-taxes (WACC):

$$PV_k = \sum_{t=T+1}^{n^*} \frac{CF_k^t}{(1+WACC)^{t-T}}$$

Therefore, its current value (t = 0) will be obtained by discounting its value in T to the non-risk interest rate:

$S = PV_k e^{-rT}$

And, therefore:

$FV(CC_k)_{RO}=PV_k e^{-rT}N(d_1)-Ee^{-rT}N(d_2)=e^{-rT}[PV_k N(d_1)-EN(d_2)]$

In short:

$FV(CC_k)_{RO}=e^{-rt}[PV_k N(d_1)-EN(d_2)]$

Time of Expiration (T) and Strike Price (E): The director (or firm's management group) have to estimate both the moment (T) when the future core competence (or future essential asset) is able to generate income, and the necessary Strike Price (E) for the project to be implemented.

Risk-Free Rate of Interest (r): Once the expiry time of the option is known, the valuating team has to establish the the risk-free rate of interest continuously compounded (r) for that period.

Volatility of Underlying Asset's Value (σ): The parameter to be estimated is the volatility of the underlying asset's value throughout the period of the option. One of the ways Damodaran (2002) proposes to estimate this variable is to use similar projects the firm has implemented in the past as benchmarks. However, given the nature of the projects involved, reliable benchmarks are unlikely to be found. An alternative is to use the volatility of the stock exchange index for the firm's sector. The reference period for estimating this historical volatility will be the same as the period until the option to be valued expires.

Should the firm's management team consider that the activity associated to the core competence

to be valued cannot be associated to any of the sector market indexes or to any other company listed on the stock exchange, they will be asked to rate the degree of uncertainty on one of three levels: "high," "medium," or "low." The end intervals will correspond to the largest and smallest historical volatilities of the sector indexes, the general index being taken as the average value.

Calculating the Financial Value of the Core Competencies as Real Options

The financial value of all core competencies as real options [$FV(CC)_{OR}$] is calculated as:

$$FV(CC)_{RO} = \sum_{j=1}^{p} FV(CC_j)_{RO} =$$
$$FV(CC^{TA})_{RO} + FV(CC^{IA})_{RO} + FV(CC^{I})_{RO}$$

With p the number of the firm's core competencies with real option characteristics. The other concepts have already been defined.

PROSPECTS AND FUTURE TRENDS

In our view, prospects for the issues discussed in this chapter are very broad, because the demand for financial valuation of intangibles, and in particular, core competencies, is going to increase steadily in the future:

- To begin with, although more a specific task for specialists in strategic management rather than financial analysts, core competencies identification methods need to be examined in greater depth.
- Second, emphasis should be placed on perfecting the methods used for estimating the impact of a core competence on the firm's net income. In our opinion, the solutions proposed so far are not sufficiently satisfactory.
- Future developments are likely to concentrate on exploring valuation models increasingly adapted to the specific characteristics of core competencies to be valued.
- Another of the channels ripe for consolidation in the future is, we feel, the valuation of real options incorporated to core competencies. New methods and models that allow a more precise and relatively less complicated valuation of these options are necessary.
- Practice will mostly make such developments possible: the valuation of intangibles in specific companies of different sizes, in different industries, with various types of organizational structure and competitive position, and so forth, will facilitate an effective contrast of current methods and provide abundant suggestions for improvements.
- Much work will also be done on implementing the intangible valuation process in specific software applications, to facilitate their use by companies, particularly small and medium enterprises. The marketing opportunities for such applications are very promising.

CONCLUSION

This chapter considers the financial valuation of intangibles. There is clearly a growing need for valuation methods and models that are more satisfactory than the ones proposed so far.

The increasing importance of intangibles in company capital means they have to be correctly valued to reduce information asymmetries and the risk of adverse selection as a means of maintaining and increasing the efficiency of the financial markets.

But detailed knowledge about the intangible assets and their value is particularly important in the corporate internal sphere. Like the large corporations, small and medium-sized companies need to value their intangibles correctly:

- So that management, shareholders and workers know the true value of their company.
- To conserve, regenerate and strengthen intangible resources and thus help to increase company earnings.
- To demonstrate the firm's guarantees when seeking new financing, whether through debt or equity.
- To negotiate company value in case of merger or takeover.
- Where applicable, for comparison with the stock market value.

Given this pressing demand for valuation models and methods, we believe that the offer developed so far is rather unsatisfactory. This is because a company's main intangible value usually resides in its core competencies rather than in its codified assets. As their origins are to be found in a complex and unique combinations of resources and skills, core competencies are sometimes difficult to identify and even more difficult to value.

Besides outlining the basic concepts related to the financial valuation of intangibles, together with a critical survey of existing approaches and models, this chapter also discusses a financial valuation method developed by a research team at the University of the Basque Country.

Based on the income approach, the method is designed to valuate individually the company's intangibles, and shares with other methods the idea that the main source of a company's intangible value resides in its core competencies. The method stresses the importance of the firm's prior strategic analysis and the combined use of both objective information and perceptions of corporate directors. We also believe that it offers various original characteristics, in that it:

- Applies a taxonomy of the core competencies based on the types of intellectual capital they drive.
- Considers the real options embedded in intangible assets and core competencies.
- Explicitly includes the possible existence of synergies among core competencies.
- Is, thanks to the relative simplicity of the process used to obtain information, even appropriate for valuing the intangibles of medium and small companies where large databases are not available.

Nevertheless, we consider that the method proposed, as well as the methods for valuing intangibles in general, needs to be perfected. And this perfecting will mainly involve conducting intangibles valuation at specific companies with different characteristics, to obtain a full view of the special features and problems of valuing intangibles in different environments.

Implementing the intangible valuation process in specific software applications for subsequent use by any type of company is another line of action requiring intense development.

This is clearly a field with strong growth prospects for the future. Business managers, either from their own convictions or from external pressure, are increasingly aware of the need for correct valuations of intangibles, and analysts continue to perfect relevant methods.

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ENDNOTES

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2 Some authors make no distinction between the terms "intangible assets" and "intellectual capital." Others, however, use the latter to indicate knowledge-based assets, and therefore exclude intangibles such as reputation and image, organisational culture, motivation and value system. These intangibles are in fact difficult to separate in practice from what is known as "tacit knowledge." However, more recent approaches tend to take all intangibles into consideration. After discussing various terms, Andriessen (2004b) chose "intangible resources" as the most suitable.

3 For most intangibles, particularly if they contain core competencies, a "market value" cannot be obtained for each intangible separately as there is no specific market for them. However, the stock market values the company's resources overall, whether they are tangible or intangible.

4 The stockholders' equity stock market value of a company is equal to the stock market price per share multiplied by the total number of shares outstanding.

5 Please consult the study quoted for EVA calculation methods.

6 An R&D project may be temporarily divided into a series of linked sub-projects or phases, each of which can only be undertaken if the previous ones have been carried out. A decision can be made at the end of each phase on whether to abandon the project or move on to the following one.

7 These tables are not included in this chapter, but are available on request.

8 Conventional valuation of the intangible assets needs to consider, where applicable, any assets belonging to the company that are not reflected in its accounting system.

9 The firm's tangible assets are taken at their market value, where applicable, or at their replacement value.

10 *WACC* is calculated by taking into account the percentages corresponding to long-term debt and equity in the firm's target financial structure.

11 Should the underlying asset generate yields for its owner over the life of the option, an extension of Black-Scholes' model will have to be used. One of the most common alternatives is the Merton (1973) model, which is applicable when yields are continuous and constant.

12 The option is valued at the present time ($t = 0$).

Chapter VII
The Intellectual Capital Statement:
New Challenges for Managers

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ABSTRACT

The aim of this chapter is to examine how firms measure and report their knowledge-based resources. In the first section of the chapter we analyze the intellectual capital construct and its sub-constructs. In the second section, we review basic models for measuring intellectual capital. The third section examines guidelines for measuring and reporting intellectual capital. Based on the analysis of intellectual capital statements published by 28 pioneering firms from Europe and India, section four explores key issues on building this innovative report. Finally we present major conclusions and implications for management.

INTRODUCTION

The aim of this chapter is to analyze how firms measure and report their knowledge-based resources. Based on the study of intellectual capital statements published by 28 pioneering firms or institutions/organizations from Austria, Denmark, Germany, Italy, India, Spain and UK since 1994, the chapter explores key issues in the field of measuring and reporting intellectual capital.

In the first section of the chapter we analyze the intellectual capital construct and its sub-constructs. In the second section, we review basic models for measuring intellectual capital. The third section examines guidelines for measuring and reporting intellectual capital. Based on the analysis of intellectual capital statements pub-

lished by 28 pioneering firms from Europe and India, section four explores key issues in the field of measuring and reporting intellectual capital in firms. Finally we present major conclusions and implications for management.

BACKGROUND

The literature of intellectual capital emerges in the mid 1990s, with the works of Leif Edvinsson and Karl-Erik Sveiby. In 1994, the first intellectual capital statement[1] ever published in the world comes to light. Although numerous advances have taken place in the field of intellectual capital after the publication of this statement, there is still a long road ahead.

Let us examine the evolution of intellectual capital statements during the first decade of their existence and then propose indicators to build the intellectual capital statement.

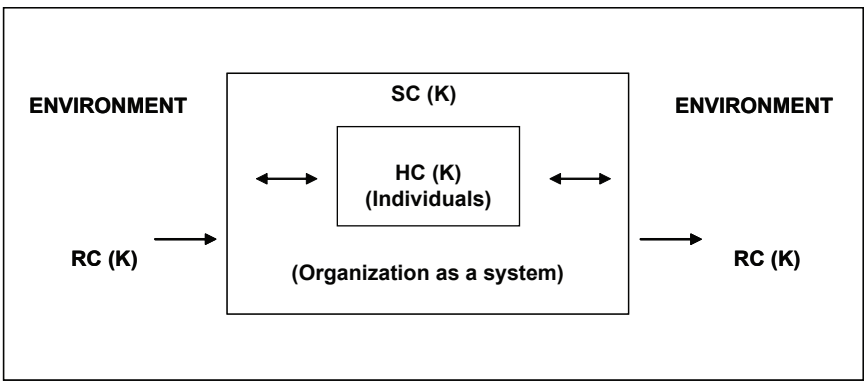
Intellectual capital constitutes the most valuable organizational resource of a company. It represents a group of intangible resources of strategic value that does not appear in the financial statements of the company, in spite of contributing to the creation of organizational value. Intellectual capital is not only key to the creation of a competitive advantage but also for its long-term maintenance[2].

Intellectual capital literature covers diverse typologies of this concept that have been developed recently. Generally, main contributions in this field agree with the idea that intellectual capital is formed by three components or sub-constructs: human capital (HC), structural capital (SC) and relational capital (RC) (Bontis et al., 2002; Bueno 2005; Ordóñez, 2004, 2005; Roos et al., 1997; Sveiby, 1997). It is important to note that usually the order of these sub-constructs is as follows: first the individual, next the organization and finally the relation with the external environment—as a system (see Figure 1). Let's explore these concepts now.

Human capital reflects the set of knowledge, capabilities, skills and experience of the employees of the company (Becker, 1964). In other words, it encompasses the accumulated value of investments in employee training, competence and future (Skandia, 1996). It also includes an even more intangible element: employee motivation.

Structural capital represents organizational knowledge that has moved from individuals or from the relationships between individuals to be embedded in organizational structures, such as organizational culture, routines, policies or procedures. Generally this sub-construct is divided into technological capital and organizational capital (Bontis et al., 2000; Bueno-CIC, 2003; Skandia, 1996). Technological capital represents industrial

Figure 1. The IC sub-constructs

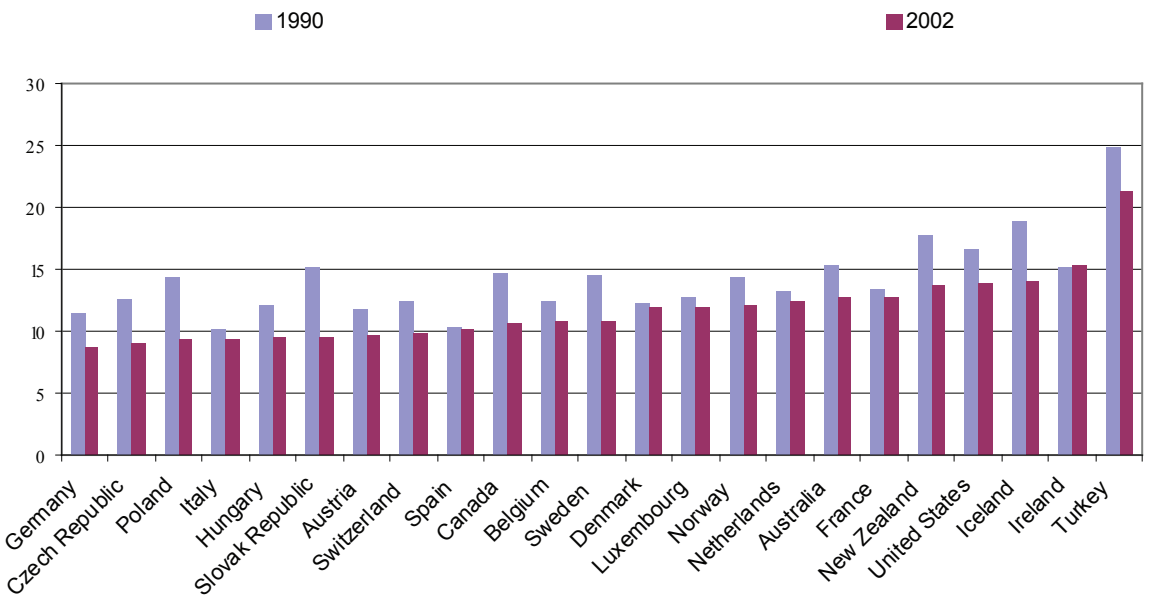


and technical knowledge, such as results from R&D and process engineering. Organizational capital includes all aspects that are related with the organization of the company and its decision making process, for example, organizational culture, organizational structure design, coordination mechanisms, organizational routines, planning and control systems, among others.

Finally relational capital reflects the value of organizational relationships. In general, it has been accepted that these relationships were mainly focused on customers, suppliers, shareholders, and the administrations, among others, without including the employees, and therefore adopting an external perspective. However, it is clear that the relationship of a company with its employees creates value and for this strategic reason it is necessary to bear them in mind. To advance in the study of relational capital, it is convenient to differentiate between internal relational capital and external relational capital. Internal relational capital includes the value of the strategic relationships created between the company and its employees. External relational capital represents the external perspective of relational capital and includes social relations of the company with key agents: customers, suppliers, shareholders and stakeholders, current and potential, regional and national administrations, and the environment, among others. On the other hand, the intellectus model (Bueno-CIC, 2003; CIC, 2004) divides relational capital into business capital and social capital.

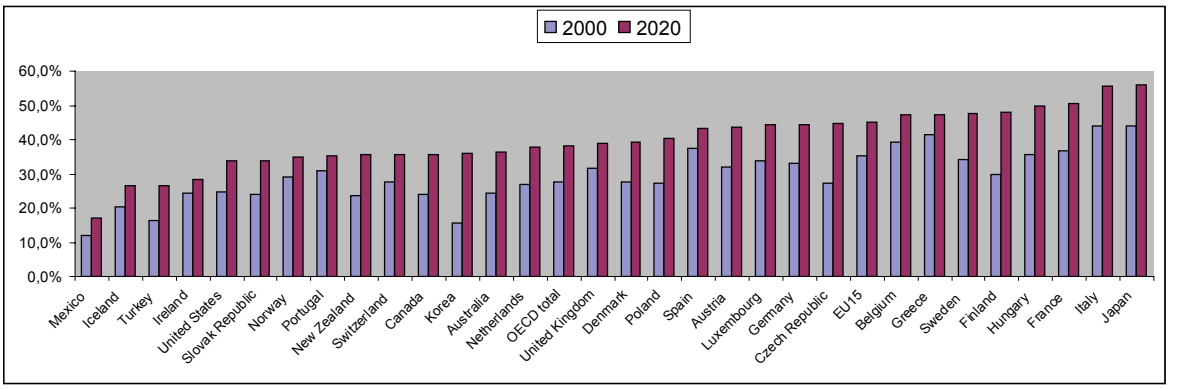
Why do many intellectual capital models[3] follow this order of sub-constructs (that is, human capital, structural capital and relational capital)? These models except one introduce the intellectual capital sub-constructs following this order but they do not explain *why* they follow this particular order[4]. The exception is the *Intellectus Model*[5], a model for the measurement and management of intellectual capital, proposed by Professor Eduardo Bueno Campos (Universidad Autónoma de Madrid, Spain) and the Knowledge Society Research Center (CIC) in Spain.

Chart 1. Birth rates: Number of live birth rates per 1,000 population



Source: OCDE Fact Book (2005)

Chart 2. Ratio of the population aged 65 and over to the labor force



Source: OCDE Fact Book (2005)

There is a logical explanation for it. The explanatory order that builds intellectual capital starts with human capital, that is, knowledge embedded in individuals. Then the second subconstruct is built: structural capital–that is to say, knowledge that resides in the organization as a result of the interactivity of individuals and groups that integrate the organization and share knowledge with groupware technologies. Finally relational capital is built as a result of organizational cognitive relations as a system and its environment.

Furthermore it is important to underline that the OECD highlights an important problem for firms and society. On the one hand, the general decrease in the birth rate in Europe and North America and on the other hand, the fact that employees get older, all together contributes to a loss of qualified professionals and therefore firms need to face some challenges related to their human capital (OCDE, 2005).

For example, the working population more than 50 years old in Spain was 20.1% in 2000. In 2020 this figure will be 28.7% (OCDE, 2006). One of these challenges is the development of talent. Human resource departments are well aware of the fact that sometimes they do not retain talent. At the same time, they recognize it is not easy to identify talent and know what talent they should take priority over. The second challenge is the professional development of the most qualified employees; that is to say, human resource departments must invest in training and provide the best employees with opportunities for development in order to avoid that these employees may leave the firm. Therefore, firms must check if they have efficient career plans for their employees. Firms must retain their best employees and at the same time they must avoid the loss of their best employee's knowledge in case they leave. Some human resource directors suggest the development of succession plans and knowledge management techniques. For example, in some countries it is usual that newly retired individuals somehow join the firm's projects in order to contribute with their knowledge and share it with new generations. At the same time, it is important to provide training to old employees, as the retirement age will probably be delayed due to the scarcity of active individuals (Cinco Días, 2005).

All this highlights that human capital—the stock of knowledge available at an individual level—belongs to the employees of the organization, who uses it in his/her daily work in a voluntary way. The firm is not the owner of this valuable resource, it simply uses the knowledge, and therefore, an important problem appears here. How does the company make sure that this knowledge will be available whenever it needs it?

This question shows an important feature of

intellectual capital: it is an intangible resource neither property of the company nor legally protected, as is the case with intellectual property, for example. This feature transforms intellectual capital into a key piece of organizational strategy. A first step toward the management of this resource is its measurement.

BUILDING THE INTELLECTUAL CAPITAL STATEMENT

Measuring and Reporting Intellectual Capital

In the literature of intellectual capital, diverse models of measurement of intellectual capital have appeared. Some are specific models developed and implemented in a particular company, in other cases they are just theoretical proposals with different levels of development, and the great majority have not advanced towards a consolidated and accepted model of intellectual capital measurement. This means that none of these models is being applied in a systematic way in firms at national or international level for the measurement of intellectual capital.

Chronologically, most important methods[6] for intellectual capital measurement are the balanced scorecard (Kaplan and Norton, 1992, 1996), citation-weighted patents (Bontis, 1996), technology broker (Brooking, 1996), intangible assets monitor (Sveiby, 1997), Skandia Navigator (Edvinsson & Malone, 1997), IC-Index Model (Roos et al., 1997), intellectual asset valuation (Sullivan & Sullivan, 2000), value chain scoreboard (Lev, 2002) and the intellectus model (Bueno-CIC, 2003). Bueno (2005) presents an exhaustive classification of these models according to their views.

Most firms currently measuring their intellectual capital also build the intellectual capital statements based on the result of the measurements. But so far there are no official guidelines for intellectual capital statements generally accepted by firms of a particular country or at international level. Certain pioneer firms have begun to publish these statements, many of them on a trial and error basis, developing new indicators, measuring their intellectual capital, and explaining in the statement those outstanding facts related to this resource. The building of the statement is guided by organizational best know-how, not by official norms and principles to regulate the building of the statement. That is to say, these firms are building their intellectual capital statements based on their own experience and on others' experience. These statements are quite idiosyncratic and therefore noncomparable.

As empirical evidence on biotechnological spin-offs in Spain[7] suggests, intellectual capital reporting involves that the normalization of the measurement is important in order to offer continuous reports to analysts and risk capital. As it takes a long period to observe the outcome of the R&D management, there is a synergy between the value of human capital and the value of business capital—a component of relational capital.

Guidelines for the Elaboration of Intellectual Capital Statements

Introduction

At the moment various guidelines exist for the building of the intellectual capital statement. These guidelines are practical indications on how to build the intellectual capital statement of a firm. However they do not represent norms that firms must follow, they are simple suggestions.

Nowadays the following guidelines for IC measuring and reporting outstand at international level: the Intellectus Model (Bueno-CIC, 2003; CIC, 2004), DATI guidelines (Danish Agency for Trade and Industry, 2000, 2001, 2003), MERITUM guidelines (Meritum, 2002), NORDIKA guidelines (Nordika, 2002) and the 3R Model (Ordóñez, 2004).

Table 1. Basic models of intellectual capital

FINANCIAL-ADMINISTRATIVE VIEW (1992-1998)	CORPORATE STRATEGIC VIEW (1997–2001)	EVOLUTIVE-SOCIAL VIEW (2000–2005 ➲)
⇒ SKANDIA NAVIGATOR (1992 --) and (L. Edvinson, 1997): Sweden	⇒ ATKINSON, A.A.; WATERHOUSE, J.H.& WELLS, R.B. (1997): USA	⇒ AMERICAN SOCIETY FOR TRAINING AND DEVELOPMENT ASTD, (2000): USA.
⇒ TECHNOLOGY BROKER (A. Brooking, 1996): United Kingdom	⇒ ROOS, J.; ROSS, G. EDVINSON, L. & DRAGONETTI, N.C. (1997): Sweden- United Kingdom.	⇒ NOVA (C. Camisón; D. Palacios, & C. Devece, 2000): Spain
⇒ CANADIAN IMPERIAL BANK OF COMMERCE (H. Saint Onge, 1996): Canada.	⇒ INTELECT: IU. EUROFORUM ESCORIAL (E. Bueno, & S. Azúa (1997): Spain	⇒ KMCI (M.W. McElroy, 2001): USA
⇒ UNIVERSITY OF WESTERN ONTARIO (N. Bontis, 1996): Canada.	⇒ INTELLECTUAL CAPITAL MODEL (N. Bontis, 1998)	⇒ INTELLECTUS (E. Bueno – CIC, 2003): Spain.
⇒ INTANGIBLE ASSETS MONITOR (K.E. Sveiby 1997): Australia.	⇒ DIRECCIÓN ESTRATÉGICA POR COMPETENCIAS: CAPITAL INTANGIBLE (E. Bueno, 1998): Spain.	⇒ "Other models under development"
⇒ EDVINSON, L., & MALONE, M.S. (1997): Sweden.	⇒ ABC – CLUSTER DEL CONOCIMIENTO. PAIS VASCO (2000): Spain.	
⇒ STEWART, T.A. (1997): USA	⇒ IBCS (J.M. Viedma, 2001): Spain	
⇒ DOW CHEMICAL (Petrash, 1998): USA.		
NON-HARMONIZED CAPITAL: INTANGIBLE ASSETS AND COMPETENCES	HARMONIZED COMPONENTS OR "CAPITALS:" HUMAN, STRUCTURAL AND RELATIONAL CAPITAL	EVOLUTIONED-HARMONIZED COMPONENTS OR "CAPITALS"

Source: Bueno (2005)

The Intellectus Model

The intellectus model—developed by professor Eduardo Bueno Campos (Universidad Autonóma de Madrid, Spain) and his research group at the Intellectus Forum (www.iade.org)—consists of five fundamental elements: its structures, principles, internal logic, development of the model (definitions) and table of indicators (Bueno-CIC, 2003; CIC, 2004).

The structure of the intellectus model is described through the components, elements (E_i), variables (V_i) and indicators (I_i). According to this model, intellectual capital is divided into human capital, capital structural and capital relational. In

turn structural capital is subdivided into organizational capital and technological capital, while the relational capital is disaggregated into business capital and social capital (see Figure 2).

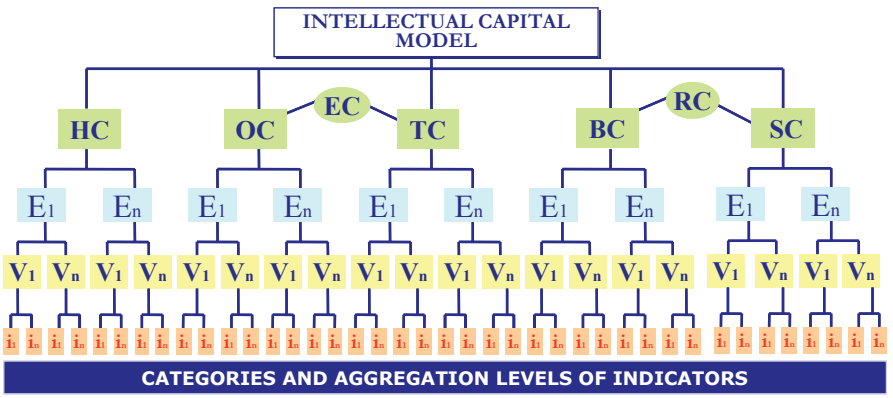
The basic features of this model are the following ones: systemic, open, dynamic, flexible, adaptative and innovative. In particular the characteristics of adaptability and flexibility clearly show:

The relative condition and the peculiar idiosyncrasy of the pattern, allowing their adaptation well to the necessities and contingencies of the organization that it applies it, in function of their own productive characteristics or business processes, well in function of their size, age, ownership or purpose. These features are coherent with an internal logic of operation that allows to take advantage of the potential of the model and [...] the internal logic seeks to explain the connectivity or existent basic interdependences among the capitals, being projected on the group of relationships they connect with the main elements of those capitals. (Bueno-CIC, 2003, p. 11)

The elements of the intellectus model are related from a double perspective: endogenous and exogenous. On the one hand, the endogenous perspective connects the elements linked with people and the organization. On the other hand, the exogenous perspective links the elements referred to the relationships of the organization with the agents of the environment.

As for the development variable, the model defines a series of outstanding concepts: (a) human capital, values and attitudes, aptitudes, capacities; (b) structural capital, organizational capital, culture, structures, organizational learning, processes, processes directed to the internal client, processes directed to the external client, processes directed to the suppliers, technological capital, R&D&I activities, technological endowment, intellectual and industrial property, innovation performance; and (c) relational capital (relationships with clients, suppliers, shareholders, institutions and investors as well as social connections with business partners, competitors and promotion institutions, quality improvements, social capital, connections with public administrations[8] and media, corporate image, environmental activities, social relationships and corporate reputation).

Figure 2. Intellectus model



Source: Bueno-CIC (2003)

DATI Guidelines

The Danish Agency for Trade and Industry (DATI) has carried out a pioneer research at international level in the development of guidelines for the presentation of intellectual capital statements. In 2003 DATI published the *Intellectual Capital Statement: The New Guideline.*

Helge Sander, Danish Secretary of Science, Technology and Innovation, states:

The growing popularity of the external statements of intellectual capital is due to the demand of information supplementing the picture offered by the financial statements. A company can use intellectual capital statements to show how it develops and deploys its most important organizational resource: knowledge. (DATI, 2003, p. 3)

Intellectual capital statements are relatively new tools and thus analysts still lack a systematic method to read and interpret these statements. In this sense, the statement elaborated by The Danish Agency for Trade and Industry for the year 2003 propose a method to approach the understanding of intellectual capital statements.

In accordance with DATI, the objective of the intellectual capital statement is to respond to three general questions regarding knowledge management: (a) how are knowledge-based resources formed?, (b) what has the company made to strengthen its knowledge?, and (c) which are knowledge management effects?

On the other hand, DATI guidelines intend to analyze four categories of knowledge-based resources (employees, clients, processes and technology) in relationship with the previously mentioned questions. The DATI method has two special characteristics: (1) it obtains a real vision of the knowledge-based resources, and (2) it facilitates an objective evaluation of knowledge management.

The statement proposed by DATI is structured in four chapters. The first chapter approaches the question that the analysis seeks to solve and analyze the problems that traditional structures of intellectual capital statements present for the analysts. The second chapter introduces the model that uses data from the intellectual capital statement to show how firms use and develop knowledge-based resources. Chapter three shows the application of the model of analysis to the intellectual capital statements of three firms. Finally the last chapter contrasts the previous examples and indicates how the results of particular analysis—coming from different intellectual capital statements—can be compared.

MERITUM Project Guidelines

The MERITUM project pursued several objectives. On the one hand, it aimed to establish a typology of intangible resources useful for the empiric analysis. On the other hand, it also looked to analyze the systems of administration control with the purpose of knowing best practices inside European firms involved in the measurement of investments on intangible resources. It also evaluated the importance of intangible resources in connection with the assessment of liabilities in the capital markets. Finally, it also develops a guideline for the measurement of intangible resources and the building of the intellectual capital statement, useful both for private decisions and public decisions.

NORDIKA Guidelines

NORDIKA stands for "Nordic project for the measurement of intellectual capital." This project—whose origin goes back to September 1999—was started by the Industrial Nordic Fund and it included several countries (Denmark, Finland, Iceland, Norway and Sweden).

The main objective of NORDIKA is both Nordic and international cooperation in matters related to the management of intellectual capital and the building of the intellectual capital statements. In particular, the goals of this project are:

- To develop a close cooperation among national initiatives of the Nordic countries.
- To explain how firms can build the intellectual capital statement through the publication of combined voluntary guidelines for intellectual capital statements for Nordic firms.
- To participate in OCDE, EU and other international networks in matters related to intellectual capital.

The NORDIKA guideline for intellectual capital statement represents a management tool for firms that wish to build intellectual capital statements. It can provide definitions, a review of the main focuses of intellectual capital as well as indications. In sum, many lessons can be learnt from the experience of other Nordic firms.

The 3R Model

The 3R model for intellectual capital statements—developed by Professor Patricia Ordóñez de Pablos—proposed a statement formed by three main documents (Ordóñez, 2004a):

1. **The Intellectual Capital Report:** It shows the situation of the intellectual capital of the firm, showing information of each of its com-

Table 2. Intellectual capital statements in pioneering firms and institutions

FIRM/ORGANIZATION	ACTIVITY	COUNTRY
o ARCS	Research organization	Austria
o NANONET-Styria	Nanotechnology network	Austria
o OENB	Banking	Austria
o Carl Bro	Consulting	Denmark
o Coloplast	Healthcare products and services	Denmark
o Cowi	Engineering and related services	Denmark
o Dieu	Course provider	Denmark
o Experimentarium	Entertaining and educational events	Denmark
o Systematic	Software development	Denmark
o DLR	Aerospace research center	Germany
o Intercos	Color cosmetics	Italy
o Plastal	Plastic components	Italy
o Balrampur Chini Mills	Sugar producer	India
o Navneet	Publisher	India
o Reliance	Various (finance, telecom, oil & gas, etc)	India
o Shree Cement Limited	Cement manufacturer	India
o Bankinter	Banking	Spain
o BBVA	Banking	Spain
o BSCH	Banking	Spain
o Caja Madrid	Banking	Spain
o Genetrix	Biotechnology	Spain
o Mekalki	Mechanized integral services	Spain
o Union Fenosa	Electricity	Spain
o Celemi	Learning Solutions	Sweden
o Center for Molecular Medicine	Research	Sweden
o Skandia	Insurance	Sweden
o Telia*	Telecom solutions	Sweden
o EES Group	Provider of lighting and earthing	UK

***** *Note: The statement including the social dimension as well actions taken in this area up to year 2001 is called "Telia's Relations 2001," not intellectual capital statement.*

ponents. Intellectual capital components will be quantified based on indicators that measure diverse categories of each component.

2. **The Intellectual Capital Flow Report:** It addresses the increases and decreases of intellectual capital during the year as well as the intellectual capital variation or net flow. This information will be elaborated for each indicator, indicator category and component of intellectual capital. It will also specify the goals and sub-goals for each indicator, category of indicators and components of the intellectual capital.
3. **The Intellectual Capital Memo Report:** It complements and further explains the information included in the intellectual capital report and in the intellectual capital flow report.

Solutions and Recommendations

This section focuses on practical insights and challenges for building of the intellectual capital statements. Learning from pioneer experiences of 28 firms and institutions from Austria, Denmark, Germany, Italy, India, Spain and UK in measuring and reporting intellectual capital since 1994 (see Table 2), and gaining tacit knowledge on how firms built and further developed these statements, we can provide some practical insights on the building of intellectual capital reports.

Definitions and Goals

What is an intellectual capital statement or report? Table 3 shows what some leading organizations in measuring and reporting intellectual capital think.

Why do firms build the intellectual capital statement? What is the major goal of this statement? Table 4 summarizes the opinion of some firms and organizations deeply involved in the building of the intellectual capital statement.

Information Content

What kind of information does the intellectual capital statement usually covers? Based on our

Table 3. An intellectual capital statement is…

Organization	ICS definition
Danish Agency for Trade and Industry (2001, 2003)	It is "an integrated part of company knowledge management. It identifies the company's knowledge management strategy, which includes the identification of its objectives, initiatives and results in the composition, application and development of the company's knowledge resources. It also communicates this strategy to the company and the world at large" (2003, p. 7). […] "an externally published document, which communicates the company's knowledge management goals, efforts and results." It "forms an integral part of working with knowledge management within a company. It statements on the company's efforts to obtain, develop, share and anchor the knowledge resources required to ensure future results. The intellectual capital can contribute to creating value for the company by improving the basis for growth, flexibility and innovation. Its merits lie in expressing the company's strategy for what it must excel at in order to deliver satisfactory products or service" (p. 13).
Intercos (2003)	The intellectual capital statement represents "an important communication means to promote the results relating to corporate performance towards clients and all main interest groups…a powerful tool for internal management…a system to control the vitality of the organization whereby ensuring company's global evolution excellence and future" (p. 2).
MEKU (1999)	[…] "mainly an internal management tool, which is to be publicized" (p. 7).
Systematic (2004)	The report "gives a broad, comprehensive picture of Systematic and illustrates our vision, mission, values and objectives. In this way, the intellectual capital report functions as a window to the world -- a kind of business card. The target group is current and future customers, employees and cooperation partners."

Table 4. The goal of the intellectual capital statement is…

Organization	ICS goal
Carl Bro Group (2001)	"[…] to measure the extent to which Carl Bro as a company has and is developing the qualifications for supplying intelligent solutions and hence for ensuring future earnings. In this context, our intellectual capital, our attitudes and our philosophy (mission, vision and values) are significant parameters" (p. 4).
Coloplast (2003)	"At Coloplast we are determined to act in dialogue with our stakeholders. We aim to balance the value creation among our stakeholders. We also need to balance short-term results with long-term considerations. This statement accounts for the various efforts supporting overall value creation."
Danish Agency for Trade and Industry (2000, 2001)	"[…] to give an image of the organizational effort to build, develop and display resources and abilities in relation to the employees, customers, technology and processes. The intellectual capital accounts underline the development of a future value of the company and also its competitive advantage in the Knowledge Economy" (2000, p. 4). Moreover, this statement shows an essential part of the Knowledge Management. This statement "informs about organizational efforts to achieve, develop, share and institutionalize knowledge-based resources which are necessary to create value for the company by means of improving their growth, flexibility and innovation" (2001, p. 13).
DIEU (2001)	To give "our wide range of stakeholders and not least, our many current and potential customers, employees and business partners, a true and future oriented picture of DIEU's knowledge, competences and results" (p. 3).
Experimentarium (2004)	With the intellectual capital statement, "we can ensure quality and renewal and strengthen the company's ability to reach its goals. At the same time, the intellectual capital statements enable the surrounding world to gain an insight into Experimentarium status and development" (p. 20)
Nanonet (2003)	"[...] is to provide a transparent, verifiable overview of the effects of the research funds invested in nanotechnology...it provides a modern communication and control instrument for knowledge-intensive issues" (p. 2-3).
OENB (2003)	The OENB's Intellectual Capital Statement "makes transparent the stock of knowledge-based capital as well as internal and external knowledge flows. It thus helps document the OENB's intangible assets, which the Annual Statement fails to capture in a comprehensive way" (p. 8).
SAPA (2000)	"[…] to monitor the creation and development of the intellectual capital within the organization which together with the company's economic assets represents the real value of the company…it intends to provide its stakeholders with useful information that is not of an economic or financial nature…to obtain a fresh viewpoint that brings to light other important aspects which form an integral through intangible part of the organization's overall capital" (p. 73).
Reliance (1997)	"[…] to redress the imbalance between non-financial and financial data, in recognition of the belief that the value of organizations will, in times to come, increasingly reside in their intangible assets…the company is also confident that this status report will introduce a new dimension in transparency that will strengthen its corporate governance."
Systematic (1999)	It offers "a holistic and overall picture of the firm with emphasis on intangible and 'soft values'…" (p. 6).

analysis of intellectual capital statements published by 28 firms, our findings on information content are summarized in Table 5.

Table 5. Type of information included in the intellectual capital statement

The ICS covers information on...
☑ The annual report
☑ Firm profile
☑ Knowledge management activities
☑ Intellectual capital description
☑ Accounting policies

Intellectual Capital Indicators

Based on the experience of these pioneer firms (see Table 2), we carefully examined the intellectual capital statements published so far and especially analyzed the indicators chosen to mea-

sure intellectual capital. Based on this analysis, we propose the following indicators to measure each basic sub-construct of intellectual capital (human capital, relational capital and structural capital) and group them in categories.

FUTURE TRENDS

Building the *intellectual capital statement* is a step ahead in efficiently managing knowledge-based resources (what is measured is managed). These corporate statements present a real picture of the intellectual capital of the firm. They are useful to complete the information received through traditional annual corporate reports. However there is no official guideline for firms operating in an industry, country or region. Regulatory bodies, academics and practitioners should work towards the development of an official guideline that helps firms to visualize their "hidden value" and efficiently manage these knowledge-based resources. Furthermore, harmonized norms and principles for intellectual capital measuring and reporting allow comparing the intellectual capital statements built by firms.

On the other hand, after the intellectual capital indicators are built, the firm must answer some check questions. For example, the firm must reconsider if the indicator offers a fair picture of the organizational work with knowledge management. It must also check if the figure for the

Table 6. Human capital indicators

HUMAN CAPITAL SUB-CONSTRUCT		
INDICATORS	**YEAR**	
	YEAR $_{T-1}$	**YEAR $_{T}$**
Employee Profile • Total number of staff • Distribution of staff (Production, Distribution, IT Department, etc.) • Age distribution • Average age of employees • Gender distribution (male, female) • Number of managers • % of research staff • Number of full-time employees		
Adaptability capacity • Number of employees who permanently work abroad • Number of employees who have participated in international projects during the year		
Staff Turnover • Beginners • Resigned • Circulation % of personnel • % of unwanted personnel circulation		
Educational Capital • Unskilled personnel • Skilled personnel • Length of education • Number of employees fluent in English language • Number of awards • Professional publications per employee • International experience (traveling activities)		

Table 6. continued

Education Renewal • Number of competence development plans • Number of carrier development plans		
Commitment and Motivation • % of individual goal achievement • Average seniority • Permanent contracts • % of staff with variable retribution/total staff • Employees with shares and convertible bonus programs • Number of award-winning employees • Suggestions systems (money prizes, point prizes) • % of promoted staff/total staff • % of staff feeling explicit recognition • % of staff feeling their opinion is taken into account		
Permanent Training • % of employees who received training during the year • Training o Training days per employee o Average number of training hours per employee/year o Ratio training hours/working hours (annual) o Training investment (employee/year) o Ratio training cost/wages (annual) o Satisfaction index about training o Average index of application of the training received in daily tasks o Mentoring pairs • Permanent learning through external agent relations o Number of alliances and collaborations with academic institutions and research centers		
Results • Satisfaction with the opportunity for on-the-job skills development • Total satisfaction with the opportunity for on-the-job skill development • Employee satisfaction index • Absence due to sickness (days/employee) • Personal injury with loss of working hours • Costs attributable to external faults		

indicator is reliable or not, if the basic data are coherent or not, and if the indicator can be reported over time, among other questions.

Additionally it is important to have some degree of continuity in intellectual capital statements, that is, that many indicators can be repeated year after year, although changes can be made. These changes should be explained in order to maintain credibility. For example, an indicator that has been reported annually cannot be removed without an explanation in the intellectual capital statement.

Another challenge for intellectual capital measuring and reporting has to do with the fact that all models developed so far have a static approach. Therefore dynamic models have to be developed and tested (Bueno, 2003; Roos et al., 2006). A few years ago and with a visionary approach, Bueno (2003) already introduced the concept of "capital de emprendizaje" (in Spanish) or "entrepreneurship capital and "capital de innovación" (in Spanish) or innovation capital.

