Innovative Technologies for Information Resources Management

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Chapter I

A Post-Implementation Case Study and Review of Enterprise Resource Planning
(ERP) Implementations: An Update */ Joseph R. Muscatello and Diane H. Parente*

Enterprise resource planning (ERP) systems, if implemented correctly, have shown that a firm can gain strategic and tactical advantages over their competition who do not implement such systems. However, with failure rates estimated to be as high as 50% of all ERP implementations, companies can be negatively impacted by a poor performing ERP system. The research on ERP has focused on events leading to the selection, evaluation, and implementation of the ERP system. The intent of this updated research effort is to capture new theories that can help practitioners successfully manage ERP systems by performing a post-ERP implementation examination of eight corporations and a pertinent research review. This chapter is based on a qualitative research design involving case study methodology. The propositions derived from the case study form a broad set of considerations that influence the success of an ERP system.

Chapter II

ERP Usage in Practice: An Empirical Investigation */ Mary C. Jones and Randall Young*

This study presents the results of an exploratory study of firms in the Fortune 1000 about their enterprise resource planning (ERP) usage, as well as benefits and changes they have realized from ERP. The study empirically examines ERP in these organizations to provide insight into various aspects that firms can use to evaluate how they are managing their own ERP systems. Findings provide information about functionality implemented, extent to which benefits are realized, extent of ERP-related organizational changes firms have realized, and the way firms measure ERP success. The study also addresses the extent to which various types of ERP software have been implemented, and whether there is a relationship between type of software and benefits. Finally, it examines ERP-enabled change in light of organizational configuration.

There is a growing concern of escalating IT investments and their lack of justification. Of all IT investments, ERP systems entail probably the highest investments. ERP systems are widely publicized for providing many benefits, including improved customer responsiveness, better supply-chain management, improved productivity, improved business processes, and reduction in several costs, including inventory costs. However, they are also blamed for several business problems and failures. Past studies have analyzed investments in ERP systems based on gross and indirect outcomes like net income, return on investment, net present value, or change in market value of a firm. However, such measures could be affected by several factors besides ERP systems. The authors argue that an analysis of more direct measures, intangible or tangible, would enhance confidence in the efficacy of ERP systems. Intangible, direct measures can be improved customer satisfaction or confidence, enhance employee morale, and so forth. Tangible direct measures can be reductions in inventory control costs, improvement in cash management, reduction in operating costs, and so forth. The authors specifically focus on direct and tangible impacts of ERP systems implementation. To reduce or eliminate confounding effects due to industry type and size, they investigate the impact of ERP systems implementation on operational efficiency of medium-sized firms in the pharmaceutical and chemicals industry. Specifically, the authors test if inventory levels are reduced, cash management is improved, and operating expenses are reduced as a result of ERP system implementation in 17 medium-sized pharmaceutical and chemical firms. Their analysis of the data indicates that for a majority of the firms, improvement of operational performance expected due to ERP systems did not materialize.

A two-stage approach is employed to examine the influencing factors of consumer behaviors in the context of mobile advertising. The first stage of the study evaluates the correlation relationship of consumer motives for receiving mobile advertising and their attitudes toward mobile advertising. The relationship between consumer intentions for receiving advertisements on the cellular phones, and their subsequent actions upon receiving the mobile advertising is also investigated. A negative sentiment was revealed of cellular phone users toward mobile advertising. This represents a warning signal, indicating that current practices of mobile advertising generally are ineffective and are in need of a careful reevaluation on the part of mobile commerce firms.The second stage of the research applies Fishbein and Ajzen's theory of reasoned action model to examine consumer behavior regarding mobile advertising. They found that positive actions on the received advertisements are significantly influenced by strong intentions, strong intentions are significantly influenced by favorable attitudes, and favorable attitudes are significantly influenced by strong motives. Implications for e-commerce application developers and marketers are discussed.