CONCLUSION

There is an increasing need for generally accepted norms useful to measure and report intellectual

Table 7. Structural capital indicators

STRUCTURAL CAPITAL SUB-CONSTRUCT (Organizational Capital and Technological Capital)		
INDICATORS	**YEAR**	
	YEAR $_{T-1}$	**YEAR $_{T}$**

Infrastructure
• Investment
  o Investment in premises and office equipment
  o Investment in computer equipment
  o IT expenses per employee
• Servers
  o Number of servers per worker
  o Number of hits on Web site per day
  o Average number of homepage hits per month
• Office
  o PCs per office
• Number of employees connected via e-mail
• Reliability of hardware and software
• Employees with the option of teleworking
• Employees with corporate mobile phone
• Employees with corporate laptop		

Knowledge-Based Infrastructure • Number of best practices on the Intranet • Number of employees with Intranet access/total staff • Shared documents on the Intranet • % of updated knowledge documents on the Intranet • Number of databases to which the firm has access • Number of employees with Internet access/total staff • Number of shared knowledge databases • Number of participants in best practices processes • Number of knowledge management projects • Database searches		
Customer Support • Number of national offices • Number of offices abroad		
Administrative Processes • Average response time for calls to switchboards • % of inquiries handled within the same day		

Innovation Capital
• Innovation results
  o Number of products/services
  o Number of new products/services
  o Volume of sells linked to new products/services introduced last year
  o Total innovation
  o % of group turnover
  o Average turnover project
• Innovation investment
  o Number of shared ideas and experiences
  o Average number of ideas per employee
  o Investment in product development
  o Investment in process improvement
  o Investment in I+D+I projects
  o Centers of Excellence
  o Ongoing projects		

Table 7. continued

Quality • Accreditations and certifications • Number of ISO-9000 certifications • Number of quality committees • Number of employees with formation on total quality • Employee participation in internal improvement and technological innovation projects		
Organizational Management Model • Maximizing benefits of leadership and cohesion o Average experience of executive team • Shared organizational values o Shared organizational values • Business and advanced management models o Investment in management models o Number of own business models • Shared strategic management o Number of users of strategic planning system o Number of employees who participated in the building of the organizational strategic plans		
Social and Environmental Commitment • Investment in cultural support and solidarity projects • Environmental investment in the business • Number of labor audits to installations of the firm		

Table 8. Relational capital indicators

RELATIONAL CAPITAL SUB-CONSTRUCT (Business Capital and Social Capital)		
INDICATORS	**YEAR**	
	YEAR $_{T-1}$	**YEAR $_{T}$**
Client Profile • Number of public clients • Number of semi-public clients • Number of private clients • Number of clients abroad		
Customers' Portfolios • Contract portfolio o Number of contracts o Points of sale o First-time customers • New stakeholders • Brand o Clients' impression of the firm o Customer loyalty index o National/International market share o Market share of closest competitor (both national and international) o Number of customer suggestions o Number of offices with customer satisfaction measuring systems o Customer satisfaction index • Strategic portfolio o 5 largest customers during the year o Duration of existing customer relationships o % of customers who would recommend our firm o New strategic customers during the year o Investment on relational marketing • Number of clients from the same business sector		

Table 8. continued

Public Image • Exposure to the media • Spontaneous notoriety index • Number of unsolicited applications		
Investor Capital • Number of contacts with investors and analysts • Number of solved consultations from shareholder's information office • Number of favorable recommendations from analysts		
Intensity, Collaboration and Connectivity • Number of business conferences attended • Lectures at scientific conferences • Sponsorship agreements • Professional networks • Employees involved in boards (business, political, scientific) • Number of countries in which the firm operates • Average number of employees per office • Number of alliances with business schools • Number of commercial alliances		

capital so that comparisons can be made. At the same time, these norms should guarantee the objectivity of the information provided in these reports. Some efforts on building guidelines have been made by Bueno-CIC (2003), CIC (2004), Danish Agency for Trade and Industry (2000, 2001, 2003), Meritum Project (2002), Nordika Project (2002) and the 3R Model (Ordóñez, 2004).

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ENDNOTES

1 See Skandia (1994).

2 Joia (2000) examined the correlation of intellectual capital and market value.

3 For example, the models developed by Edvinsson and Malone (1997) and Bontis (1998).

4 For example, the Spanish firm UNION FENOSA has an Intellectual Capital Model "which addresses three types of capital (Human Capital, Structural Capital and Relational Capital), the relational flows between them, indicators which measure these intangibles and projects in process which provide value and contribute to guaranteeing that UNION FENOSA generates income in the medium and long term" (Union Fenosa, 2006). However the firm does not justify why the sub-constructs are introduced in this order.

5 The document Bueno-CIC (2003) addresses this model. For more information on this model and the research of the Knowledge Society Research Center, visit the Web site, www.iade.org.

6 In the IC literature, there are other measurement models available such as Tobin's Q (Tobin, 1969), Economic Value Added (EVA), Market-to-Book Value, Total Value Creation, among others.

7 For more information on biotechnological spin-offs in Spain, you can visit the Web site of the *Knowledge Society Research Center* (CIC) www.iade.org and the Web site of *Madrid's Scientific Park* www.fpcm.es/empresasIncubadas.htm. One of these spin-offs is *Genetrix* (www.genetrix.es).

8 See CIC (2005) and Bueno, Salmador, & Merino (2005) for an exhaustive analysis of managing intangible resources in Public Administrations in Spain – in particular, the case of *Agencia Tributaria Española* (in Spanish, Spain's Tax Agency) and *Instituto de Estudios Fiscales (Ministerio de Economia y Hacienda)* (in Spanish, Institute of Fiscal Studies, Ministry of Economics and Treasury).

Section II
Intellectual Capital and Information Technology

In the eight chapters of this section, information technology and intellectual capital are juxtaposed, and the ways in which information technology can generate the various capitals that compound a firm's intellectual capital are revealed. By way of conclusion, the essential role of information technology in creating, sharing and managing knowledge within a firm is evaluated in detail.

Chapter VIII
The Impacts of Information Technology on the Stock and Flow of a Firm's Intellectual Capital

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ABSTRACT

In this theoretical chapter, we examine the contribution of IT systems and tools to the emergence and use of different types of knowledge in a firm. We divide knowledge into explicit, tacit and potential and argue that these three types of knowledge characterize firms' three main functions - operational effectiveness, gradual development, and innovation, respectively. On the basis of our examination, we conclude that the main part of IT applications serves dissemination, storing and acquisition of explicit knowledge. However, there are also some tools that serve the elicitation of tacit and potential knowledge and the conversions between tacit and explicit knowledge. At the end of the chapter, we evaluate more generally the potential provided by IT. We argue that the addition of "a human touch" to the information produced and conveyed by IT is an emerging issue. We present two ways in which this can be done: the use of IT for the development of social capital in a firm, and the use of external experts—knowledge-intensive business services (KIBS)—as supporters in firms' knowledge functions linked to IT.

INTRODUCTION

The idea of the so-called knowledge society starts from the argument that in current and future economies the key resource is knowledge. At the beginning of the 1990s, it was considered important to reinforce the knowledge base and to invest in information infrastructures on both societal and organizational level. Towards the end of the decade and at the beginning of the new millennium, the processes of learning and innovation have been increasingly emphasized in addition to the stock of knowledge. (Lundvall, 1992, 1999; Schienstock & Hämäläinen, 2001) The essentially increased rate of change has brought to the fore the capability for rapid learning and production of new knowledge.

A corresponding shift of focus can be found in the knowledge management literature: knowledge was earlier analyzed mainly as an asset (e.g., Sveiby, 1990), but nowadays it is more and more often analyzed as a capability (Leonard-Barton, 1995; Teece et al., 1997; Eisenhardt & Martin, 2000). The type of knowledge to which the greatest attention has been paid also reflects the change. At the first stage of development of the discipline of knowledge management, explicit knowledge was the main focus of interest. Gradually the significance of tacit forms of knowledge was understood. The adoption of the concept of potential knowledge is the newest stage (Snowden, 2002).

The development of information technology (IT) has drastically facilitated and will further facilitate handling, storing and transferring of information. It has also provided new means that support learning: it has enabled more usable interfaces and specific problem-solving methodologies. These new means do not only provide firms with access to information dispersed in society, but they also enhance connectivity and receptivity in the economic system. Enhancing the connectivity means increasing of the shared learning experiences between and within firms. The promotion of receptivity is achieved by making the absorption of external knowledge easier and faster, which increases the readiness of firms to use external knowledge sources (Antonelli, 1998, 1999).

Intellectual capital (IC) resources have been defined and categorized in many ways. The one thing that is common to all categorizations is that IC resources are intangible and consist of knowledge that has value to firms, that is, which the firms use to make profit. In this chapter we discuss the role of different kinds of IT tools in the accumulation and renewal of knowledge. As a background for our analysis we apply the idea that the competitive advantage of firms is formed by successful functioning in three different areas: (1) managing existing businesses effectively, (2) ensuring growth in these businesses and (3) developing new businesses. Together these areas represent what has been called the "fundamental management challenge of a firm" (Fitzroy & Hulbert, 2005, p. 266). Thus, a firm needs to handle concurrently the functions for (1) operational effectiveness, (2) gradual development, and (3) innovation (see also, Ståhle et al., 2003). We argue that in each area of activity a specific type of knowledge is crucial. In the area of operational effectiveness—which is usually linked to production-centered activities—explicit knowledge is especially important. In the developmental activities, tacit forms of knowledge and the conversions between tacit and explicit knowledge play a central role. In innovation activities, knowledge is still to a large extent in a potential, chaotic form; the task here is to bring order to this chaos and make some elements of the potential knowledge "existent."

The main part of our analysis consists of the examination of the linkages of various IT tools to the above-mentioned types of knowledge: explicit, tacit, and potential. The purpose is to increase our understanding of the specific role of different kinds of IT tools from the viewpoint of knowledge management. We make a preliminary categorization between those tools that: (1) are

mainly linked to the realm of explicit knowledge, (2) serve the conversions between explicit and tacit knowledge, and (3) are targeted to elicit out potential knowledge. Even though it is not possible to draw any sharp boundaries—one and the same tool may serve several knowledge types and knowledge processes (Mäki et al., 2001)—we expect that this kind of examination takes us a step further in the discussion of the benefits and limitations of IT in knowledge development, and in the development of intellectual capital.

After the analysis of the role of different IT tools, we evaluate more generally the potential provided by IT. We argue that an emerging issue is the extent to which "a human touch" has to be added to the information produced and conveyed by IT tools. We agree with those researchers who suggest that using IT for the enhancement of the social capital in a firm leads to the building of intellectual capital more efficiently than relying on IT tools as such (Lengnick-Hall et al., 2004). In addition, we suggest that firms could use outside facilitators for finding relevant knowledge, and for analyzing and interpreting it in a meaningful way. Such facilitators are knowledge-intensive business service firms (KIBS), whose core service is contribution to the knowledge processes of their clients (Toivonen, 2004). We end the chapter with a short summary and some conclusions.

BACKGROUND

In organization theories, two tasks of organizations—operational effectiveness and gradual development—have been recognized long before the discussion on the management of knowledge in firms even started. Burns & Stalker (1961) divided the management systems of firms into "mechanistic" and "organic." For them, these two modes represent "two polar extremities of the forms which such systems can take when they are adapted to a specific rate of technical and commercial change" (p. 119). In other words, two systems enable the management of human resources of a firm in different circumstances. The mechanistic management system represents hierarchy and specialized functional tasks and is designed for stable conditions. The organic management system is designed for changing conditions and follows the logic of continuous adjustment and re-definition of individual tasks through interaction with others.

The discussion of "loosely coupled systems" also applies the idea of firms' dual strategy—effectiveness and gradual improvements. According to Orton and Weick (1990, p. 204), "organizations appear to be both determinate, closed systems searching for certainty and indeterminate, open systems expecting uncertainty." In any part of an organization, the system functions both on a technical level that is closed to outside forces, and on institutional level which is open to outside forces. Thus, there is a paradox in the functioning of an organization: a successful organization is a system of interdependent actors which has to be rational and indeterminate at the same time.

The dual strategy model covers only the efficient production of a pre-designed product and the gradual improvement of a product, production method or a production process. This kind of a model describes well the traditional economy, where the cycle of renewal was much longer than today, due to the physical capital intensiveness of the economy. A firm that abundantly possessed monetary capital, land, labor and machinery was able to achieve the benefits of scale with only slight modifications to existing products over time. However, the new knowledge-based economy functions with a different logic: the logic of "increasing returns." The characteristics of knowledge as a "public good," with endless replication possibilities, have made it the dominant source of competitive advantage (e.g., Drucker, 1995). This has led to the recognition of a third mode of organizational strategies: besides efficient production and gradual development, a firm needs a separate system to initiate innovation.

The operational effectiveness mode, the gradual development mode and the innovative mode all require a different kind of "knowledge environment." Correspondingly, every type of knowledge needs its own kind of operative mode and management style in the firm (Scharmer, 2001). The fundamental management challenge of a firm is to handle the three different modes of operation and the three different types of knowledge simultaneously. Firstly, the existing business has to be managed by using mainly well specified, explicit and codified knowledge to improve effectiveness. Secondly, gradual improvements have to be carried out by gathering experience-based, tacit knowledge from inside and outside of the firm and by applying this knowledge to the existing business processes. Thirdly, in the innovative mode, new businesses are developed by using small pieces of information from many different sources and by condensing them into new ideas. A potential or emerging type of knowledge is typical of this mode. In the following we describe each mode based on Ståhle et al. (2003) and Smedlund and Pöyhönen (2005).

In the environment of operational effectiveness, pre-designed products are produced in a hierarchical structure of well-specified tasks. The skills and competencies of the employees are also specified. By allowing people to concentrate on their own expertise, a well-functioning hierarchy reduces the transaction costs. In order to produce permanent high quality and to achieve the predetermined goals, clear and coherent rules and regulations are enforced by the managers. Thus, the essential knowledge in the environment of operational effectiveness should be in an explicit form and circulated to all relevant employees. It is usually enough that information flows in one direction, mostly top-down, because discussion and elaboration open up the possibility for modifications, which in this type of an operative mode are unwanted and mere hindrances to its effectiveness.

The gradual development mode is horizontal in structure. It joins people in a firm together, even if they do not belong to the same hierarchy of producing planned products or services. In this mode, communication is daily and casual, and tacit knowledge based on the experiences of employees plays a central role. The experiences may be related either to products, services, production methods or processes. Employees learn from each others' experiences and in this way their competencies develop gradually in the course of time. The continuous step-by-step development is based on lateral two-way information flows, double contingent relationships, and empowering leadership. Learning takes place in reciprocal, long-term and trustworthy relationships at the inter-personal level and through informal dialogue—in a way which very much resembles the idea of the working of communities of practice (Brown & Duguid 1991).

The innovative mode requires an environment that encourages the continuous creation of new ideas for products, production methods or processes. The relationships are mainly spontaneous, and they last until the idea is condensed. The relationship structure in this knowledge environment—the environment for potential knowledge—is diagonal. This means that the actors participating in the process of idea generation can be from different levels of the organization's formal hierarchy. As the idea generation process moves forward, some persons leave the group and others join it. The information flow is fast, chaotic and includes a lot of extra information. The knowledge environment for potential knowledge should foster the emergence of knowledge that is novel for everyone in the firm. This requires that there is room for creativity and that the network of employees is rich and informal, not too structured or formalized. Intuitive knowledge, "knowledge not yet invented," should be highly valued. The actors' competencies are "hidden," to be found in innovation activities. The activities in this

operative mode are ideally led by a person who is the most suitable for coordinating resources and knowledge, that is, the authority migrates according to expertise rather than to the position in a hierarchy.

IT SYSTEMS LINKED TO THE DIFFERENT TYPES OF KNOWLEDGE

Before starting our analysis of the linkages of various IT tools to the different knowledge types, we have to define our scope as regards IT. In the broadest sense, IT covers both information technology and communications technologies. Information technology consists of hardware for office machines, data processing equipment, data communications equipment, software and services. Communications technologies consist of telecommunications equipment and telecommunications services (EITO, 2004). Analyzing all these technologies is not possible in the present context, due to which we focus on those technologies which are most directly linked to the knowledge processes of firms: software systems and tools (including the respective services).

Hardware as well as information technology equipment and telecommunications equipment can be regarded as the basic infrastructure which plays an indirect role in knowledge functions. However, the significance of the availability and continuous growth of computing capacity and network connectivity has to be emphasized. By providing quick and easy access to external sources of knowledge and new and more intense communication channels with partner organizations, the IT infrastructure increases both the efficiency and innovation ability of enterprises (cf., Corso et al., 2001). In telecommunications services, key technologies are e-mail, voice over Internet (VoIP), instant messaging, video calls and unified messaging (EITO, 2004). All these technologies have greatly increased the possibilities for human interaction and act as enablers for more specific knowledge functions. A detailed analysis of them has, however, to be postponed to a later occasion. Here we only point out the role of video communication as the "next best thing" when the benefits of face-to-face interaction are pursued, but the holding of a meeting is not possible.

Software Systems and Tools Linked to Explicit Knowledge

Efficient production of goods or services requires timely provided explicit and codified knowledge, circulated to all relevant actors. This kind of knowledge includes, for example, production orders, drawings of a product and information about stock levels. We argue that most software systems and tools serve this purpose. They can be divided into three main groups according to their functions in knowledge processes: systems and tools that support (1) knowledge dissemination, (2) knowledge acquisition, and (3) knowledge storing (Mäki et al., 2001). Knowledge dissemination refers to active transferring of knowledge to defined target groups using selected dissemination techniques. Knowledge acquisition includes locating of knowledge, access to knowledge needed, as well as tools for processing acquired knowledge. In knowledge storing existing knowledge is organized and stored into electronic databases.

At a more detailed level, software systems and tools can be grouped on the basis of the organizational activities to which they are linked. The following list is not exhaustive—especially the specific tools are examples—but we think it is illustrative and comprehensive enough for the purposes of the analysis at hand.

1. Integrated business software
   - Enterprise resource planning (ERP) and its extended form (EERP)
   - Customer relationship management (CRM)

- Supply chain management (SCM)
- Human resources management (HRM)

2. Systems and tools for specific business functions
   - tools for strategic planning and evaluation, for example, balanced scorecard (BSC)
   - portfolio and project management systems
   - industry specific systems
3. Cross-organizational systems
   - e-business platforms
   - Web services
4. Shared systems for the storage and searching of knowledge
   - tools for document and content management
   - data warehouse solutions
   - methods and tools for data mining

ERP systems are the broadest packages among business software. They blend the functionality of earlier manufacturing resource planning (MRP) systems with a variety of other application areas such as quality, maintenance, marketing and accounting. They provide real-time links across all of a firm's activities: order capture, procurement, material resource planning, production scheduling, after-sales service, and human resource management. ERP provides a single, comprehensive database in which business transactions are entered, recorded, processed, monitored and reported. Most ERP systems are modular—thus, a firm can choose to implement the financial module but not the human resource module, for example. Vendors, however, continually expand their offerings to include more advanced applications such as customer relationship management and supply chain management. Dominant vendors also develop configurations designed for industry-specific needs (Lengnick-Hall et al., 2004). In practice, companies still have separate CRM, SCM and HRM systems, and a number of smaller systems. In addition, e-business platforms and the emerging Web services provide an alternative for companies to distribute information and support the execution of business transactions (EITO, 2004).

In order to illustrate the characteristics of business software in more detail, we describe the functional areas of CRM as an example. Three broad functional areas are usually identified in CRM: collaborative, analytical and operational. Collaborative functionalities allow customers to efficiently and consistently interact with an organization through multiple channels; thus, channel management is in the core of this area. Analytical functionalities integrate, store and manage customer information collected through multiple channels to be used by operational functionalities. Data warehousing and knowledge management tools help to store and manage large quantities of historical data about customers, products and markets. Operational functionalities support an organization's planning, marketing, sales and after-sales activities by exploiting CRM data—data analyses include data extraction, aggregation and forecasting (EITO, 2004).

Business software—especially its integrated forms—provides an efficient tool for the transfer and use of explicit knowledge. It supports the operational effectiveness of firms in many ways. It provides easy access to "an information portrait of an enterprise," based on a consistent and comprehensive database. The precise and reliable information that results enables firms to accurately assess and tightly coordinate their production capabilities. Comprehensive performance assessment and feedback tools, like the Balanced Scorecard, can be used (cf., Kaplan & Norton, 1996). Electronic data exchange increases the speed of information flows, which can lead to cycle time reductions and other quick-response benefits. (Lengnick-Hall et al., 2004, pp. 5-6) In addition, integrated business software increases firms' connectivity both internally and externally. Inside a firm, the functional units can communicate directly with each other, and all the more often the IT systems also cut across organizational

boundaries, that is, firms use the IT tools for inter-organizational networking and integration (EITO, 2004). All these factors also promote the actualization of tacit knowledge. However, in order to be really successful in this respect, the above-described tools have to be supplemented with some additional tools and activities. These tools and activities will be discussed next together with the software specifically targeted to facilitate tacit-explicit knowledge conversions.

Software Systems and Tools for Tacit-Explicit Knowledge Conversions

Nonaka and Takeuchi (1995) have presented a well-known model of the conversions between explicit and tacit knowledge. We will apply this so-called SECI model in our analysis of the linkage of IT to tacit knowledge. The model goes through four modes of knowledge conversion: (1) socialization (from tacit knowledge to tacit knowledge); (2) externalisation (from tacit knowledge to explicit knowledge); (3) combination (from explicit knowledge to explicit knowledge); and (4) internalization (from explicit knowledge to tacit knowledge). In the strategic management of a firm, the SECI model has been argued to suit especially well to situations where already existing processes are being gradually improved (c.f., Scharmer, 2001).

The IT tools discussed in the previous section can be argued to cover the combination part of the SECI model: one essential function of those tools is to link together different knowledge sources. Thus, the tools already described can be applied not only to the distribution and utilisation of existing knowledge as such, but new knowledge based on the principle of combination can also be created by means of their use. For example, CRM systems may provide new information about the customer base or customer behaviour of the company. Project management systems can be used in the planning of new managerial efforts in a project based organization.

Business software increases the visibility, transparency, and accountability of the knowledge resources of a firm, which means that there is also a potential for externalization, that is, for the eliciting out of tacit knowledge. New tools, like *data analytics* and *business intelligence* solutions support this kind of knowledge conversion and help to get real value from the extensive IT investments (EITO, 2004). Still, from the viewpoint of the utilization of tacit knowledge, business software is more an enabling technology rather than a solution on its own. Tacit knowledge, which is not at the conscious level of understanding and which is difficult to articulate, does not fit well to the requirements of business software: a clear understanding of stable cause-and-effect relationships. Benefits depend to a great extent on the ways in which the IT tools are applied—these tools should be conformed to the new insights gained from IT-generated information (cf., Lengnick et al., 2004).

The same is valid also regarding the opposite conversion: internalization. The internalization part of the SECI model is closely linked with learning. The implementation of extensive IT systems is usually an important learning experience in firms. Integrated software applications—especially ERP—affect everything a firm does. They reshape not only a firm's information processing, but also workflow, design and interpersonal interactions in fundamental ways (Martin, 1998). The change of the patterns of interaction means that the whole culture of the firm is often changed. Further, the continuous feedback that the integrated IT systems provide can be translated into opportunities for learning among individuals, groups and the organizations as a whole. On the other hand, while the raw information needed for organizational learning is available, structural and procedural hurdles that make it difficult to capitalize on potential insights are simultaneously introduced

(Lengnick et al., 2004). Firms are under the pressure to adjust the way they want to work to fit the way the system will let them work (Dillon, 1999). There are, however, alternative practices through which even the integrated systems can be put to serve human judgment, instead of seeing them as a prime directive to be blindly followed. These practices will be discussed later in this chapter.

There are also specific IT tools developed for the converting of explicit knowledge to tacit and vice versa. From the viewpoint of the former, all those IT tools that facilitate learning and those tools developed specifically for computer-aided learning are relevant. In the marketplace for corporate *e-learning*, there are both vendors who provide training portals external to the company, and vendors who help an organization develop an integrated learning platform for its own use (Ruttenbur et al., 2000). The elicitation of tacit knowledge, in turn, can be supported by those IT tools that aim at the facilitation of free expression of opinions and ideas. Discussion pages in a firm's intranet are an illustrative example. There are also a growing number of IT tools targeted to supporting teamwork and group sessions. As these tools play an important role in making potential knowledge "existent," we discuss them in the following section, which is devoted to this type of knowledge. The same tools can also play some role in the conversions from tacit to tacit knowledge. However, we argue that here the IT tools have not very much to provide. Socialization is mainly the realm of human interaction—a topic to which we return at the end of this chapter.

Software Systems and Tools for making Potential Knowledge "Existent"

The chaotic and complex elements of knowledge and their management are attracting increasing attention today, together with the growing emphasis on innovation. Scharmer (2001, p. 6) describes this third knowledge type—potential knowledge—as "not-yet embodied, self-transcending…tacit knowledge prior to its embodiment in day-to-day practices." It is needed in sensing and actualizing emergent business possibilities; in other words, it is essential for innovations to happen. By using a bread metaphor similar to Nonaka and Takeuchi (1995), Scharmer argues that certain kinds of information about bread, such as weight, price and ingredients are explicit knowledge. The activities of baking and producing the bread are examples of tacit knowledge. Finally, the knowledge that enables a baker to invent baking bread in the first place is self-transcending. This is the type of knowledge that gives momentum to "knowledge spiral" in the SECI model by Nonaka and Takeuchi.

The idea of potential knowledge has much in common with the descriptions of the so-called "front-end" in the innovation process. The front-end phase refers to those activities that come before the formal and well-structured new product and process development. For example, Koen et al. (2001, p. 49) characterize these activities as "chaotic, unpredictable and unstructured." The front-end phase includes idea generation and idea management. Idea generation refers to the discovery of some new business opportunities and to the first thoughts about their utilization. Idea management prepares the transfer to actual innovation projects; it covers the systematic collection, documentation and evaluation of ideas (cf., Summa, 2004).

An important group of IT tools that can facilitate idea generation are *tools assisting creative problem solving*. Visual outliners help users to express their ideas by means of mind maps and concept maps. Idea processing software offers tools to record, process and manipulate ideas. Questioning programs use sets of questions, keywords or exercises based on user input to provoke new ideas (Proctor, 1998). Another important means in the elicitation of potential knowledge are different kinds of *group-working tools*. They are used to structure, for example, brainstorming

sessions and/or social encounter systems, such as media spaces. Media spaces are video-based systems for social purposes where people can meet at distant coffee bars or at other social areas connected via camera and monitor systems. Group decision support systems and media spaces are examples of the so-called collaboration technology, which can be used in sharing of tacit knowledge among employees or even with customers or suppliers (Andriessen, 2003).

In idea management, some applications based on general document and knowledge management systems can be used. It is possible to define specific paths of document flows so that they support the management of ideas. There are also software tools that are particularly targeted to early filtering, prioritizing and structuring of ideas, as well as tools that support adding details and notes to a new idea as it develops. Applications that provide access to patent information and scientific Web sites help to eliminate the reinvention of existing products and to avoid the infringement of intellectual property rights (Summa, 2004). In the evaluation of ideas, some futures information is often desirable. The mapping of the so-called "weak signals" is one method for which IT-based systems have been developed. A weak signal is the first indication of change; it does not necessarily seem important, but may have a decisive impact on the formation of the future (Uskali, 2005). The information for weak signals is gathered from experts using specific IT systems that collect and categorize the experts' opinions and perceptions about the issues of interest.

During the later stages of an innovation process, knowledge is more and more in an explicit form. Thus, we come back to those IT tools that were mentioned in the discussion of this kind of knowledge. However, only part of the software that is efficient in the handling of explicit knowledge is suitable to the innovation context. Even though the innovation process becomes more systematic after the front end, it is not linear but proceeds recursively (Schienstock & Hämäläinen, 2001). This kind of process does not fit well together with the integrated business software systems. Unconventional data or ideas cannot easily enter these systems; barriers to free-flowing information are quite formidable. In addition, the implementation of this kind of software is typically the result of a top-down management directive, which tends to limit unplanned diversity and unanticipated creativity (Lengnick et al., 2004). On the other hand, portfolio and project management tools are an example of business software which is highly relevant also in the innovation context. These tools are important as facilitators of the innovation process management. A type of software not yet mentioned is linked to the design of products and processes. A wide variety of tools—computer-aided design (CAD) programs, 3-D modeling, simulation, and so forth help to develop an idea into a concrete solution (Summa, 2004).

FUTURE TRENDS

In the recent literature, the limits of IT have been an emerging topic. Several researchers have stated that the contribution of IT depends on the ways in which it is used. The need to add a "human touch" to the technology has also been emphasized. In the following, we consider these issues in the framework of two rather new research areas: the linkage of IT to the development of social capital, and the use of external experts— knowledge-intensive business services (KIBS)—as supporters in a firm's knowledge functions.

Using IT Systems for the Development of Social Capital

In the former discussion we have argued that the IT tools serve best the handling of explicit knowledge, that is, those functions of firms which aim at operational effectiveness. However, as some researchers have pointed out, the emergence of competitive advantage is not self-evident even

here. Particularly the most comprehensive tools, the integrated business software, are designed to reflect "best practices" of different industries. Pursuing operational effectiveness through commonality across an industry diminishes the distinctiveness of individual firms, which again may jeopardize their long-term competitiveness. Customization in the context of integrated software is fairly modest and firm-specific modifications tend to emphasize technical interface concerns rather than strategic issues. It is not rare that firms adapt or even completely reconfigure their business in order to conform to the requirements of the IT system (Davenport, 2000; Dillon, 1999; Lengnick et al., 2004).

Lengnick et al. (2004) have made an important analysis about the ways in which IT can be used to enhance a firm's long-term competitive position, instead of improving operations here and now at the expense of strategic distinctiveness. The analysis focuses on ERP and starts from the argument that even though ERP itself has not the characteristic of supporting the development of asymmetric organizational capabilities, the information and relationship outputs of the system could provide the seeds for this kind of a development. The way in which the benefits of ERP can be augmented is the creation of organizational distinctiveness linked to social and intellectual capital. ERP provides a platform for increasing social capital, which again can be used to build firms' intellectual capital. Social capital can be increased on three dimensions: structural, relational and cognitive (cf., Nahapiet & Ghostal, 1998).

- The structural dimension refers to the configuration of impersonal links between people and units. ERP data flows and network connections present a tremendous opportunity to enhance this type of social capital.
- The relational dimension includes the personal relationships that people develop with each other across a history of interactions. ERP together with HRM systems can increase the opportunity for these kinds of relationships to some extent, but electronically mediated exchanges require face-to-face communication to support it.
- The cognitive dimension is the knowledge and language system providing shared representations, meanings and interpretations among members of a network. Here, the shared experience of implementing ERP and the technical training of the new systems can be used as an effective vehicle for developing common language and organization culture.

Thus, when consciously used for the building of social capital, IT tools can considerably increase its accumulation. Social capital, again, supports the building of intellectual capital in several ways. The proponents of the idea of the dual-core organizations suggest that social capital is essential for the successful loose coupling of the functions of operational effectiveness and gradual development (Orton & Weick, 1990). Social capital can also increase a firm's innovativeness. Interactions between employees promote trust, a sense of community, and commitment to common aims—an atmosphere which encourages the emergence of strategic initiatives and new ideas (Lengnick et al., 2004).

Using KIBS as Supporters of a Firm's Knowledge Functions

Until now we have discussed software mainly as a technical device without commenting separately the services which the vendors provide linked to it. However, IT systems are often so complicated that firms cannot use them effectively by themselves, but purchase IT as a combination of technology and services. In fact, products form only one third and services two thirds in the global markets of software (EITO, 2004). Even

when firms purchase commercial 'off-the-shelf' software, training and maintenance services are usually needed. Integrated business software is usually sold as an overall solution including both the product and services. Finally, many firms consider customized and tailor-made solutions to be the best alternative, as these kinds of solutions can capture the firm-specific issues and do not require the modification of business to conform to software mandates. The production of customized software is a service activity by nature.

The role of external services as supporters of the development of intellectual capital in the IT context is not restricted to software services. As the information flows continuously grow, the question of how, where and when to dip into these flows becomes more and more urgent. This highlights the competences linked with locating and selecting the relevant information and using it in efficient ways. There is increasing demand for highly qualified professionals who are able to provide comprehensive and customised interpretation of random data (Lundvall & Johnson, 1994; Preissl, 2000). Not all firms have these professionals, nor do they have possibilities to use human resources for these kinds of tasks due to the pressures of everyday business. In many cases the knowledge needed is so specific that IT professionals alone cannot satisfy the need.

One answer is provided by knowledge-intensive business services firms (KIBS), which operate in many different professional fields. These firms have rapidly increased during the last decade (Toivonen, 2004). The above-mentioned IT services are one branch inside the KIBS industry. However, there are a great number of firms in other KIBS branches: in technical consultancy, in legal, financial and management consultancy, and in marketing communications. These KIBS, too, are important facilitators in the knowledge-related activities of their client companies. On the basis of their abundant contacts with various clients, KIBS have a broad view of the latest developments in society. They convey explicit knowledge to help their clients to manage existing business efficiently. They ensure the growth of their clients' business by transferring best practices which abundantly involve tacit knowledge. Finally, they help their clients to develop new business by acting as sources of potential knowledge and by facilitating the innovation processes.

The development of IT has had an important impact on the KIBS sector. KIBS have been found to be among the most intensive adopters of new IT (Miles, 2002). Using the new technology, KIBS can better than before provide their clients with access to information dispersed in the society and enhance connectivity and receptivity of the economic system. However, it is not self-evident that firms purchase external services, even though they would need expertise from outside. There is much to be developed in the awareness of the benefits that the use of KIBS can offer. In addition, the use of external services should be skilful, which means that attention should be paid to the careful selection of a suitable service provider, to active interaction during the service process, and to the continuous evaluation of the service quality.

CONCLUSION

In this chapter we have analyzed the contribution of software tools to the emergence and use of different types of knowledge. Based on earlier studies we have categorized knowledge to explicit, tacit and potential. We have argued that firms need all these knowledge types in order to make successful business. Their importance varies, however, according to the different functions of firms: explicit knowledge serves operational effectiveness in particular, tacit knowledge and the conversions between explicit and tacit knowledge are highlighted in gradual development, and potential knowledge is characteristic of innovation activities. We want to point out that this categorization should not be interpreted too

straightforwardly—we speak about the dominant type of knowledge in the context of each of the three functions, but understand that the other knowledge types are also needed. Thus, our categorization is first and foremost a clarifying tool which helps to tackle the vast and complex topic at hand.

On the basis of our analysis, we argue that the main part of software applications serves dissemination, storing and acquisition of explicit knowledge. The development of IT has given new incentives to the codification of knowledge. In the Internet economy, where the markets for information can be said to have exploded, it has become less costly to codify knowledge and in some areas much more attractive to do so. On the other hand, there is also software which supports the conversion of tacit knowledge to explicit, and vice versa. Some tools also facilitate the early stages of innovation activity, that is, idea generation where potential knowledge is made "existent." The number of software tools linked to tacit and potential knowledge is, however, considerably smaller than in the case of explicit knowledge, and these tools are more miscellaneous than the tools targeted to the management of explicit knowledge. The following table summarizes our analysis of the linkages of different software tools to different knowledge types and to different functions of firms—each function being dominated by a specific knowledge type.

Several researchers have emphasized the importance of differentiating knowledge from information. Knowledge is not just organised information, but it involves the ability to organise information, as well as the results of applying that ability. Knowledge transfer typically requires more interaction than information transfer. Information is a flow of messages, while knowledge is created by that very flow of information, anchored in the beliefs and commitment of its holder (Lundvall, 1999; Miles et al., 1995; Nonaka & Takeuchi, 1995). An interesting issue is whether the new software tools have something to do with knowledge, not only with information. On the basis of our analysis it seems that they have. Even if we make a simplification and assume that the software tools linked with explicit knowledge fulfil mainly information functions, the tools serving the elicitation of tacit and potential knowledge surely go beyond the realm of mere information. These tools are tightly linked to human interpretation and also to human interaction.

Table 1. Software tools linked to different functions and different knowledge types in a firm

Firms' functions	**Knowledge type**	**Most suitable software systems and tools**	**Supporting activities**
operational effectiveness	explicit	business software (ERP, SCM, CRM, HRM), function- and industry-specific systems, e-business platforms, document management, data warehouse, data mining, and so forth.	development of social capital which can further support the development of intellectual capital the use of external facilitators (KIBS) for the search and interpretation of relevant knowledge
gradual development	tacit and tacit-explicit conversions	business software as an enabler; specific tools (e.g., business intelligence and e-learning tools)	
innovation	potential	tools assisting creative problem solving (e.g., mind maps and questioning programs), group-working tools	

On the other hand, there are major knowledge-linked issues to which IT as such cannot give an answer. Our analysis shows that effective and sustained advantages depend much on the way in which the software tools are applied. IT investments in firms have often been characterized by a technology-push type of orientation. Many times these investments have not led to the desired result, or the exploitation of the systems has been only partial. A more careful consideration of the specific knowledge context for which the IT support is sought could improve the situation. IT tools are successful only as a part of processes and working practices based on a common understanding of what is to be achieved.

In addition to these general points, there are two specific ways in which the benefits of IT can be augmented (Table 1). First, the shared experiences and abundant new links between people enabled by IT can be used to the building of social capital in a firm. Social capital, again, can support the accumulation of intellectual capital: it creates ties between operational and developmental functions of the firm and promotes the emergence of an innovative atmosphere. Secondly, in addition to the linking of IT to the development of human resources inside a firm, more benefits of IT can often be gained by using external resources. There are nowadays a great number of specialized professionals of different fields in the so-called knowledge-intensive business service firms (KIBS). These professionals and experts can help firms in the location and interpretation of relevant knowledge by using different IT tools. The skillful purchase and usage of KIBS' services is an essential question for companies today.

We have to point out that our analysis describes the capabilities of IT in their present form. However, IT tools are developing further both continuously and rapidly. For example, business software is being developed into a tool that, more efficiently than today, can support the building of a flexible enterprise and fluid process relationships. The make-to-order systems that are already included in advanced business software form a basis for this kind of development (Lengnick et al., 2004) One key challenge is to support life-cycle thinking, which is applied today in many different contexts, with information technology devices. Further, an important issue is the interlinking of business software with scientific databases and design processes. The significance of customer interface from the viewpoint of innovation creates pressure to develop this kind of a combination. Yet only a few companies have made practical efforts in this area. Still one area, which in the future can essentially contribute to the accumulation and renewal of intellectual capital is the development of semantic searches and the semantic Web. These solutions aim at overcoming the limitations of currently used keyword-based search methods, which cannot differentiate between synonyms and do not understand homonyms, general phrases or implicit information (Summa, 2004)

Finally, the question is not only about the development of IT applications, but also about the actual use of already existing opportunities. Studies have shown that there is much to be desired in the adoption of IT especially among small and medium-sized enterprises (e.g., Kohn et al., 2003). It is self-evident that the necessary conditions for the realization of the benefits of IT, which we have discussed in this chapter, are that firms are aware of the existing tools, acquire them and use them efficiently.

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Chapter IX
Information Technology, Social Capital, and the Generation of Intellectual Capital

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ABSTRACT

Networked collaboration, which spans functional, formal and hierarchical boundaries, has become increasingly important for all types of organizations. Communities rather than formal organizations are the social context in which most knowledge sharing, creation and learning take place. With the spread and evolution of information technologies, an increasing amount of interaction and communication is conducted online, in virtual communities. In this chapter we examine how different types of virtual communities function as platforms for the formation of social capital, which in turn enable production of new intellectual capital. We propose information technology-enabled social capital as a framework for understanding how organizations generate intellectual wealth. Specifically, we claim that social capital in physically-based virtual communities improves the incremental continuous development of existing intellectual capital, while in Internet-based communities it facilitates generation of new intellectual capital through radical innovations and paradigmatic change.

INTRODUCTION

As traditional factors of production can no longer guarantee sustained competitive advantage, the interest of researchers and practitioners has turned towards knowledge as a source of wealth creation. Knowledge and competence management have become important issues in organizations, and

intellectual capital is increasingly seen as a deeply strategic factor that should be measured, reported and consciously managed. For organizations, regions and nations alike, the key issue is what is known and what capabilities there are for using knowledge for productive purposes.

The literature on the intellectual wealth of organizations emphasizes three main themes: intangible assets, the capabilities required for creating and modifying these assets, and the social relationships in which the knowledge processes take place. Each of these approaches implies a different conception of knowledge in business contexts, and in order to fully understand value creation in the knowledge economy, it is ultimately necessary to integrate all three aspects. In this chapter we examine the links between social capital, renewal capability and intangible assets. We propose a model that portrays how information technology enables the development of social capital, and how social capital in turn influences organizational renewal and the creation of new intellectual capital.

Knowledge creation and leverage are fundamentally social processes. The concept of social capital (Coleman, 1988; Putnam, 1993; Cohen & Prusak, 2001) is used to capture the relational resources of firms and to unite social interaction, knowledge and value creation. Social capital is thus the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or a social unit (Nahapiet & Ghoshal, 1998). This perspective portrays knowledge as a public good that is owned and maintained by social aggregates. While social capital is an important phenomenon on a multitude of analytical levels ranging from individuals to regions and nations, we focus on the organizational perspective in this chapter.

Networked collaboration, which spans functional, formal and hierarchical boundaries, has become increasingly important, and collaborative improvement and innovation are significant sources of advantage for all types of organizations. Communities rather than formal organizations are the social context in which most knowledge sharing, learning, development and knowledge creation take place (Nonaka & Konno, 1998; Brown & Duguid, 1991; Lave & Wenger, 1991). On the general level, a community is:

A self-organizing group of individuals whose organizing principle is the perceived need for co-operation so as to satisfy a shared interest or set of interests. (Baker & Ward, 2002, p. 211)

With the spread and evolution of information technologies, an increasing amount of interaction and communication is conducted online. Such patterns of social interaction are often referred to as virtual communities, constituting groups of people who share the same interests and communicate regularly within a location or through a mechanism that is at least partially mediated by information technology (Preece, 2000; Ridings et al., 2002; Porter, 2004). We propose that, in order to understand social capital, it is useful to view the organization as a collection of different kinds of communities, formal and informal, face-to-face and Internet-based, which reside within and across its formal borders.

In the fast-paced market environment of today and the future, it is not enough for organizations of any kind merely to leverage their existing intellectual capital through communities. There is increasing pressure to concentrate on the proactive production of continuous change and renewal (Leonard-Barton, 1995; Teece et al., 1997; Eisenhardt & Martin, 2000; Pöyhönen, 2004, 2005b). The creation of new intangible assets takes place in social interaction among the members of different kinds of communities. We propose that information technology-enabled social capital could constitute a framework for understanding how organizations generate intellectual wealth. Specifically, we claim that social capital in physically-based virtual communities

improves the incremental continuous development of existing intellectual capital, while in Internet-based communities it facilitates generation of new intellectual capital through radical innovations and paradigmatic change.

BACKGROUND

Social capital is a concept that deals with how social organization affects economic activity. Essentially, it consists of the features of the social structure that facilitate action (Coleman, 1988; Adler & Kwon, 2000, p. 90). It could be thought of as the wealth or benefit that exists because of an actor's (whether an individual person or an organization) social relationships (Lesser, 2000, p. 4). To put it simply, social capital deals with how the people we know benefit us in terms of what we do.

As the importance of collaboration across functions, competence areas and between organizations has grown (Inkpen, 1996; Powell, 1998; Pöyhönen & Smedlund, 2004; Smedlund & Pöyhönen, 2005; Blomqvist & Levy, 2006), researchers in the business sciences have become increasingly interested in studying issues that have traditionally belonged to the field of the social sciences, such as relationships, social networks and interaction. Another factor influencing current interest is the emerging understanding that knowledge processes are essentially social in nature (e.g., Kogut & Zander, 1992; Amabile, 1988; Nemeth, 1997; Nonaka & Takeuchi, 1995). For example, knowledge is typically created, enriched, shared and leveraged in social interaction among several people. Most discussion and decision-making occurs in groups, and the social context influences the motivation and action of individual organizational members to a significant degree. In fact, social capital is currently widely perceived as a necessary precondition for effective organizational behavior. As Lesser (2000, p. 16) argues, for example:

Much as oil serves as the lubricant to ensure a vibrant and powerful engine, social capital acts as the fluid that enables the knowledge-intensive organization.

The positive consequences of social capital include improved information flow, as well as the opportunity to influence and control other actors within the social structure (e.g., Burt, 1992, 1997; Adler & Kwon, 2002). Furthermore, it promotes mutual support and increases trust, and thereby facilitates cooperation and the coordination of collective action (Putnam, 1993). It is also said to provide the justification and rationale for individual commitment, to enable the flexible organization of work, and to facilitate the development of intellectual capital (Leana & Van Buren, 1999; Nahapiet & Ghoshal, 1998).

Social capital as a resource has both similarities with and differences from other types of capital. First, like all other forms it is productive in that it facilitates the achievement of certain goals (Coleman, 1988). Secondly, it is a resource that can be consciously built up and invested in for the purpose of ensuring future returns (Adler & Kwon, 2000, p. 93). It is also appropriable: in other words, a social organization initiated for one purpose can also be used for other purposes: a network of friends can function as an efficient source of information about career opportunities, for example (Coleman, 1988). It can also function as a substitute for or a complementary asset with other types of resources (Adler & Kwon, 2000, p. 94).

Social capital differs from financial capital in that it requires maintenance: interpersonal connections deteriorate unless they are revitalized once in a while. Furthermore, it does not depreciate with use, but is likely to be strengthened and developed when it is applied (Adler & Kwon, 2000) It exists in relations between people, and is therefore a jointly owned resource rather than being controlled by any one individual or entity (Coleman, 1988). Finally, unlike any other form

of capital, social capital may have negative consequences (Putnam, 2000).

The costs of social capital include the resources needed for maintaining relationships and norms, and diminished creativity and innovation: if it is rooted in highly cohesive relations it can lead to inertia, group think and dysfunctional stable power structures (Uzzi, 1997; Leana & Van Buren, 1999, pp. 547-552). Corruption and in-group favoritism have also been cited as possible negative consequences (Putnam, 2000).

Dimensions of Social Capital

According to Nahapiet and Ghoshal (1998), social capital has structural, relational and cognitive dimensions. Similarly, Lesser (2000, pp. 4-7) differentiates three primary dimensions, namely relationship structure, interpersonal dynamics, and a common context and language. We consider each of these components in more detail in the following section.

The Structural Dimension

Social capital resides in social networks, that is, in clusters of relationships between people. Social networks have been an object of study in the social sciences since Jacob Moreno's and Kurt Lewin's works in the 1930s (Scott, 1991), but it is only recently that they have started to attract attention more widely, helped no doubt by the developments in computerized analysis. The structural dimension encompasses the relational network of the system under investigation; in other words, the actors and the configuration of links among them. Typical research interest within this pattern of linkages includes the density and connectivity of the network and the frequency of interaction.[1]

Ties between actors in the network could be classified as strong, that is, close and frequent, or weak,that is, distant and infrequent. The classic work by Granovetter (1973, 1985) demonstrated that these two types of links produce different kinds of benefits. Strong ties tend to increase trust and diminish opportunism among actors, and serve to satisfy expressed needs. Weak ties, on the other hand, produce information benefits, as most new knowledge is likely to come from actors who represent social groupings that are different from the actor's own immediate community.

Another important aspect of structural social capital in the context of organizations is the ability of the members to locate relevant information sources. This includes finding explicit knowledge in databases, for example, but more crucially, having the ability to find and contact people with task-relevant tacit knowledge (Lesser, 2000). A further essential factor in inter-organizational relationships is the extent to which the relationship with the key partner provides the organization with access to a wider network of business partners or customers (Uzzi, 1997; Yli-Renko et al., 2001).

The Relational Dimension

A thorough understanding of the concept of social capital requires more than the tracing of network patterns among organizational members, or between an organization and its external partners. For example, one could easily imagine a situation in which the members of a small firm are in constant and intense interaction with one another, but the nature of these relationships is hostile, prone to conflict and characterized by a lack of trust. In other words, the relational pattern alone does not paint an adequate picture of social capital: the qualitative characteristics of the interaction within these social structures should also be considered.

First, trust is an essential feature of relationships. It could be defined as the willingness to be vulnerable to another party based on the belief that the other is (a) reliable, that is, that there is consistency between actions and words, (b) open and honest, (c) concerned about the well-being of the trusting subject, and (d) competent (Mishra, 1996). The level of trust in a relationship has

been shown to critically influence the outcomes of interpersonal, intra-organizational and inter-organizational collaboration (e.g., Kramer & Tyler, 1996; Blomqvist, 2002), and it is often considered one of the primary features of social capital (e.g., Nahapiet & Ghoshal, 1998; Cohen & Prusak, 2001; Putnam, 2000).

Secondly, the content of values and norms within the social structure influences the interpersonal dynamics to a significant extent. For example, if there is a norm of amplified reciprocity, the actors are more likely to behave altruistically, as their deed is likely to be reciprocated in the future (Coleman, 1988; Putnam, 2000). Thirdly, the relational dimension also includes the closeness and personal nature of relationships. Relations characterized by intimacy, personal quality, informality and mutual identification are likely to yield extensive support to the actors, and thereby to facilitate action (e.g., Nahapiet & Ghoshal, 1998; Yli-Renko et al., 2001).

The Cognitive Dimension

The third dimension of social capital consists of the shared mental models and narratives that enable effective collaboration (Nahapiet & Ghoshal, 1998; Cohen & Prusak, 2001). Obviously, interaction is easier to the extent that the parties understand each other and share a common context and language. Whereas the content of values and norms belongs to the relational dimension of social capital, the extent to which these are shared across the members of the organization, or the two collaborating organizations, is a feature of the cognitive dimension. The shared representations and interpretations should ideally form a strategic alignment throughout the organization, thereby enabling the members to direct their efforts towards collective goals.

Communities in General and in the Virtual Context

Networked collaboration spanning functional, formal and hierarchical boundaries has become an increasingly common method of organizing work activities. People are less often working in one stable community, relying on permanent connections and exploiting once obtained competencies, but are increasingly involved in rapidly multiplying and fluctuating communities (Hakkarainen et al., 2004, p. 3).

Generally, a community is:

A self-organizing group of individuals whose organizing principle is the perceived need for co-operation so as to satisfy a shared interest or set of interests. (Baker & Ward, 2002, p. 211)

Yet not all groups turn into communities. According to Kling (1996), communities refer to human groups sharing some values with a significant sense of caring or obligation. They also develop some sense of trust, show commitment to the community, and express mutual interest (Jones, 1997). The term "community" remains ambiguous, however, as it refers to different things depending upon who is using it and the context (Nelson et al., 1960; see Jones, 1997). Indeed, Hillery (1955; see Porter, 2004) found 94 definitions of communities. Thus the most fruitful approach may be to accept it as a concept with fuzzy boundaries, and perhaps as more appropriately defined in terms of its membership (Preece & Maloney-Krichmar, 2005).

Communities, rather than formal organizations, are the social context in which most knowledge sharing, learning, development and knowledge creation take place (Nonaka & Konno, 1998; Brown & Duguid, 1991; Lave & Wenger, 1991). We therefore propose that, in order to understand the creation of social and intellectual capital, it would be useful to view the organization

as a collection of different kinds of communities, formal and informal, which reside within and across its formal borders.

As information technologies and the emerging information-intensive environment enable virtual social interaction, our personal or professional community is no longer limited to a physical location (Balasubramanian & Mahajan, 2001). Nowadays, an increasing amount of work-related interaction and communication is conducted online. What kind of opportunities and challenges does this pose from the perspective of social capital?

"Community" is the dominant metaphor for the social groupings evolving on the Internet (Daniel et al., 2003). Ridings et al. (2002, p. 273) define virtual communities as:

Groups of people with common interests and practices that communicate regularly and for some duration in an organized way over the Internet through a common location or mechanism.

While Porter (2004, p. 4) considers a virtual community:

An aggregation of individuals or business partners who interact around a shared interest, where the interaction is at least partially supported and/or mediated by technology and guided by some protocols or norms.

Virtual communities are formed around some kind of human need: they are interest-driven, whether it be a professional interest, a need for emotional support, or access to valuable knowledge. They are also member-driven, at least to a certain degree (Baker & Ward, 2002; Lechner & Hummel, 2002). In sum, the key elements of virtual communities are *people* who *interact* to meet common *interests,* and their interactions are partially or totally mediated by information *technology.*

ISSUES, CONTROVERSIES AND PROBLEMS

Issue 1. How Does the Virtual Context Influence Social Capital?

Virtuality is such a pervasive form of communication and interaction nowadays that it must be granted focused research attention. While the theory of social capital was originally crafted for "natural" face-to-face communities, we suggest that it is both viable and useful to apply it in the context of virtual communities. However, the existing research literature offers relatively little information on its nature and development.

Thus the application of the social capital framework to the analysis of virtual communities is quite a new and under-explored area of research. According to Wellman and Gulia (1999, p. 170), existing analysis of virtual communities almost always:

treats the Internet as an isolated social phenomenon without taking into account how interactions on the Net fit together with other aspects of people's lives.

Such a conception is flawed, however, because when people get involved in online interactions they still remain carriers of their cultural milieu, socioeconomic status and offline connections (Wellman & Gulia, 1999, p. 170). The Internet is not a separate social reality—all the human and social issues continue to exist—it is just that in the virtual environment they are adapted to the modes and norms of computer-mediated communication.

Resnick (2002, 2004) introduced the term "sociotechnical capital" referring to the productive resources inherent in social relations that are maintained with the support of information and communication technology. He further argues that such technologies are more useful in sup-

porting impersonal forms of social capital, thus involving interactions in which affective ties are not present. This is coherent with other authors' findings, according to which strong affective ties are related to offline interactions, evolving from membership in an Internet-based community (Blanchard & Markus, 2004; Koh & Kim, 2003). Yet, prior research has typically focused only on one aspect of social capital, such as the substitution of personal trust by impersonal systems, identification with a particular virtual community, or the simple recapitulation of traditional social capital theory (Daniel et al., 2003; Resnick, 2004). The pioneering and systematic work carried out by Blanchard & Horan (1998) on applying the findings of computer-mediated communication and virtual communities to the elements of social capital (networks, norms and trust) stands somewhat alone.

In sum, there are two important issues concerning social capital and IT that have not been explicitly addressed. First, research on social capital in virtual community environments is scarce and lacks understanding of its complementary dimensions. Thus far, researchers have focused on the three aspects of networks, norms and trust (Blanchard & Horan, 1998), and have discussed impersonal systems as a facet of social capital creation within online networks (Resnick, 2004). In the following section we offer a contribution to the theoretical discussion on the relationship between social capital and information technology by evaluating the structural, relational and cognitive dimensions of social capital in virtual communities, thereby building on the ideas put forward by Blanchard and Horan (1998), and including additional elements such as identification, a common language/code and shared narratives. The second issue concerns the nature of social capital produced in virtual communities in terms of the community origin. In addressing this we distinguish between two types of virtual community, namely the physically-based and the Internet-based.

Issue 2. How Does IT-Enabled Social Capital Influence the Creation of New Intellectual Capital?

During the last decade, intellectual capital has become a well-established framework for examining the crucial drivers of competitiveness in the knowledge era. It is often divided into three aspects: human capital, structural capital and relational capital (e.g., Bontis, 1999). However, this taxonomy has been criticized for over-emphasizing the static and individualistic aspects of knowledge-based value creation and neglecting the dynamic social processes by which knowledge is created, leveraged and maintained (see Nahapiet & Ghoshal, 1998; McElroy, 2002; Pöyhönen, 2004, 2005b; Pöyhönen & Smedlund, 2004). This problem could be alleviated if the intellectual capital paradigm were to include two additional factors, social capital and renewal capability.

In more general terms, one could extract three main themes in the current discussion on the intellectual resources of organizations: intangible assets, competencies and the capabilities required to create and modify these assets, and the social relationships in which the knowledge processes take place. Each of the approaches implies a different conception of knowledge in organizational contexts. When knowledge is framed as an intangible asset, it is understood as a static asset or as a possession or property of the organization (e.g., Stewart, 1997; Brooking, 1996; Lev, 2004). The capability approach, in contrast, views knowledge as an ongoing, emergent process, and focuses not on the intangible assets per se, but on the capability to leverage, develop, and change them (Leonard-Barton, 1995; Teece et al., 1997; Eisenhardt & Martin, 2000; Pöyhönen, 2004). Finally, according to the relational approach, knowledge is a socially constructed and shared resource, and the focus is on the social relationships connecting the various actors and the social capital embedded in them (Brown & Duguid, 1991; Lave & Wenger, 1991;

Table 1. Three approaches to knowledge in organizations

	Asset approach	**Capability approach**	**Relational approach**
Knowledge understood as	Valuable possession	Enacted process	Socially constructed resource
Main interest	Identification and valuation of existing intangibles	Abilities to create, develop and modify intangibles	Social relationships and interaction
Key concepts	Intangible assets, intellectual property rights, investments in intangibles	Dynamic capabilities, organizational renewal capability	Social capital, social networks, communities of practice
Background science(s)	Economics and accounting	Strategic management	Organization and social science
Representative authors	Stewart, 1997; Brooking, 1996; Lev, 2004.	Leonard-Barton, 1995; Teece et al., 1997; Eisenhardt & Martin, 2000; Pöyhönen, 2004	Brown & Duguid, 1991; Lave & Wenger, 1991; Nahapiet & Ghoshal, 1998; Cohen & Prusak, 2001

Nahapiet & Ghoshal, 1998; Cohen & Prusak, 2001) (see Table 1).

While most of the existing literature on intellectual capital is grounded on the first approach, we claim that the dynamic and social facets of knowledge are particularly important in understanding and developing the future potential of an organization (see also Nahapiet & Ghoshal, 1998; Pöyhönen, 2004, 2005a, 2005b). The asset approach is adequate for examining the amount and value of existing intangibles, but as intellectual capital is leveraged and developed by human agents acting in collaboration with one another, in order to understand it we have to take into account the quality of the social interaction and its effects on the shared capabilities of renewing the asset base. It is not systems or databases that acquire and create new intangibles; it is rather the collaborative formations of intentional human agents acting in particular social contexts. Therefore, if we wish to understand how new intellectual capital is created we have to examine the characteristics of social interaction rather than the amount or value of intangible assets. This type of outlook could be called the dynamic approach to intellectual capital (see also Ståhle et al., 2003; Pöyhönen, 2004, 2005a, 2005b).

In the second part of this sub-section we combine the asset, capability and relational approaches in a model that represents how social capital influences renewal capability and thereby leads to the creation of new intangible assets. While Nahapiet & Ghoshal (1998), in their classic article, address the question of how social capital facilitates the creation of intellectual capital through its effect on the four necessary conditions of knowledge creation, they do not distinguish between different types of communities, social capital, or processes of intellectual capital generation. Our model thus offers an alternative viewpoint.

SOLUTIONS AND RECOMMENDATIONS

Issue 1. How Does the Virtual Context Influence Social Capital?

Blanchard and Horan (1998) differentiate between two main types of virtual community according to their origin, namely communities based on a physical location and those based on an interest. The former have their roots in geographical communities and the latter are geographically dispersed. Physically-based communities are typically stable, while interest-based communities may eventually become characterized by stronger commitment and relationships than face-to-face communities, but at the same time they remain fragile (Blanchard & Horan, 1998; Walther, 1996; Wellman & Gulia, 1999; Feng et al., 2002).

Virtual communities also differ in technical and communicative terms, although text-based environments such as discussion forums have long dominated. A community may use one or several communication channels depending on the communication needs of its members (Preece, 2000). These include Web-based solutions, such as discussion forums, chat lines and blogs, e-mail and mailing lists, Usenet newsgroups, instant messaging services, and immersive virtual environments (Preece, 2000). Communication may be asynchronous or synchronous, the former meaning that each member can participate whenever he/she is willing to do so, and the latter meaning that interactions take place in real time (Preece, 2000; Riva & Galimberti, 1997). IT tools offer a "location" or space for social interaction, but they do not constitute a community (Preece, 2000; Jones, 1997).

Given the dominant role of Internet communication technologies, we refer to geographically dispersed virtual communities as Internet-based, and other types as physically-based. We now examine the dimensions of social capital in the two community types in more detail.

Structural Social Capital and Virtual Communities

The origin of the community affects the development of social capital (Blanchard & Horan, 1998). Internet-based communities are able to provide members with a number of weak ties, thus offering access to new knowledge and insight, while the physically-based may increase network density as online and face-to-face networks overlap.

Online and off-line, weak ties link people with different backgrounds (Wellman & Gulia, 1999). The importance of such ties lies in their ability to provide people with specific knowledge: for example, Constant et al. (1996) found that online contacts with a wide range of social characteristics helped members of a large organization to solve problems more efficiently than when they received help from socially similar people. Social similarity usually indicates that people carry the same information, while weak ties provide new information by enabling connections to more diverse social circles (Granovetter, 1973; Wellman & Gulia, 1999). A virtual community structure provides easy access and the dissemination of information from one-to-many within a short time and at low cost, which in turn may increase frequency of interaction (Granovetter, 1973; Wellman & Gulia, 1999; Preece, 2000).

As far as strong ties are concerned, supportive and companionate relationships seem to evolve over time (Wellman & Gulia, 1999; Walther, 1996). On the other hand, some authors argue that computer-based communication cannot support strong, intimate ties due to a lack of social and physical cues (Stoll, 1995; see Wellman & Gulia, 1999, p. 179). However, the strong dichotomy between online and off-line may not prove reasonable at this point, as they are complementary rather than separate realities. As Wellman and Gulia (1999) point out, critics and enthusiasts of communities have thought of computer-mediated relationships as solely virtual. Similarly, later empirical research (Blanchard & Markus, 2004; Koh & Kim, 2003) indicates that some online relationships tend to strengthen and later become characterized by offline interaction, which in turn affects the experienced sense of community and social capital. As Kling (1996, p. 52) suggests, online networks "might help build social capital by bridging together people who also develop off-line social relationships." The next logical step is thus to describe the elements of relational social capital in virtual community contexts.

Relational Social Capital and Virtual Communities

In the context of social capital, *trust* is in the form of relational trust that develops over time (Rousseau et al., 1998). Resnick (2004) broadens the traditional view by adding the impersonal elements of IT, trust and reputation, resulting in impersonal sociotechnical capital.

Community relationships differ significantly in terms of trust: on the one hand, its development may be delayed in virtual interactions due to the lack of physical cues (Bos et al., 2002), but on the other hand, it may sometimes develop too easily and result in hyper-personalized relationships (Walther, 1996). Physically-based communities face fewer challenges related to anonymity and deception than purely virtual communities (Blanchard & Horan, 1998). The paradox of trust in Internet-based communities arises from the need to display initial trust in order to become involved in the often-anonymous interactions, but this may hinder the development of trust for the same reason (Blanchard & Horan, 1998).

Two forms of trust are apparent in virtual communities: interpersonal trust in other members, and impersonal trust. Impersonal trust is founded upon the systems and reputations that indicate the trustworthiness of another party (Atkinson & Butcher, 2003, p. 290). It is based not on any property or state of the trustee, but on perceived properties or reliance on the system within which trust exists (Abdul-Rahman & Hailes, 2000). Most research on trust has been on the interpersonal level, but in terms of online interactions, the role of impersonal trust should not be understated. The notion that trust emerges (or does not emerge) on the Internet solely in interpersonal relations might not only be unrealistic, but also restrictive (Ba, 2001). According to Kollock (1999a), an individual may have a limited number of exchange partners in online transactions, and would discover their untrustworthiness only through hard experience. This evidence would suggest that both trust cultures, impersonal and interpersonal, live in parallel in virtual communities.

It is not only trust in IT networks, infrastructures and general mechanisms that provides members with information on the trustworthiness of the other party in terms of building up initial trust, but also collective trust in the entity of the specific community (Ridings et al., 2002; Daniel et al., 2003). A general willingness to trust also seems to affect community involvement and participation, especially at the initial stage (Ridings et al., 2002). Forms of trust may influence social capital differently. For instance, individuals may trust a particular community but not its individual members, or they may express strong in-group trust with no generalized trust, resulting in isolation and resistance to outsiders (Daniel et al., 2003).

Values and *norms* also affect the development of relational social capital. A strong norm of reciprocity can be identified in communities, and there seem to be no major differences between community types (Blanchard & Horan, 1998; Hall & Graham, 2004). Both information and support are exchanged. It is in the nature of virtual communities that an act of helping is relatively easy to produce, and a single act can be viewed by a large community (Blanchard & Horan, 1998; Hall & Graham, 2004). Many virtual communities are loosely coupled groupings kept together by common values (Ljungberg, 2000).

Thus community members may not wish to develop strong relationships with others, and rather express commitment to the community "as such." A study based on technical communities in Usenet newsgroups indicated that people participated due to moral obligation, which in turn resulted in pro-social and altruistic behavior (Wasko & Faraj, 2000). Over time, people become attached to the community and develop a strong sense of belonging (Blanchard & Markus, 2004). Repayment of a helping act is the general norm, and there is substantial evidence of such reciprocity in online interactions, even involving weak ties (Wasko & Faraj, 2000; Järvenpää & Staples, 2000; Wellman & Gulia, 1999; Kollock & Smith, 1996; Constant et al., 1996; Hiltz et al., 1986). Helping others can be a means of expressing one's identity, increasing self-esteem, and gaining status in the community (Wellman & Gulia, 1999).

Finally, identity and identification are key facets of relational social capital. The theory of

social identity (Tajfel & Turner, 1979; Turner, 1982) has been adopted in the virtual environment to describe an individual's identification and commitment within the group (Bagozzi & Dholakia, 2002; McKenna & Green, 2002). Social identity is a cognitive state, an individual's self-concept derived from perceived membership of social groups (Hogg & Vaughan, 2002). This view also lies at the heart of the SIDE theory (Social Identity and De-individuation Effect) (Spears & Lea, 1992). According to SIDE, "visual anonymity" does not necessarily lead to the loss of identity and asocial behavior. As the online group becomes salient, the de-individuation process shifts individual identities onto the social (i.e., group) level. Given the absence of physical cues and norms, the norms of the group may become even more important than in physically-based groups. Thus according to the SIDE theory, computer-mediated interactions may be more social than conventional face-to-face communication (Spears et al., 2001)

Yet, strong identification may not become the reality in every type of virtual community. According to Blanchard and Markus (2004), creating and making identifications was an important part of the process of developing a sense of belonging in an interest community. More interestingly, they also noted that members emphasized their own identity instead of the collective one. It seems from the literature that, while some communities rely on a strong group identity and tend to blot out members' personal identities, others do exactly the opposite. Further research needs to be conducted before conclusions can be drawn on issues related to identification in virtual community environments.

Cognitive Social Capital and Virtual Communities

The cognitive dimension refers to shared representations, interpretations, and systems of meaning (Cicourel, 1973; see Nahapiet & Ghoshal, 1998). A common language is a means of exchange and discussion; it influences our perceptions, and enhances our capability to advance knowledge by combining information. A shared narrative, on the other hand, is embedded in communities in the form of myths, stories and metaphors that enable the creation and exchange of rich sets of meanings. The emergence of narratives allows the community to make new interpretations and thus facilitates the combination of knowledge (Lave & Wenger, 1991; Brown & Duguid, 1991, 2000; Nahapiet & Ghoshal, 1998)

Prior research has not explicitly identified the cognitive dimension of social capital from communities mediated by ITs, although the cultural aspects, including a shared linguistic code and the role of "virtual storytelling," have long been under discussion (Rheingold, 1993; Kollock, 1999b; Hine, 2000). So far, empirical findings indicate that Internet-based communities can develop a common culture and implement textual means that allow participants to meaningfully

Table 2. Aspects of social capital in physically-based and Internet-based virtual communities

	Structural	**Relational**	**Cognitive**
Physically-based virtual communities	Networks of both strong and weak ties, providing more dense knowledge networks as f2f networks combined with cmc	Norms of reciprocity Interpersonal trust Identification	Common language Shared narratives
Internet-based virtual communities	Networks of weak ties, providing access to knowledge that could not be accessed in f2f networks	Norms of reciprocity Impersonal trust (in some instances also interpersonal trust) Identification	Common language Shared narratives

present themselves to one another, resulting in a shared language and code. The common thread in all these findings is that, despite the reduced social cues and sometimes problematic nature of anonymity, computer-mediated interactions are functional in a social sense, and lead to the development of distinct cultures (Hine, 2000), just as in traditional communities. A key component of sustainability in virtual communities is the development of common sets of practice and beliefs (Baker & Ward, 2002).

In sum, shared language, codes and narratives are important stepping-stones for constructing communities and developing social capital. Nevertheless, having a clear and coherent image of the community (Slevin, 2000) and well-defined boundaries may also have negative effects, as this could make it difficult for a community to integrate new members and assimilate new knowledge from external sources and other communities (Wenger, 1998). Table 2 summarizes the aspects of social capital in the two community types.

Issue 2. How does IT-Enabled Social Capital Influence the Creation of New Intellectual Capital?

Social capital and renewal capability are the generative forces of intellectual capital that determine what the firm can do with the intangible assets within its reach. As noted above, social capital concerns social relationships and their qualities (e.g., Coleman, 1988; Putnam, 1993), while renewal capability focuses on capacity within the system to effect coherent and purposeful changes and modifications in what it knows and can do (Ståhle et al., 2003; Pöyhönen, 2004). The inclusion of these two facets in the discussion makes it possible to address issues concerning how new IC is generated within the intellectual capital paradigm. In order to determine how social capital influences the creation of new intellectual capital, we distinguished between two forms of the former, bonding and bridging, and two forms of organizational renewal—incremental development and radical innovation.

A major dividing factor in studies on social capital is the perspective from which its benefits are viewed (Table 3). It can be considered from the viewpoint of an individual actor (be it an individual person, a community or an organization), that is, the so-called egocentric approach (Leana & Van Buren, 1999; Adler & Kwon, 2002). In this case, the focus is on the benefits that an individual actor's relationships bring to this particular actor, and how these benefits influence the actor's relative position compared with other actors within the same social structure. The basic function of social capital is to connect the focal actor to relatively dissimilar and distant others.

This perspective is customarily traced back to the French sociologist Pierre Bourdieu's (e.g., 1989) work on cultural capital, in which he analyzed how individuals construct cultural capital or a certain "taste," and how this taste functions as a tool for social differentiation and inclusion. Another influential proponent of the egocentric school is the social-network theorist Burt (1992, 1997), who has examined the information and power benefits that individuals gain because they control structural holes within their relational networks. The structural-hole theory focuses on network structures in which the actor's contacts have no direct links with one another, and consequently the actor can function as a bridge between social groupings that would otherwise be unconnected, thereby exerting control over these parties.

Secondly, social capital could be approached from a socio-centric viewpoint, as a public good of a collective. In this case it is understood as a shared resource of a given social aggregate, which facilitates the attainment of the mutual goals of all the participants (Leana & Van Buren, 1999; Adler & Kwon, 2002). Then the basic function is to bond a group of actors in a close and cohesive collective. The classic works in this line of social capital research include Coleman's (1988) studies

Table 3. Bonding and bridging types of social capital (partly based on Adler & Kwon, 2000, 2002; Leana & Van Buren, 1999)

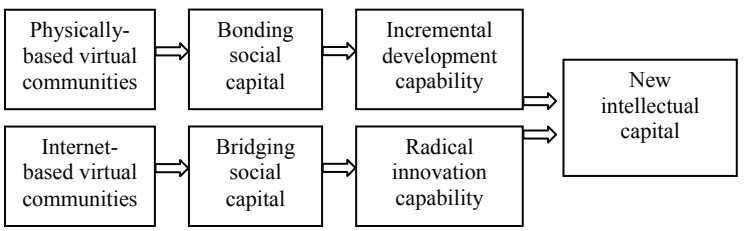
	Bonding social capital	**Bridging social capital**
Type of IT community	Physically-based	Internet-based
Approach	Socio-centric	Egocentric
Necessary ties	Resilient	Fragile
Ideal network form	Plenty of strong internal connections	Plenty of external weak connections
Main initiators	Coleman, Putnam	Bourdieu, Burt
Meta-theoretical background	Integration theory	Conflict theory

on the creation of integration in local communities. In his view, tightly knit networks in which every actor knows all the others constitute an ideal basis for social capital—a view that is in direct opposition with that of Burt. According to Coleman, network closure, that is, a social structure in which all actors are directly linked with one another, creates trustworthiness and effective norms. Another influential source is Putnam (1993, 1995, 2000), who emphasizes the role of networks, norms and trust in facilitating coordination and cooperation for mutual benefit.

We claim that the two types of virtual community are related to different kinds of social capital: Internet-based with bridging social capital, and physically-based with bonding social capital. The bonding type arises from the similarity, safety and predictability provided by a closely-knit community whose members engage in frequent face-to-face interaction in addition to the virtual communication, and tends to be produced by physically-based IT communities: the virtual interaction functions as an enhancing factor that strengthens the existing "natural" community. Internet-based communities, on the other hand, tend to produce the bridging type of social capital, which arises from weak ties connecting multiple different and distant physical communities: it develops between dissimilar actors such as people from diverse cultures or communities (Woolcock, 1998), and creates links across physical divides.

Furthermore, the two types of social capital enabled by different kinds of IT communities are related to distinct IC generation mechanisms. There are two main ways in which organizations learn and create new knowledge: incremental development and radical innovation (Tushman et al., 1986; March, 1991; Eisenhardt & Tabrizi, 1995; Pöyhönen, 2004). Incremental development refers to activities that exploit the existing knowledge base and competencies, and facilitate cross learning among the actors, while radical innovation refers to processes that produce radically new knowledge and competencies. Figure 1 illustrates

Figure 1. The associations between IT communities, social capital, renewal capability and the creation of new intellectual capital



the connections between IT communities, types of social capital, renewal processes and intellectual capital generation.

Ideally, physically-based virtual communities provide bonding social capital, which is characterized by internal cohesion and strong interlinking ties within the community, but relatively few external connections. These characteristics enable easy and fluid knowledge sharing between similar others (Woolcock, 1998; Putnam, 2000; Daniel et al., 2003). This type of social capital is related to social support, trust and mutual commitment, and increases consensus-oriented knowledge sharing, stability, standardization and routines within a community. It creates a strong basis for the cross learning of tacit knowledge from similar others through socialization mechanisms (Nonaka & Takeuchi, 1995). It therefore influences intellectual capital generation through the effective maintenance and incremental development of existing knowledge and competencies.

Incremental development is characterized by subtle changes in the intangible assets. It can be achieved by building on existing resources and capabilities, and extending them by cross-learning and by assimilating new information from external sources to reinforce the current intellectual capital (Grant, 1996). It is analogous to exploitation (March, 1991), single-loop learning (Argyris & Schön, 1978), incremental innovation (e.g., Tushman & Anderson, 1986), modular innovation (Henderson & Clark, 1990), competence-enhancing change (Abernathy & Clark, 1985), adaptive maneuvering capacity (Volberda, 1996), and continuous improvement (Bessant & Caffyn, 1997). Value is created through the exploitation and continuous development of the existing intellectual capital of the organization. However, the sense of harmony and internal cohesion it fosters may also have negative consequences, such as groupthink tendencies (Janis, 1982), cognitive inertia (Uzzi, 1997) and risk avoidance, which can lead to core rigidities (Leonard-Barton, 1995) and the inability to change even when the situation would require it.

Internet-based virtual communities tend to produce the bridging type of social capital, which is characterized by boundary-spanning networks of weak ties and structural holes. These provide flows of divergent information and possibilities for communication with dissimilar others, and thereby grant the actors flexibility (Gargiulo & Benassi, 2000) and control, and information advantages (Burt, 1992; Hansen, 1999). Exposure to diverse viewpoints increases divergent and complex thinking processes, and enhances creativity and the quality of problem solving (Nemeth, 1997). The creation of radically new knowledge is associated with minority dissent, task-related conflicts and the perpetual challenging of existing views and ways of conduct, which are all likely to exist in boundary-spanning networks. Communication with dissimilar others and knowledge flows from various distant sources facilitate the acquisition and creation of completely new intangible assets, competencies and strategies. Thus the bridging type of social capital enables intellectual capital generation through radical change and innovation.

Radical renewal is characterized by major changes in the intangibles of the organization. This type of renewal alters the underlying paradigms or operating principles of the firm. The changes may come about through the re-interpretation of existing resources in a new constellation, as with architectural innovation (Henderson & Clarke, 1990), or through a dramatic change in both content and the combination of intangible resources and capabilities, such as through a merger. It derives from the literature on radical innovation (e.g., Tushman & Anderson, 1986), and is also related to the notions of competence-destroying change (Abernathy & Clark, 1985), double-loop learning (Argyris & Schön, 1978), strategic flexibility (Volberda, 1996), and strategic innovation (Hamel, 1998). Value is created through radical

Table 4. Bonding and bridging social capital and the renewal of organizational knowledge

	Physically-based virtual communities	Internet-based virtual communities
Social capital	Bonding	Bridging
Renewal capability	Incremental development: maintenance, dissemination and slight modification of existing intangible assets	Radical change: acquiring, developing and creating significantly new intangible assets
Knowledge strategy	Value creation by exploiting existing intellectual capital	Value creation by exploring and building new intellectual capital
Learning	Adaptive and single-loop learning	Creative and double-loop learning
Member characteristics	Homogenous	Divergent
Essential form of knowledge	Embedded tacit knowledge	Self-transcendent and emergent knowledge
Goal of communication	Integration and harmony	Multi-voicedness
Knowledge-integration mechanism	Consensus-oriented group decision making and cross-learning	Self-organizing innovation
Perception of risk and uncertainty	Uncertainty avoided and risks minimized	Uncertainty tolerated and risks sought
Disadvantages	Closure, groupthink, inertia	Chaos, information overload, misunderstanding

renewal and change in the intellectual capital of the organization. Table 4 presents the ideal typical qualities of intellectual capital generation in physically-based and Internet-based virtual communities.

Several researchers have examined the double-edged nature of social capital (e.g., Uzzi, 1997; Hansen, 1999; Gargiulo & Benassi, 2000; Johansson, 2001; Reagans & Zuckerman, 2001). They have reached the conclusion that there is an inherent trade-off in the dynamics of relationships: it is impossible to maximize bonding and bridging types of social capital simultaneously, and the optimal advantage lies in creating a balance between the two. However, there is little knowledge, if any, of what the optimal ratio might be. According to our model, the bonding type should be emphasized to the extent that the goal of the activity is to create cross-learning and incremental development. However, if the goal is to produce radically new ideas and to acquire competence-destroying knowledge and capabilities, then the bridging type is to be preferred. IT is an important enabler of both types of community, and from the organizational perspective it is advisable to use it for maintaining and enabling both types of social capital.

FUTURE TRENDS

Finally, we propose some potential future research directions on the conjunction of social capital, information technology and intellectual capital. The differences and similarities between physically-based and Internet-based virtual communities should be empirically analyzed, which would require further theoretical and methodological development.

One fundamental but controversial issue in the boundary of social capital and information technology is trust. In other words, trust in the virtual social context is a relatively new and multidisciplinary research phenomenon, which lacks conceptual cohesion and understanding. The question of how to build a model of virtual trust prevails, and community studies should be able to identify the impersonal and interpersonal characteristics of trust. Furthermore, the relationship between trust and the willingness to share

information and knowledge is open for further research (Ridings et al., 2002). These questions should also be evaluated from a broader socio-technical perspective: trust and trustworthiness should not only be seen as technical measures.

Cognitive social capital, exemplified by shared narratives and common language, should also be explicitly studied in communities, as this dimension has attracted the least research interest (e.g., Nahapiet & Ghoshal, 1998, p. 244). Future research in virtual community environments in particular should focus more on cognitive social capital as common language and shared narrative that lie at the core of a community, and that are the key to new knowledge creation. In other words, the existence of networks, trust and common norms is only the starting point for community interaction: the real value comes from collective knowledge (see Spender, 1996), exemplified by storytelling and shared narratives.

A significant gap in the current literature on intellectual capital is that, on the whole, it does not adequately explain the generation, development and change of intellectual capital. The existing frameworks and tools address the identification, assessment and valuation of existing intangibles, but how new intellectual capital is created has so far remained a relatively neglected topic. In order to promote understanding of this aspect of intellectual capital, the view should be widened from an accounting-based logic to a relational and capability logic (see Pöyhönen, 2004, 2005a, 2005b; Pöyhönen & Smedlund, 2004). Our model showed how the three facets of knowledge in organizations—context, activity and value—come together. It is the first step in developing a comprehensive theory of intellectual capital, and it should be further refined and empirically applied in future research.

We also argued that the bonding and bridging types of social capital enable value creation through different knowledge processes: the former increases intellectual capital through incremental development, while the latter generates intellectual capital through radical renewal and innovation. However, these two types of social capital are mutually contradictory and cannot be maximized simultaneously: bonding requires tight internal networks in an operationally closed structure, while bridging requires plenty of weak ties with external communities. Indeed, some recent theoretical discussions posit that combining these two dimensions is the key ingredient in enabling sustainable competitive advantage in the face of turbulent environments (Teece et al., 1997; Benner & Tushman, 2003; Pöyhönen, 2004; Ståhle et al., 2004). Providing new knowledge on how to achieve this fragile balance is a promising future research direction in its own right.

CONCLUSION

This chapter examined the role of information technology and social capital in intellectual capital. We began by considering the nature of social capital in virtual communities, and then we focused on how intellectual capital is generated in information technology-enabled communication. We presented a model that illustrates how the social capital produced in virtual communities influences the generation of intellectual capital through renewal processes. We also argued that the role of information technology in this process depends on the type of virtual community concerned.

On a more general level, we claimed that the intellectual capital paradigm should be amplified by a conscious focus on how new intellectual capital is created, and on the social contexts in which this takes place. While examining intellectual capital as a static asset enables the identification and valuation of the existing intangible wealth of an organization, it neglects the important issue of how these intangible assets are accumulated in the first place. In order to promote effective intellectual capital management, it is crucial to provide knowledge on how intangibles are created

and further developed, and on the characteristics of the social interaction in which this happens.

Information technology can be used to enhance existing face-to-face communities, or to create opportunities for geographically dispersed communities. Both types have their benefits and disadvantages in terms of the creation of intellectual capital. The bonding type of social capital should be emphasized to the extent that the goal of the activity is to create cross-learning and incremental development. However, if the goal is to produce radically new ideas and to acquire competence-destroying knowledge and capabilities, then the bridging type should be prioritized. The challenging task for managers is thus to find the optimal balance by combining both types of community in the overall relationship networks of an organization.