Product customization is an important facility that e-commerce offers to its users. On the Web, Choiceboard systems have become quite prevalent as the means by which users are able to customize their products. These systems allow customers to configure products and services by choosing from a menu of attributes, components, delivery options, and prices. In the context of a choiceboard environment, this research examines the impact of system and information quality and information presentation on interface satisfaction and decision satisfaction. Further, it examines the impact of the latter two satisfaction factors on overall user satisfaction and intention to use. The research reveals that improved system quality, vis-à-vis choiceboards, leads to better information and decision satisfaction on the part of the users. This in turn leads to higher overall satisfaction and intention to use. The research uses an experiment for data collection and examines these relationships using the structural equation modeling (SEM) approach.

As organizations implement enterprise systems, the issues of whether to "build or buy" new IT modules, and if buying, how much to customize, continue to be key concerns. In this chapter, they develop a framework in order to better understand effective information system module choice and customization from a strategy perspective. Analysis of the strategic importance of the IS module can provide general guidance for the amount of specialization that is appropriate. To illustrate these ideas, they apply them to four case examples.

This chapter presents an evolutionary framework for the establishment and progression of client-vendor relationships in the context of offshored applications development. It is argued that such a relationship typically begins as a cost-reduction exercise, with the client contracting out simple, structured applications to one or more offshore vendors. Over time, the client assigns increasingly complex applications to selected vendors, and cultivates loose, trust-based, network-like relationships with them. As offshored applications continue to evolve and become business critical, the client may seek to regain control by establishing a command-based hierarchy. This may be achieved through part or full ownership of a vendor organization, or by starting a captive offshore subsidiary. Thus, the initial client objective of cost reduction is ultimately displaced by one pertaining to risk control. Pertinent prior research is used to justify the proposed framework. This is followed by a case study that describes how a specialty telecommunications company is pursuing just such an evolutionary path.

This chapter uses the theory of loose coupling to explain failure in the adoption of an information technology aimed at improving collaboration across one organization's internal boundaries. The research details an interpretive case study of a single organization, MacGregor Crane, in which relatively autonomous individuals are only loosely connected in terms of their daily interactions. The company implemented Lotus Notes© in an attempt to increase collaboration. However, this effort failed because employees in various units, particularly engineering, were reluctant to share information across unit boundaries. In light of these findings, it is suggested that the successful implementation of a collaborative IT within a loosely coupled organization should involve the reconsideration of the organizational members' roles and functions.

Organizations must provide appropriate work-group structures and communication technologies for work groups to effectively and efficiently engage in group problem solving and decision making. Communication technologies, such as videoconferencing systems, have enabled the creation of "virtual organizations" and "virtual teams" that span time, space, and distance. This study investigates the hypotheses that team structure (e.g., fully collocated teams vs. virtual teams comprised of dispersed subgroups) and the associated communication mode (i.e., face-to-face vs. videoconferencing) will impact virtual team group processes (e.g., team orientation, workload sharing, proclivity to seek and exchange information) that evolve. Further, this group processes will dictate team member information exchange patterns (e.g., across all team members vs. only within collocated subgroups), which subsequently impacts team productivity (i.e., accuracy and timeliness) and group process satisfaction. A causal path model depicts the proposed hypotheses, and regression analysis was chosen as the path analytical method. Four-person teams worked in either face-to-face (i.e., fully collocated group) or videoconferencing (i.e., dispersed subgroups) settings to develop detailed design documentation for specified enhancements to a hypothetical university information system. Results indicated that the dispersed subgroups exhibited more within subgroup collective behaviors and engaged in greater within subgroup information exchange as compared to fully collocated teams, where more team-wide collective behaviors and information exchange were observed. Further, greater team collective behaviors gave rise to greater information exchange and activation among team members. Finally, information exchange and activation was positively associated with productivity and process satisfaction.

Despite the recent growth in the number of women in the American labor force, women are still underrepresented in the IT workforce. Key among the factors that account for this underrepresentation is balancing work-family issues. This study presents a framework for analyzing work-family balance from a field study of women employed in the American IT workforce. The findings are examined through the lens of the Individual Differences Theory of Gender and IT to show the range of ways in which work-family considerations influence women's IT career decisions. The framework is used to support the theoretical argument that women exhibit a range of decisions regarding career and parenthood. the nonparent, the working parent, the "back-on-track" parent, and the "off-the-track" parent. These findings illustrate an identifiable theme that crosses geographical regions and timeframes. Societal messages are complex and difficult to digest, and are processed in different ways by different women; yet they contribute to the decisions women make about their professional and personal lives.