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ENDNOTE

[1] Network analysis proper is a rigorous method of examining structural configurations, which involves mapping the actors and their interrelationships, and calculating various quantitative indices such as the density of the whole network or the centrality of an individual actor (see, e.g., Scott, 1991; Wasserman & Faust, 1994).

Chapter X
Method for Aligning Information Technology Resources to the Knowledge Management of an Organization

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ABSTRACT

This chapter discusses and introduces a quantitative method for aligning information technology resources to the knowledge management of an organization whose purpose is to quantify the intensity of the available software functionalities, so as to maximize the benefits and minimize costs of the knowledge management process. Two important topics had to be developed for devising this method, whose results also are presented: the cycle of activities for an effective knowledge management and the description of functionalities, which may be implemented by means of software algorithms, with a potential to contribute to one or more process activities of knowledge management. The most important thing to emphasize about the method proposed herein is its capacity of aligning investments in information technology resources to the organization's knowledge management process and the capacity of defining priorities for investments in software functionalities and proper algorithms for knowledge management.

INTRODUCTION

Challenges for Implementing an Organizational Knowledge Management

A significant part of the knowledge management projects that take place in organizations is not successful according to the research results by Storey and Barnett (2000). This scenario is not surprising, seeing that the diffusion the concepts and principles of knowledge management in organizations began a little more than a decade ago. Knowledge management, as an applied practice to organizations with clearly defined rules, roles, tools, and operational and managing activities, is not yet a reality. Knowledge management lacks an effective framework to help its implementation in organizations.

Making knowledge management a very successful organizational practice is somewhat difficult due to its complexity. The development of an organizational environment that is favorable to effective knowledge management involves: (1) managing employees' motivation with the goal of increasing the size of the knowledge basis, as well as its utilization; (2) possessing a favorable organizational structure that, for example, helps information sharing; (3) creating an organizational culture that favors experimentation and learning with proper risk control; (4) possessing clarity of activities, rules, events, actors and roles, which characterize the process of the organizational knowledge management; (5) possessing technological capabilities that contribute to every activity required in the process of knowledge management. Among several others, those are a few important topics for providing knowledge management to organizations.

This chapter will deal with the fifth topic mentioned above: investments in information technology (IT) resources aiming at an effective knowledge management. The multitude of software choices, which offer different functionalities and contribute in various different ways in the process of knowledge management, plus the high cost of this technology, make this investment a great challenge.

Much has been published concerning IT applied to knowledge management, but these are mainly research studies with an operational focus. As an example, Zhang and Zhao (2006) have researched about publications made in major international academic journals, which correlate IT with the practice of knowledge management. Of the total number of articles found, 64% were found to discuss IT as a tool for knowledge management.

For this reason, the method presented here, to promote alignment of IT resources to knowledge management of the organization, is an important step for seeking better results with the practice of knowledge management.

Goals and Phases for the Method for Aligning Information Technology Resources to the Knowledge Management of an Organization

The considerations made in the previous subsection provided the main reason for developing the method proposed herein and they made possible to set its goal: quantify the intensity of the available software functionalities so as to maximize the benefits and minimize costs of the knowledge management process (KM process), or, in other words, to provide effectiveness, efficacy and efficiency to an organization's KM process.

The objective of quantifying obviously involves a quantitative method, which is the characteristic of the method presented herein.

This method has four phases:

Phase 1: Identify major, medium and minor priorities among the activities that compose the organization's KM process.

Phase 2: Identify available software functionalities that contribute to the success of the organization's KM process.

Phase 3: For each activity of the management process of organization knowledge, classify software functionalities into three categories: relevant functionalities (Class A), which are those that add more value to activities of KM process of an organization, medium functionalities (Class B), and irrelevant functionalities (Class C).

Phase 4: Make a decision about the intensity of each software functionality for each activity of the organization's KM process.

The two first phases will be discussed in the subsections of the next chapter: (1) the KM process in organizations and (2) the software functionalities that contribute to the KM process. The importance of clearly analyzing and defining these two topics is justified by the following problems, respectively:

a. Making a KM process operational, and particularly the activities involved therein, is still a not too-well-known process academically, and practically unknown to organizations;
b. The discussion about IT applied to knowledge management is limited to software titles and categories, which present a great deal of overlapping of functionalities. The proper procedure would be firstly to specify the functionalities that contribute to the knowledge management, and only afterwards to define which tools (software) would be capable of implementing the required functionalities.

The goal of this chapter is to present a method for aligning IT resources to the knowledge management of an organization, but it also brings up two other important issues: the discussion and definition of one cycle of activities for an effective knowledge management and the description of functionalities, which may be implemented by means of software algorithms, with a potential to contribute to one or more process activities of knowledge management.

BACKGROUND

The Organizations' KM process

The analysis of management by processes exhibited major breakthroughs in the 1990s, especially because of the heated discussions about practicing reengineering and restructuring organizational business processes. Initially, the proposed method for implementation of management by processes—reengineering, also called *business process reengineering* (BPR), whose concepts were spread with the efforts of Hammer (1993) and Davenport (1993)—have not been significantly adopted by organizations due to the high risks involved. At a later date, the principles of the management by processes were resumed and implemented successfully in organizations by means of another not-so-radical method regarding innovation, speed and scope: process redesign or *business process redesign*.

Management by business processes caused organizations to possess a smaller number of hierarchical levels, higher employee autonomy for decision-making ("*empowerment*"), reduction of interference and friction among functional areas by promoting organized jobs managed by multifunctional teams among other characteristics. Those organizations that are structured and managed by business processes are called horizontal organizations or "*flat organizations*" (Ostroff, 1999).

Management by process has given organizations an understanding of business processes, which until then was something intuitive and perceived only by high rank administration pro-

fessionals who had been with the organization long, and who had a wide and systemic vision of the activities developed by the organization. From the moment that the practices of management by processes became explicit and the limits, activities, resources involved, products and customers for each business process were discussed widely, a higher visibility and understanding of these processes began to take place in the community of persons directly involved with the organization. Some examples of business processes that have been defined and announced at the onset of the practice of management by processes are: customer relationship management (CRM), supply chain management (SCM), product lifecycle management (PLM) employee relationship management (ERM) and supplier relationship management (SRM).

The very informational process of the organizations was also reconsidered in the 1990s with the evolution of reengineering and process redesigning. Such process began to be comprehended beyond the narrow borders of the data processing area, which included three basic activities: collecting, storing and distributing information. A macro vision of the informational process was incorporated, such as: contextualizing information according to the target audience, which is an activity performed by the communication and public relations departments of organizations; adopting different manners of organizing information of various kinds and criteria for its retrieval and selection, according to the best practices of archiving and librarianship; attention to the use and assimilation of the information by employees and how they create new knowledge from existing information—activities performed by the research and development area (R&D) of the companies labeled as "*learning organizations*."

The evolution of the activities contained in the specific business process for managing the information resource, herein called informational process, brought a significant addition to the perception of the potential strategy of this process to company businesses. As the initial expectations have been exceeded, such business process began to be perceived not only by dealing with information, but also with the generation of knowledge, and so it became known as KM process. Since it has been devised recently, this process presents a group of activities not yet fully defined.

Chart 1 lists the activities involved during the KM process of organizations according to the view of some authors. There are several other interpretations of the KM process in organizations, which characterize variations of the models described in Chart 1. The variation of the activities involved in each model can be explained due to the unique background of each author. It may reflect their particular business segment or line of research and study, which end up emphasizing a few activities more than others of the KM process. It should be stressed that, among those variations, the model devised by Bukowitz and Williams (1999) is the

Chart 1. Different perspectives about the activities involved in the KM process of organizations

Davenport (1997)	Bukowitz & Williams (1999)	Probst, Raub, & Rombardt (2000)	Davenport & Marchand (2000)	Gupta, Bhatt, & Kitchens (2005)
• Determine requirements • Capture • Distribute • Use	• Get • Use • Learn • Contribute • Assess • Build and sustain • Divest	• Identify • Acquire • Develop • Share/distribute • Utilize • Retain	• Map • Acquire/create/ capture • Package • Store • Share/ transfer/apply • Innovate/evolve/ transform	• Create • Maintain • Distribute • Review and revision

one of choice because it exhibits a more ample and detailed discussion of each activity of the KM process, including multiple practical examples of several organizations. According to Okunoye & Karsten (2002, p. 18), the Bukowitz and Williams' model "…offers the detailed framework for thinking about the KM process."

The large diversity of perceptions about what the KM process is in organizations may be interpreted as something positive, since it shows interest from researchers and practitioners. It should be emphasized that such diversity also has a bad side when it incorporates, for example, inaccurate or even incorrect definitions about the KM process. One commonly made mistake, including in academic publications, is to interpret the theoretical concept of the spiral of knowledge management (Nonaka & Takeuchi, 1995), which describes four processes of knowledge conversion between implicit and explicit formats, as a single KM process. Such confusion is identified, for example, in articles written by Mass and Testa (2004) and Sabherwal and Becerra-Fernandez (2003).

As previously explained, one of results of this chapter is the discussion and formulation of one set of activities which characterize the essence of the KM process in view of the most recent theories and practices. The analysis and compilation of the models of KM processes proposed by several authors resulted in the model shown in Figure 1.

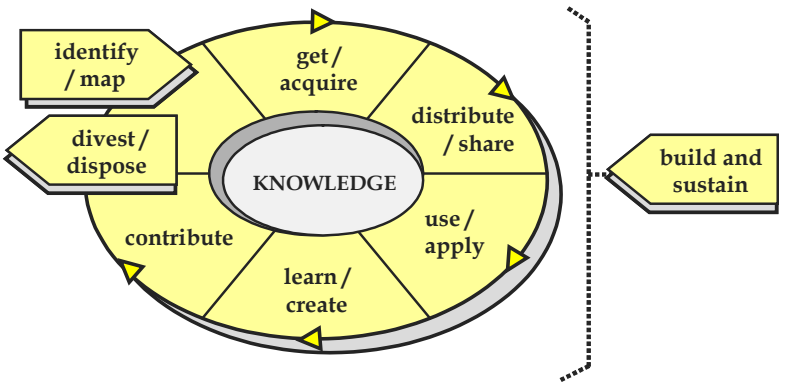
We chose to highlight the main sets of jobs, which are necessary to knowledge management by means of specific activities, with the purpose of offering the reader higher clarity and understanding of the process as a whole. The eight activities contained in the knowledge management cycle proposed are described in the following paragraphs.

Identify/Map Knowledge. This first activity should identify and analyze both the existent and the desirable knowledge environment of the organization. Knowledge environment is defined as skills, information, and internal and external data (Probst, Raub, & Rombardt, 2000, p. 33). The development of maps for the knowledge available in the organization is a way of making knowledge more understandable and familiar to organization people, in other words, a manner of increasing the likelihood of access by the organization people, considering that:

People have a tendency to look for understandable bits of information in the corners of the universe where they feel at home or at ease. (Davenport & Marchand 2000, p. 201)

The definition of relevant knowledge to be designated in the "informational maps" involves a critical analysis of the knowledge that is already available in the organization and the comparison with the ones identified as necessary by the competitive strategy of the organization.

Figure 1. Activities accomplished in the organizational KM process



Get/Acquire Knowledge. It is defined as the group of uninterrupted actions of exploration of the knowledge environment of the company, involving human and automated activities. The main concern during this activity is classifying, formatting, structuring and contextualizing the new knowledge identified (Davenport, 1997, p. 181). These issues can directly affect the manner in which future readers will read and handle it. A demand for professionals who are specialized in the KM process becomes more evident during this activity, since they are going to perform and give support to a group of activities that are traditionally not performed and managed by librarians, IT or corporative communication professionals. In this activity each knowledge unit should have a standardization for the writing style, language, used media, level of detail, content, indices to be made available for the search, among other aspects that distinguish possession from non-possession of knowledge by the organization.

Distribute/Share Knowledge. The bottom line in this activity is defining how knowledge is going to be made available to the user: whether it will be delivered (or "pushed") to their users, or if it will be simply informed, and readers will then be expected to analyze it and get the knowledge that they may deem adequate. The model of knowledge management devised by Bukowitz and Williams (1999, p. 67) recommends a combined approach: the knowledge units generated should not be pushed, but only the informational maps that describe them. These maps will alert the organization people about new sources of knowledge, letting them decide whether or not to get the content of the new knowledge.

Use/Apply Knowledge. This activity arouses experimentation and receptiveness with respect to new knowledge, strongly focusing on the behavior about using information. Some of these practices include: high management staff's announcements and attitudes, use of corporate knowledge linked to worker performance appraisals, rewarding employees when they use knowledge and punishing when they do not. Although it is difficult to measure the use of information, it is relatively easy to measure intentional access to information (Davenport, 1997, p. 195).

Learn/Create/Develop New Knowledge. This activity arouses encouragement to creativity for generating new knowledge. Although the process of creativity is very personal and individualized, several researchers have already shown that it is possible to create learning processes aimed at developing more creative people, who in turn learn and become more creative (Marakas & Elam, 1997). Gupta, Bhatt, & Kitchens (2005, p. 30), for example, believe that organizations can generate new realities and knowledge from the moment their individuals question strict premises, hypotheses and organizational concepts. The creation of knowledge is responsible for leveraging the potential value of a successful solution or turning an unsuccessful solution into a new idea with other implications. In order for this to happen, the company should provide visibility to the strategic importance of the KM process, making it familiar to the entire organization. This familiarity is reached, for example, through actions that include reflection techniques in the development of working habits, the art of "learning by doing," and learning from mistakes, failures and disagreements.

Contribute with New Knowledge. The goal of this activity is to raise awareness of the importance of transferring learned knowledge by individuals and teams to the rest of the organization. The generation of new knowledge for an isolated individual or team within the organization does not mean an addition of intellectual capital to the company. In order for this to happen, is it vital that the source of new knowledge is willing to share it. This is something quite different from the habit existing in the majority of the organizations, where information is provided by means of reports. As far as contribution of new knowledge is concerned, sharing is a voluntary action and not an imposed one as it occurs in the act of reporting.

Contribution demands time from its holder, and its value is not always clear, which may explain its low priority. The organization is responsible for creating a culture of contribution and support to the process of contribution by means of structures and functions that motivate workers, establish an environment of confidence and favor contribution activities (Bukowitz & Williams, 1999).

Build and Sustain Relationships. This phase involves the activities that are necessary for developing and supporting the infrastructure and the people who are needed to increase and renew the essential knowledge to the organization strategy. In order for this to happen, the company ought to build and sustain relationships with its main knowledge sources: workers, suppliers, customers, competitors and communities in which they act. Since some sources might be specific only to some activities of the KM process, the "build and sustain relationships" activity is highlighted in Figure 1 outside the process operational cycle, making it a strategic activity whose goal is to contribute to all the other activities.

Divest/Dispose Knowledge. Like people, organizations have trouble letting go of their assets and tend to grasp to knowledge, activities, and resources that they have gathered throughout the years. Disposal may be performed by turning knowledge investments that bring little advantage into other sources with higher value. This may occur, for example, by means of the sale or disposal of a business unit or the sale or donation of a patent. The simplest kind of disposal is the non-absorption of unnecessary knowledge, which requires a good perception about the company informational needs. These needs take us back to the first activity of the KM process—identify/map knowledge—thus closing the cycle and establishing an interaction among the activities.

The importance assigned to each activity of the management process of organization knowledge will depend upon several factors, which are specific for each company: the business segment of the company, its operational nature, and the adopted strategy, among other characteristics.

With this description of the activities performed in the of KM process, the reader is expected to have wide and up-to-date understanding of what the practice of the knowledge management in the scope of organizations is. In the following subsection, we will show the various software functionalities, which can help with the performance of one or more process activities of knowledge management.

Software Functionalities Available that Contribute to the Success of the Organization's KM process

Moffett, McAdam, and Parkinson (2004, p. 178) classify the software for supporting knowledge management into three groups: (a) *cooperative tools*, including technologies for team work (groupware), system of support for meetings (video conferencing and brainstorming), directories of knowledge (yellow pages), Intranet and extranet; (b) *management of content*, including the Internet (information provider), agents and filters (information management), management system of content, system for office automation and electronic publication system; and (c) *business intelligence system*, including date warehouse (date mining), decision support system (executive system information), system based on knowledge and workflow. For the same purpose, Frappaolo and Capshaw (1999, p. 45) have defined four categories: (a) *cognition*, including expert systems; (b) *externalization*, including image systems, document management system, workflow system, mentoring system; (c) *intermediation*, including Intranets, groupwares, practice and workflow communities; and (d) *internalization*, including data warehouse, search software, software agents and presentation tools.

There is a wide range of other software categories developed by the academy that could be

introduced. Nevertheless, none is accepted as the most complete or most adopted. In reality, there are titles and tools that are often grouped in different manners and by different authors, resulting in a great diversity of categories of software that supports knowledge management.

The problem with working with classifications based on software titles, tool names or systemic solutions is that these entities do not always offer a clearly defined scope in terms of available functionalities. Besides, there is a lot of overlapping of functionalities. In order to avoid such drawback to the proposed method for the strategic alignment of IT resources to knowledge management of the organization, which is the main object of this research, we have chosen to work with the logic specifications of the main functionalities that contribute to knowledge management instead of working with problematic software titles or tools.

Thus, we will now describe the grouping of functionalities of software, which contribute to the organization's KM process.

Functionalities for storage of content (data warehouse, data mart). The environment for storage of the digital content of the organization should be safe and have easy access. It should allow storage of content in different formats (reports, videos, photos, figures and voice) and it should also allow for collecting historical volumes of content, as it occurs, for example, in data warehouse environments. The presentation and analysis of subgroups should be feasible, just as it occurs, for example, with the data mart with respect to date warehouse, thus avoiding the high complexity imposed by the handling and analysis of large data collections.

Functionalities for classification of content (taxonomy software). Due to the increasing accumulation of digital documents in organizations, it is very important to have mechanisms that allow for an automatic classification of each new content created or received by the organization. The functionalities of taxonomy perform classification activities considering the categories of subjects and topics previously defined, each with their document—examples and/or key words that are utilized to analyze and classify new digital content. According to Loesch and Theodori (2005, p. 279), the categories and groups sorted from documents, created by taxonomy, are necessary to define elements of a document, allowing it to be classified in a significant manner and, consequently, facilitating its subsequent recovery. The functionalities of taxonomy are applied to the information received in digital format (e-mails, reports, etc.) or those that can be converted to this format, for example, printed documents sent by fax or delivered by regular mail. In short, certain content may only be considered as a part of the knowledge assets of the organization when it is properly classified.

Search engines and capture of content (agent software, Web researchers). The search and capture concepts reflect a notion of content in motion, or, in other words, flows of knowledge. The flow facilitates the connection between a researcher of certain knowledge and his provider (Holtshouse, 1998, p. 278). From the software functionality viewpoint, a good search algorithm should allow individuals to work with a combination of multiple attributes that characterize each content available: key words, text portions, periods of time of creation of content, source of content, type of media where the content is stored, language, and digital file size, among other attributes, which can help the search and selection of the knowledge required. The final user can run the search operation in real time, through a "search engine," in which the user plugs values or limits in the comparison parameters, or it may also be scheduled for predefined periods of times, through agent software which self execute according to pre-programmed periods of time.

Functionalities for representing realities in graphic form (geo-spatial maps, sociograms, diagrams). Much of the digital content becomes more significant to the readers when they are shown

graphically. Some practical and much acclaimed examples are: road maps used for analyzing vehicle routes, diagrams that describe activities and resources along a production line or a business process, or social relationship diagrams:

Which add value to diagnose standards of interaction among people from an organization. (Anklam, 2002, p. 9)

The social network analysis technique is widely used; for example by the sales staff to analyze the actors of an organization who participate in a buying process. Part of the organizational knowledge may be represented graphically so as to help future readers in judging and handling the knowledge available. Thus, the functionalities with graphic representation contribute directly to the activity of obtaining and acquiring knowledge, as they offer information in the format that is more suitable for use.

Functionalities for distribution of content (e-mail, workgroup). These are the functionalities that contribute directly to the operations performed by the activity related to the distribution and sharing of the KM process. Through these functionalities, potential users of information are notified about the information available in the knowledge assets of the organization. It is possible to send the very digital content which brings the new knowledge or, simply, make this knowledge available by means of a specific message or informational maps. The functionality of distribution content is fundamental when it is desirable to adopt the strategy of "pushing" information.

Functionalities for publication of content (Web site, e-learning, portal). The functionalities for publication of information contribute directly to the activities of distributing and sharing the KM process. With this information, its potential users can have access to the knowledge collections available in the organization. The functionality of publication of content is vital when an organization wishes to adopt the strategy of "pulling" information.

Functionalities that support analysis and interpretation of content (data mining, text mining). The increase of technical capacity and cost reduction of data storage technologies, combined with the continuous and increasing introduction of new data collecting mechanisms and information systems, have significantly increased information databases in organizations, which strongly hinders analysis and interpretation. In order for large volumes of data, which are potentially valuable in terms of revealing important knowledge to business, to become raw material to the activity of acquiring new knowledge of the organization, the use of algorithms that enable cross-analysis of multiple dimensions of the same occurrence is necessary and these algorithms should develop statistical inferences and show to business analysts interesting relationships of a detailed analysis. More sophisticated algorithms of text mining also deal with language semantic issues, and they are capable of finding and capturing semantic information which reveals standards that are meaningful to the business (Liddy, 2000, p. 13). One example is the discovery of relationship patterns among people, helping with the creation of the necessary databases for the application of the techniques of *social network analysis*.

Functionalities for managing the evolution of content (content management system). Most of the organizational knowledge shows changes over time, demanding from the KM process a continuous follow-up of the evolution of the digital knowledge database. The need for access to former versions of reports, software titles, maps, organizational diagrams, engineering project designs, and advertisement projects, as well as various other kinds of digital knowledge, is quite common. For this reason, the functionality of management of content ought to offer services for the preservation, organization and dissemination of the evolutionary history of collections of digital content (Han, 2004, p. 355).

Functionalities that support experimentation (simulators). This is worthy of note among others since it is the functionality that is the most appropriate for learning activities and the creation of the KM process. Such feature is an important means of encouraging the creation of new ideas. Organization employees lose their fear of trial and error activities, since all experimentation occurs in a virtual environment, which is favorable to the performance of different tests. Some very well known examples of simulators are found in flight simulation software for pilots, simulation for operation and planning of machine loads in manufacturing environments, and analysis of financial results from scenarios which involve changes of important variables, such as interest rates, exchange rates and pay raise rates. According to Klaila and Hall (2000), an effective simulation functionality evinces the purpose of the business to be attained and helps their users to take in the most critical and important concepts.

Functionalities of interactivity for discussion and exchange of ideas (Web conference, workgroups, voice over IP). Making software available to help people communicate is a benefit that adds value to most of the process activities of the organizational knowledge management. Queries and questions are important elements in the process of identification and mapping informational needs, and they should be managed and developed by the organization; in other words, it is an input to the activity of identifying and mapping knowledge. The implicit knowledge of the organization, indicated by informational maps, which are forwarded by the distributing/sharing activity, become more explicit when they can be accessed via tools of interactivity, whether by means of exchange of e-mails, a conversation over a voice communication system over IP or by use of a Web conferencing system. The discussions about content, facilitated by interactivity tools also contribute to the learning activity and creation of the KM process.

Functionalities for identification and exception handling (rule engine). This grouping of functionalities allows the user to specify relevant situations that need to be monitored. Algorithms that define operational rules are used to monitor the occurrence of relevant situations, as well as the how they are to be handled, usually triggering a predefined action. This action may cause a software application to run, or notify a user so that he/she can decide about what to do in the presence of the occurrence. Unforeseen situations according to the rules are prioritized events for the knowledge management, and since they are something new, they require an analysis and interpretation, which can result in learning and creation of new knowledge. According to Ross (2003, p. 85), "the exception to a rule is simply another rule." Therefore, pointing out and documenting unforeseen circumstances for an operation is a good attribute of this functionality, contributing to the activity of acquiring the KM process; more specifically, unfolding a new operational rule.

METHOD FOR ALIGNING INFORMATION TECHNOLOGY RESOURCES TO THE KNOWLEDGE MANAGEMENT OF AN ORGANIZATION

Phases and Premises of the Method

The method is composed of the four phases mentioned in the first subchapter:

Phase 1: Identify major, medium and minor priorities among the eight activities that compose the organization's KM process (as explained in the first subsection of the last subchapter).

Phase 2: Identify available software functionalities that contribute to the success of the

organization's KM process (as explained in the second subsection of the last subchapter).

Phase 3: For each activity of the management process of organization knowledge, classify software functionalities into: relevant functionalities (Class A), which are those that add most value to process activities of knowledge management of the organization, medium functionalities (Class B) and irrelevant functionalities (Class C) (will be explained in the next subsection of this subchapter).

Phase 4: Make a decision about the intensity of each software functionality for each activity of the management process of organization knowledge and for the group of activities (will be explained at the end of this subchapter). "Intensity" depicts software degree of usefulness.

In addition to the considerations about the two first phases which have been dealt with in the two former subchapters, two premises were identified as very important for the conception of the method of IT resource alignment to knowledge management of the organization:

a. The eight process activities of knowledge management do not have the same level of importance, since the importance of each one varies from organization to organization, as it depends upon the business segment, the adopted business strategy, the operational nature, the organizational structure, the level of geographic dispersion of the organization, among several other agents that are specific to each organization;
b. Investments in IT resources should be planned and made considering the KM process as a whole, since the functionalities that they implement contribute to different levels of intensity for each one of the eight activities of the KM process.

The first assumption requires that weights be assigned for each of the eight activities that compose the organization's KM process identified in Phase 1.

Classification of software functionalities in categories: relevant, medium and irrelevant, by means of matrices for prioritization of functionalities (Phase 3)

There are various software functionalities that can contribute to the execution of the activities of organizational KM process. Through the proposed method of aligning IT resources to the KM process, the first step of Phase 3 is to create eight *matrices of functionality prioritization*, one for each activity of the organization's knowledge management process.

The *prioritization matrix of functionalities* is classified into the following categories: relevant functionalities (Class A), which are those that add most value to the activities of the KM process of the organization, medium functionalities (Class B) and irrelevant functionalities (Class C). The *Nihans' index* is used for this classification. This classification compares each functionality with all others using weights that vary from +2 to –2. The weights for each functionality are added together, allowing that the functionalities are placed in a rank of importance for each activity of the management process of organization knowledge.

The *prioritization matrix of the functionalities* is a square matrix, containing all the functionalities to be analyzed on its rows and columns. Since the matrix is diagonally symmetric with the opposite sign, it is a null matrix sum. Since the Nihans' index may be applied only to positive numbers, it is necessary to add a constant value to the sum of the weights for each functionality.

This is the method of aligning IT resources to the organization knowledge management, which is outlined in Table 1 (which shows only part of the prioritization matrix, and the reason for that will be explained at the end of this section):

Step 1: For each activity of the KM process selected in Phase 1, create a prioritization square matrix. It should have on its rows and columns all the software functionalities that contribute to the KM process. These functionalities have been identified in Phase 2. For each matrix, the following steps must be followed.

Step 2: Compare software functionality on each row with all the functionalities on the columns, assigning weights between +2 and –2, according to the degree of importance of the functionality for each activity of the knowledge management under analysis, that is: +2, functionality on the row is far more important than that of the column; +1, more important; 0, of equal importance; –1, less important; and –2, far less important.

Step 3: Add the weights of each row and write down the amount of the sum on a column to the right of the matrix, which is called "sum of the weights" (S). The sum of the values of all the rows of this column is zero since the matrix is diagonally symmetric with the opposite sign. If the sum is not equal to zero, there is an error in the assignment of weights. This column represents the ranking of relevance of each functionality for the activity of knowledge management under analysis in the prioritization matrix.

Step 4: Add a constant value (Y) to all values of the S column , so that they will all become positive numbers and write them down on a column called X = (S + Y). In the example given in Table 1, the value 22 was added. The sum of the X column will be equal to the number of rows times Y.

Step 5: Square the values of the X column and write them down on the X^2 column. Add all the values of the X^2 column.

Step 6: Calculate the Nihans' index using the following formula:

$$N = \frac{\sum(X)^2}{\sum(X)}$$

Step 7: Create a column called "Class A and Class not-A," in which all software functionalities whose X value is superior to the Nihans' index are written as "Class A" and all functionalities whose X value is inferior to Nihans' index are written as "Class not-A." Class A software functionalities are those that strongly contribute to increasing the performance of the organization in the specific activity of the KM process under analysis.

Step 8: Repeat steps 4, 5 and 6 to identify medium (Class B) and irrelevant (Class C) software functionalities taking into consideration only the software functionalities of Class not-A, creating columns X and X^2 of the Class not-A, whose values are copied from columns X and X^2 of steps 4 and 5, and creating Class B and Class C columns to indicate the class to which each software functionality belongs, assigned as "Class not-A" in step 7.

Table 1 shows a subset of the *prioritization matrix of the functionalities* that contribute to *the learning activity of the KM process*. Note that only a portion of the matrix is shown in *Table 1* due to its large size. The left half has 11 columns, one for each functionality described in the second subsection of the last subchapter, but only seven of them are shown. Obviously, the values of the "Sum of the weights" column (S) result from the sum of all the 11 columns.

With this procedure, the software functionalities are grouped into three categories: Class A, those functionalities that strongly contribute to increasing the performance of the organization in learning the KM process, which is the activity under analysis; Class B, those functionalities that contribute reasonably; and Class C, which covers those that do not contribute at all and are irrelevant functionalities for increasing performance of the organization in learning activities.

In the example described in Table 1, which represent a hypothetical situation, the value of the Nihans' index that sets apart Class A from not-A is 25.1 (6,076 divided by 242, as shown on the last row). Thus, the values of the X-column that are higher than 25.1 match the functionalities classified as Class A, which are: interpretation, experimentation and exception handling.

By re-applying the Nihans' index to the values of the Class not-A functionalities, we get Classes B and C (not shown in Table 1). The Nihans' index, which sets apart Class B from C, is 19.6 (2,801 divided by 143). Hence, the values of the X column that are higher than 19.6 belong to Class B, and the lower values, belong to Class C. Class B functionalities are: classification, search and capture, graphic representation, evolution and interactivity. And Class C functionalities are: storage, distribution and publication.

Note that S or X Columns of Table 1 show that the method not only groups the software functionalities in these three classes, but it also arranges these functionalities decreasingly by their degree of relevance; in other words, it displays the ranking of relevance of software functionalities for the organization's KM process.

Weighed Intensity of Each Software Functionality (Phase 4)

When IT resources are used to give support to a functionality, different levels of implementation may be chosen, from very simple solutions to highly complex ones, both from technological and financial standpoints. Obviously, the different ways of implementation of the functionality produce different levels of organizational effectiveness, efficiency and efficacy.

As an example, take three possible compositions of IT resources employed to support the functionality *interactivity*:

Table 1. Subset of the prioritization matrix of the functionalities, which contribute to the learning activity of the KM process

	Storage	Classification	Search and capture	Graphic representation	Distribution	Publication	Interpretation	(S)	X=(S+Y)	$(X)^2$	$N=(X)^2/(X)$	Class A and Class not-A
Storage		-2	-1	-1	0	0	-2	-11	11	121	11	**Not-A**
Classification	2		0	0	1	1	-1	1	23	529	23	**Not-A**
Search and capture	1	0		1	1	1	-1	3	25	625	25	**Not-A**
Graphic representation	1	0	-1		1	1	-1	-1	21	441	21	**Not-A**
Distribution	0	-1	-1	-1		-1	-2	-12	10	100	10	**Not-A**
Publication	0	-1	-1	-1	1		-2	-10	12	144	12	**Not-A**
Interpretation	2	1	1	1	2	2		9	31	961	31	**Class A**
Evolution	1	0	-2	0	1	1	-1	-2	20	400	20	**Not-A**
Experimentation	2	1	1	1	2	2	1	13	35	1,225	35	**Class A**
Interactivity	0	0	0	0	1	1	-1	-1	21	441	21	**Not-A**
Exception handling	2	1	1	1	2	2	0	11	33	1,089	33	**Class A**
	11	-1	-3	1	12	10	-9	0	242	6,076	**25.1**	=> ***N***

a. Use of electronic mail system (e-mail);
b. Use of a workgroup tool which enables the development of communities of practices, with discussion forums classified by relevant topics, current and history lists for questions and answers, with all communications being performed by means of texts, whether by browsing documents or sending messages (e-mail); and
c. The resources of the workgroup tool described in the previous item, integrated to Web conference resources, plus ease of voice and video communication among members of the community of practice.

It should be noted that there are three different levels of intensity of investments with respect to the IT resources, resulting in three different levels of effectiveness, efficiency and efficacy for supporting functionality *interactivity*.

Whenever it becomes defined how IT resources will contribute to the organization's KM process, one should not discuss if a certain activity will be supported or not by the IT resources, but instead, the degree of intensity of the software resources, which depend on the degree of investment performed or planned.

Consequently, the most important quantitative concept in the proposed method is functionality intensity. There are two other quantitative variables used by the method, arising from functionality intensity. These three variables are defined as follows:

- **Functionality intensity** is the intensity whereby the functionality is understood (or used) by a company in order to contribute to a given activity of the KM process. It is also understood as the degree of effectiveness of use of the functionality resources or the power and reach of a functionality. It is evaluated between zero and five, where "zero" intensity means that the functionality is not being used by the company, "one" is minimum intensity and "five" maximum. It is, therefore, a discrete variable with a domain between 0 and 5 (see Table 2).
- **Functionality average intensity** is the average intensity of the functionalities, taking into account all eight process activities of knowledge management. It is a continuous variable with a domain between 0 and 5 (see Table 2).
- **Functionality weighed intensity** is the weighed average of the intensity of the functionalities considering all eight process activities of knowledge management. This is done by means of weights that are assigned to each activity, and they reflect the level of importance of each activity for the company. It is a continuous variable with a domain between 0 and 5 (see Table 3).

Adding the concept of intensity of the functionality with the classes defined in the previous section (Class A, Class B and Class C), we have:

- The functionalities classified as **Class A:** which are the relevant ones and strongly contribute to increasing the effectiveness of an activity of the KM process—must have maximum intensity (value 5 is assigned to them);
- The functionalities classified as **Class B:** which are ranked medium and they fairly contribute to increasing the effectiveness of an activity of the KM process—must have medium intensity (value 3 is assigned to them); and
- The functionalities classified as **Class C:** which are the irrelevant and do not contribute to increasing the effectiveness of the company in the execution of a given activity—must have small intensity (value 1 is assigned to them).

The values assigned to the variable *intensity of the functionality* should be interpreted as follows:

- **Maximum intensity (value 5):** The best possible solution must be sought in terms of IT resources applied to the functionality, considering the high relevance of this functionality;
- **Medium intensity (value 3):** A satisfactory solution must be sought in terms of IT resources applied to the functionality, considering the medium relevance of this functionality;
- **Small intensity (value 1):** The simplest possible IT features must be made available; and
- **Null intensity (value 0):** Make no IT resources available for implementing this functionality.

Table 2 shows the result generated in Phase 4 of the method for a hypothetical organization. To set it up, data from the eight matrices of prioritization of functionalities described in the previous section were used, always taking into account the 11 functionalities. This chart presents the intensity of each functionality, considering their contribution for each of the eight process activities of knowledge management. The main information in this chart is the average intensity of the functionalities, shown on the last column on the left.

In Table 3, the intensity of each functionality had a weight assigned according to each one of the eight activities that compose the organization's KM process identified in Phase 1. These weights reflect the importance assigned to each activity of the management process of organization knowledge. In Table 3, which is about a hypothetical organization, weight 3 was assigned to those activities identified as priorities; weight 2, for those of medium importance; and weight 1, for those of little importance.

Matrix of Intensity of Functionalities for the Organization's KM Process

As described in the first subchapter, the goal of the *Method for Aligning Information Technology Resources to the Knowledge Management of an Organization* is to quantify the intensity of the available software functionalities so as to maximize the benefits and minimize costs of the KM process. Tables 2 and 3 allow this goal to be achieved.

Table 2 shows the desirable intensity of each functionality for each activity of the KM process. The last column of Table 3 shows the weighed average intensity, with the purpose to point out the average importance of the functionalities, considering the organization's KM process as a whole, in other words, assigning weights that reflect its importance to each activity of the process. By classifying the values on this column, by means of the Nihans' index, into relevant, medium and irrelevant functionalities and by assigning intensities 5, 3 and 1, respectively, we reach the goal of the method.

The Nihans' index that sets apart Class A from Class not-A, for the values of the average intensity weighed, is 2.84. Values that are far higher than this index are in Class A, and the closer values are in Class A/B. The Nihans' index, which sets apart Class B from C, applied only to the values of the weighed average intensity of the Class not-A, is 2.39. Values that are far higher than this index are in Class B, the closer values are in Class A/B, and the very low values are in Class C.

Class A includes the functionalities that should have an intensity value of 5. Class B includes medium functionalities, which should have an intensity value of 3. Class C includes irrelevant functionalities, which should have an intensity value of 1. Classes A/B and B/C include intermediate functionalities, which should have intensities 4 and 2, respectively. Table 4 shows the result of this conclusion.

To clarify the meaning of intensity of functionalities, take the functionality "C*lassification*," whose value 4.00 from the weighed average intensity (*Table* 3) depicts that it is the most relevant of the functionalities for the KM process of the hypothetical company analyzed and should, therefore, have an intensity of 5. What is the meaning of having an intensity equal to 5? It means that the best possible solution in terms of IT resources for this functionality must be sought, considering its high relevance to the KM process as a whole. This functionality has shown to be very relevant to various activities of the KM process. Efficient classification features contribute significantly to the activity of acquiring new knowledge, for example, allowing people to analyze the content in the most convenient order or manner. For the activity of contribution, automatic classifications of content exempt the interested party to do the job or part of the classification job, thus increasing the chances of more people participating and, consequently, of the increase of content and the contribution of the people involved with the KM process of the organization. The importance of the *classification of content* functionality for several other process activities of knowledge management is also worthy of note.

Class B functionalities require "reasonable intensity" (intensity 3), in other words, they should receive IT resources that allow them to operate only with satisfactory effectiveness. Class C functionalities require "little intensity" (intensity 1), in other words, the company should not be concerned about them, making few or even no IT resources available to them. If functionalities get a weighed average result that is too close to the boundary between two classes, they must be analyzed individually to provide a better understanding of its role in the KM process as a whole.

This interpretation is consistent with the assumption made in the beginning of this subchapter: software functionalities contribute with different levels of intensity for each of the eight activities of the KM process.

Table 2. Matrix of intensity of the functionalities for the organization's KM process

		KM process activities								**average intensity**
		Identify / map	Get / acquire	Distribute / share	Use / apply	Learn / create	Contribute	Build and sustain	Divest / dispose	
Functionalities	Storage	5	3	1	5	1	5	1	5	**3.3**
	Classification	5	5	3	5	3	5	3	3	**4.0**
	Search and capture	5	5	3	3	3	1	1	1	**2.8**
	Graphic representation	3	3	3	3	3	1	5	1	**2.8**
	Distribution	1	3	5	3	1	3	1	1	**2.3**
	Publication	1	5	5	3	1	3	1	1	**2.5**
	Interpretation	1	1	1	1	5	1	5	1	**2.0**
	Evolution	1	1	1	1	3	1	1	1	**1.3**
	Experimentation	1	1	1	1	5	1	1	1	**1.5**
	Interactivity	3	5	3	3	3	5	5	3	**3.8**
	Exception handling	1	1	1	1	5	1	3	1	**1.8**

Table 3. Matrix of intensity of the functionalities for the organization's KM process

		KM process activities								weighed average intensity *
		Identify / map	Get / acquire	Distribute / share	Use / apply	Learn / create	Contribute	Build and sustain	Divest / dispose	
	Assigned importance (weight) =>	*1*	*2*	*3*	*3*	*3*	*2*	*1*	*1*	
Functionalities	Storage	5	6	3	15	3	10	1	5	**3.0**
	Classification	5	10	9	15	9	10	3	3	**4.0**
	Search and capture	5	10	9	9	9	2	1	1	**2.9**
	Graphic representation	3	6	9	9	9	2	5	1	**2.8**
	Distribution	1	6	15	9	3	6	1	1	**2.6**
	Publication	1	10	15	9	3	6	1	1	**2.9**
	Interpretation	1	2	3	3	15	2	5	1	**2.0**
	Evolution	1	2	3	3	9	2	1	1	**1.4**
	Experimentation	1	2	3	3	15	2	1	1	**1.8**
	Interactivity	3	10	9	9	9	10	5	3	**3.6**
	Exception handling	1	2	3	3	15	2	3	1	**1.9**

* Sum of the values of the eight columns on the left divided by the total weight which is 16 points

CONCLUSIONS ABOUT THE PROPOSED METHOD

The explanation of the method for aligning IT resources to the knowledge management of an organization has shown that the method is effective and very suitable for achieving the purpose of providing effectiveness, efficacy and efficiency to knowledge management of the organization, as it will be further discussed.

To apply the method, a company ought to have a perception of the KM process that has been already implemented or that will be implemented, and the functionalities of software that can contribute with the knowledge management. The requirement for weighing activities and quantifying the intensity of the functionalities offers great confidence in the results of this method, which compensates for the necessary efforts employed in the analysis.

An ample discussion and diffusion of these two topics in the organizational scope constitutes an important result of this method, considering that most organizations have little awareness of the KM process. Analyses are more often based on names of software categories instead of on its logic specific traits or functionalities, and this leads to confusion.

The perception of the knowledge management as an organizational process yields visibility and provides the necessary structuring to its implementation as an organizational practice. In the 1990s, concepts and principles of the knowledge management were widely announced, however, without the required strictness and formality, so as to allow its implementation as a practice of the organization by means of operational and managerial processes. The transmission of good concepts and principles from the field of ideas to practical

Table 4. Intensity of the functionalities for the process of organization knowledge management

		Weighed average intensity	Class	Intensity of functionality
Functionalities	Storage	**3.0**	**A/B**	**4**
	Classification	**4.0**	**A**	**5**
	Search and capture	**2.9**	**A/B**	**4**
	Graphic representation	**2.8**	**A/B**	**4**
	Distribution	**2.6**	**B**	**3**
	Publication	**2.9**	**A/B**	**4**
	Interpretation	**2.0**	**C**	**1**
	Evolution	**1.4**	**C**	**1**
	Experimentation	**1.8**	**C**	**1**
	Interactivity	**3.6**	**A**	**5**
	Exception handling	**1.9**	**C**	**1**

applications in organizations occurs especially by means of methods that incorporate the required strictness and formality. The proposed method meets this requirement.

The concept of functionality as a characteristic of software which contributes to the KM process guides the organization towards valorizing the logic specifications about what resources should be available, instead of the traditional valorization of the physical implementation, in other words, the purchase and implementation of software. Regardless of working with one or more software titles, an important issue is that a set of functionalities is available to suitably handle a determined knowledge set, by means of certain pre-established activities.

The method may be applied to the alignment of IT resources to the KM process as a whole, as well as to the analysis and improvement of an activity of the KM process. Thus, the method may be applied to macro scenarios for planning an organizational KM process, as well as to projects for local improvements, such as locally improving the capacity of people's contribution to the company's knowledge base, or any other specific activity of the KM process. Its practical application to those different scenarios occurs in the following manner: for the macro scenario, eight *matrices of prioritization of functionalities must be created* plus a *matrix of intensity of the functionalities*, while, in the scenario of a local improvement, the *prioritization matrix of the functionalities will suffice,* relative to the specific activity intended to be improved and the consequent decision about the intensity of the functionalities.

The proposed method is adequate for two reasons. Firstly, because it provides the organization with a criterion to optimize the cost/benefit ratio of the KM process: in other words, to excel only in those activities and functionalities that are relevant. Following the same line of thinking, the functionalities indicated as medium should have a medium intensity of investments, and the irrelevant ones should have a minimum intensity. Secondly, because the method forces a comparison of alternatives and assignment of quantitative values to them, it results in a more precise evaluation of the various possibilities that are open to the company. These considerations show that the method provides effectiveness, efficacy and efficiency to the KM process.

When the approach is merely qualitative, the results are strongly influenced by subjective evaluations. The quantitative analyses of the pro-

posed method are established in the prioritization matrix of the functionalities and in the matrix of intensity of the functionalities. These two points also discriminate positively the proposed method from other methodologies that have the purpose to align IT resources to the KM process.

The prioritization matrix of the functionalities is capable of identifying, with plenty of confidence, the importance of the functionalities for each activity of the KM process, as it compares quantitatively each functionality with all others, analyzing individually each activity of the KM process. The functionalities regarded as relevant (Class A) are those whereby the organization must acquire high competence.

The concept of intensity of the functionalities depicts the different degrees of intensity of each functionality in the presence of the KM process as a whole. The intensity of a functionality may be understood as the amplitude of the software functions or algorithms made available to support the activities of the KM process of the organization. The higher the importance of the group of the process activities of knowledge management, the greater the intensity of the functionality should be. The functionalities with higher relevance to the organization, indicated as Class A, should have maximum intensity (intensity = 5); in other words, they should be the best possible. The functionalities indicated as Class B have medium importance to support the process activities of organizational knowledge management, therefore, they should have medium intensity (intensity = 3). The functionalities indicated as Class C should have low intensity (intensity = 1); in other words, they should be sufficient only to support, with the lowest level of service possible, the process activities of knowledge management.

The most important thing to emphasize about the method proposed herein is the capacity of aligning investments in IT resources to the organization's KM process and the capacity of defining the priorities of investments in software functionalities and proper algorithms for the knowledge management.

In other words, the method provides effectiveness, efficacy and efficiency to the organization's KM process.

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Chapter XI
ICT for Knowledge and Intellectual Capital Management in Organizations

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ABSTRACT

This chapter describes which information and communication technologies (ICT) can help in the process of managing knowledge and intellectual capital in organizations. We start the chapter examining the risks we face when we use technologies for knowledge management (KM) and for intellectual capital management (ICM). Once we have done this, we review the literature to see which technologies different authors mention; choosing then the most frequently cited ones. We classify these technologies in base technologies and technological applications, getting to a final number of 17. Each of them is then summarily described and its possibilities in helping KM and ICM are stated. The chapter ends by classifying all of them according to their utility in helping in KM and ICM and in which of the processes needed in organizations for managing knowledge and intellectual capital they can be used.

INTRODUCTION

Since the 1960s, information and communication technologies (ICT) have been present in organizations. After some years in which organizations just used ICT to automate repetitive processes, an era begun in which ICT started to be used to process data in order to get information out of it: organizations that were able to carry out this process obtained a sustained competitive advantage over their competitors. But, obviously, and as it usually happens, after some time, all companies

in one sector where obtaining the same kind of information using the same data as input and the same ICT as tools, arriving to a state in which good use of ICT stopped providing a competitive advantage.

But in the last few years, a new opportunity has arisen in this area: the use of ICT to process knowledge and intellectual capital. This is a huge challenge for organizations. In fact, organizations that get to use ICT for these mentioned processes will once again obtain sustained competitive advantage over their competitors. In this chapter we examine which of all the technologies that belong to the vast amount named under ICT can be used for knowledge and intellectual capital management and in which of the processes needed to process these two items in organizations they can be used.

BACKGROUND

We start the chapter describing and analyzing technologies that serve as KM facilitators. In this section we review the literature on those technologies.

The first contribution that we cite is that of Bollinger & Smith (2001), who classify the tools that they believe facilitate KM processes into four types: hardware, software, collaborative work and intelligent tools, as shown in Table 1.

We can see that one of the groups, intelligent tools, comprises the tools that permit user needs to be anticipated and new knowledge to be extracted from existing knowledge. Therefore, the tools in this group are more interesting for KM although, as we shall see later, they unfortunately have the problem of a low present level of development,

Table 1. Computer information technology tools for knowledge management

Tool category	Tool
Hardware	• Investment in IT • Networks • Intranet
Software and database tools	• Knowledge-based systems (KBS) • Collaborative hypermedia for documentation of discussions • Learned lessons databases • Data warehouses • Databases for classification, codification, and categorization of information • Storage of e-mail threads to create a repository of best practices • Corporate memory databases, also known as knowledge archives • Corporate yellow pages • Employee home pages on an Intranet
Collaboration tools	• Electronic meeting systems • Video-conferencing • GroupWare • Electronic bulletin boards
Intelligent tools	• Decision support tools using neural networks • Virtual reality • Genetic algorithms • Intelligent agents • Internet search engines • Knowledge mapping

Source: Bollinger and Smith (2001, p. 12)

which is the reason why their diffusion is still in its infancy.

Ruggles (1998) cites four technologies as being the most used in KM nowadays: Intranets and Extranets, knowledge repositories, tools to support decision making-and workgroup tools to support collaborative work

Wen Chong, Holden, Wilhemij, and Schmidt (2000) indicate that the most frequently used technologies are Intranets, knowledge repositories, search engines, workflow management tools, data warehouses, workgroup tools, document management systems and decision support systems.

Another author who cites ICT for knowledge management is Binney (2001), who defines a KM spectrum and classifies the applications and technologies according to their usefulness to the management of each type of knowledge. That spectrum is shown in Table 2.

As we can see in Table 2, Binney (2001) believes that there are six types of KM, ranging from transactional KM to KM in the areas of innovation and creation of knowledge, via analytical KM, knowledge resource management, KM of the processes and development of an organization's knowledge capabilities. The order in *Table 2* is relevant since, from left to right, the theories move from the most technological theories to the most organizational, and the knowledge moves from explicit to tacit.

Junnarkar and Brown (1997) also examine the use of technologies for KM and, in the spiral that describes the knowledge management process in organizations (Nonaka, 1994), they identify

Table 2. Enabling technologies mapped to the KM spectrum

	Transactional	Analytical	Asset Management
Definition	The use of knowledge is embedded in the application of technology.	Interpretations of, or creates new knowledge from, vast amounts or disparate sources of material.	Management of explicit knowledge and intellectual property assets
KM Applications	• Case-Based Reasoning (CBR) • Help Desk Applications • Customer Service Applications • Order Entry Applications • Service Agent Support Applications	• Data warehouse • Data mining • Business Intelligence • Management Information Systems • Decision Support Systems • Customer Relationship Management (CRM) • Competitive Intelligence	• Intellectual Property • Document Management • Knowledge Valuation • Knowledge Repositories • Content Management
Enabling Technologies	• Expert Systems • Cognitive Technologies • Semantic Networks • Rule-Based Expert Systems • Probability Networks • Rule Induction, Decision Trees • Geospatial Information Systems	• Intelligent Agents • Web Crawlers • Relations Object DBMS • Neural Computing • Push Technologies • Data Analysis and Reporting Tools	• Document Management Tools • Search Engines • Knowledge Maps • Library Systems
Portals, Intranet, Extranet and Internet			

Table 2. continued

	Process	Developmental	Innovation and Creation
Definition	Codification and improvement of process	Increase the competencies or capabilities of an organization's knowledge workers.	Provide an environment in which knowledge workers can come together in teams to collaborate
KM Applications	• TQM • Benchmarking • Best Practices • Quality Management • Business Process (Re)Engineering • Process Improvement • Process Automation • Lessons Learned • Methodology	• Skills Development • Staff Competencies • Learning • Teaching • Training	• Communities • Collaboration • Discussion Forums • Networking • Virtual teams • Research and Development • Multi-disciplined Teams
Enabling Technologies	• Workflow management • Process Modelling Tools	• Computer-based Training • Online Training	• Groupware • E-mail • Chat Rooms • Video Conferencing • Search Engines • Voice Mail • Bulletin Boards • Push Technologies • Simulation Technologies
Portals, Intranet, Extranet and Internet			

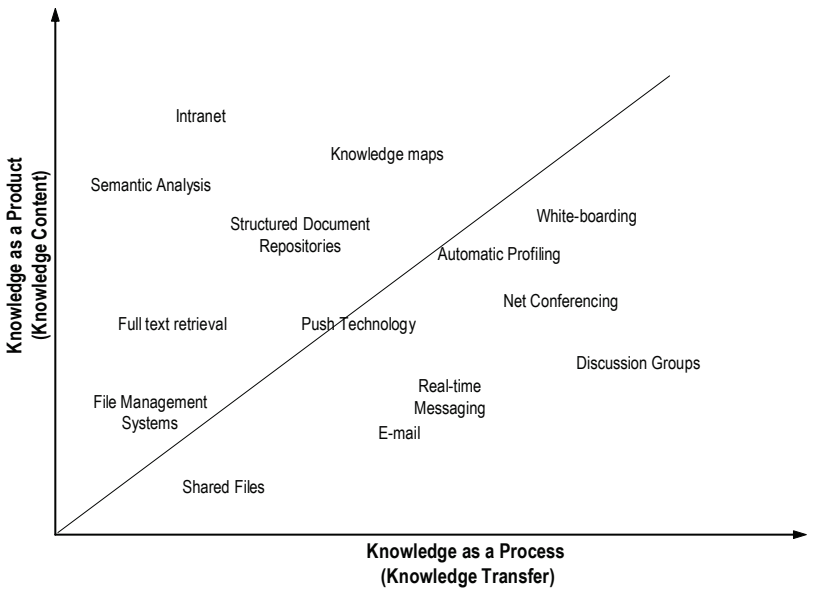
Source: Binney (2001, p. 38)

a series of enabling technologies in each type of interaction. In *socialization,* they identify videoconferences and virtual and asynchronous conference systems; in *externalization*, electronic mail and distribution lists. In the case of *combination*, they name workgroup tools, IS, distribution of documents in electronic formats, Intranets and push technologies. Finally, in *internalization*, they identify data mining tools based on neuronal networks, simulations and visualization technology based applications, such as geographical information systems.

Another interesting point of view is that of Mentzas, Apostolou, Young, and Abecker (2001), who classify KM software according to whether the knowledge is considered a process or a product (Figure 1). In the first case, KM is considered to be a social communication process, since the knowledge is possessed by the person that generates it and is shared through the interaction. Therefore, the ICT are used to transfer the knowledge and not to store it. In the second case, greater attention is paid to the documents containing the knowledge, and to the creation, storage and reuse of the knowledge.

Other authors who explicitly use the term knowledge technologies in their mention of technologies for KM are Meso and Smith (2000), who identify technologies frequently used in those systems and group them according to their function in KM. Thus, for the use of knowledge they cite workgroup tools, messenger tools, videoconference, push technologies, and technologies to support group decision-making. In the case of searching for knowledge, they cite navigators and Web technologies, data mining tools, search and

Figure 1. The process-centered and product-centered approaches in KM software



Source: Mentzas et al. (2001, p. 96)

Table 3. Technologies and technological applications for KM

Technologies	Technological Applications
Web Technologies	Data warehouses
Databases, repositories and data mining	Help desk tools
Real world imitation technologies	Decision support systems
Computer-based learning	Discussion forums
Work and document flow management	Intranets and Extranets
Geographical information systems	Yellow pages
Knowledge maps	Knowledge portals
Workgroup tools	Case-based reasoning
	Document repositories

locate technologies and intelligent agents. For knowledge creation, they only consider intelligent agents suitable and, finally, in the case of packaging knowledge, they identify document management systems and intelligent agents. Of all those technologies, the authors themselves consider that workgroup and Web navigators are the most prominent nowadays.

That ends our review of the principal works citing technologies for KM, in which it is clear that certain technologies are repeated on various occasions. The next two sections give more detailed descriptions of which of those technologies we consider the most important for KM, and classify them into two blocks: base technologies and technological applications (Table 3). The first group includes those technologies that are available in the market for any type of use and that can be employed in KM processes, although they were not conceived solely for that purpose.

The other group comprises those packets formed by the combination of a group of basic technologies and those specifically configured for KM, although they may also have uses in other organizational areas.

Apart from the technologies and technological applications shown in Table 3, we have seen that the literature mentions many others that are not habitually used in KM, although we should not discount the possibility of their future applicability. Among those, we can refer to data analysis and report tools, trees of deduction and induction by rules, process modeling, probability networks, semantic networks, library systems, simulation technologies and cognitive technologies.

Dangers and Potential Problems when Using ICT for KM and ICM

We dedicate this section to analyze the dangers and potential problems that can arise from the use of technologies in knowledge and intellectual capital management. First of all, we examine some of the dangers cited by various authors. For example, from their experience in two practical cases, Swan, Newell, Scarbrough, and Hislop (1999) draw the conclusion that focusing the KM project on technical and infrastructural elements blinds those in charge to the social and cultural aspects. These authors state that these last two aspects are necessary to change the management of organizations in order to enable the development of a true and complete network of shared knowledge.

Chase (1997) agrees with that approach when he indicates that, in spite of the investments that organizations make in ICT and in training employees in its use, the best knowledge existing in the organization is not normally available in the right place, time or format.

Junnarkar and Brown (1997) consider that, although ICT constitute a key enabler of knowledge creation, they are insufficient by themselves to increase an organization's collective intellectual capital. In other words, ICT are necessary but insufficient for KM and therefore, Baker, Baker, Thorne, and Dutnell (1997) and Tiwana and Bush (2001) indicate that, for ICT to function as facilitators of communication among an organization's members, they require a structured framework that permits that communication to take place efficiently.

Sveiby (2001) indicates that a climate of internal competitiveness should not be created since, in this case, the knowledge to be shared is only that which adds no value, while Junnarkar and Brown (1997) consider that there are three key elements that would facilitate the use of ICT for KM. Firstly, standards of hardware, software and communications should be developed for the entire organization in order to facilitate the sharing of information and knowledge. Secondly, investments in ICT must be made according to the organization's overall KM strategy. Thirdly, multidiscipline workgroups of the organization's experts in the areas of organizational design, organizational development and technologies should be formed with the aim of developing a joint strategy.

Finally, we should cite Lueg (2000) and Lang (2001), who state that the area of application of ICT for information management, and especially for KM, is very limited since, if information is considered to be the result of man's interpretation of the data, the complexity of getting computers to perform that task can easily be appreciated. They also indicate that the problems lie in the present ICT and believe it necessary to redefine them and create new languages, categories and metaphors. For their part, Baker et al. (1997) consider that the technologies are especially valid to access explicit knowledge since, for technology to permit access to tacit knowledge; it must be capable of solving problems related to the non-structure of this type of knowledge, to the impossibility of writing it and to the numerous interactions between the individuals involved.

Our opinion is in line with those contributions. We agree that the limitations of current ICT for KM may be overcome, on the one hand, by improving their capability to work with tacit knowledge, and attempting to improve significantly both the way in which they are used and the corporate approach to them, and, on the other, by selecting those ICT that really are relevant to the area and creating a bundle labeled knowledge technologies and applying them selectively.

BASE TECHNOLOGIES FOR KNOWLEDGE AND INTELLECTUAL CAPITAL MANAGEMENT

In this section we give a detailed description of the previously outlined technologies that are especially significant to KM. We first describe each of them and then define their specific contribution to KM.

Web Technologies

There are numerous technologies created around Web services and based on the use of HTML, its extensions and XML. Web technologies serve to access knowledge resources available on Internet or Intranets by using a Web navigator (Meso & Smith, 2000). These technologies are widespread for a variety of reasons, from which we can highlight their allowing simple development of KM systems, their flexibility in scalability terms, their simple use and their imitation of the way humans interrelate, by making the knowledge of others available irrespective of hierarchies, formal barriers and other aspects. We can include the following technologies in this group of Web technologies:

- **Intelligent Agents.** Laudon and Laudon (2000) define these as programs that perform specific, repetitive and predictable tasks for a particular user for a business process or a software application. They are programmed to seek and find information relevant to the user based on his/her preferences. Some examples of these tasks are the deletion of junk mail, making appointments or searching for the cheapest travel tickets of interest to the user. The agents are not endowed with great intelligence but they do hold a significant amount of information about their owner.
  Search Engines. Search engines comprise a series of programs that permit the location of documents that meet certain of a wide range of criteria. The searches can vary from the very simple to the highly complex.
- **Push technology.** This technology consists of providing the user with the information required, thus avoiding the need to search for it on the Web. The user indicates the type of information required (sports, weather, etc.) and the software warns the user when it locates something interesting that is available to the user (Laudon & Laudon, 2000). In that respect, the syndication technologies and reception of feeds in RSS format are currently enjoying great success. To be specific, that is a shift from a proactive user to a system of proactive sources that provides the user with the requested information. In the case of KM, the main use of *push* technologies is in their ability to make a selective diffusion of knowledge.

Databases, Data Warehouses and Mining Tools

A *database* is a set of data organized to service a series of applications efficiently by centralizing the data and minimizing their redundancy. When databases contain a large amount of static data, in other words, data that is not frequently modified, for example, historical data, they are called *data warehouses*. *Mining tools* serve to analyze a great quantity of data normally contained in a database, searching for patterns that can be used

to guide decision-making and to predict future behaviors (Laudon & Laudon, 2000). The three described elements are initially thought of for data management but may also be used in information and knowledge management, providing that the latter is explicit. That is why some authors speak of *knowledge repositories* instead of using the term data warehouses.

From the point of view of KM, databases and knowledge repositories capture the explicit codified knowledge present in different organizational levels. In other words, they are used to store and make available what we know of the organization. That task is supported by mining tools, which are able to collaborate in the knowledge generation process (Bhatt, 2001).

The main problem of those repositories is that they usually lack contextualization, meaning that the users have to make a significant interpretation; in other words, the repository contains information and not knowledge (Bhatt, 2001). Some repositories aim to integrate the maximum possible content when information is captured, thus permitting the storage of resources complementary to text, such as images, audio and video. In any case, it is clear that there is the limitation of their only being able to capture and represent a fraction of the knowledge and intellectual capital, namely, the explicit knowledge (Quintas, Lefrere, & Jones, 1997). In spite of those problems, repositories facilitate the maintenance of the organization's shared intelligence and historical memory (Ruggles, 1998).

These technologies have a highly promising future in KM processes since they will participate in the vast majority of associated processes, namely, the creation, codification, application, validation, protection and distribution of knowledge.

REAL WORLD IMITATION TECHNOLOGIES

In recent times we have witnessed the appearance of a series of technologies whose objective is the development of systems that simulate the behavior of entities in the real world, be they human humans, cell groups or social systems. In this section we examine some of them.

Expert Systems. Expert systems are systems dedicated to the capture and codification of the knowledge and wisdom of a human expert in specific domains (Laudon & Laudon, 2000). They belong to the area of artificial intelligence and their functioning comprises three distinct phases. In the first phase, they convert the experts' tacit knowledge into explicit knowledge in the form of IF….THEN…. rules until a rule base is created. In the second, faced with a determined situation, they are able to arrive at a valid result by using a minimum number of context-relevant questions for the user to answer, thus advancing in the search for the result. In the final phase, they are able to explain how they arrived at a solution, thus enabling new, apprentice experts to absorb that tacit knowledge by transforming it into tacit knowledge.

Their area of application is limited to situations where we have one or several experts to help us in the creation of the expert systems. However, those experts are not sufficient in number to be present wherever and whenever decisions are made. The expert system helps users who are not experts but who have a certain basic knowledge of the issue to be resolved. According to Hornik and Ruf (1997) expert systems allow training costs to be reduced, albeit in exchange for high initial investment in their development. Those authors also show that knowledge is transferred to a greater extent with expert systems than without the aid of this type of tool. In any case, the ideal way of using this type of system is in combination with analogue techniques (principally contrasts and reflection) so that, on the basis of the problem posed by the expert system itself, it is the learner who thinks and not always the expert system that answers the questions.

Two areas where they have been successfully applied are health and finance. In the health area, their use is based on codifying the diagnoses of diseases and their treatments in a system that is later used by a doctor to aid him/her in relations with the patient. In the financial field, the most common application has been as an aid in granting loans and in conducting audits (Hornik & Ruf, 1997).

Genetic Algorithms. Genetic algorithms, also called adaptive computing, refer to a set of techniques that use the conceptual model of the adaptation of living beings to their environment as a method of survival (Laudon & Laudon, 2000). One of the principal advantages of these algorithms is that they are able to solve problems in which individuals are unable of understanding its structure (Holland, 1975).

Genetic algorithms are particularly indicated for product optimization and the design and monitoring of industrial systems. For example, in business environments the need for optimization (minimization of costs, maximization of profits, efficient allocation and use of resources, etc.) is usual in complex and turbulent environments (Laudon & Laudon, 2000), which is precisely where they are seen to be more useful.

Since this is such an incipient technology and is in a phase that we could call embryonic, its use in KM is still rare, although it is foreseeable that, in the not too distant future, genetic algorithms will become increasingly important in the same areas as expert systems and even is some areas where the latter display little utility.

Neuronal Networks. A neuronal network is a set of software and hardware that attempts to imitate the process patterns of the human brain. These networks have been attracting great attention recently since, as Laudon and Laudon (2000) indicate, we are witnessing a resurgence of interest in approximations of artificial intelligence that are based on an approach in which machines are designed to imitate the biological process of thought.

The neuronal network approach differs from that of expert systems in that neuronal networks are able to understand, but not to explain, how they came to a specific conclusion while the expert systems, being based on rules, are always able to explain their method of working.

Their use is centered on the resolution of problems related to the classification of patterns, predictions, financial analyses, control and optimization, all of which are applications in which the importance of the knowledge is very high. Normally, their aim is to help a human, not to replace him/her.

Computer-Based Learning

Learning is fundamental to an organization's ability to execute KM processes. As we have seen in the previous sections, the two concepts are intrinsically linked since, to be able to manage knowledge, it is essential to have suitable conditions for learning to take place (Mellander, 2001).

Computer-based learning is that set of technologies designed for the worker to access organizational knowledge about ways of doing things from his/her computer whenever he/she wishes or needs, instead of attending training courses planned by the organization itself or by the organization charged with providing the information.

There are two principal advantages to using this type of system (Trodsen & Vickery, 1998). On the one hand, concepts are retained better when they are applied directly and immediately. On the other, it improves knowledge transfer since it has been shown that students learn faster in a risk-free environment, with no fear of being seen to make mistakes or of teachers or colleagues discovering their ignorance.

Work and Document Flow Management

Work and document flow management consists of analyzing the sequence of tasks and documents involved in executing a business process and creating the necessary mechanisms for the transfer of documents and information to take place in the most automated way possible under some procedural norms (Laudon & Laudon, 2000). Sometimes, workflow management is also called document flow management.

When these systems are used to automate the transfer of documents, with pre-established rules and no value to the firm, between administrative assistants, their contribution to KM is quite limited. However, when the analysis achieves the definition of the set of business rules, and even permits its management, we are performing tasks of knowledge codification, validation, creation and distribution. As in most of the described KM cases, for this process to be executed correctly, there must be a series of standards and classifications referring to the basic concepts of the business (Sveiby, 2001).

Geographical Information Systems

Geographical information systems (GIS) are tools designed to analyze and display data on maps of a geographical or other nature (Laudon & Laudon, 2000). Their capabilities include those of combining, storing, manipulating and representing information with geographical references (georeferenced information).

From the KM perspective, the main use of geographical information systems is the creation of knowledge by locating patterns of behavior in the data by spatially visualizing it. Just as data mining tools look for patterns by means of numerical analysis of data, these tools enable humans to be the ones that look for patterns by means of spatial analysis.

The future development of this technology will be to create geographical data mining tools that are able to contextualize the data geographically and then look for significant patterns in those data. However, we believe that the development of this type of tool will take quite a time: that is, until numerical data mining reaches a point of maturity that permits its application in other contexts.

Knowledge Maps

A knowledge map is a diagram that shows the knowledge available in an organization. It allows fast and efficient location of information relevant to decision-making and problem-solving. Moreover, it is a directory that describes a series of categories of specialized information and indicates where it can be found, and its state, value and utility.

According to Ruggles (1998), it is evident that a great part of organizational knowledge can not be codified; it remains in the minds of experts. Therefore, it is important to be able to locate those experts through these maps and to know what knowledge they possess. Ruggles states that there are several reasons for the complexity of constructing the maps. On the one hand, someone must determine who in the organization knows the most about a topic. That task is complicated; not only in terms of locating the subject who meets that requirement, but also because of the possible problems among other workers who may feel undervalued. On the other hand, true experts are not normally interested in being easily located by anyone in the organization, especially if there is not a system that rewards them for the additional workload involved.

We find the use of these maps in the distribution and creation phases of KM. They permit concepts to interrelate, thus easily defining a common language by observing the different maps and checking the meanings of a particular term in each of them.

Workgroup Tools

Workgroup software, or groupware, refers to software that includes functions and services that facilitate the collaborative activities of geographically disperse workgroups by permitting the users to interact and share structured and non-structured information (Shani, Sena, & Stebbins, 2000), thus facilitating the creation of systems to aid decision-making (Meso & Smith, 2000).

Many workgroup software options are available on the market. These packages usually include a series of applications aimed at managing the following aspects:

- *Meetings of physically disperse groups* (Bollinger & Smith, 2001), either through visual systems such as videoconference, or through textual tools such as chat.
- *Information sharing*, which is achieved through the exchange of electronic messages between members of a group, with the messages stored by topic, making it possible for every member to access everything that has been said about any topic. Similarly, it is possible for several group members to work on a document because it enables all members to access the document and make modifications that are clearly displayed.
- *Electronic agenda* of group members and the resources they have available. Those resources include the management of common resources such as meeting rooms or equipment, while also permitting meetings between group members to be arranged according to their availability.
- *Electronic mail*, a tool that has previously been described, the only difference being that, in this case, the application is included in an overall system.

As in the case of Web technologies, and since workgroup technologies are available to every organization, we cannot consider them to be providers of strategic resources although they could become so depending on the use made of them and the contents inserted into them.

TECHNOLOGICAL APPLICATIONS FOR KNOWLEDGE AND INTELLECTUAL CAPITAL MANAGEMENT

Having analyzed the principal technologies used in KM, either as direct contributors to the processes, or simply as supports in their development, we now describe the most common KM technological applications that use the technologies described in the previous section.

Data Warehouses

The term data warehouse is used to refer to the combination of a database management system, a series of mining tools and a set of current and historical data of potential interest to an organization's managers (Laudon & Laudon, 2000). Those data are standardized and consolidated for the firm as a whole so that the joint analysis of the data of the different areas is possible. The data are available to everyone with access to the warehouse, with no modification to the data permitted.

The main utility of these data warehouses lies in their enabling quality information for decision-making to be obtained (Boar, 2001) by facilitating the extraction of knowledge from operational level databases by manipulating them until what was being sought is found. That extraction is conducted with data mining tools.

From the point of view of KM, data warehouses are also interesting because, to a great extent, they facilitate the distribution of knowledge, permitting all the organization's components to have access to the strategic data that they need for their work.

Help Desk Tools

Help desk services are those which users of a product or service can contact (normally by telephone) when they have a query regarding the installation, set up, use or functioning (e.g., technical assistance in ICT related issues). The objective is to combine a series of resources in such a way that incidents are resolved by optimizing the resources, and customer satisfaction is achieved (Wen Chong et al., 2000). The term help desk can be used both for services provided internally in organizations and for services provided to external customers.

Since these are services whose objective is to assist and satisfy the customer, in many cases they include such diverse concepts as business resource management, customer relationship management (CRM), call centers, sales force automation (SFA) and front and back office solutions.

The knowledge used in those applications is complex since it has to be vast and at the same time deep in order to meet all requests. Therefore, the use of KM in technical assistance services leads to a series of advantages (Davenport & Klahr, 1998), such as higher quality solutions given to customers, consistency in the responses, a higher proportion of problems resolved on the first call without having to escalate the problem to a higher level, lower cost per call, fewer calls to the support service and lower total costs, the possibility of having less technical, more user-oriented, staff, speedier learning and improved staff satisfaction.

Decision Support Systems

The term *decision support systems* (DSS) was first coined by Peter G. W. Keen and his collaborators at Massachusetts Institute of Technology in the mid-1970s. According to Keen and Scott-Morton (1978), DSS are based on four basic characteristics:

- The point of attention is not the operational level, but the resolution of the managers' specific problems, whether in their repetitive tasks or one-off tasks.
- The objective of the system is to support decision-making and not to replace the decider.
- The system comprises the person responsible for management and the technological mechanisms that permit a conversational interactive functioning.
- It is a support system that must be conceptualized more as a service that grows and evolves as the user learns and adapts, than as a finished product.

In practice, DSS are the result of the combination of ICT with operational research and business science, giving rise to generalized or specifically designed interactive models that are frequently of the "what if" type and intended to support decisions that are not completely structured in any level of the organization.

DSS are very useful in organizations wishing to improve their workers' capacity to make decisions, by making available the wealth of knowledge existing in the organization. Wisdom is collected from those who know about different subjects, transformed into rules and guides and made available, usually by means of ICT, to the organization as a whole (Ruggles, 1998). The possibility of making better decisions is one of the main reasons behind setting KM projects in motion (Wen Chong et al., 2000).

Discussion Forums

The term discussion forum is used generically to refer to any type of system of online bulletins where it is possible to post questions or messages in general, and find answers from others who read the forum. They usually include the option of accessing the forum with the sole purpose of reading the contents without actively participating.

Various organizations have attempted to implement the approach of creating a space for these forums on the firm's Intranet, with the idea that the workers use them as a place to exchange their ideas and experiences and to resolve their most common queries. Unfortunately, that type of approach is not usually successful (Shani et al., 2000), since the workers are normally reluctant to air their queries in public and in writing, on the one hand, and to answer their colleagues' queries, on the other.

Intranets and Extranets

An intranet is a private network in which Web technologies are used for communication between members of an organization, and which is protected from outside access by the use of passwords and firewalls (Laudon & Laudon, 2000). An Extranet is an Intranet to which access is granted to a limited group of external users and organizations, such as partners, customers, suppliers and collaborators in the distribution channel (Cothrel & Williams, 1999). In what follows, we only use the concept of Intranet although all the statements could equally be applied to extranets.

Not every intranet project should be thought of as a KM project; however intranets are frequently used to permit access to knowledge and to exchange it within the organization (Ruggles, 1998). Despite the apparent evidence about the utility of an Intranet, the reality seems to be quite different. Thus, authors like Cornellá (2001) indicate that it is common to find organizations shocked by the little use made of their Intranet and the low impact of Intranet on the generation of outcomes despite the significant investment that it represents. That situation is especially serious if it is considered that the objective of the intranet is precisely the exchange of knowledge between members of the firm.

According to that author, the answer lies in the fact that every *digital space* (a set of information and technological exchange tools) invariably needs a *social space* (a series of motivation, incentive and recognition mechanisms that stimulate people to make use of the digital space) and that this need has a multiplicative format, so that, if either of the two is absent, the result is zero, irrespective of the strength of the other.

Yellow Pages

Corporate yellow pages are databases on experts: a place in which the specialty areas of all the organization's members figure. One of its simplest applications is to locate experts in a determined field. The function mechanism of yellow pages is very simple: the management defines the areas of interest to the organization's functioning and the relevant workers declare themselves experts in the different areas.

As in the case of previously mentioned technologies, it is necessary to have reward systems linked to the use of this tool otherwise workers will not register as experts in any aspect because it would entail an additional workload. From the point of view of KM, the main interest in yellow pages is their contribution to the application and distribution of knowledge in organizations.

Knowledge Portals

A knowledge portal is a Web page containing a series of intelligent agents necessary to locate on the Internet information that is important to us.

Knowledge portals were conceived with the idea of them becoming the brain of the organization and providing its workers with the vital information needed for success in the hypercompetitive markets (Kotorov & Hsu, 2001), thus guaranteeing the survival of the organization.

Those authors believe that one of the problems is that, with the cost of publication practically nil, there has been an avalanche of content that has caused the cost of finding valid information for decision-making to soar. Knowledge portals

represent a possible solution to that problem since they locate on the Web what the user needs.

However, for information to be valuable, it must not only be relevant, it must also be timely, exact, verified and suitably presented. We have already seen that intelligent agents are ideal for locating timely and relevant information but they are unable to participate in its verification and presentation. The problem of verifying information is especially serious when the source is Internet, where any rumor can become reality in a very short time, regardless of whether it is true or not.

In short, knowledge portals are applications of special interest in KM, since they permit access to knowledge in a simple, automated way, even when faced with high levels of uncertainty and an avalanche of information. However, they do have their limitations, one of the most significant being their inability to verify the information.

CASE-BASED REASONING

Expert systems capture and codify the knowledge of expert individuals, but organizations also possess collective knowledge that has been accumulated over the years. *Case-based reasoning* (CBR) systems are useful to capture and store that type of knowledge.

Their working mechanism is based on storing descriptions of the experiences of human specialists in the form of cases in databases, to be retrieved when a situation that is identical or similar to a stored experience occurs. Once the most similar case is located, new parameters are applied and, if possible, the solution to the old case is adapted to the new case. If the outcome is successful, the new case is also stored in the repository (Laudon & Laudon, 2000). In other words, adapting the solutions of previous problems solves new problems.

While the functioning of expert systems is based on a set of IF-THEN, IF NOT-THEN rules, case-based reasoning represents knowledge as a constantly expanding combination of cases. These systems comprise four elements: a dictionary of resources used, a cases base, the resources to find similarities, and the resources to adapt the solutions (Richter, 1995). As previously mentioned, their contribution to KM is based on their capturing and applying organizational knowledge. Therefore, we can say that they participate in the codification and application phases.

DOCUMENT REPOSITORIES

The objective of document repositories is to capture knowledge and pass it to documents that the entire organization can use later (Davenport & Völpel, 2001). According to those authors, repositories are the most common type of KM and usually contain different types of knowledge: about the best practices carried out, sales management, lessons learnt during the development of projects or products, putting IS into motion, intelligence for the strategic and planning functions, and so forth.

Repositories may be official (edited, vetted and approved by management) or not. A portal is usually created to permit simultaneous access to several repositories. Many of them contain pointers to the experts in each document, thus creating yellow pages of knowledge at the same time.

Davenport and Klahr (1998) point out that one area in which repositories are normally used is technical assistance for users. However, they also state that, although the knowledge is stored on electronic documents, performing a search in all of them is not a valid option because it takes too long while the user is on the other end of the line. In seeking a solution to that problem, Tiwana and Bush (2001) propose a system of star-rating the documents according to the perceived usefulness of each of them, so that the most useful documents appear in the search results before those that are less useful.

CLASSIFICATIONS

After the review of the principal technologies and technological applications currently used in KM, this section classifies them according to their utility and the KM processes in which they play a part.

Utility

In Figure 2, we show the relationship between the current utility of the mentioned technologies for KM and the actual use that organizations are making of them. It should be borne in mind that the use being made of them is measured as a whole and not only for their use in KM.

Dividing that figure into four quadrants, we examine each quadrant in turn, starting at the top-right and moving in an anti-clockwise direction. The first group contains the high-utility, high-use technologies comprising Web technologies, work-group tools, databases, repositories and mining tools, and work and document flow management tools. These are the elements available to organizations wishing to conduct KM processes. The only aspect that needs developing in this group is a more intensive application of the technologies in KM, especially in the cases of databases and workflow management tools, which are currently used in the resolution of operational and routine tasks that do not really contribute much to KM.

The second group contains the lower-utility, high-use technologies; comprising computer-based learning and geographical information systems. Given the lower utility of the technologies in this group, the actions to be taken should be on the lines of discovering whether it is possible to use these technologies to a greater extent for KM. The third group, the low-utility, low-use technologies, is empty because no elements meeting those two conditions were included in the technologies under consideration.

Figure 2. Utility and current use of the different technologies in KM

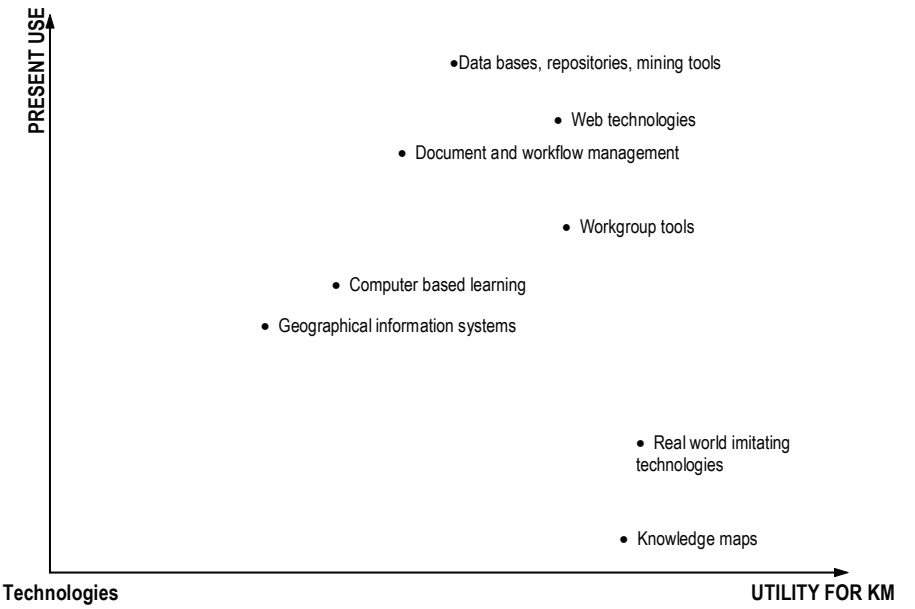
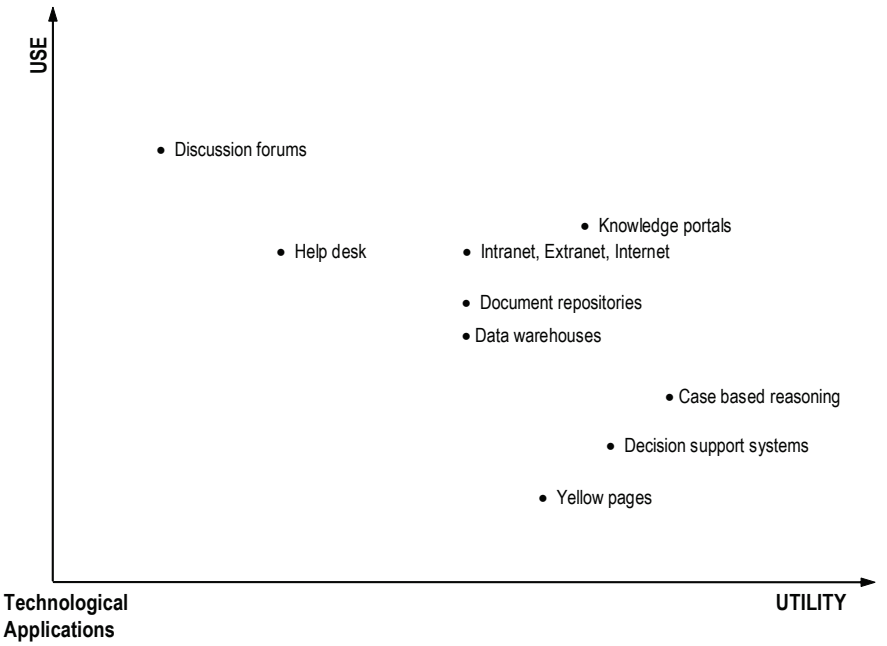


Figure 3. Utility and use of the different technological applications in KM



Finally, we come to the group with the highest potential for development: the high-utility, low-use technologies. This group comprises the real-world imitation technologies and knowledge maps. It has been confirmed that experiences of these technologies in the field of KM have been positive; therefore, we consider it advisable to intensify research into these areas, both in the technologies themselves and in their applicability to KM.