Computer-supported collaborative learning (CSCL) has received increasing research attention owing to advances in e-learning technology and paradigmatic shifts in the educational arena. Owing to the growing diversity in student population in terms of nationality, the role of cultural diversity becomes greatly pronounced and must be addressed. In this study, a laboratory experiment with a $2\times2\times2$ factorial design was conducted to investigate the interaction effects of perceived cultural diversity, group size, and leadership on learners' performance and satisfaction with process. Contrary to an expected negative relationship between perceived cultural diversity and performance, a positive relationship emerged as a result of leadership. Leadership lowered learners' satisfaction with the process in perceived homogeneous groups (as compared to perceived heterogeneous groups) and smaller groups (as compared to larger groups).

Much of today's organizational knowledge still exists outside of formal information repositories, and often only in people's heads. While organizations are eager to capture this knowledge, existing acquisition methods are not up to the task. Neither traditional artificial intelligence based approaches, nor more recent, less-structured knowledge management techniques have overcome the knowledge acquisition challenges. This study investigates knowledge acquisition bottlenecks, and proposes the use of collaborative, conversational knowledge management to remove them. It demonstrates the opportunity for more effective knowledge acquisition, through the application of the principles of Bazaar style, open source development. Additionally, this study introduces wikis as software that enables this type of knowledge acquisition. It empirically analyzes the Wikipedia to produce evidence for the feasibility and effectiveness of the proposed approach.

This study examines the effects of the organizational climate maturity on knowledge management performance, measured in terms of knowledge quality and knowledge-sharing level. Reward, top management support, and IT service quality were investigated as the managerial drivers to positively influence such climate maturity. The hypothesized relationships were tested by the partial least square analysis with data from 42 organizations in Korea. Findings of the study indicate that more mature (knowledge friendly) organizational climate is linked to higher knowledge management performance, and reward, top management support, and IT service quality are critical managerial drivers influencing such climate maturity.

Achieving IT-business alignment has been a long-standing critical information management issue. A theoretical framework of the maturity levels of management practices and strategic IT choices that facilitate alignment was empirically tested and validated. Confirmatory factor analysis (CFA) validated six factors and identified 22 indices to measure strategic alignment maturity. A mixed model repeated measures analysis of variance (ANOVA) obtained significant results for both the main effect and interaction effect of differences for the six maturity factors across the 11 business units. Regression analysis found a positive association bettheyen overall strategic alignment maturity and respondents' self-rated maturity. These exploratory findings show promise for the assessment instrument to be used as a diagnostic tool for organizations to improve their IT-business alignment maturity levels.

This chapter discusses the positive effects of IT investment on firm financial performance when a distinct range of characteristics is examined. The relationship between IT investment and firm performance considering the information-intensity of the industry is explored using a distributed lag model. Findings indicate both a positive effect and a positive lag effect of IT investment. The effects of IT investment in the high information-intensive industry are significantly larger than in the low information-intensive industry. Furthermore, a lagged effect of IT investment is larger than an immediate effect, regardless of the information-intensity of the industry. They conclude that firms in the high information-intensive industry need to be more cognizant of performance factors when investing in IT investment than in the low information-intensive industry. Moreover, it is necessary to consider the time lag between IT investment and firm performance.