Figure 3 is similar to the previous one, but for the technological applications. Once again, we analyze the quadrants in an anti-clockwise direction. The first quadrant contains a series of high-utility, high-use applications comprising data warehouses, document repositories, Intranets and Extranets and knowledge portals.

The second quadrant refers to low-utility, high-use applications, in which we include discussion forums and help desk systems. The former have been in use since the early days of Internet in the 1970s, although rarely for KM-related tasks. The latter are generally proposed with the aim of managing knowledge, although that has been accomplished on only a few occasions. Their diffusion is relatively widespread, but we believe that by themselves they can not properly support KM processes, and that applications such as case-based reasoning are required.

As in Figure 2, the third quadrant, high-utility, low-use, is empty. The fourth quadrant contains the group of applications with the greatest potential: those that we consider to have high-utility for KM processes, but whose actual use in those processes is low, either because they are still in the development phase, or because the results of tests that have been conducted were not as positive as expected. These applications are case-based reasoning, decision support systems and yellow pages. Therefore, we propose that future research focus on those three applications and the two previously mentioned technologies, namely, real-world imitation technologies and knowledge maps.

Knowledge Management Processes

We also consider it interesting to classify the contribution of the different technologies and technological applications to the various basic processes related to the knowledge existing within an organization. To that end, we use a chart containing seven processes: creation, codification, validation, distribution, protection, updating and application.

Table 4 shows that the technologies contribute most in the codification and distribution processes, which was logical to predict, since they are the two areas where technologies display significant advantages over other means. However, they also have the ability to collaborate in each of the other five processes, albeit to a lesser extent.

In the previous section, we also indicated the contribution of each technological application to the seven processes necessary for KM. We use that information to produce Table 5.

The results shown in Table 5 are similar to those in Table 4, but with differences in the support given by technological applications to the knowledge application processes, on the one hand, and the near absence of applications that aid the creation and updating phases. That situation is normal since it is precisely those two processes that depend most on the human component.

FUTURE TRENDS

It is logical that the study proposed here should be, and is, in a state of constant evolution. Since what is being proposed is the possibility of defining a group of knowledge technologies, the evolution of participation of these and other technologies in KM and ICM in organizations will have to be seen.

Table 4. Classification of technologies for KM according to the process in which they play a part

Technologies	Creation	Codification	Application	Validation	Protection	Updating	Distribution
Web technologies			☒			☒	☒
Databases, repositories and mining tools	☒	☒	☒	☒	☒		☒
Real-world imitation technologies		☒	☒		☒		
Computer-based learning		☒			☒	☒	
Workflow management	☒	☒		☒			☒
Geographical information systems						☒	
Knowledge maps	☒	☒		☒			☒
Workgroup		☒					☒

Table 5. Classification of the technological applications for KM according to the process in which they play a part

Data applications	Creation	Codification	Application	Validation	Protection	Updating	Distribution
Data warehouses	☒	☒		☒	☒		☒
Help desk tools		☒	☒	☒			☒
Decision support systems		☒	☒				☒
Discussion forums				☒	☒		
Intranets & Extranets		☒	☒	☒			☒
Yellow pages			☒				☒
Knowledge portals		☒	☒				
Case-based reasoning	☒		☒	☒		☒	
Document repositories		☒	☒	☒	☒		☒

CONCLUSION

The principal conclusion that we can draw from this work is that the participation of ICT in the KM and ICM processes can be significant, especially in the management of explicit knowledge and under determined organizational circumstances. We should not fall into the error of thinking that two components of the organization as complex as its knowledge and intellectual capital can be properly managed with ICT alone. However, we can be sure that, with ICT, those processes can be facilitated and greatly improved. Moreover, it is foreseeable that, in the near future, other technologies based on those mentioned in this work will appear, and they will be technologies that enable further development of this applicability since they will be conceived more specifically for that purpose.

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Chapter XII
Knowledge Sharing in the Context of Information Technology Projects: The Case of a Higher Education Institution

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ABSTRACT

The proposal for this chapter is to analyze the influence of knowledge sharing in the context of an IT project management. This study is a result of field research that enabled an investigation of the way knowledge sharing figured among the parties involved in the ERP (SAP R/3) system implementation project in a Brazilian Higher Education Institution, as well as the analysis of how this sharing influenced the project in question. Data was collected in semi-structured interviews, open questionnaires and from documentary analysis. The research enabled us to verify that the factors that influenced knowledge sharing and consequently the project itself can be related to the context and dynamics of the institution in which the system was installed, to the way in which the project was planned and conducted, and also to the individual characteristics of the participants.

INTRODUCTION

Knowledge has always been part of organizations. However, conceptions of its value and role have changed along with the society and organization's development. The transition from industrial society to knowledge society, according to Toffler (1980), is represented by the third wave of change, and has been accompanied by a new group of values and by the perception that

intangible assets are strategic and indispensable resources for organizations.

Knowledge has come to be seen as an asset that needs to be managed as any other tangible asset. Many of the factors which have led to increased interest in intangible assets are consensual, such as changes in the global economy, increasingly competitive companies, the need for ever faster and more flexible organizations and the huge advances in technology in the fields of information and communication.

The recognition of intangible assets as strategic resources that need management has led to growing discussion and attention to knowledge management throughout organizations in general and in the context of project management in particular. According to Kasvi, Vartiainen, and Hailikari (2003), project management success is based on accumulated knowledge and on individual and collective competence.

However, knowledge management in the context of project management faces several challenges considering the nature of a project. Projects involve people with different knowledge, cultures and languages. Projects are limited to one period of time and the people involved and the lessons learnt are frequently dispersed at the end of the project (Bresnen, Edelman, Newell, Scarbrough, & Swan, 2003; Kasvi et al., 2003). It can therefore be difficult to develop a systematic process that can maximize information flow and learning. Knowledge sharing constitutes a central challenge.

The inherent challenges in project management also need to be considered in information technology (IT) projects. IT project examples are development and implementation of a new product, service or process (Karlsen & Gottschalk, 2004). This study examines an IT project for the implementation of an ERP (Enterprise Resource Planning) system in a Brazilian higher education institution.

An ERP integrates information and processes among different organizational areas—production, finances, accountability, human resources, and so forth. Its purpose is providing support for running and managing most of a company's operations (Kummar & Hillegersberg, 2000). The critical issues related to these systems rely essentially on change from a traditional departmental management to one centered on processes, and on organizational difficulties for aligning systems' technological features to business needs (Davenport, 1998). This alignment demands knowledge of the critical organizational processes, as well as detailed knowledge of the system (Soh, Kien, & Tay-Yap, 2000).

This means that complex IT projects, such as ERP ones, are knowledge intensive and involve people interaction with different expertise and skills: on the one hand, the company represented by its collaborators who have knowledge of the organizational requirements and the infra-structure of the existing technology and on the other, the system suppliers and/or consultants who have knowledge of its functionality and have experience in its implementation.

Project group members' knowledge basis and distinct languages may make knowledge sharing more problematic (Soh et al., 2000; Bresnen et al, 2003; Ko, Kirsch, & King, 2005). As well as this, much knowledge is tacit, and this can make sharing it even more difficult. Taking into account the diversity of knowledge involved in an IT project, it is necessary to consider a way of sharing and integrating this knowledge that will contribute to the success of the project (Clegg, Waterson, & Axtell, 1997; Soh et al., 2000; Mabert, 2001).

Considering this, the proposal of this chapter is to analyze the influence of knowledge sharing in the context of IT project management. This study is a result of field research that enabled an investigation of the way knowledge sharing figured among people involved in the ERP (SAP R/3) system implementation project in a Brazilian higher education institution, as well as the analysis of how this sharing influenced the project in question.

This chapter is structured in five sections. This first section presents the introduction that outlines the subject, the context and the objectives of the study. The second section presents the theoretical basis to the researched subject. Theoretical basis took into account the following topics: IT project management and the knowledge management; knowledge sharing in IT projects; and factors that may influence the knowledge sharing in the context of IT projects. The third section presents the methodology of the research. The fourth section presents the field research collected data analysis. The fifth and last section exposes the final considerations of the study.

BACKGROUND

The theoretical basis was the search of knowledge management and knowledge sharing importance in IT projects and possible factors that may influence knowledge sharing.

Knowledge Management in IT Projects Management

Studies on knowledge management and IT usually focus on technology supporting the knowledge management process in the organizations. Few works are dedicated to the importance of knowledge management in IT projects implementation. In many cases, IT project failure is due to the losses of generated knowledge in each of its steps. It's also related to the dependence on the relation between the institution and the consultancy company.

The key point is that various individuals are supplying different forms of knowledge, skills and expertise for a period of time despite how many or what projects steps and relations (Clegg et al., 1997). Some examples of knowledge forms are business strategy, IT strategy, systems project and analysis and project management.

So knowledge management becomes one of the critical competences for project management (Ruuska & Vartiainen, 2003; Seng, Zannes, & Pace, 2002; Bresnen et al., 2003; Crawford, 2000). According to Kasvi et al. (2003), knowledge management in projects or IT projects management is fundamental if the organization intends to become a learning organization and use the learned lessons in other projects. However, Bresnen et al. (2003) emphasize that knowledge management in projects faces several challenges, considering the people, materials and information fluxes discontinuity in each project step.

Four groups of knowledge management activities should be considered to face these challenges (Kasvi et al., 2003): (1) knowledge creation; (2) knowledge administration (storage, organization and recovering); (3) knowledge sharing and (4) knowledge use. This research focuses the role of knowledge sharing in IT projects. According to Karlsen and Gottschalk (2004), the correct environment and tools for knowledge sharing will increase the team capacity to reach project goals. A question remains: what does knowledge sharing mean?

Knowledge Sharing in IT Projects

Davenport and Prusak (2000) characterize knowledge sharing as the knowledge transferring either spontaneously (informal) or structured (formal) among individuals. The term transference is related to two actions: the transmission (sending or presenting knowledge to a person or a group) and the absorption (incorporation or assimilation this knowledge by the one that received it). However, even transmission and absorption together have no value if the acquired knowledge is not placed into use. Ko et al. (2005) also emphasize that knowledge sharing is related to knowledge communication by the transmitter and knowledge learning and application by the receptor.

Lahti and Beyerlein (2000) observe that knowledge sharing involves the knowledge transmission

and diffusion inside an organization or between different organizations. Both cases are present in the context of IT projects. For example, an implementation team of an ERP system is usually composed of a supplier and/or system consultants and by the organization team. Knowledge sharing can also occur inside the project—between its members—or outside the project—between the project team and the organization (Kasvi et al., 2003).

The difficulty of knowledge sharing is directly related to the type of knowledge involved (explicit or tacit). Explicit knowledge may be codified by procedures or represented by documents, books, archives and databases. It is easily identified and shared. Tacit knowledge, however, is personal and subjective, incorporated to the individual experience along time. Sharing tacit knowledge demands intense personal contact, either by partnership, by an orientation relationship or by learning (Davenport & Prusak, 2000; Sveiby, 1997).

An IT project is pervaded by explicit as well as by tacit knowledge. Several factors may influence the way individuals interact and share what they know. Mussi and Angeloni (2001) say that those factors must be analyzed and considered to the effective understanding of individuals' attitudes and behaviors regarding their activities in the organizational and project context and their knowledge sharing.

Factors that may Influence Knowledge Sharing in IT Project Management

Organizational knowledge management literature broadly discusses knowledge sharing. It regards several factors that may inhibit or stimulate knowledge sharing. However, there are few studies about factors that may affect the knowledge sharing in IT projects, as Karlsen and Gottschalk (2004) and Ko et al. (2005).

Among those factors we join those found in mentioned specific researches about knowledge sharing in IT projects and others from knowledge management research: cultural and structural factors, systems and procedures, information technology, working place and informal spaces, language, absorptive capacity, knowledge partiality and motivation.

Cultural and structural factors are critical for knowledge sharing success (Davenport & Prusak, 2000; Cameron, 2002; Seng et al. 2002; Karlsen & Gottschalk, 2004). Many IT projects are positively influenced by organizational cultures that appreciate, facilitate and promote sharing (Karlsen & Gottschalk, 2004).

In an organizational culture non-favorable to knowledge sharing there are no incentives to promote knowledge sharing and insights from the workers. Low time and attention are dedicated to identify the learned lessons about projects' successes and failures. Suppositions about new projects are not challenged. The organization hires and promotes individuals based only on technical expertise. Management is reluctant about project failures. Different conflicting cultures are produced by distinct missions and visions from divisions and departments (Cameron, 2002).

Another critical fact about knowledge sharing in IT projects is called "**systems and procedures**" by Karlsen and Gottschalk (2004). Systems and procedures must be defined to structure knowledge sharing. A clear planning about knowledge sharing in the project must exist. An example of project procedure should be defining the need of a management experience report after a project ending.

The use of **information technology** in the context of a project is also a factor that may maximize knowledge sharing, as it allows individuals to communicate even though located far apart. It increases the knowledge exchange velocity. It eases the contact between people looking for knowledge (Davenport & Prusak, 2000; Karlsen & Gottschalk, 2004). Computer networks, e-mail, databases, discussion groups, electronic bulletins and groupware are some examples. Many of

those tools have been used as important support to project execution.

Project working place and informal spaces are factors that may inhibit and/or facilitate sharing in IT projects. According to Majchrzak and Wang (1996), the working place layout may affect positively or not the collective responsibility. Some layouts may encourage people to share their knowledge and try new ideas. Others may hinder spontaneous sharing between people. One way to incite project knowledge sharing is the creation of meeting spaces and occasions for informal interaction. Social events during an IT project may help team spirit and compromise.

A **common language** between the project team is also essential to the absorption of transmitted knowledge. The term common language assumes that the vocabulary, references, and actions are common understanding. The used ways for sharing are understood by all persons. People cannot share knowledge if they do not speak the same language (Davenport & Prusak, 2000).

A standard reference structure (Lahti & Beyerlein, 2000) is important as it supplies a shared understanding between individuals. Knowledge can be better shared this way. An IT project has multidisciplinary teams composed of by people with different background and knowledge. Individuals from the company share a common culture, experiences and references. Suppliers and/or consultants also share. The technology professional's language is distinct from the businessman. Sveiby (1997) poses that the challenge is to make both groups act in a collaborative and shared way.

Besides language, **absorptive capacity** is another factor that may influence the knowledge sharing in IT projects. Absorptive capacity is defined by Cohen and Levinthal (1990) as the individual capacity to assimilate and use a new knowledge. This capacity is a function of individual preexisting knowledge structure: the relation degree of their previous knowledge base with the new acquired knowledge. Ellinor and Gerard (1998) state that for learning occurrence, new information must be processed. This involves relating them to what is already known: extracting meaning or sense from the new data by the connection to our knowledge system.

Another factor that may be present in IT projects is **knowledge partiality.** According to Clegg et al. (1997), more value to some forms of knowledge and expertise is generally attributed in the system implementation project. Even some knowledge can be excluded from a project. It is usual, for example, to give more importance to technical questions than user knowledge about working activities and its problems. Clegg et al. (1997) suggest that a system implementation project may be partial in relation to knowledge incorporation, emphasis and timing.

O'Dell and Grayson (1998) and Leonard and Sensiper (1998) remark that higher value and trust use to be done to explicit knowledge sharing than to tacit knowledge sharing. Kim (1993) observes that knowledge or ability acquisition demands two basic meanings: abilities or **know-how** acquisition, the ability to produce action; and the **know-why** acquisition, the ability to articulate conceptual comprehension of an experience. Know-how and know-why complement each other. Acquiring just one of them may represent a partial knowledge, not allowing the individual to apply it effectively.

Motivation is considered in Ko et al.'s (2005) research as an influencing factor on knowledge sharing. They referred to intrinsic and extrinsic motivation. Intrinsic motivation means that the motivation is due from one's own satisfaction by the activities carried out. Extrinsic motivation is resulting from external stimuli. Lahti and Beyerlein (2000) also remark that motivation is a key necessary element not only for the one that shares knowledge but for the one that receives it. To absorb a transmitted knowledge it is necessary to be motivated and to desire to hear and learn. Sharing comes from a clime of reciprocity from who shares and who receives the knowledge.

RESEARCH METHODS

Following the problem nature and the proposed goals, this research is qualitative case study type. The focus is exploratory and descriptive. The studied organization is a higher education institution, the first university to implement SAP R/3 in Brazil.

The researched university has approximately 28,000 students, 1,800 professors and 700 technicians. It offers 59 regular undergraduate courses, 30 specialization courses and 7 graduate courses, besides other courses offered. The research universe in this case study is restricted to the persons involved on the SAP R/3 implementation project. It was implemented considering three *campi* and the areas from these *campi* related on the system modules implemented.

Thirty-seven persons were directly related to the project, either from the university (key-users, IT area members, etc.) or from the service suppliers. Thirty persons were indirectly involved as end-users. The intentional sample is presented on Table 1.

As shown in Table 1, research takes account of 28 participants distributed as follows: 19 persons from the institution directly related to the project, 6 end-users indirectly participating in the project and 3 consultants from SAP.

Primary data were obtained based on semi-structured interviews from the persons from the institution. The interview script was open and flexible. It was prepared to analyze not only knowledge sharing intervenient factors found in references, but also possibly the identification of other factors from the interviews.

A total of 25 interviews were conducted in the work environment of the participants. Beyond the interviews with the university participants, the consultants also received an open questionnaire. Only three consultants from SAP fulfilled the questionnaire. Secondary data were found in several project-related documents, such as newsletters, an internal newspaper and an institutional Web site, to complement the information.

Data analysis was done based on a deep study from collected data for theoretical support for the reflections.

DATA AND RESULTS PRESENTATION

Project Nature and People Involved

The SAP R/3 implementation project was named Vision Project inside the institution. It covered three university *campi*. It considered the financial and administrative processes with the following modules implementation: Financial (FI), Control (CO) and Materials (MM). Vision Project was developed during fifteen months, as previously defined in term and aim. The project may be characterized in three different generic steps:

Table 1. Research universe and sample

UNIVERSE GROUPS	UNIVERSE	SAMPLE
PEOPLE DIRECTLY INVOLVED FROM THE INSTITUTION	27	19
PEOPLE DIRECTLY INVOLVED FROM SUPPLIERS	10	3
PEOPLE INDIRECTLY INVOLVED – END-USERS	30	6
	67	**28**

pre-implantation, implantation and **post-implantation**.

In **pre-implantation** step identified the need of university systems change. The university is fast-growing and the need of informational support for an integrated vision of its sector and *campi* was the main reason. It was constituted a multi-departmental and multi-*campi* group. It was composed by directors from affected organizational areas and representatives from the IT area. The group made a methodic process analysis of systems fitting and market suppliers in relation to the institution needs. The German company SAP and its R/3 system were chosen. Most of consulting services were supplied by SAP, as it was the first Brazilian university to use SAP R/3. It was an opportunity for SAP to get know-how in the sector.

The system **implantation** was oriented by a SAP implantation methodology called ASAP (*Accelerated SAP*). The implantation team was composed of full-time dedicated working teams structured by module. Those project teams were composed of professionals from the organizational areas involved (key-users), IT area members and SAP consultants. There were two project managers: one from the university and another from SAP. Institutional committees were created with partial dedication to the project: executive committee (rectory and *campi* managers) and validation committee (organization area managers and two IT area representatives). Another consultant was also hired. His role was the sensitization of institution personnel for the changes attending the integrated system implementation.

The **post-implantation** system step was happening during this research. The SAP consultancy was already finished and the end-users were being trained to use the system. Some adjustments were made due to organizational changes at the time.

Factors Influencing Knowledge Sharing and Its Relation with System Implementation Project

It was observed that, despite the SAP project step numbers, a certain number of people from the university and outside it participated and added knowledge to the project. This point was remarked upon by some of the people interviewed talking about the interaction between people from the university and the SAP consultants.

... we knew how process worked here and SAP has the know-how, knowledge, how system works and how adapts it to our processes. This marriage happened, SAP enters effectively with software knowledge and we with processes knowledge (interview 22); *... the consultant, from outside, has system knowledge and we knew the management unit, so we join both to get the best.* (interview 21)

Sharing is a process pervaded by different factors with positive and negative influence (Davenport & Prusak, 1998; O'Dell & Grayson, 1998). In this sense, this work searched to rescue and to analyze the factors influencing knowledge sharing on the SAP R/3 implementation in the educational institution for better understanding: these factors will be regarded separately though it was observed that they are inter-related.

Cultural and structural factors related to the traditional department vision prevail on most organizations. It increases the barriers to the integrated systems implementation (Lam, 1997). This department vision in the studied institution harmed the interdepartmental sharing practice during the project. Baba, Falkenburg, and Hill (1996) observe that integration implies sharing and opening. People must be concerned in how

their actions and decisions impact the organization as a whole. In a department organization, people are concerned on tasks with limited focus to their department. Besides, a strong department culture and structure increased the resistance to change from isolated systems to an integrated system. Sometimes this resistance influenced knowledge sharing during the project. This diminished the strength from people to participate and share what they knew.

The lack of definition of **systems and procedure** to knowledge sharing "outside" the project was another identified factor. Knowledge sharing practices outside the project were weak and nonsystematic. Some users belong to the project institutional team. They were called key-users. When needed during implantation, some end-users—that didn't integrate in the project team—were called to collaborate or participated by their own initiative. Anyway, it was not perceived a systematized integration and interaction between the team project and the other system users. This should propitiate more effective sharing between both parts, mainly regarding the involved areas' needs.

However, the used system implantation methodology previewed documentation procedures by institution project members that eased explicit knowledge sharing. Most of key-users considered that their prepared documentation about knowledge acquired related to the system operation contributed for learning and became registered to other users. The operational procedures from the implantation system step to what would be documented and the form of this documentation were previewed in SAP implantation methodology.

The use of **information technology**, especially project management *software*, was also previewed by the system implantation methodology. It favored generated knowledge exchange, register and integration by the different module teams. At the implantation step one of the explicit knowledge that needed to be shared and understood by team members was ASAP system implantation methodology. *Microsoft Project software* was used for this purpose. Each project module documents were available and could be shared by the team. Computer networks and file structure were used for documentation storage and access of all project products. All team members could access all project step products. *Microsoft Word* was used for system operation documentation register by the working team during interaction with consultants. Those documents are today available for all users.

The project **working place** also facilitated knowledge sharing, confirming Majchzak and Wang's (1996) remarks. The use of the same room by consultants and institution team members contributed to effective interaction between them. Besides, even module teams could share doubts, decisions and help each other easily to keep the conception and vision of integration between modules. **Informal spaces**, as for example institutional social events during the project, also helped for better integration between university team members and consultants.

Language differences usually exist between professionals with different experiences, knowledge and habits. It was observed in the interactions between university team members and consultants. These differences were related to their own vocabulary. Both parts used different words and terms to express a same meaning. The use of technical terms and English language in excess by consultants was one of the highlighted factors. These language difficulties in a certain way retard knowledge sharing. Anyway they were corrected during the work by university team members' inquiry. The IT university team members did not have difficulties with consultants' language. This is understood because of their technical background.

Absorptive capacity factor (Cohen & Levinthal, 1990) was also observed. Previous knowledge and experiences from both university teams and consultants influenced sharing. This is due to their influence in assimilation capacity and use

of a new knowledge. Some university team members felt that more previous knowledge of system advantages considering integration and process vision could maximize knowledge sharing during interaction with the consultants. This would increase their inquiry capacity. Others remarked that the previous experience in ERP systems implementation in other companies helped the project participation.

Consultants' systems implantation knowledge and experiences in other companies also helped on knowledge sharing. At the same time, the fact that the institution was the first university to implement the R/3 influenced the process. The consultants did not have experience in this exact field. So, the system implementation project was a learning process for both the university and SAP. It should be said that as much previous knowledge (absorptive capacity) from both—knowledge from customer process by the consultancy and from the system by the users—more effective would be knowledge sharing for system adaptation to the organization. Soh et al. (2000) say that organizations may ease knowledge acquisition process. They may preview resources for system training for key-users, anticipating the training about the system focus and selecting suppliers with knowledge about its business field.

About system-related knowledge sharing between consultants and the university team, the interview testimony shows special concern with system operation (*know-how*) assimilation and less emphasis to system parameterization (*know-why*). Both types of knowledge are important and complementary (Kim, 1993). This case of **knowledge partiality** made more difficult the university team's vision of better system parameters combination to reflect institutional context and its changes. It may indicate greater dependency of external people when needing this knowledge type.

The **means of knowledge sharing** appeared as an influencing factor of sharing. Among several means by what knowledge was shared, it was verified the presence of the ones that allows both explicit and tacit knowledge sharing. The institution emphasized potential means of tacit knowledge sharing: during the system implantation step, face-to-face conversation and means of learning by doing, for example, simulations and system integrated tests with institution real data. This is a positive factor considering in this period the need of an intensive process of sharing. The consultants needed to obtain a vision about institution process and the university team needed to have a vision about the system functionalities. The institution necessities alignment to the system offerings came from the interaction of both parts.

Another factor to be considered is the **project team composition and structure**. IT area institutional team quantity as well their role reveals that the project implementation was directed to institutional needs. The IT sector assumed a facilitator role instead of conducting the project. This is reinforced by the fact that the project manager was originally from the planning area. He knew the strategic directions of the university. Regarding this way team composition facilitated knowledge sharing. Bancroft, Seip, and Sprengel (1998) remarked that the IT professionals are not the main holders of the institution process knowledge but users.

At the same time, low operational areas' collaborative representation and the participation of people hired to work just in the project seemed to be a factor that prejudiced the knowledge sharing from the university team to the consultants. This is observed by Nonaka and Takeuchi (1995), as this kind of knowledge is most tacit, developed and internalized by the individual along time by the vivid experiences in the institution.

Institution work teams' motivation contributed for knowledge transmission, as well for consultant knowledge absorption. It was remarkable the team spirit, cooperation, persistence and team members' dedication for working together. The observed motivation and its positive influ-

ence in knowledge sharing contribute to Lahti and Beyerlein's idea (2000), as they emphasize that it is necessary to be motivated and have the will and disposition to hear and learn for sharing to occur.

In general, one may perceive that the factors presented here (Table 2) influenced positively and/or negatively in knowledge sharing. Depending on their configuration in the company and project context, they may influence the system implementation.

It must be remarked that the empirical research was performed after system implantation. This allows researching the implementation project vision as a whole. It was possible to observe that the users' practical experience with system use is contributing to new knowledge acquisition. It also allowed solidifying of the knowledge acquired during project.

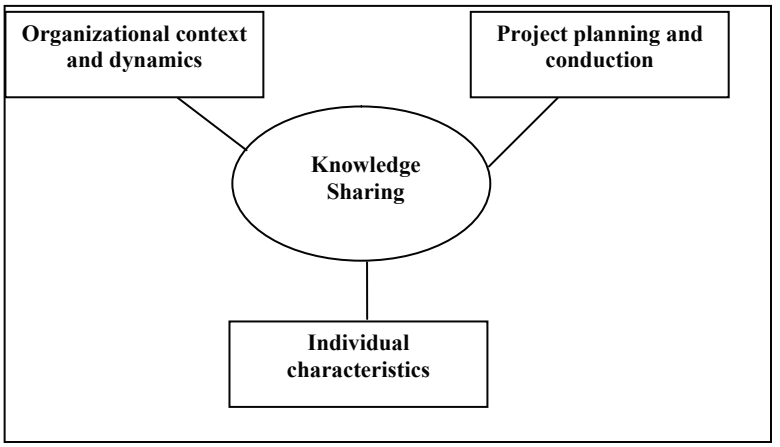
Dimensions Influencing Knowledge Sharing in the Context of IT Projects

Identification of factors that influenced the knowledge sharing in the IT project at the university enabled us to observe that they are related to three

Table 2. Factors affecting knowledge sharing in the system implementation project: Enabling and restricting aspects

SYSTEM IMPLEMENTATION	KNOWLEDGE SHARING	
OBSERVED FACTORS	ENABLING ASPECTS	RESTRICTING ASPECTS
Cultural and structural factors		-Traditional department vision. -Change resistance.
Systems and Procedure	-Documentation procedures prepared by institutional project members.	-Knowledge sharing practices outside project were weak and no-systematic. -End-users fragmented and located participation during implantation. -Lack of systematized communication and integration between project team and end-users.
Information Technology	-Use of project management *software*, computer networks and file structures.	
Working places and informal places	-One room for all module project working teams. -Social events between institutional and SAP consultant teams.	
Language		-Vocabulary differences. -Consultants exceeding use of technical and English terms.
Absorptive capacity	-Participation of some university team members in other ERP implementation projects in other companies. -Consultants knowledge and experiences in other ERP implementations in other company	-Needing of previous system knowledge and process vision by some institutional teams members. -Lack if consultancy experience in the university sector.
Knowledge partiality		-Greatest concern about system operational knowledge learning (*know-how*) and less emphasis on knowledge related to its parameterization (*know-why*)
Means of Knowledge sharing	-Means for sharing explicit and tacit knowledge.	
Project team composition and structure	-Number of IT area members and its role (facilitator and support). Institution strategic directions knowledge from the project manager.	
Institution working team motivation	-Team work, persistence, individual commitment from university team members.	

Figure 1. Knowledge sharing in IT projects



dimensions shown in *Figure 1*: organizational context and dynamics, project planning and conduction, project team individual characteristics.

The "**Organizational context and dynamics**" embodies those factors related to the organization where the project has been developed. Cultural and structural factors are one example. The project will be negatively affected by an organizational culture that does not value sharing. Extreme departmental structures may influence the knowledge sharing in an IT project principally when the project is about an integrated system implementation.

The "**Project planning and conduction**" are those factors related to the project as: system and procedures definition to ease sharing inside and outside the project, technological infrastructure sharing droved, working place for sharing stimulation, prevision of means of tacit and explicit knowledge sharing, project team structure and composition.

The "**Individual characteristics**" embody the factors related to the people participating in the project like: project participation motivation, absorptive capacity related to previous knowledge and experiences and standard language among team.

To contribute with knowledge sharing in implementation of IT complex systems, as the ERP systems, this study presents the indications of the need to work all three dimensions and factors related to them.

CONCLUSION

This research interest was focused in knowledge sharing description and analysis and its influence on ERP system implementation project (SAP R/3) in a Brazilian university. It was founded to understand as the implementation process was developed, identify people involved and analyze factors that influenced sharing and its relation to the system implementation project.

Based on the interviews, it was concluded that some factors influenced knowledge sharing in a more positive way. Others had a negative influence and some have both influences.

The knowledge sharing factors analysis allows verifying that these factors are strictly related to the system implementation project. Those factors that made sharing easier or more difficult in the same way ease or turn project implementation more difficult. Despite that new technology implementation projects should be influenced by a great number of factors, this study evidences reinforced the importance of observing and

"working" those related to knowledge sharing for project effectiveness.

The study also indicates that the observed factors may be related to the institution context and dynamics, and to the way the implementation project is planned and conducted, as well as to the individual characteristics of the project team. Therefore, knowledge sharing in IT projects may be considered a complex process, difficult to measure, involving several internal and external factors to the individual and related to different dimensions affecting one another. Due to the influence of knowledge sharing in an IT project it is important to take into account the three dimensions presented in this research and observe the factors effect to each one. This way action may be developed to promote knowledge sharing.

Finally, the theme of this research may imply in future researches as comparative case studies, IT project analysis with focus in other knowledge management process as, for example, knowledge creation and codification.

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Chapter XIII
The Impact of Information Technology on the Management of Intellectual Capital in the Banking Industry

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ABSTRACT

This study seeks answers to two questions: what types of intellectual capital are affected by IT and how can IT affect these types of intellectual capital? An analysis of intellectual capital indicators of the banking industry using an input-process-output model reveals that the process mediator variables, namely management capabilities, are highly affected by information technology. These management capabilities include risk management, quality management, taking advantage of new opportunities, product development and delivery, marketing management, and fulfilling customer needs. Information technology plays a key role in supporting decision-making, making possible business innovations and tightening controls of various processes through its tracking, informational, dissemination, analytical, simulative, and detection capabilities. Moreover, disintermediation is possible because of information technology. Although limited to one industry, it is believed that the study results can provide organizations with useful guidelines for managing intellectual capital with information technology.

INTRODUCTION

Managing intellectual capital is critical for corporate success in the new economy (Roos et al., 2006). The value stream based on intangibles provides organizations with short-term and long-term resources for creating and sustaining a competitive edge. Identifying and managing these resources, however, is a challenge for business managers (Agor, 1997). Information technology (IT) has been applied in various ways in managing organizational intangible assets: as the major leverage of

knowledge management (Alavi & Leidner, 2001), as a major force for structure change (Markus & Robey, 1988), and as the key enabler for business innovations (Kandampully, 2002). However, little research has gone into understanding the impact of IT on organizational intellectual capital (IC) in light of the type of intellectual capital that can be affected by IT and how IT can affect those types of intellectual capital.

Part of the reason for the lack of understanding of the impact of IT on IC is that intellectual capital is organized under various broad definitions and split into different categories. Most intellectual capital categories take a product view of these intangibles, and different categories of intellectual capital are separate components of organizational assets. Furthermore, the management of IC is distributed into different functions (including human resources, operation, marketing, customer service, and research and development) with different management methods. An overlooked point is that these categories are interrelated and even integral to one another (Andriessen, 2004). For instance, a highly-satisfied customer base requires well-organized processes and skilled human resources to deliver the service, while a good partner relationship requires proper technology to strengthen the link. As a result, the product-oriented measurement of intellectual capital does not provide guidelines for handling issues or solving problems, which in most cases are cross-functional. There is a need for a process view of these components, so that the dynamic interrelationships among these indicators can be captured.

This study attempts to organize intellectual capital into a system of value generation with a simple model of the input-process-output sequence. Indicators of intellectual capital are allocated according to their role in the system. This system model assists the analysis of the impact of IT on the whole intellectual capital system and is expected to provide insights into the impact on critical intellectual capital indicators.

Instead of designing this study around general industries, we chose to focus on a specific industry and to look deeply into the specific processes that could be affected by IT in developing intellectual capital. The banking industry in Taiwan was selected because it is an industry that accumulates and transforms knowledge into a competitive advantage. The business nature of the banking sector is "intellectually" intensive (Mavridis, 2004), and, as a whole, banking employees are intellectually more homogeneous than in other economic sectors (Kubo & Saka, 2002). While banking activities have become more profitable in general, evidence suggests that they have also become riskier. The changes brought about by IT—new products, more sophisticated customers, changing cost structures, and enhanced competitive pressures—have all combined to transform the structure of the banking industry. Moreover, information technology is likely to continue to transform banks into new types of financial institutions whose business bears little resemblance to that of a traditional bank (Jordan & Katz, 1999).

The objective of this research is to build a useful understanding of how IT affects the management of intellectual capital in the banking industry. Using a Delphi feed-forward technique, case data were collected on 12 business managers from ten banks. Intellectual capital indicators were organized in an input-process-output model. Indicators requiring high support from IT were identified, and the necessary IT capabilities were explained. Business management capabilities of managing risk, quality, opportunity, product, marketing, and customer needs are the most important forms of intangible capital and are highly dependent on information technology for its informational, analytical, tracking, simulative, detection, and disintermediation capabilities. It is hoped that the results will provide organizations with a useful guide to managing intellectual capital through information technology.

IT CAPABILITIES AND THEIR ORGANIZATIONAL IMPACTS

IT capabilities and their organizational impacts can be described in different ways. Many researchers have studied the impact of information technology on different aspects of intellectual capital. For instance, customer service can be directly affected by technology, and deep knowledge of customer behavior can inspire innovations in serving customers in different ways and in different markets (Karimi, 2001).

Table 1 summarizes the eleven capabilities of IT in supporting the management of intellectual capital. This table is mainly adopted from Davenport's (1990) work on IT levers for innovative processes, with additional items identified from several recent studies. This table is later used for assessing the impact of IT on various intellectual capital indicators.

Information technology support not only brings quality improvement (Mukhopadhyay et al., 1997), but it also leads to process changes through its transactional, geographical, automational, sequential, and other capabilities (Hammer & Champy, 1994; Davenport, 1990). Furthermore, the analytical, informational, and simulative capabilities of IT have long been noted for supporting decision-making in resource management and strategic planning (Wijnberg et al., 2002). With human resources management, IT is known for coordinating the learning processes among employees (Argyres, 1999). Skills of empowered employees (Leach, Wall, & Jackson, 2003) can be upgraded through the ability of IT to capture and disseminate knowledge. IT is applied in tracking daily operations and also in detecting hidden problems and troubleshooting unknown errors (Fayyad & Uthurusamy, 1996). Another potential benefit of IT is its simulative capability in assisting the management of the human dynamics of IT-enabled change (Angehrn & Manzoni, 1998). An awareness of IT capabilities can influence short- and long-term benefits of process change (Davenport, 1990).

DIFFERENT ASPECTS OF INTELLECTUAL CAPITAL

Intellectual capital is the possession of knowledge, applied experience, organizational technology, customer relationship knowledge and professional skills, which together provide organizations with

Table 1. IT capabilities affecting organizational processes

IT Capabilities	Organizational Impacts
Transactional	Transform unstructured processes into routine transactions
Geographical	Transfer information with rapidity and ease across large distances, making processes independent of geography
Automation	Replace or reduce human labour in processes
Analytical	Bring complex analytical methods to bear on a process
Informational	Bring vast amount of detailed information into a process
Sequential	Allow multiple tasks to work simultaneously
Dissemination	Allow the capture and dissemination of knowledge and expertise to improve a process
Tracking	Allow the detailed tracking of task status, inputs, and outputs
Simulative	Test or predict behaviors in some situations or processes
Detection	Discover hidden problems
Disintermediation	Internal and external connections

a competitive edge in the market (Edvinsson & Malone, 1997). Collective brainpower (Stewart, 1997) is formalized, captured, and leveraged to produce an asset of higher value (Klein & Prusak, 1994). Various studies (Bontis, 1996; Brooking, 1996; Dzinkowski, 1998; Bukh, Larsen, & Mouritsen, 2001; Edvinsson & Malone, 1997; Heldreth, 2000; Hubert, 1996; Kaplan, 1996; Kautz & Thaysen, 2001; Roos & Roos, 1997; Stewart, 1997; Sveiby, 2000; Swan, 1999; Van Buren 1999) have tried to categorize and measure forms of intellectual capital. Three types of intellectual capital have been identified by almost all researchers: human capital, structural capital, and customer capital. A company's human capital is embodied in the people whose talent and experience create the products and services. This capital is the reason why customers go to a certain company and not to a competitor (Stewart, 1997).

Structural capital belongs to the organization as a whole. It can be reproduced and shared. Some of what comes into the category of structural capital is associated with legal rights of ownership; for example, technologies, inventions, data, publications, and processes can be patented, copyrighted, or shielded by trade-secret laws (Stewart, 1997). Structural capital might best be described as the embodiment, empowerment, and supportive infrastructure of human capital (Edvinsson & Malone, 1997).

Structural capital is composed of three types of capital: organizational, innovational, and process-related (Edvinsson & Malone, 1997). Organizational capital is the company's investment in systems, tools, and an operating philosophy that speeds the flow of knowledge through the organization. Innovational capital refers to renewal capability and the results of innovation in the form of protected commercial rights, intellectual property, and other intangible assets and talents used to create and rapidly bring to market new products and services. Process capital is those work processes, techniques (such as ISO 9000) and employee programs that augment and enhance the efficiency of manufacturing or the delivery of services.

Customer capital is the value of an organization's relationships with the people with whom it does business (Stewart, 1997). There are many ways to invest in customer capital, including innovating with customers, empowering customers, focusing on customers as individuals, sharing gains with customers, learning about a customer's business, and teaching customers your business. Customer capital concerns the organization's ongoing relationship with people or other organizations to which it sells (Edvinsson & Malone, 1997). As discussed by many researchers (Edvinsson & Malone, 1997; Dzinkowski, 2000), customer capital would have been a truly alien notion to bookkeepers just a few decades ago. Yet it has always been there, hidden within the entry for "goodwill."

These three categories of intellectual capital will not produce value individually. They must be in alignment to complement one another (Andriessen, 2004). Corporate value does not arise directly from any of its intellectual capital categories, but only from the interaction between these categories. A process model is needed to connect these categories and reorganize the indicators according to their interrelationships. A system theory (Bertalanffy, 1968) is applied in this study to build a model for reorganizing intellectual capital indicators according to their value-generation processes.

SYSTEM THEORY FOR ORGANIZING INTELLECTUAL CAPITAL

Systems theory was proposed in the 1940s by the biologist Ludwig von Bertalanffy (1968) and furthered by Ross Ashby (1956). Bertalanffy emphasized that, rather than reducing an entity (e.g., the human body) to its parts or elements (e.g., organs or cells), systems theory focuses on

the arrangement of, and relations between, the parts that connect them into a whole (cf., holism). This type of organization determines a system that is independent of the concrete substance of the elements (e.g., particles, cells, transistors, people, etc). Thus, the same concepts and principles of organization underlie the different disciplines (physics, biology, technology, sociology, etc.), providing a basis for their unification. Although systems are modeled in many ways, one simple and popular way is a sequence of input-process-output (IPO).