Chapter XVI

The Institutionalization of IT Budgeting in Firms: Investigating Sources of

Organizations around the world invest billions of dollars each year in information technology (IT) re-lated products and services. What are the factors influencing each individual firm's investment budget decisions? Limited empirical results derived from firm-level data suggest that internal affordability, such as previous IT budget levels, sales, profitability, and size, are significant sources of influence. In this study, the authors introduce the perspective of "external institutional influence" for examining corporate IT budgeting processes, in addition to the internal affordability perspective. Using firm level IT and financial data of publicly traded companies in the financial sector, they show that the two most significant sources of influence on corporate IT budgets are the firm's IT spending level of the previous year (internal) and the IT spending level of the perceived industry leaders (external). They posit that as IT becomes pervasive in all aspects of business operations and all sectors of the economy, IT budgeting processes have been, at least partially, institutionalized. The implications of this institutionalization are discussed and future research directions are suggested.

Chapter XVII

A Metadata Model and Related Framework for Unstructured Document Management

Effectively managing documents is a strategic requirement for every organization. Available document management systems (DMS) often lack effective functions for automatic document management. One reason is that relevant information frequently is conveyed by unstructured documents, whose content cannot be easily accessed and processed by applications.This study proposes a metadata model, the DMSML (document management and sharing markup language), to enable and to ease unstructured document management by supporting the design of DMSs. The authors argue that the extensive use of this metadata language will render organizational information explicit, promoting information reuse and interoperability, in a more profitable way than what is guaranteed by proprietary DMSs. They also describe the DMSML framework, a set of tools that they have developed in order to ease DMS design and deployment. Finally, they briefly depict the design and deployment phases of a Web-based DMS prototype based on the DMSML framework.

Chapter XVIII

Relevance and Usefulness of Corporate Web Site Disclosure Practices

In this study, the authors investigate whether corporations are following the "best disclosure practices" when presenting business reports on their Web sites. As a benchmark, they use the recommendations made by the Jenkins Committee (1994) to evaluate disclosures on corporate Web sites for value, relevance, and quality of information. They compute a disclosure score using 26 items recommended by the Jenkins Committee and Meek, Roberts, and Gray (1995) as indicators of best reporting practices. Our findings reveal that most corporations do not follow "best disclosure practices" when reporting information on their Web sites. Only about half of the 26 disclosure items recommended by the Jenkins Committee are

reported, and less than 50% of the sample firms in our study make such disclosure. Some of the items that the Jenkins Committee recommends as essential for improving quality and relevance of reporting, such as forward-looking information (e.g., plans, opportunities and risks, forecasts, critical success factors), nonfinancial items (e.g., changes in operating performance, research and development activities), or off balance sheet financing, are least often reported. The findings suggest that corporations must improve their Web site disclosures for investors to find them valuable, relevant, and useful.

This chapter investigates consumer online purchasing behavior using an augmented technology acceptance model. Particularly, the authors posit that Web use leads to intention to purchase online. Impulsiveness, Web use, and social norms are included in the model to test several hypotheses concerning online consumer beliefs, intentions, and the effect of psychological traits. They developed a survey instrument to collect data, and used structural equation modelling to validate the research model. All of our hypotheses were confirmed except the one that links social norms and online buying behavior. The positive relationship between consumer impulsiveness and online purchasing behavior suggests that online stores should design their Web sites to attract impulse purchases.

This chapter examines the role of technology in home-based telecommuting (HBT), and the implications of this role for organizational IT departments and for managers of telecommuting employees. Specifically, it addresses the question: Does technology both facilitate and hinder home-based telecommuting? Although technology enables HBT, it has also been blamed for HBT's slow growth. To clarify the role that technology currently plays when employees telecommute, the authors describe a recent study that investigated the relationship between different forms of organizational support (classified as technology-related, somewhat technology-related, and nontechnological) and employees' reactions to HBT. Two technology-related support variables and manager's trust (a nontechnological support) were found to have broad impact on employees' reactions to HBT. So, while technology plays a crucial role and thus could be a major factor in HBT's slow growth, they argue that HBT is better understood within a multifactor rather than a single-factor framework. Other implications are that organizations should emphasize providing IT support and appropriate technology for telecommuters as well as HBT-related training for nontelecommuting coworkers and managers of the telecommuters.

Preface

Modern organizations are discovering that the relationship between effective and distinctive information resources management tactics, and the facilitation of growth and success both internally and externally, is undeviating. In order to gain a competitive edge, they must find innovative and creative ways of effectively managing their ever-evolving information resources. An increasing number of organizations are implementing new knowledge management strategies and maximizing the human aspects of effective information management. *Innovative Technologies for Information Resources Management* provides information technology researchers, scholars, educators, and practicing managers the latest research on managing the technological, organizational, and human aspects of information utilization and management. This volume presents new concepts in handling and sharing information resources with organizations and individuals worldwide.

Chapter I, entitled "A Post Implementation Case Study and Review of Enterprise Resource Planning (ERP) Implementations: An Update," by Joseph R. Muscatello, Kent State University (USA) and Diane H. Parente, Penn State Erie - The Behrend College (USA), discusses the strategic and tactical advantages that firms can gain from the successful implementation of enterprise resource planning (ERP) systems. They will also examine the negative impacts of implementing poorly performing ERP systems. The intent of this study is to capture new theories that can help practitioners successfully manage ERP systems by performing a post-ERP implementation examination of eight corporations and a pertinent research review. Information technology is based on a qualitative research design involving case-study methodology. The propositions derived from the study form a set of considerations that influence the success of ERP systems.

Chapter II, entitled "ERP Usage in Practice: An Empirical Investigation," by Mary C. Jones and Randall Young, University of North Texas (USA), presents the results of an exploratory study of enterprise resource planning (ERP) usage in firms in the Fortune 1000. They examine the benefits and changes they have realized from ERP, and give insight into various aspects that firms can use to evaluate how they are managing their own systems. The study also addresses the extent to which various types of ERP software have been implemented, and whether there is a relationship between types of software and benefits. Additionally, it examines ERP enabled change in light of organizational configuration.

Chapter III, entitled "Improvements in Operational Efficiency Due to ERP Systems Implementation: Truth or Myth?" by Vijay K. Vemuri and Shailendra C. Palvia, Long Island University (USA), presents the concern of escalating IT investments and their lack of justification. In this study, the authors emphasize the need for more direct measures, such as intangible or tangible. Intangible direct measures can be improved customer satisfaction or confidence, enhanced employee morale, and so forth. Tangible direct measures can be reductions in inventory control costs, improvement in cash management, reduction in operating costs, and so forth, in order to reduce or eliminate confounding effects due to industry

type and size, they investigate the impact of ERP systems implementation on operational efficiency of medium-sized firms in the pharmaceutical and chemicals industry.

Chapter IV, entitled "Consumer Perceptions of Mobile Advertising: An Application of the Theory of Reasoned Action," by Wen-Jang (Kenny) Jih, Middle Tennessee State University (USA), Su-Fang Lee, Overseas Chinese Institute of Technology (Taiwan), and Yuan-Cheng Tsai, Chung-Shan Institute of Science and Technology (Taiwan), presents a two-stage approach used in examining the influencing factors of consumer behaviors in the context of mobile advertising. The first stage of the study evaluates the correlation relationship of consumer motives for receiving mobile advertising and their attitude toward mobile advertising. The second stage of the study applies Fishbein and Ajzen's theory of reasoned action model to examine consumer behavior regarding mobile advertising. Additionally, they will discuss implications for e-commerce application developers and marketers.

Chapter V, entitled "Effective Product Customization on the Web: An Information Systems Success Approach," by Pratyush Bharati, University of Massachusetts (USA) and Abhijit Chudhury, Bryant College (USA), presents research that uses an experiment for data collection and examines these relationships using the structural equation modeling (SEM) approach. They explore the impact of system and information quality and information presentation on interface satisfaction and decision satisfaction. Additionally, they examine the impact of the latter two satisfaction factors on overall user satisfaction and intention to use. The study reveals that improved system quality, vis-à-vis choiceboards, leads to better information and decision satisfaction on the part of the users. This, in turn, leads to higher overall satisfaction and intention to use.