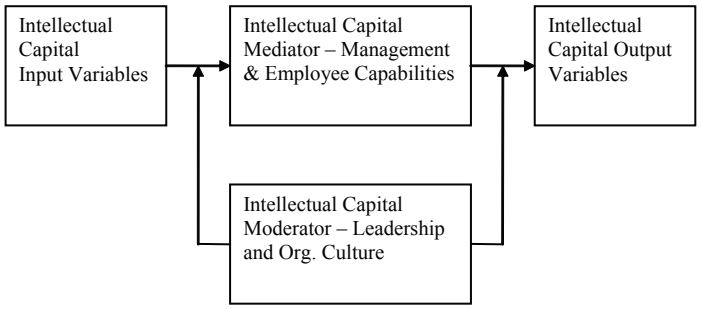
As depicted in Figure 1, elements of intellectual capital can be constructed based on system theory with a sequence of input variables, process variables, and output variables. The input variables produce output variables through the influence of process variables. The process variable contains two sets of variables: mediator and moderator. Intellectual capital input becomes output by the influence of the mediator, which is the management capability of the organization, whereas the leadership and organizational culture are the moderators that affect the process and output of intellectual capital.

A company can be regarded as a system, with its input including its work force, material, capital, technologies, commands, and morale. The input will be processed and transformed in the system to produce the output, that is, the target or expectation, such as products, development, and goodwill.

Tsan et al. (2002) applied the IPO model in analyzing intellectual capital in the hi-tech industry in Taiwan. The results show that high investment in intellectual capital input variables could affect mediator variables (management and employee capability) and lead to high output. The level of intellectual capital input could significantly affect intellectual capital output.

In reference to Tsan's work (2002), intellectual capital input variables in this study are the investments, capabilities and information for sustaining normal operations of intellectual capital. Examples include investment in new markets, human skills, and R&D. The mediator variables are the management capabilities of an organization; that is, the capabilities which transform the input into output, including fulfilling customer needs, taking advantage of new opportunities, quality management, time to market, employee motivation, and so forth. The moderator variables are the leadership and organizational culture, which are factors affecting the input to output process. They include leadership, business culture and strategy execution. Intellectual capital output means the product of the intellectual capital system and the performance following system operation, examples of which include the results of sales growth, employee satisfaction, customer rating, and R&D productivity.

Figure 1. Input-process-output model for intellectual capital



AN IPO FRAMEWORK OF INTELLECTUAL CAPITAL IN THE BANKING INDUSTRY

In this study, two sources of intellectual capital indicators were consolidated in building a framework of four sets of intellectual capital variables. The two sources are Edvinsson and Malone's (1997) work on intellectual capital in the finance industry and Tsan's (2002) work on intellectual capital of the system theory model. Edvinsson and Malone's (1997) work was selected because it is the first complete study on the finance industry, and Tsan's work was selected because it incorporated works on intellectual capital over the past five years and was verified by a good number of experts (245 senior business managers of 100 hi-tech companies). Table 2 consolidates the intellectual capital indicators according to the input-process-output model.

In the present study, the consolidated lists of intellectual capital indicators were then verified and enhanced by four industry experts from banks in Taiwan. The four experts ensured the fit of each indicator for the banking industry. Three of the four experts had over 20 years experience

Table 2. Variables of the IPO intellectual capital framework

Intellectual Capital Indicators	Source
Input variables	
1. Market growth	Van Buren 1999
2. Employees' professional capabilities	Bukh, Larsen, & Mouritsen, 2001; Bontis, 2000
3. R&D resources/total resources	Edvinsson & Malone, 1997
4. Strategic partners	Edvinsson & Malone, 1997
5. Training time	Edvinsson & Malone, 1997; Bontis, 2000; Van Buren, 1999; Sveiby, 2000
6. IT investment	Edvinsson & Malone, 1997; Dzinkowski,1998
7. Employee motivation	Edvinsson & Malone, 1997
8. Ideal level of employee competence	Edvinsson & Malone, 1997; Bontis,2000
Moderator variables– leadership and organizational culture	
1. Leadership	Edvinsson & Malone, 1997; Skandia AFS, 1997
2. Strategy execution	Edvinsson & Malone, 1997; Van Buren, 1999
3. Supportive atmosphere	Dzinkowski, 1998; Kautz & Thaysen, 2001; Heldreth, 2000; Swan, 1999; Bontis, 1998
4. Level of departmental collaboration	Bukh, Larsen, & Mouriten, 2001; Van Buren, 1999; Kautz & Thaysen, 2001; Heldreth, 2000; Swan, 1999
5. Sharing best practice	Van Buren, 1999; Kautz & Thaysen, 2001; Swan, 1999
6. Procedures supporting innovation	Bontis, 1998; Kautz & Thaysen, 2001
Mediator variables – employee and management capabilities	
1. Fulfilling customers' needs	Van Buren, 1999; Bontis, 2000; PZB, 1988
2. Employees come up with new ideas	Dzinkowski,1998; Bontis, 2000
3. Taking advantage of new opportunities	Edvinsson & Malone, 1997; Van Buren,1999
4. Time to market	Edvinsson & Malone, 1997
5. R&D management	Van Buren, 1999
6. Product and service quality	Van Buren, 1999

Table 2. Variables of the IPO intellectual capital framework

Intellectual Capital Indicators	Source
7. Quality of decisions	Van Buren, 1999
8. Risk management	Suggested by experts
9. Marketing capability	Suggested by experts
Output variables	
1. Market share	Edvinsson & Malone, 1997; Roos, 1997; Van Buren, 1999; Bontis, 2000; Kaplan, 1996
2. Proportion of customer's business that your product (service) represents	Kaplan, 1996; Dzinkowski, 1998
3. Research leadership	Van Buren, 1999
4. Customer rating	Edvinsson & Malone, 1997
5. Confident of future with customer	Bontis, 2000
6. Customer satisfaction	Edvinsson & Malone, 1997; Roos,1997; Dzinkowski, 1998; Bontis, 2000; Kaplan, 1996, Van Buren, 1999
7. Customer loyalty	Dzinkowski, 1998; Bontis, 2000
8. Proportion of sales to repeat customers	Dzinkowski, 1998; Kaplan, 1996
9. Customer growth	Kaplan, 1996; Bontis, 2000
10. Customers lost	Edvinsson & Malone, 1997; Roos, 1997
11. Average customer size	Edvinsson & Malone, 1997; Roos, 1997; Van Buren, 1999
12. Employee satisfaction	Kaplan, 1996; Bontis, 2000; Dzinkowski, 1998
13. Employee productivity	Kaplan, 1996
14. Employee loyalty	Suggested by experts

in the banking industry. Each was interviewed, the interview taking over 90 minutes. The fourth expert had worked as a bank industry consultant for 8 years.

DATA COLLECTION AND ANALYSIS

Understanding the impact of IT on intellectual capital requires broad and deep data collection and analysis. Broad analysis covers the multi-faceted nature of intellectual capital, while deep data collection sets up a practical instrument for understanding IT's impact on intellectual capital. To accomplish the goal of broad and thorough data collection, this study adopted Delphi's method (Lindstone & Turoff, 1975) and collected a wide range of information from experienced bank managers.

The Delphi method was developed by the "think tank" of Olaf Helmer, Nicholas Rescher, Norman Dalkey and others at RAND to remove conference room impediments to a true expert consensus (Gordon, 1994, 2000). To overcome the difficulties of a time-consuming process, time constraints, and the constantly shifting characteristics of our interviewees, the feed-forward approach (Gordon, 1994), one of the modern Delphi data analysis techniques, was used to gain a thorough understanding with participants by presenting an emerging consensus derived from prior interviews.

Twelve banking managers were interviewed (see Table 3). Their work experience ranged

from five to 30 years in 10 banks in Taiwan. The data collection took place under the control of the researchers. Each interview lasted 60 to 90 minutes, and appointments were made according to interviewees' schedules. Questionnaires and research questions were explained in the interviews to make sure the interviewees understood the statements completely.

The variables of intellectual capital in Table 2 were rated on a Likert scale of 0 (IT has no impact on this indicator) to 5 (IT has a strong impact on this indicator). Open questions were asked first in order to identify the overall influence of IT on a company's intellectual capital, and iterative verification was done. Furthermore, detailed descriptions of the eleven IT capabilities were requested to provide support to the ranking. All the interviews were recorded and transcribed for later analysis and further verification. A second round of telephone interviews was conducted to verify the ranked results and to clarify the supporting case data.

One of the major concerns in this study was the selection of the experts. Although all had extensive knowledge of banking operations, they brought different experiences in judging the impact of IT on intellectual capital. Of the 12 interviewees, five had a lot of experience in using IT applications, while the others had less experience with information systems. The results show a division between these two types of interviewees. The managers with IT experience ranked the impact of IT as high in more areas than did the managers with no IT experience. However, the divided opinions on the impact of IT were reduced in the second-run verification. Most interviewees modified their views of IT after considering the other experts' opinions. The averaged scores of the IPO variables are depicted in Figure 2, and average scores of detailed IC indicators are listed in Table 4.

IT IMPACT ON INTELLECTUAL CAPITAL

As depicted in Figure 2, research results show that IT has a moderate impact on intellectual capital input, output variables and leadership and organizational culture. Only management capabilities are strongly affected by IT.

For intellectual capital input variables, most interviewees thought information technology indirectly supported those indicators. Some business managers mentioned that IT provides an

Table 3. Description of experts interviewed

Number	Current Position	Experience in banking (years)	Interview time (minutes)
A	MIS Vice President	5	40
B	MIS Assistant Manager	15	70
C	MIS Manager	20	70
D	MIS Manager	7	80
E	Specialist	17	50
F	Junior Manager	8	50
G	Manager of Branch	30	50
H	Junior Manager of Branch	24	50
I	Junior Manager of Branch	8	50
J	Consultant	20	100
K	Consultant	18	100
L	MIS Manager	15	50

infrastructure for linking easily with "strategic partners," such as financial service providers and affiliated businesses. Deep integration among these business entities can be built for information sharing, collaboration, and cross-selling.

Another intellectual capital input indicator that can be affected by IT is "employees' professional capabilities." Some organizations interviewed encouraged employees to take e-learning classes during their spare time. These companies usually provided a virtual bank to train and evaluate employees in a simulated bank environment. However, the success of e-learning depended on enforcement by top managers and the organizational culture. Employees of banks with a conservative culture still tended to use weekends for on-site job training.

The impact of IT on these management capabilities is summarized in Table 5.

IT has a strong impact on the mediator variables, that is, the management capability of an organization. Six of eight mediator indicators were ranked above 4.0, meaning that IT has a great influence on these forms of intellectual capital. These indicators, listed by rank, are risk management, product and service quality, time to market, taking advantage of new opportunities, R&D productivity, marketing capabilities, and fulfilling customers' needs.

In "risk management," the major concern of a bank is to prevent bad debts. Having high quality credit checks is the most important practice in a bank. Information technology is used to review customer credit through an extensive and rigorous evaluation. Banks also depend greatly on IT to prevent criminal actions. For companies to control huge transactions, information technology such as neural networks and statistical analysis is widely used to detect unusual consumer behaviors and automatically notify customers for further confirmation.

Regarding "product and service quality," most banks have transferred more than 60 percent of their customer transaction processes into automated facilities such as ATMs and Internet banks and provide personalized services only to VIP customers. Audit rules are implemented to prevent operational errors. With workflow management systems, procedures are tightly controlled with no fraud or missing tasks allowed. Further checkpoints are installed to track, analyze and detect operations that could yield errors. However, there is a trade-off between a rigorous credit check and a speedy loan process. A well-designed loan approval process with proper credit assessment and efficient operation is a challenge for the system designer.

Regarding "taking advantage of new opportunities" and "fulfilling customer needs," advanced technologies such as data warehousing, data mining and customer relationship management are widely applied. With vast data processing capacity, daily transactions over the counter and the Internet and via ATMs, customer call centers and wireless communications are tracked and stored in a data warehouse. Meanwhile, informa-

Figure 2. Scores of IT impact on intellectual capital

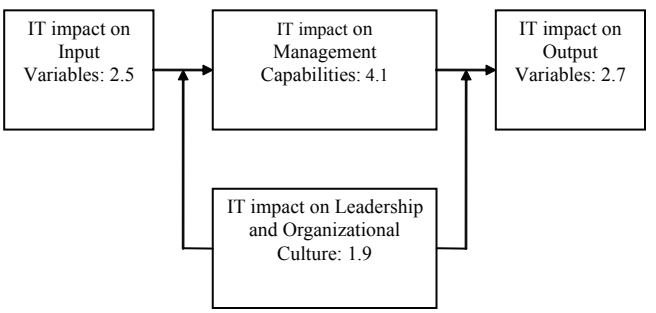


Table 4. The impact of IT on intellectual capital indicators

Nbr	Indicator	Mean	Nbr	Indicator	Mean
Input			**Moderator - Leadership and organizational culture**		
A1	Market growth	2.1	C1	Leadership	2.0
A2	Employees' professional capabilities	2.4	C2	Strategy execution	2.2
A3	R&D resources/total resources	2.1	C3	Atmosphere is supportive	1.8
A4	Strategic partner	2.4	C4	Collaboration level	1.8
A5	Time in training	2.3	C5	Sharing best practice	1.9
A6	IT investment	2.9	C6	Procedures support innovation	2.0
A7	Employee motivation	2.7		**Output**	
A8	Employee competence ideal level	2.7	D3	Research leadership	3.0
	Mediator – management capability		D4	Customer rating	2.7
B1	Fulfilling customers' needs	4.0	D5	Confident of future with customer	2.8
B2	Employees come up with new ideas	3.2	D6	Customer satisfaction	2.8
B3	Taking advantage of new opportunities	4.1	D7	Customer loyalty	2.8
B4	Time to market	4.2	D8	Proportion of sales to repeat customers	2.8
B5	R&D productivity	4.1	D9	Customer growth	2.6
B6	Product and service quality	4.4	D10	Customers lost	2.5
B7	Quality of decision	3.9	D11	Average customer size	2.7
B8	Risk management	4.7	D12	Employee satisfaction	2.7
B9	Marketing capability	4.1	D13	Employee productivity	3.8
			D14	Employee loyalty	2.6

Table 5. Critical impact of IT on management capabilities of intellectual capital

Indicator	IT capability	Effects on business
Risk management	Dissemination, informational, tracking, detection, simulative	Reduce bad debts, prevent crime, reduce loss, exceptional problem detection
Product and service quality	Tracking, informational, analytical, simulative, detection	Detect errors beforehand, improve goodwill, reduce operation errors, improve data integrity and correctness
Time to market	Dissemination, informational, simulative, disintermediation	Quick response to market needs and fast delivery of products through connected channels
Taking advantage of new opportunities	Tracking, analytical, informational, simulative, detection, disintermediation	New market segmentation, target customer, different channels, customized products and services
R&D productivity	Analytical, informational, simulation, disintermediation	Proper and low-risk products and services, faster product development, well-tested products and services on an integrated and modularized infrastructure
Marketing capabilities	Tracking, analytical, informational, simulative, disintermediation	Target marketing, campaign on different market segments, personalized marketing
Fulfilling customer needs	Tracking, analytical, informational, dissemination, simulative, disintermediation	Grasp customer needs by reviewing consumer behaviors, transaction patterns and world economic trends to provide proper products and services

tion from external databases (Market Intelligence Center, economics journals, and other research centers) flows in as well. Data mining techniques are then used to analyze transactional behaviors, customer needs and world economic trends. The systems also support management decisions by suggesting appropriate new or customized products or services.

Regarding "time to market" and "R&D productivity," simulation software linked with transactional databanks is applied to model new products, test options, and trial-run transactions in the simulated environment. With the support of real-time information, modularized product design and the development and delivery of products can be increasingly enhanced.

"Marketing capabilities" can be supported with various analyzed information tracked by different transactional and knowledge systems. For example, with a customer relationship management (CRM) system, market trends, customer patterns and product channels are analyzed; and market segments, cross-selling opportunities, market channels, and promotion strategies can be planned.

In general, interviewees believed that IT did not affect the moderator variables leadership and organizational culture. Although IT provides managers with a knowledge platform to share management experience and facilitate collaboration, it still plays a solely supportive role. The key to successful leadership lies in the executives' views and the culture of executive collaboration.

Output variables were not directly affected by IT but could be influenced by the mediator indicators. For example, process errors such as out-of-service ATMs, slow response from Internet banks, incorrect billing, and improper disclosure of customer data can all affect customer satisfaction; and R&D capability can certainly affect R&D leadership in the market.

IT CAPABILITIES FOR INTELLECTUAL CAPITAL

Table 6 summarizes the interviewees' selection of critical IT capabilities for the intellectual capital management items.

The results show that in addition to automation capabilities, which automate transactional operations and bring immediate cost reductions, other IT capabilities can enhance business management capabilities in generating and sustaining business competitiveness. IT in banks tracks vast information through detailed processes and detects hidden errors in complicated operations. The informa-

Table 6. Critical IT capabilities for management capabilities of intellectual capital

	Transactional	**Geographical**	**Automational**	**Sequential**	**Dissemination**	Tracking	**Informational**	**Analytical**	**Simulative**	**Detection**	**Disintermediation**
Risk management					X	X	X	X	X	X	
Quality management						X	X	X	X	X	
Time to market					X	X	X	X		X	X
New opportunities					X		X		X		X
R&D capabilities							X	X	X		X
Marketing management						X	X	X	X		X
Fulfilling customers' needs					X	X	X	X	X		X

tion is disseminated across the organization, and, through links with external parties, a broad and in-depth knowledge database is established. Through various analytical methods, business issues are analyzed and solutions simulated with different business situations.

According to the results of this study, information technology contributes in three ways to the enhancement of management capabilities. First, IT supports decision-making through multidimensional analysis of a broad range of data, and provides options for effective resource management and planning. Second, IT makes possible business innovation by simulating methods of product and service development. Further, IT tightens business controls by detecting hidden errors and learning from retrospective analysis of tracked data. Companies planning investment in intellectual capital should pay special attention to those critical IT capabilities that enhance the management potential for the realization of benefits.

CONCLUSION

This study tries to answer two questions: what types of intellectual capital can be affected by IT and how can IT affect this capital? By organizing intellectual capital indicators into an input-process-output model, the study revealed that the intellectual capital indicators of mediator variables, namely management capabilities, are highly affected by IT, whereas the remaining indicators are indirectly affected by IT. Information technology plays a key role in enhancing management capabilities by supporting decision-making, enabling business innovations, and tightening controls of processes through its tracking, informational, dissemination, analytical, simulative, and detection capabilities. Moreover, disintermediation is possible because of information technology.

In the study, the process view of intellectual capital indicators for the banking industry was reorganized into an input-process-output model. Consequently, a different view of intellectual capital and its sequence and interrelationship was developed. Future studies on intellectual capital management may consider a similar approach for understanding management issues.

The content of intellectual capital management in the banking industry has similarities and differences with other industries. The management categories of intellectual capital are common across industries in respect to customer, product, and human resources. The difference lies in the constructs of these categories. Customers in the banking industry are mainly retail consumers and major corporations who look for customized services to satisfy their financial needs. The product development cycle is short in comparison to manufacturers and requires more flexibility due to the constantly changing nature of the market. Bank employees tend to be knowledge workers who make decisions based on real-time information. Lately, banks have been paying more attention to risk management results because of the Basel Committee's recently revised standards (2004). These standards encourage banks to develop and use better risk management techniques in monitoring and managing their risks. Risks in banks, including credit risk, market risk, operational risk, and equities and interest rate risk, require various techniques in detecting and eliminating problems and simulating optional solutions. Because of this, the management structure in a bank requires high capability in detecting and preventing risks, developing and customizing products, controlling and improving quality, and identifying and fulfilling customer needs.

Because of IT's powerful and evolving capabilities, its utilization in the management of banks' intellectual capital is essential and challenging. However, this technology must be managed by people who know how to take advantage of its capabilities. A strong understanding of the potential of IT in this intangible but crucial form of capital is encouraged for reducing risks and increasing returns.

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Chapter XIV
Impact Analysis of Intranets and Portals on Organizational Capital:
Exploratory Research on Brazilian Organizations

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ABSTRACT

This chapter analyzes the impacts of intranet quality on organizational capital practices. The chapter describes a research model empirically tested in 98 large Brazilian organizations. The variables proposed by the TAM (technology acceptance model) (Venkatesh & Davis, 2000) and the TTF (task technology fit) (Goodhue & Thompson, 1995) were converted into portal's context, emphasizing the importance of leveraging classical information science and information system studies to understand better the portal phenomenon. Furthermore, the knowing organization model (Choo, 1998) was applied in order to offer a theoretical support for the intellectual capital-based variables. The results give evidence that the portal quality has more influence on knowledge creation than on sense-making and decision-making. The chapter reinforces the usage of the Knowing Organization model as a framework to understand intellectual capital and knowledge management initiatives.

INTRODUCTION

Intranet is an appropriate tool to systematize and add the explicit knowledge that is dispersed through departments. Intranets are organizational assets, and an important part of the structural dimension of the intellectual capital (Stewart, 1998). However, the efficient usage of intranets is closely related to a wider comprehension of information management contribution to organizational

performance. Intranets should be understood as a part of organizational information context and its usefulness is influenced by culture, values and principles concerning strategic information management.

The correct balance between managerial and technical aspects constitutes one of intellectual capital's greatest challenges. Culture and user behaviors are the key drivers and inhibitors of internal sharing, and organizations should develop ways of stimulating people to use and contribute to information systems (Detlor, 2004).

In an attempt to consolidate various departmental Intranets, organizations are constructing corporate Intranets or portals (Choo et al., 2000). But portals are evolving into more complex and interactive gateways, so they may integrate in a single solution many information systems. They are becoming single points of entry through which users and communities can perform their business tasks, and also evolving into virtual places where people can get in touch with other people who share common interests. Due to this evolution from Intranets towards portals, many organizations are using them as the major technological infrastructure of their knowledge management (KM) and intellectual capital initiatives.

The chapter's purpose is to analyze the impacts of Intranet quality on organizational capital practices. This chapter is organized as follows. First, the TAM—*technology acceptance model* (Venkatesh & Davis, 2000)—and the TTF—*task technology fit* (Goodhue & Thompson, 1995)—are applied to portal's context, emphasizing the importance of leveraging classical information science and information system studies to understand better the portal phenomenon. These studies offer a background to analyze the impacts of portal deployment on a user's behavior, and consequently on organizational capital initiatives. Then, the knowing organization model (Choo, 1998) is presented in order to offer a theoretical support for the intellectual capital-based variables. The next section describes the exploratory research where the model was empirically tested in 98 organizations. Finally, the future trends and conclusion sections describe future works and give advice about how the research model can be used.

BACKGROUND

A portal's primary function is to provide a transparent directory of information already available elsewhere, not act as a separate source of information itself (Choo et al., 2000). Common elements contained in corporate portals design include an enterprise taxonomy or classification of information categories that help easy retrieval, a search engine and links to internal and external Web sites and information sources. Perceiving the portal as a specific type of information system is a way of exploiting previous studies related to user behavior, technology acceptance and its organizational impact.

One of the most referenced models of information system (IS) adoption is the TTF (task technology fit) model (Goodhue & Thompson, 1995). The model analyzes the linkage between IS usage and individual performance. According to TTF, a technology has a positive impact on individual performance when it is utilized and has a good fit with the tasks it supports.

The TAM (technology acceptance model) was developed to explain and predict computer usage behavior (Davis, 1989). TAM has received substantial theoretical and empirical support from hundreds of studies, becoming a generally accepted cognitive model for predicting user IT acceptance (Detlor, 2004). TAM has two variables that influence attitudes and use. *Perceived usefulness* is defined as the degree to which a person believes that using a particular system would enhance his or her job performance. In contrast, *perceived ease of use* refers to the degree to which a person believes that using a particular system would be free of effort (Davis, 1989).

A combination of TTF and TAM into one extended model has proven to be a superior model to either the TAM or the TTF model alone (Dishaw & Strong, 1999). Therefore, the portal quality construct presented in this chapter will use concepts from both models, adapting them to the portal's context. For different reasons, the following TTF factors have not been taken into account for the development of the quality construct: TTF3, TTF6, TTF7, and TTF8. Authorization (TTF3) is not a critical issue for portals, which are virtual environments that are usually accessible to all the users within the organization. Production timeliness (TTF6) and relationship with users (TTF8) have been removed because they are beyond the scope of this research in that portal managers will be involved. Finally, reliability (TTF7) was eliminated from the quality construct due to the high predictability of the portal environment. As the amount of users is known by the organization, it is quite easy to preview the demand, and scale the system to support it in a reliable manner.

On the other hand, the factors TTF1, TTF2, TTF4, and TTF5 were incorporated into the quality construct. The quality dimensions comprised by TTF1 (accuracy, novelty, level of detail) are fundamental because information retrieval is the most basic motivation for portal existence. Analogously, locatability (TTF2) is also critical, because it will be worthless to have high quality information if the user is not able to find or understand its meaning. Compatibility (TTF4) was kept in construct because one of the greatest portal challenges is to integrate heterogeneous IS. Ease of use (TTF5) was chosen for being not only a TTF factor, but also a TAM concept. The final list of variables of the quality construct is presented in Table 1.

Table 1. Variables related to portal quality

Variable	Inspiration
Quality of information	TTF1
Locatability	TTF2
Meaning of information	TTF2
Compatibility	TTF4
Productivity increase	TAM
Job facilitator	TAM
Job quality gain	TAM
Usefulness	TAM
Ease of training	TAM
Ease of use	TAM and TTF5

As the research objective is to analyze the effects of portals on organizational capital, it is necessary to provide some background concerning information and knowledge usage. In order to establish a more consistent link between information and knowledge processes, the research model proposed in this paper will adopt the knowing organization model (Choo, 1998) as a theoretical background. This framework describes organizations as systems where the processes of sense-making, knowledge creating and decision-making are continuously interacting.

Organizational capital is closely related to the organization's capabilities of collecting, filtering, organizing and disseminating existing information and knowledge. Therefore, the knowing organization model (Choo, 1998) may be a suitable framework to investigate the underlying processes that support organizational capital. In this model, sense-making is related to how the organization interprets and makes sense of its changing environment which leads to shared meanings and intent. Knowledge creation is accomplished through the conversion and sharing of different forms of organizational knowledge, resulting in new capabilities and innovation. Finally, the organization processes and analyzes information through the use of rules and routines that reduce complexity and uncertainty (Choo, 1998).

Besides organizational capital, the knowing organization dimensions have also some conceptual links to other types of intellectual capital. The sense-making dimension is associated to client capital, as it reflects the organizational capacity to scan the environment and develop partnerships

and alliances with clients, suppliers and government. Furthermore, the knowledge creation dimension is also related to human capital, because creativity and collaboration among employees are important conditions to generate knowledge.

The organizational knowledge strategy is usually a mix of exploitation and exploration (Choo & Bontis, 2002). Exploitation emphasizes knowledge codification and the reuse of existing knowledge, taking advantage of organizational capital. When exploitation is overemphasized, the organization may diminish its capacity to innovate, resulting in obsolescence. On the other hand, exploration stimulates the creation of new knowledge, applying it to the development of products and services. When exploration is overemphasized, the organization reduces its ability to externalize knowledge and to convert it into organizational capital.

Despite the quicker return over investment (ROI) of exploitation approach, the dynamic balance between exploration and exploitation seems to produce better results in a longer term, because radical innovation demands exploration.

Figure 1. Research model

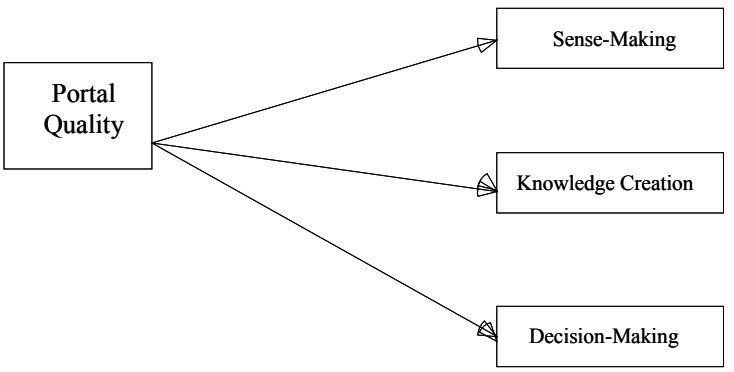


Table 2. Variables of the quality construct

Variable	Question
(q1) Quality of information	The Intranet maintains accurate and up-to-date information at an appropriate level of detail sufficient for users to carry out their tasks.
(q2) Locatability	It is easy to determine what information is available on the Intranet and locate it.
(q3) Meaning of information	The exact meaning of information available on the Intranet is either obvious, or easy to find out.
(q4) Compatibility	The Intranet supports comparison and consolidation of information from different sources, without generating unexpected or difficult inconsistencies.
(q5) Productivity increase	The Intranet enables users to accomplish tasks more quickly, increasing their productivity.
(q6) Job facilitator	The Intranet makes it easier for users do their jobs.
(q7) Job quality gain	The Intranet enables users to improve the quality of their work.
(q8) Usefulness	Overall, users find the Intranet useful in their jobs.
(q9) Ease of training	Users quickly learn how to operate the Intranet to perform their tasks.
(q10) Ease of use	Overall, users find the Intranet easy to use.
(q11) General usage	On an average working day, how much time do you spend using the Intranet?

MAIN THRUST OF THE CHAPTER

The research model has been designed to analyze the relationships between portal quality and the dimensions of the knowing organization model. Figure 1 provides a graphical perspective of the research model.

The research model's variables were translated into a Web-based questionnaire using Likert scales (0-10) with the extremes "totally disagree" and "totally agree." The questionnaire is presented in the *Appendix A*. None of the questions were written in a negative manner; therefore the value 10 always means the most advanced level of the practice being evaluated. Only for the usage variable, the 11-point Likert scale was presented with the extremes "(0) – very rare usage (once a month or less)" and "(10) – very frequent usage (more than 5 hours per day)" in order to guide respondents. Additionally, the middle of the scale (value 5) had a label "between ½ and 1 hour per day." The quality construct was based on TAM and TTF models, and its variables are described in Table 2.

The sense-making, knowledge creation and decision-making constructs were based on knowing organization model (Choo, 1998), and its variables are closely related to organizational capital as described in Table 3.

The model variables were submitted for discussion in a research group composed of three Ph.D. professors and Ph.D. students. Previous questionnaires developed by Davis (1989), Goodhue et al. (1995), Detlor (2004), Terra and Gordon (2002) and Choo et al. (2000) were used as references. A preliminary version of the questionnaire was applied in two Brazilian organizations: a government bank and a chemical industry. Both organizations have Intranets for more than five years and knowledge management programs since 2002. The respondents (two persons, one from each organization) were chief knowledge officers (CKO). This pilot test contributed to the tuning of some statements of the questionnaire.

Table 3. Organizational capital variables inspired by the knowing organization model

Construct (Variable)	Question
Sense-Making(sm1)	The organization dedicates resources to detect and obtain external information from competitors, clients, universities, government, suppliers, and industrial associations.
Sense-Making(sm2)	The organization develops partnerships and alliances with other organizations in order to acquire and exchange information.
Sense-Making(sm3)	The organization creates opportunities to discuss changes in external environment.
Sense-Making(sm4)	The organization has a systematic approach to communicating its mission, values, shared meanings, and common beliefs.
Knowledge creation(kc1)	The organization promotes the creation of communities of practice.
Knowledge creation(kc2)	The organization has formal mentoring and/or apprenticeships programs.
Knowledge creation(kc3)	The organization documents its projects and makes this information easily accessible.
Knowledge creation(kc4)	The organization maintains an organized and up-to-date information repository of good work practices and lessons learned.
Decision-making(dm1)	Information about good work practices, failures and/or errors, project documentation and lessons learned is taken into account when decisions are made.
Decision-making (dm2)	The organization has established decision routines and rules to support budget planning, project analysis, allocation of resources and project preordination.
Decision-making (dm3)	The organization extensively collects information to generate multiple options and alternative solutions to its problems.
Decision-making (dm4)	The organization stimulates collaborative decision-making, allowing individuals and groups to express openly their opinions.

The model variables were converted into a Web-based questionnaire using Likert scales (0-10). The answers were recorded in a secure SQL database. The first part of the questionnaire was related to portals and organizational capital portal maturity and had 17 items. The second part was 7 social and geographical questions. From March 2005 to May 2005, the questionnaire was applied to 98 Brazilian organizations. This sample was extracted from three Brazilian discussion lists: competitive-knowledge, Intranet-portal and the list of the Brazilian KM Society (SBGC). The three lists have together approximately 1,500 members, but it is hard to predict the response rate, as a person can be member of more than one list.

Among the organizations, 17% were related to government, 14% to information technology sector, 11% belong to the banking industry, 8% were chemical and petroleum industries, 6% belong to the utilities sector, and the rest were distributed across 15 industries.

Among the respondents, 42% were from IT department (Webmasters, intranet leaders, CIOs), 18% were from HR (human resource) department, 11% had specific KM roles (chief knowledge officers or knowledge management project leader), and the rest were from other departments (communications, research and development). All portal projects had more than 2 years, 85% of organizations had more than 100 employees, and 59% of the organizations had more than 500 employees.

The average working time in the organization of the respondents was 9.58 years (s = 7.72), and the average time in this job was 9.79 years (s = 7.34). Actually, 52% of the respondents have been working in their job for more time than they are in their present organization. This result indicates a high level of professional experience of the respondents, contributing to the quality of the survey. Table 4 provides descriptive statistics (average and standard deviation – s) about portal quality.

Within the scope of this survey, portals were considered as *useful* (q8) and *ease to use* (q10) tools, but the *compatibility* issue (q4) was poorly evaluated, showing that the integration level is superficial. Portals work as a launch pad to many applications, but not always those systems that share the same interpretations of data or agree upon a common terminology. The variables (q5, q6, q7, q8, q9 and q10) based on the technology acceptance model (Davis, 1989) obtained better

Table 4. Average of quality variables

Variable	Avg	s
(q1) Quality of information	6.0	2.7
(q2) Locatability	5.9	2.5
(q3) Meaning of information	5.9	2.4
(q4) Compatibility	4.7	3.0
(q5) Productivity increase	6.6	2.9
(q6) Job facilitator	7.0	2.8
(q7) Job quality gain	6.8	2.8
(q8) Usefulness	6.9	2.7
(q9) Ease of training	6.7	2.7
(q10) Ease of use	6.9	2.6
(q11) General usage	5.7	2.1

Table 5. Average of knowledge dimensions variables

Variables	Avg	s
Sense-making(sm1)	5.5	3.1
Sense-making(sm2)	6.1	3.0
Sense-making(sm3)	5.7	2.9
Sense-making(sm4)	6.8	2.9
Knowledge creation(kc1)	4.7	3.2
Knowledge creation(kc2)	5.0	3.3
Knowledge creation(kc3)	5.6	2.8
Knowledge creation(kc4)	4.9	3.0
Decision-making(dm1)	5.0	3.0
Decision-making(dm2)	5.7	3.1
Decision-making(dm3)	5.4	3.0
Decision-making(dm4)	5.8	2.9

results than those ones (q1, q2, q3 and q4) inspired by the Task Technology Fit (Goodhue & Thompson, 1995). These results indicate that portals need a better fit to organizational processes.

For the usage variable, there was a concentration of answers in the middle of the scale, indicating a diary usage of the Intranet from ½ to 1 hour. This level of usage reinforces the perception of portal not as a critical and essential system, but as a support system, confirming previous studies of Breu et al. (2000). Table 5 provides descriptive statistics about knowing organization dimensions.

Among the knowing organization dimensions, sense-making presented the better results with averages slightly superior to knowledge creation and decision-making. This result may be partially explained by the increasing competitive environment that requires organizations to develop their abilities to interpret changing scenarios. Moreover, sense-making is more procedural than knowledge creation and decision-making, providing then more conditions to a systematic approach through competitive intelligence and environmental scanning activities. When compared to portal quality variables, organizational capital variables have presented the worst averages, giving some evidence that the technology may be in a more advanced stage than the adoption of practices related to the development and maintenance of organizational capital.

Factor analysis is used to unveil the dimensions of a set of variables. In this research, factor analysis was used to validate a scale by demonstrating that

Table 6. KMO measure of sampling adequacy and Bartlett's test of sphericity

		Bartlett's Test of Sphericity		
Constructs	**KMO**	**Chi-Square**	**Degrees of Freedom**	**Significance**
Portal quality	0.92	1799.41	55	0.00
Sense-making	0.80	363.40	6	0.00
Knowledge creation	0.80	326.26	6	0.00
Decision-making	0.84	455.96	6	0.00

Table 7. Factor analysis: Portal quality construct

Variables	**Factor 1**	**Communalities (h^2)**
(q1) Quality of information	0.822	0.676
(q2) Locatability	0.793	0.628
(q3) Meaning of information	0.808	0.652
(q4) Compatibility	0.741	0.550
(q5) Productivity increase	0.868	0.754
(q6) Job facilitator	0.888	0.789
(q7) Job quality gain	0.888	0.788
(q8) Usefulness	0.892	0.795
(q9) Ease of training	0.843	0.711
(q10) Ease of use	0.732	0.535
(q11) General usage	0.571	0.326
Explained Variance ($(\Sigma h^2)/(\Sigma \sigma^2)$)	**65.50%**	

its variables load on the same factor, and to drop proposed scale items that cross-load on more than one factor. Nevertheless, when using factor analysis, it is necessary to verify the correlation matrix through Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (which should be greater than 0.7) and Bartlett's test of sphericity, that tests the null hypothesis that variables are not correlated on the population. Therefore, if the significance is below 0.05, the null hypothesis will be rejected. All constructs have obtained satisfactory index, according to Table 6.

Factor analysis was applied resulting in only one factor for each construct, as shown on Tables 7 to 10. Communality is the proportion of variance explained by common factors (Malhotra, 2001).

Reliability is the correlation of an item with a hypothetical construct that truly measures what it is supposed to. Cronbach's alpha measures how well a set of variables measures a single unidimensional latent construct, and values over 0.8 are considered as indicators of reliability (Netemeyer et al., 2003). Item-total correlation is also suggested to evaluate convergence among variables, and values over 0.4 are considered adequate (Table 11).

Convergent and discriminant validities were also performed, but for parsimony reasons, are not presented in this chapter. Convergent validity evaluates how the items of a construct are positively correlated to each other (Malhotra, 2001). Discriminant validity assesses the degree

Table 8. Factor analysis: Sense-making construct

Variables	**Factor 1**	**Communalities (h^2)**
Sense-making3	**0.893**	0.797
Sense-making2	**0.881**	0.777
Sense-making1	**0.875**	0.765
Sense-making4	**0.761**	0.579
Explained Variance ($(\Sigma h^2)/(\Sigma\sigma^2)$)	**72.94%**	

Table 9. Factor analysis: Sense-making construct

Variables	**Factor 1**	**Communalities (h^2)**
Knowledge-creation1	0.806	0.649
Knowledge-creation2	0.779	0.607
Knowledge-creation3	0.862	0.743
Knowledge-creation4	0.913	0.834
Explained Variance ($(\Sigma h^2)/(\Sigma\sigma^2)$)	**70.83%**	

Table 10. Factor analysis: Decision-making construct

Variables	**Factor 1**	**Communalities (h^2)**
Decision-making3	0.923	0.852
Decision-making2	0.884	0.781
Decision-making1	0.875	0.766
Decision-making4	0.875	0.765
Explained Variance ($(\Sigma h^2)/(\Sigma\sigma^2)$)	79,10%	

Table 11. Reliability analysis of constructs

Constructs	Variables	Item-total Correlation	Squared Multiple Correlation	Alpha if item deleted	Cronbach's Alfa
Sense-Making	Sense-Making1	0.7596	0.5770	0.8293	0.8753
	Sense-Making2	0.7728	0.5972	0.8238	
	Sense-Making3	0.7937	0.6300	0.8160	
	Sense-Making4	0.6080	0.3697	0.8861	
Knowledge Creation	Knowledge creation1	0.6542	0.4666	0.8393	0.8576
	Knowledge creation2	0.6225	0.4067	0.8543	
	Knowledge creation3	0.7319	0.5845	0.8090	
	Knowledge creation4	0.8184	0.6869	0.7700	
Decision-Making	Decision-Making1	0.7769	0.6084	0.8932	0.9117
	Decision-Making2	0.7895	0.6494	0.8891	
	Decision-Making3	0.8546	0.7349	0.8657	
	Decision-Making4	0.7765	0.6100	0.8933	
Portal quality	(q1) Quality of information	0.7785	0.6495	0.9406	0.9463
	(q2) Locatability	0.7452	0.7347	0.9420	
	(q3) Meaning of information	0.7638	0.7598	0.9413	
	(q4) Compatibility	0.6866	0.5770	0.9447	
	(q5) Productivity increase	0.8321	0.8333	0.9385	
	(q6) Job facilitator	0.8571	0.8946	0.9374	
	(q7) Job quality gain	0.8573	0.8452	0.9375	
	(q8) Usefulness	0.8612	0.8134	0.9373	
	(q9) Ease of training	0.8015	0.8001	0.9397	
	(q10) Ease of use	0.6739	0.6965	0.9445	
	(q11) General usage	0.5127	0.3589	0.9494	

to which a concept and its indicators differ from another concept and its indicators. All constructs obtained sufficient scores in convergent and discriminant validities.

The final common criterion for construct validity is nomological validity, or the degree to which the construct as measured by a set of variables predicts other constructs that. Nomological validity assesses the relationships among theoretical constructs, confirming significant correlations. In this research, path analysis procedures were used to model the value of each dependent variable based on its linear relationship to predictors. The regression coefficient is the linear correlation between the observed and model-predicted values of the dependent variable, and its large value indicates a strong relationship.

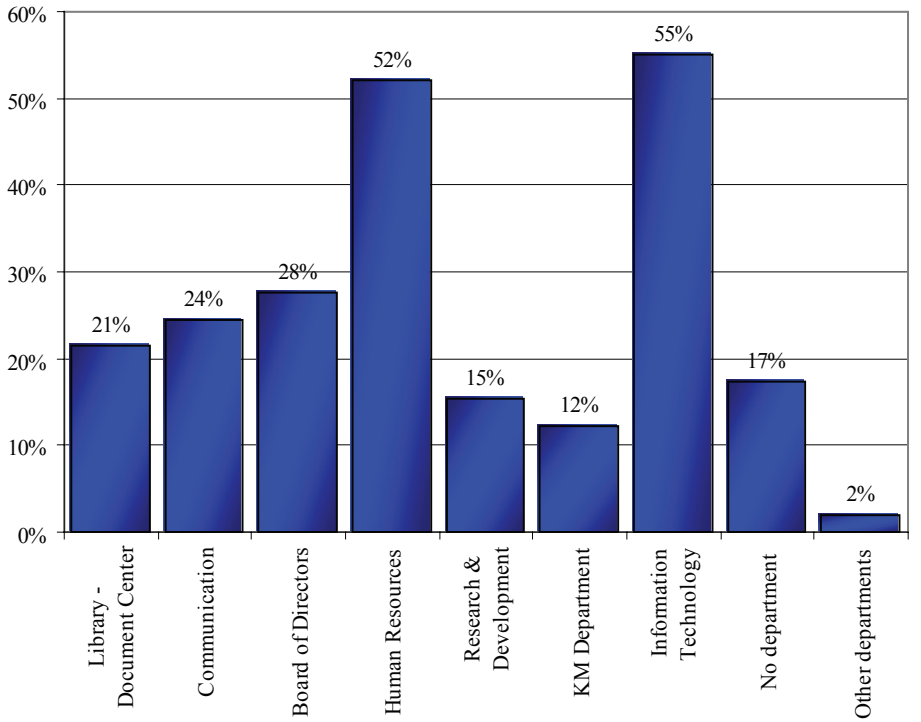
Those constructs marked with ** indicate that the relationship is significant at the level of 1%, and those marked with *** are at the level of 0.1%. The bigger the regression value, the greater is the influence of the independent variable on the dependent variable, as shown on Table 12.

As shown by regression coefficients, portal quality will positively contribute to foster structural capital. The path analysis revealed that portal quality had a more significant influence on knowledge creation than on decision-making and sense-making. These results give some evidence that knowledge creation is more information in-

Table 12. Path coefficients of the research model

Constructs					
Independent	**Dependent**	**Regression**	**Std. Error**	**t-Value**	**Sig.**
Portal Quality ***	Sense-Making	0.30	0.08	3.97	0,00
Portal Quality ***	Knowledge Creation	0.46	0.06	7.92	0,00
Portal Quality **	Decision-Making	0.19	0.05	3.51	0,00

Figure 2. Departments responsible for knowledge management



tensive than sense-making and decision-making, which are more procedural processes guided by rules. Many organizations have established rules to collect and gather information from the environment. Rules can be applied to decision routines as well. Nevertheless, it is hard to define detailed procedures to support knowledge creation, which is a process inspired by creativity, perception and novelty. Therefore, knowledge creation may be considered as a trial-and-error or chaotic process requiring back and forth movements and intensive information retrieval.

On the other hand, the coefficient values were lower than informally suggested by portal software vendors, to whom portal software is the key to foster intellectual capital and knowledge management initiatives. The path analysis revealed that portal quality variables explain the variance of organizational capital variables in a limited manner. These results give evidences that the existence of a good quality portal is not sufficient to assure the success of organizational capital practices.

The question related to the responsibility for knowledge management allows multiple responses, as more than one department can take charge of it. Therefore, the sum of percentages is over 100%. Only the option "no department is responsible for knowledge management." As shown by Figure 2, the information technology (IT) and human resource (HR) departments appeared as the main leaders of KM initiatives.

FUTURE TRENDS

Overall, the results demonstrate that the evolutionary path from Intranets to portals is not as easy and fast as it may seem. Organizations need to address compatibility issues. Many applications are being integrated to the portal environment without a structured planning. Providing a single point of access is an important step, but users also expect to obtain consistent data when they shift from applications. Real integration requires investments on better interfaces among systems, common taxonomies and infrastructure. The synergy between portal and EAI (Enterprise Application Integration) agendas seems to be a promising manner to deal with this question.

Government organizations were a significant percentage (17%) of the respondents, reinforcing the assumption that it is worth investigating knowledge management initiatives in the public sector. The good news is that the Brazilian public organizations that participated in this survey seem to be interested in the development of their organizational capital. When polls unveil a change of political parties, there is usually a great loss of knowledge as social and economical programs are not continued and most of the executive staff is changed. The availability of organizational capital may help the new staff to distinguish which initiatives and practices of the former government should be exploited or not.

It is interesting to report that few organizations (12%) have created a specific department for KM. This option may be partially explained by the organizational pragmatism and the need of reducing costs, creating then obstacles for the creation of areas related to more intangible aspects. Therefore, the creation of a specific KM area does not appear as a trend in this survey. Another relevant result was the reduced involvement of libraries and documentation centers as leaders of KM projects. A warning could be sent to the organizations (17% of respondents) where there is no explicit responsibility for KM, which may compromise the ability of the organization to innovate and compete.

CONCLUSION

The research model presented in this paper intends to be an initial step for a common framework to evaluate the effects of portal usage on intellectual capital projects. As portals require continuous investments (user interface, content update, application integration), organizations need instruments to evaluate whether the expected effects are being achieved or not. This research gives evidence that the portal quality has more influence on knowledge creation than on sense-making and decision-making.

Nevertheless, the model still has some limitations. Due to the size of the sample and to the cultural aspects of intellectual capital, it is not possible to generalize the results to other countries. Furthermore, even in Brazil, there might be organizations that have portals and organizational capital practices, but do not belong to any of the discussion list of the KM societies where the invitation for the survey was published.

On the other hand, it is important to report that the many of the respondents have found the model quite useful as a diagnosis mechanism for their portals. Some respondents have commented that the questionnaire has helped them in identifying strengths and weakness of their portal initiatives. The research model combines studies

from information science and information systems literature, adapting them to the portal's context. In addition, it tries to establish a link between technological and management perspectives in order to increase the benefits of using portals to support organizational capital practices.

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APPENDIX A. SURVEY OF THE INTRANET'S EFFECTS ON KNOWLEDGE MANAGEMENT PRACTICES

First Part. Intranet Questions

Instructions: *The following statements are about Intranet's quality from the perspective of the community of users, and* ***not from your experiences as a user****. Therefore, please have your users in mind while evaluating the statements. Please indicate the extent to which the* ***majority of users*** *agree or disagree with the following statements as they describe your* ***current*** *Intranet.*

FIRST PART	Level of agreement From: (0)–Strongly disagree To: (10)–Strongly agree										
Intranet Attributes	0	1	2	3	4	5	6	7	8	9	10
1. The Intranet maintains accurate and up-to-date information at an appropriate level of detail sufficient for users to carry out their tasks.											
2. It is easy to determine what information is available on the Intranet and locate it.											
3. The exact meaning of information available on the Intranet is either obvious, or easy to find out.											
4. The Intranet supports comparison and consolidation of information from different sources, without generating unexpected or difficult inconsistencies.											
5. The Intranet enables users to accomplish tasks more quickly, increasing their productivity.											
6. The Intranet makes it easier for users do their jobs.											
7. The Intranet enables users to improve the quality of their work.											
8. Overall, users find the Intranet useful in their jobs.											
9. Users quickly learn how to operate the Intranet to perform their tasks.											
10. Overall, users find the Intranet easy to use.											

11 - On an average working day, how much time does a single regular user spend using the Intranet? (Consider the delimiters of the following scale to guide your answer.)

Very rarely Very Frequently

0 – Once a month or less	1	2	3	4	5 – Between 30 and 60 minutes per day	6	7	8	9	10 – More than 5 hours per day

Second Part. Knowledge Management Questions

Instructions: *The following statements are about KM practices from the organizational perspective. Please indicate the extent to which you agree or disagree with the following statements as they describe* ***your current organization***.

Second Part	Level of agreement From: (0)–Strongly disagree To: (10)–Strongly agree										
KM Practices	0	1	2	3	4	5	6	7	8	9	10
1. The organization dedicates resources to detect and obtain external information from competitors, clients, universities, government, suppliers, and industrial associations.											
2. The organization develops partnerships and alliances with other organizations in order to acquire and exchange information.											
3. The organization creates opportunities to discuss changes in external environment.											
4. The organization has a systematic approach to com municating its mission, values, shared meanings, and common beliefs.											
5. The organization promotes the creation of communities of practice.											
6. The organization has formal mentoring and/or apprenticeships programs.											
7. The organization documents its projects and makes this information easily accessible.											
8. The organization maintains an organized and up-to-date information repository of good work practices and lessons learned.											
9. Information about good work practices, failures and/or errors, project documentation and lessons learned is taken into account when decisions are made.											
10. The organization has established decision routines and rules to support budget planning, project analysis, allocation of resources and project preordination.											
11. The organization extensively collects information to generate multiple options and alternative solutions to its problems.											
12. The organization stimulates collaborative decision-making, allowing individuals and groups to express openly their opinions.											

Third Part. Background Information

1 – Please indicate your industry. (Please select only one option)

( ) Agribusiness
( ) Automotive
( ) Banking
( ) Chemicals and petroleum
( ) Consulting
( ) Education
( ) Electronics
( ) Food and beverage
( ) Government
( ) Health care
( ) Information Technology
( ) Insurance
( ) Media and communications
( ) Mining and steel
( ) Pharmaceutical and cosmetics
( ) Real state
( ) Retail
( ) Transport and logistic
( ) Telecommunication
( ) Utilities
( ) Wholesale

If your organization is in other industry, please specify: _____

2 – Please check the option that indicates the number of employees of your organization.

( ) 0-100
( ) 101-500
( ) 501-1,000
( ) 1,001-5,000
( ) 5,001-10,000
( ) 10,001-20,000
( ) More than 20,000

3 – Which of the following groups/departments are responsible for the knowledge management practices in use in your organization? (Check **all** that apply)

( ) Human Resources
( ) Information Technology
( ) Library/Documentation Center
( ) Research and Development
( ) Knowledge Management Unit
( ) Corporate Communications
( ) Board of Directors
( ) No particular group/department has responsibility for KM
( ) Other, please specify _____

4 – Please indicate your current job title.

( ) CIO or IS/IT Manager
( ) CKO
( ) HR Manager
( ) IS Project Manager
( ) KM Project Manager
( ) System Analyst
( ) Support Analyst
( ) Human Resources Analyst
( ) Webmaster
( ) Administrative Staff
( ) Other, please specify: _____

5 – How long have you been in your organization? _____ years

6 – How many years have you been doing this type of work? _____ years
(Previous experience for other organizations should be taken into account.)

Chapter XV
The Impact of RFID Technology on a Firm's Customer Capital:
A Prospective Analysis in the Retailing Industry

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ABSTRACT

The emergence of radio frequency devices associated with smart tags—in what is called radio frequency identification (RFID) technology—has been widely discussed in the logistics field, mainly with respect to the implications accrued from this technology in the improvement of organizational efficiency and the creation of strategic ecosystems. However, very little research is available regarding the benefits of this technology in leveraging the relationship of firms with their customers, especially in the retailing arena. Hence, the purpose of this chapter is to analyze the potential of RFID technology with respect to the relationship between retailers and their clients, in order to understand how this technology is capable of increasing a firm's customer capital, in-line with intellectual capital taxonomy. Lastly, from this study, prospective scenarios are elaborated concerning the use of this technology to increase a firm's customer capital.

INTRODUCTION

The consolidation of intellectual capital as an actual knowledge field is still in progress. It should be remembered that years ago some mavericks foresaw the importance of intangible assets for a company, laying down the initial foundations for this very recent discipline.

In 1945, Frederick Hayek presented research about the use of knowledge in society (Hayek, 1945). In a seminal work, Fritz Machlup from Princeton University produced an eight-volume work in 1962, under the general title: *Knowledge: Its Creation, Distribution, and Economic Significance* (Machlup, cited in Stewart, 1997, p. 11). In this work, using data gathered in 1958, it was

established that 34.5 percent of the gross national product of the United States could be ascribed to the information sector. In 1993, Peter Drucker analyzed the new knowledge economy and its consequences (Drucker, 1993). Consequently, academics, researchers and practitioners have increasingly highlighted the importance of the intangible assets of a corporation and even those of both countries and other organizations, including non-profit entities.

A watershed was reached in July 1994 when a meeting took place in Mill Valley with a view to establishing how the knowledge of an organization could be measured. Knowledge may be intangible, but that does not mean that it cannot be measured. Markets do precisely that when they value the stock of highly knowledge-intensive companies way above their book value.

In 1995, Skandia—the largest insurance and financial services company in Scandinavia—released its Intellectual Capital Annual Report, based on its Navigator framework (Edvinsson & Malone, 1997). Some other companies, like Dow Chemical, the Canadian Imperial Bank of Commerce, Posco, and so forth, to name but a few, also entered this new era.

On the other hand, relationship marketing literature presents some empirical and theoretical evidence regarding the mutual benefits – both to sellers and buyers – accruing from deepening the commercial relationship between them (McKenna, 1993; Reichheld & Teal, 1996; Peppers & Rogers, 1997; Seybold, 1998; Kotler, 1999).

In-line with this, the relationship between a firm and its clients has been called its customer capital, according to intellectual capital taxonomy, as explained in greater detail later in this chapter (Edvinsson & Malone, 1997). Customer capital, according to these authors, is a component of a broader capital, namely either relationship capital or external capital (Röos et al., 1997; Stewart, 1997; Sveiby, 1997; Joia, 2000). This capital deals with the intangible assets of a firm accrued from its external relationships with its main stakeholders (suppliers, customers, partners, etc.), as well as with the firm's brand name, its distribution channels, and so forth. However, among all these components, the firm's relationship with its clients can be considered the major contributor to a company's external capital (see, for instance, Sveiby, 1997, pp. 142-165; Röos *et al.* p. 44; Joia, 2004, p.590, to name only a few).

On the other hand, the emergence of smart tags based on radio frequency technology allows mass retailers to identify their clients and to offer services and products in-line with each customer's interests and financial potential. Moreover, the customization of offerings is considered an important competitive advantage for the suppliers, as well as a distinctive source of value for them, according to the customers' perceptions (Seybold, 1998; Peppers et al., 1999).

The use of radio frequency devices in smart tags is usually called RFID (Radio Frequency Identification), a technology explained in greater depth in the course of this chapter. Hence, the scope of this chapter is to discuss the potential impacts accrued from the use of RFID technology in the relationship between firms and their clients, that is, in their customer capital, as well as to propose feasible scenarios addressing the implementation of this technology in the Brazilian retailing realm.

BACKGROUND

Intellectual Capital Taxonomy

Based on research carried out by Edvinsson and Malone (1997), Röos et al. (1997), Sveiby (1997), Stewart (1997) and Joia (2000), it is proposed that corporate capital taxonomy be used in this chapter.

The taxonomy adopted is based on the equation[1].

This equation (1) shows that stock value has a tangible portion (book value) in addition to an

Equation 1.

MARKET VALUE = BOOK VALUE + INTELLECTUAL CAPITAL

Equation 2.

BOOK VALUE = MONETARY CAPITAL + PHYSICAL CAPITAL

Equation 3.

INTELLECTUAL CAPITAL = HUMAN CAPITAL + STRUCTURAL CAPITAL

Equation 4.

STRUCTURAL CAPITAL = INTERNAL CAPITAL + EXTERNAL CAPITAL + INNOVATION CAPITAL

Equation 5.

INTELLECTUAL CAPITAL = HUMAN CAPITAL + INTERNAL CAPITAL + EXTERNAL CAPITAL + INNOVATION CAPITAL

intangible component. Hence, assuming that the intellectual capital is greater than zero (IC > 0), the market value/book value is greater than 1 (M/B > 1)—the more knowledge-intensive the company, the greater the M/B value.

The book value (also called financial capital) is then calculated using the formula 2, and intellectual capital, formerly called goodwill by accountants, is calculated using formula 3.

Human capital does not belong to the company, as it is a direct consequence of the sum of the expertise and skills of its employees. Structural capital belongs to the company, and can be traded (at least theoretically), as it is the actual environment built by the company to manage and generate its knowledge adequately. It is compounded by the internal structure or day-to-day operations of the company, encompassing its processes, databases, codes, culture, management style and internal networks (such as intranets), namely its' internal capital. Then, there is the external capital, which is concerned with the customers, suppliers, subcontractors and other major players involved—as metabusiness is now a reality (Keen, 1991)—it being hard to define a company's precise boundary (Joia, 2000). Finally, there is innovation capital, a direct consequence of the company's culture and its ability to create new knowledge from the existing base. Thus, the formula 4 summarizes what has been said above.

Finally, the overall intellectual capital formula can be presented as:

Figure 1 depicts the above concepts, showing the components of intellectual capital (the intangible assets) as gray-shaded boxes, all of which have the same relevance for the company.

It can be seen that intellectual capital is compounded of four constructs, namely HC, IC, EC and IVC—that is, human, internal, external and innovation capitals, respectively—each one of which interacts with the others (Hussi & Ahonen, 2002).

Some academics, including Alle (2000), have argued that a holistic rather than a Cartesian approach is indicated for intellectual capital management. It would indeed seem to be the wisest option. However, the very reason for splitting the intellectual capital into different capitals lies in the need to measure the influence of each one of these capitals on a company's performance, so as

to arrive at an intellectual Capital Index (Röos et al., 1997; Joia, 2000), which would be almost impossible to achieve using a holistic model. Furthermore, several authors including Röos et al. (1997, p. 125) have argued that intellectual capital analysis must take the time factor into account as a very important variable, that is, that any intellectual capital analysis must be dynamic rather than static. Again, this is advisable, and the explanation for it lies in the difference between "stock" and "flow" of knowledge (Johnson, 1999). However, as stated and proven by Joia (2000, pp. 81-83), some phenomena such as the "time-lag trap"—the asynchronous relationship between a company's strategy and its intellectual capital index—have prevented academics and practitioners from fully grasping the dynamics of intellectual capital.

Based on Edvinsson and Malone (1997), Röos et al. (1997), Joia (2000), Bontis et al. (2000) and McPherson and Pike (2001), it can be stated that correct strategic management of intellectual capital leads to superior business performance, specifically better financial results, as stated by Peppard & Rylander (2001, p. 231). Such financial results support the leveraging of the company's intellectual capital, which again impacts positively on its financial results and so on, in a sustainable loop, as presented in Figure 2. Hence, each construct of intellectual capital should have a causal effect on the financial results of a company with the passing of time, and as these capitals are evaluated through indicators, every indicator should have a causal relationship with the company's financial results.

Moreover, as Röos (Röos, cited in Chatzkel 2002, p. 106) argued, addressing a company's drivers of value:

...Why are drivers of value important? These are drivers of value in the minds of customers. These are the drivers of perceived value. They are important because they impact on two drivers of cash. The first driver of cash is margin and the other driver of cash is revenue. Revenue is driven by revenue drivers. These are, for example, the number of client relationships, how long they last, how much they buy every time, and how frequently they buy...

Thus, it can be perceived from this statement that the mark-up of frequent customers, their average ticket and their interest in purchasing more expensive products/services are important drivers of cash and, consequently, potential intangible corporate assets.

Customer Capital

According to Edvinsson and Malone (1997), the main focus of the external capital (referred to by

Figure 1. Intellectual capital taxonomy

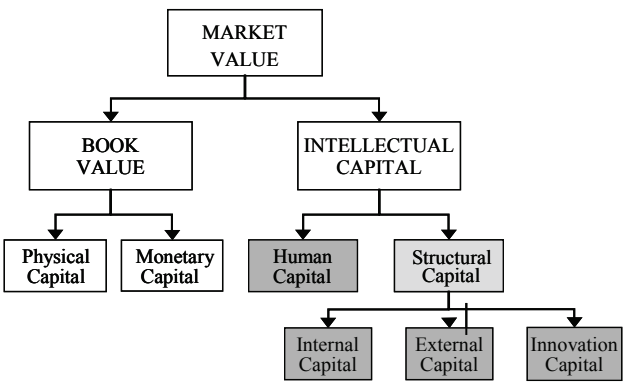
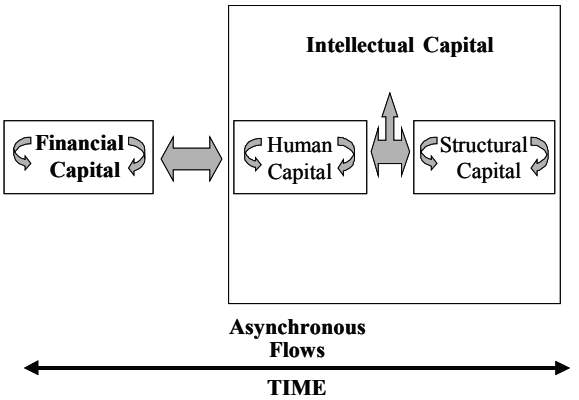


Figure 2. Flows of capital within a company with the passing of time



them as customer capital) of a company is the customer. The authors argue (pp. 94-95) that:

...the indicators associated to this capital must capture the flow of relationship between a company and its current and potential customers...

According to them (pp. 95-99), customer type, customer duration, customer role, customer support and customer success are the main facets of this capital, and are the locus of the customer capital, a component of the external capital.

Röos et al. (1997) broadened this concept (referred to by them as customer and relationship capital), adding supplier relationships, alliances with partners and shareholders and other stakeholder relationships (p. 43) to the former categories.

Sveiby (1997), for his part, calls this concept external structure, and adds the company's brand equity as another component, in addition to customer and supplier relationships.

It is important to stress here the fact that all these academics and practitioners appreciated—in different ways—that it was important for a company to strengthen its links with its customers or, in other words, to cultivate customers by winning over their loyalty. Sveiby (1997) divides customers into three categories in order to establish which are the most profitable (pp. 178-179). Even Kaplan and Norton (1997), when defining the balance scorecard concepts, stated the importance of customer retention, defined by them as:

...the rate at which a business unit retains or maintains ongoing relationships with its customers. (Kaplan & Norton, 1997, p. 68)

As respected authors in this very recent knowledge field, these academics and practitioners have paved the way for other researchers and practitioners to take it as an established fact that customer capital has a positive effect on valuing external capital—every time, everywhere and for every industry.

Consequently, the impressive number of important authors who quote the role of customers in their research as a relevant parameter for measuring the external intangible dimension of a business is hardly surprising. Among these authors we find Alle (2000, pp. 20, 25), Sullivan Jr. and Sullivan Sr. (2000, pp. 36, 43), Liebowitz and Suen (2000, p. 57), Sánchez et al. (2000, p. 323), Guthrie (2001, pp. 35-36), Gibbert et al. (2001, pp. 113-116), Lim and Dallimore (2002, p. 270) and Pablos (2002, p. 298), to name but a few.

These authors are in-line with what is preached by relationship marketing academics and practitioners, as presented below.

Relationship Marketing

Relationship marketing literature points to evidence that the closer a company is to its customers the greater its competitive advantage. In general, the strengthening of the relationships with their clients leads to premium price for the suppliers (McKenna, 1993; Reichheld & Teal, 1996; Kotler, 1999). Besides, Day (1999) argues that companies attain superior profitability when they build better linkages with their customers. McKenna (1993) stresses this idea stating that the development of strong relationships with clients leads businesses to increase their competitive advantage.

Another important item in this issue is switching costs. Reinartz and Kumar (2002) suggest that switching costs are almost nil for the customers who want to terminate a commercial relationship with a company. According to Jones and Sasser (1995), nowadays it is not enough for the companies just to satisfy their customers aiming to develop a loyal relationship with them, as they have freedom to choose their suppliers. These authors argue that in industries with a low level of competition clients are more easily retained, due to the lack of substitutes or higher switching costs. On the other hand, in industries with a high level of competition, where there is a great diversity of options as well as low switching costs, even with highly satisfied customers, the companies cannot be sure that their clients will not abandon them.

Rust and Oliver (2000) argue that companies can obtain better profitability through the maintenance of a high level of expectation in their clients, reflected in their enchantment with the level of quality of the company's services and available products. According to the authors, enchantment programs are barriers to new entrants, as well as being difficult to emulate, due to the high cost of implementation associated with them.

Another strategy used by enterprises to satisfy their clients is the creation of loyalty programs, involving prizes awarded to the customers according to purchasing amount, frequency, revenue, and transaction profitability. Bolton et al. (2000) point out that loyalty programs make customers less sensitive to losses related to the quality and prices practiced by the company, in comparison with the competition. In other words, consumers involved in these programs undervalue the negative evaluations ascribed to the enterprise *vis-à-vis* its competitors.

Interestingly, retailer company investments associated with customer relationship are still inexpressive. Day and Montgomery (1999) suggest that although the theoretical emphasis in the marketing realm has changed from a transactional to a relational approach, marketing *praxis* indicates that the transaction-oriented model still reigns either alone or combined with the relational approach. These speculations are supported empirically by the study developed by Coviello et al. (2002), who presented evidence that just 11% of the retailers in the USA stress customer relationship as their main marketing approach.

Furthermore, strengthening the customer relationship opens the way for the development of tailor-made customer service. Peppers et al. (1999) suggest that this customization facilitates the implementation of distinct offerings, leading businesses to exploit the individual potential of each customer, as well as considering his/her interest areas.

Radio Frequency Devices and Smart Tags

RFID (radio frequency identification) is a term used in a general way to designate technologies based on radio waves, which are used in the automatic identification of items of different types. RFID technology has traditionally been used to track goods, through tags embedded in microchips connected to minuscule antennas. When the tag is powered up by a reader—via radio waves—the microchip transmits back its identification code as well as other information stored in its memory.

This identification is relayed from the reader to the computer that activates a database containing information about this item (Wilding & Delgado, 2004a; Rappold, 2003).

Tags can be of two kinds: active or passive. The active variety contains a battery to power its electronic circuitry and is consequently larger. These are used when it is necessary to store and transmit larger volumes of data. They can also be read by relatively distant equipment (seven meters or more). Due to the additional costs of the battery, this type of equipment has a shorter lifespan and is considered expensive for use on a broad scale or on low value items. On the other hand, the electronic circuitry of the passive tag is powered up by the energy from the radio signal issued by the reader, thereby making its implementation cheaper. However, this reduces the power of the signal, limiting the distance for data transmission and rendering the tags more susceptible to interference (Baird, 2004; Hodges & Harrison, 2003; Juels, 2004; Wilding & Delgado, 2004a).

The memory of these components can be configured in various ways: read-only; programmable once-only and unlimited reading; and unlimited programming and reading (York, 2003; Manning, 2001). There are also chipless tags (without microchip) that have advantages in terms of cost and transportability, albeit they have limitations such as the inability to record data (Harrop & Henry, 2000).

According to Levary and Mathieu (2004), RFID is wireless technology that identifies objects without the need for physical or visual contact. Its use has been evaluated in various applications, leading renowned institutions such as MIT (Massachusetts Institute of Technology), to create specific laboratories for research into their application. In addition to this, joint ventures like Auto-ID and the EPC (electronic product code) bring together companies and research institutions for the development and application of this technology in the most wide-ranging segments of society.

Another important characteristic in this analysis is the frequency used by the radio waves. The higher bandwidths permit greater reading distance and higher data transmission speed, reducing the possibility of interference in the signal, whereas they are more expensive and have greater difficulty in traversing through objects, mainly metals, liquids and the human body. The lower frequencies have inverse behavior, with reduced range and slower data reading speeds, though at lower cost and with enhanced capacity for traversing through solids and liquids. In general, current applications are based on high frequencies, working on a maximum of one meter for reading purposes (Baird, 2004; Wilding & Delgado, 2004a).

In addition to the tags, the RFID system has other components such as antennas, readers and software responsible for retrieving and processing data stored on the microchips (Hodges & Harrison, 2003; Intermec, 2004). Also, they use ONS (Object Name Service) servers to translate the codes retrieved into identifiable items by the organizations (Rappold, 2003; Faber, 2002).

BENEFITS AND LIMITATIONS OF RFID TECHNOLOGY

Innumerable advantages and disadvantages of RFID technology have been reported in specialized literature. Current expectations would suggest benefits and limitations related to stock management, reutilization of tags, the incidence of fraud, operational efficiency, supply-chain management, availability of information to clients, and so forth (see, for example, Wilding & Delgado, 2004a; Doyle, 2004; Kinsella, 2003).

This section analyzes the benefits and limitations of RFID technology, applied to the relationship between companies and customers in the Brazilian retail segment from a qualitative standpoint.

Technological Benefits

- **Security:** Smart tags are harder to forge or tamper with by comparison to magnetic stripe cards that are traditionally offered to preferential customers. Also, the privacy of information can be ensured by the encryption of data stored on the microchips, guaranteeing that only systems used by the company in question can read or alter the content contained on the tags. The security of the data can also be guaranteed by the use of tags, which accept once-only data programming (Doyle, 2004; Wilding & Delgado, 2004b).
- **Durability:** Smart tags are also more durable when compared with identification using barcodes or magnetic stripes, as they can be reutilized and withstand harsher environmental and handling conditions. Passive tags have a lifespan in excess of 20 years (Baird, 2004).
- **Convenience:** The ease of use of smart tags is an important advantage of RFID technology. The use of cards that do not require direct contact affords greater convenience and agility for consumers, to the extent that the tags do not need to be removed from handbags or wallets. This characteristic can be even more relevant for senior citizens and people with special needs, such as locomotion difficulties (Doyle, 2004).
- **Flexibility:** The use of microchips permits a broader range of applications and presentation formats, such as key rings, watches, wristbands, necklaces, and so forth. This characteristic makes the technology more pervasive. Furthermore, the updating of information on magnetic stripe cards is not commercially viable, whereas exploratory results from tests conducted on smart tags have been excellent (Wilding & Delgado, 2004c).
- **Compatibility:** A card with RFID can also be equipped with a magnetic stripe or barcode, maintaining compatibility with traditional readers. This simplifies the adoption of the technology while safeguarding previous investments made by companies (Bean et al., 2003).

Technological Limitations

- **Untested:** Magnetic stripe technology is currently used on a broad scale in commercial systems and has been fully tested and certified, whereas the implementation of RFID is still at the exploratory stage, involving a significant degree of risk in investments made (Baird, 2004). In recent research, Bono et al. (2005) deciphered the logarithmic encryption used by systems in tollbooths, gas stations and in vehicle ignition systems based on RFID. This vulnerability affects millions of people worldwide and reflects the embryonic stage of this technology.
- **Reliability:** The reading effectiveness of RFID technology is considerably inferior to that experienced when using magnetic stripe readers. This is essentially due to physical contact and individual manipulation observed during the magnetic stripe reading. The high error ratio using RFID is associated with the distance between the antennas and the smart tags, as well as the reading of multiple tags simultaneously (Baird, 2004).
- **Lack of Standardization:** This limitation demands a higher level of investment by companies, due to the adoption of heterogeneous solutions in different countries and continents, limiting mass production and increasing the price of the components used (ITAA, 2004; Wilding & Delgado, 2004a).
- **High Cost of the Tags:** This is the most significant restriction of RFID technology

(Smith & Konsynski, 2003; Atkinson, 2004). However, the rapid rate of development of this segment leads one to believe that this limitation will be overcome in the next few years. The industry is taking the cost of US$ 0.05 as the ideal price range for smart tags to be used on a commercial basis (Faber, 2002).

- **Privacy:** By using RFID technology, consumers can be tracked without being aware of the fact. This includes the company that supplied the tag to the consumer, either through products sold or cards and key rings distributed in special loyalty programs, as well as other entities, including people or organizations that possess readers that are compatible with the tags used (ITAA, 2004; Atkinson, 2004).

FUTURE TRENDS

By careful reading of scientific magazines, working papers and sites on the Web, using the criteria proposed by Malhotra (2002, pp. 125-151) and Cooper and Schindler (2001, pp. 220-240), prospective scenarios were put forward for the application of technology in the relationship between companies and clients in the Brazilian retail segment, with a view to increasing the customer capital of companies.

In generic terms, the scenarios generated were in-line with the ideas put forward by Schwartz (1991, pp. 100-117). Also, for the construction of prospective scenarios relating to the use of RFID in the retail sector, the secondary data were consolidated following the specific criteria suggested by van der Heidjen (1996, pp.183-224).

Thus, in accordance with van der Heidjen (1996, p. 187):

- A minimum of two scenarios should be constructed to reflect the uncertainty of the research. The elaboration of too many scenarios is counterproductive;
- All of the scenarios should be lifelike, that is, likely to happen;
- The scenarios should be relevant to the person who will receive them. They should provide useful, wide-ranging and challenging ideas, in such a way that clients receiving the scenarios can structure their strategies, business plans, and so forth;
- The scenarios should reflect a new and original perspective about the problems that the clients involved are likely to face.

The secondary data analyzed made it possible to structure inductive, as opposed to deductive, scenarios (van der Heidjen, pp.196-198). In order to achieve this, an interpretative analysis was required (Walsham, 1995; Klein & Myers, 1999). This analysis sought to infer standards, tendencies and structures, while also attempting to link the secondary sources with existing and widely accepted theories (van der Heidjen, 1996, p. 194). Based on this analysis, scenarios relating to the impact of RFID technology on a firm's customer capital in the retail arena in Brazil are put forward and commented upon at the end of this chapter.

RFID is considered promising in various business segments. In the area of logistics and operations, which is by far the most advanced in application of this technology, hundreds of companies, led by the giants such as Wal-Mart, Proctor and Gamble and Nestlé, have made significant efforts to increase their operational efficiency and ensure a differentiated position from their competitors (Langford, 2004; Wal-Mart, 2004a, 2004b, 2004c).

This technology enables mass retailers to identify clients who are bearers of smart tags. The microchips can be incorporated to objects in various ways (cards, discount coupons, key rings, stickers, packaging, etc.). This increases the likelihood of usage by the consumers and consequently their identification.

In this study, the analysis is conducted from the standpoint of the relationship between suppliers and purchasers in the Brazilian retail segment. The identification of consumers through smart tags provides opportunities for companies to strengthen their links with their clients. Two scenarios associated with this technological application are discussed below in an exploratory manner.

As mentioned earlier all the scenarios should be lifelike (van der Heidjen, 1996). Therefore, for the scenarios set forth below real examples are presented that demonstrate the viability of the prescriptions, thereby making them relevant to those who intend to analyze them.

It should be pointed out that the following premises are valid for all of the proposed scenarios:

- Distributing smart tags to selected clients. With this in mind, several criteria may be used, such as economic class (see ANEP, 2003), consumer profile or purchasing history.
- Providing detailed information to the clients about the implications of using a smart tag, pointing out the perceived benefits and limitations. In all subsequent interaction, the retailers should remind the consumers that they were identified through use of a smart tag.

Scenario 1: RFID Applied to the Interaction with Clients

In order to strengthen the bond between suppliers and purchasers, this section recommends the following implementation actions:

- Equip the store entrance and the key departments with RFID readers. This identification system should be linked to the client database in order to analyze client preferences and purchasing history.
- Equip the store with terminals that trigger a signal whenever a selected consumer enters the store or a department equipped with readers. Forms of notification can include traditional computers, wireless computers and cell phones.
- All clients identified should be welcomed by name, thereby providing personalized service. The greeting should also be standardized; for example, "Good morning, welcome to our store Mr. Smith."
- All selected clients should receive benefits and differentiated treatment in order to justify the use of the tags throughout the relationship. This form of approach should include differentiated prices and exclusive offers.
- The retailer should respect the profile of each client. For some consumers, swift service will be the most relevant aspect. Others may be more interested in being informed about new products and services. And there will be those who show a marked preference for a specific consumer category, such as cheeses, wines, meats, and so forth.
- The company should establish if the client has some special payment facility. For example, a discount coupon, pre-approved credit or if payment of installments for some goods previously purchased in the store is nearing conclusion. It is important that the sales process should be conducted in such a way as to reflect this facility.
- The announcements should be personalized and dynamic, seeking to exploit the potential of clients who are inside the store. This can be done in a directed way, by individual contact or in the conventional manner, using the in-store loudspeaker systems to announce the promotions currently on offer.
- Relevant commemorative dates for each client should be taken into consideration in the approach. An example of this is the birthday of the consumers themselves or

their relatives, as well as special dates like Mother's Day, Father's Day, Saint Valentine's Day and Children's Day, and so forth

As a practical example of this type of scenario one could mention the clothing department of the Prada store, which recognizes its clients via RFID. In this retail outlet, the sales staff are notified via wireless terminals, distributed around the store, about the preferences of the clients and are then able to offer products with differentiated characteristics in terms of style, color, price, and so forth (*RFID Journal*, 2002; Ideo, 2003).

Scenario 2: RFID Linked to the Payment Process

In the retail segment, concerns with the payment process involve security problems, attendance time, checkout line management, and so forth. In this section the following implementation actions are recommended:

- Identify the clients in the checkout line and ensure differentiated treatment, either for some specific requirement of the clients such as age or locomotion difficulties, or loyalty programs that include mileage, discounts, and so forth.
- The payment process should be handled using the preferential payment terms appropriate for each consumer. For example the checkout operator should ask the client if the expenses are to be debited from a previously registered credit card. The client should then punch in the identification pin number for the retailer in order to authenticate each transaction made.

As real instances of this scenario, MyGrocer and Exxon Speedpass are cases in point. In MyGrocer—a project involving the European Union, the universities of Athens and Helsinki and various manufacturing and retail companies—direct experiences with consumers were performed during the payment process. When questioned, 88% of their clients agreed that RFID technology made the purchasing process swifter and 97% said that it was easier to make purchases (Wilding & Delgado, 2004b). In the case of Exxon Speedpass—introduced in 1997 in the service stations marketing Mobil fuel products—the payment operation is performed automatically with credit or debit cards by means of pre-arranged agreement with the client. According to Exxon Mobil, there are already over 5.5 million Speedpass users and over 7,300 Exxon and Mobil service stations in the U.S. equipped with RFID technology (Wilding & Delgado, 2004c).

CONCLUSION

In this chapter the use of identification technology via radio frequency was discussed as being an instrument to facilitate and implement actions geared to the enhancement of the relationship with clients, in order to increase the customer capital of retail companies.

It transpired, mainly with respect to relationship marketing aspects, that the application of RFID in a customer-centric vision is a viable prospect. The scenarios for application presented are feasible both in terms of technological reality and the requirements of companies, despite some limitations inherent in the technology, which were duly pointed out. The viability of these scenarios was backed up with the presentation of practical examples (real cases) of what is being done within major corporations.

It is important to stress the business vision of the companies that have been pioneering first-movers in the use of this technology. They have made great efforts and invested considerable funds to develop and consolidate the new technology in many areas, thereby gaining a competitive advantage over their competitors in the use of RFID. In the case of customer-centric

initiatives, this becomes even more apparent, as few companies have invested in RFID with this in mind, despite all the potential benefits listed in this article.

We can therefore conclude that RFID technology is an important means for the application of relationship marketing initiatives, with great potential impact on customer capital. By harnessing the creativity of the marketing teams and the synergy of these teams with the technological areas of the companies it is possible to implement a large number of potential actions geared to winning over customer loyalty.

As suggestions for academic research, more in-depth scientific investigation into the full potential of the scenarios proposed in this chapter is recommended, relating them directly to the Brazilian retail market. It is also necessary to conduct research to broaden the scope of the level of identification of clients evaluated in the experiment with a view to increasing the effectiveness of marketing actions. It is important that research be conducted into new ways of applying the technology—not discussed in this chapter—in order to discover the true potential of the application of RFID on the customer capital of companies. Lastly, it is essential to measure, accurately and over the course of time, the impact of RFID technology on the variation in customer capital of the companies that adopt this technology.

In future works it will also be important to evaluate the extent to which the first-movers in the use of this technology achieve a sustainable competitive advantage or if they obtain only a temporary advantage or even mere competitive parity. This should be examined in light of the fact that barriers for entry for new users can be considered low, thereby enabling other retailers to appropriate the use of this technology in their processes. To achieve this, a suggestion would be the application of the resource-based view strategy (see Penrose, 1959; Wernerfelt, 1984), more specifically with the application of the VRIO model developed by Barney (1991).

Similarly, experiments are necessary for the evaluation of the effectiveness of smart tag readings in different environments and situations, in view of the fact that results obtained to date indicate that RFID technology still needs to evolve in this respect.

The importance and scale of the results that can be obtained through association with RFID in terms of intellectual capital seem to be abundantly clear. This would also appear to represent confirmation that the future of the retail trade lies in radio frequency, which is a fact that the major world players in the sector have already appreciated.

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