Chapter VI, entitled "Fit Between Strategy and IS Specialization: A Framework for Effective Choice and Customization of Information System Application Modules," by Marc N. Haines, University of Wisconsin - Milwaukee (USA), Dale L. Goodhue, University of Georgia (USA), and Thomas F. Gattiker, Boise State University (USA), presents a framework they developed in order to better understand effective information system module choice and customization from a strategy perspective. In this study, they present four case examples in which they analyze the strategic importance of the IS module, and provide guidance for the amount of specialization that is appropriate.

Chapter VII, entitled "The Progression of Client-Vendor Relationships in Offshored Applications Development," by Rajesh Mirani, University of Baltimore (USA), presents an evolutionary framework for the establishment and progression of client-vendor relationships in the context of offshored applications development. It is argued that such a relationship typically begins as a cost-reduction exercise, with the client contracting out simple, structured applications to one or more offshore vendors. Over time, the client assigns increasingly complex applications to selected vendors, and cultivates a loose, trust-based, network-like relationship with them. As offshored applications continue to evolve and become business critical, the client may seek to regain control by establishing a command-based hierarchy. This may be achieved through part or full ownership of a vendor organization, or by starting a captive offshore subsidiary. Thus, the initial client objective of cost reduction is ultimately displaced by one pertaining to risk control. This chapter justifies the proposed framework through prior research, and follows up with a case study that describes how a specialty telecommunications company is pursuing just such an evolutionary path.

Chapter VIII, entitled "Understanding Information Technology Implementation Failure: An Interpretive Case Study of Information Technology Adoption in a Loosely Coupled Organization," by Marie-Claude Boudreau, University of Georgia (USA) and Jonny Holmström, Umeå University (Sweden), uses the theory of loose coupling to explain failure in the adoption of an information technology aimed at improving collaboration across one organization's internal boundaries. Their research details an interpretive case study of a single organization, MacGregor Crane, in which relatively autonomous individuals are

only loosely connected in terms of their daily interactions. In an attempt to increate collaboration, the Company implemented Lotus Notes©. However, the effort was deemed unsuccessful because employees in various units, particularly engineering, were reluctant to share information across unit boundaries. As a result of this outcome, it is suggested that the successful implementation of a collaborative IT within a loosely coupled organization should involve the reconsideration of the organizational members' roles and functions.

Chapter IX, entitled "The Impact of Communication Medium on Virtual Team Group Process," by Hayward P. Andres, North Carolina A&T State University (USA), examines the crucial work group structures and communication technologies used by organizations for work groups to effectively and efficiently engage in group problem solving and decision making. Communication technologies, such as videoconferencing systems, have enabled the creation of "virtual organizations" and "virtual teams" that span time, space, and distance. This study investigates the hypotheses that team structure (e.g., fully collocated teams vs. virtual teams comprised of dispersed subgroups) and the associated communication mode (i.e., face-to-face vs. videoconferencing) will impact virtual team group processes (e.g., team orientation, workload sharing, proclivity to seek and exchange information) that evolve. The overall results of the study indicated that information exchange and activation was positively associated with productivity and process satisfaction.

Chapter X, entitled "Understanding the 'Mommy Tracks': A Framework for Analyzing Work-Family Balance in the IT Workforce," by Jeria L. Quesenberry, Eileen M. Trauth, and Allison J. Morgan, The Pennsylvania State University (USA), presents a framework for analyzing work-family balance from a field study of women employed in the American IT workforce. In this study, the framework is used in support of the theoretical argument that women exhibit a range of decisions regarding career and parenthood. The findings are examined through the lens of the individual differences theory of gender and IT to show the range of ways in which work-family considerations influence women's IT career decisions.

Chapter XI entitled "Perceptions in Computer-Supported Collaborative Learning: Interaction of Cultural Diversity, Group Size and Leadership," by Yingqin Zhong and John Lim, National University of Singapore (Singapore), examines computer-supported collaborative learning (CSCL), a topic under which research attention has grown exponentially due to advances in e-learning technology and paradigmatic shifts in the educational arena. In this study, a laboratory experiment with a 2×2×2 factorial design was conducted to investigate the interaction effects of perceived cultural diversity, group size, and leadership on learners' performance and satisfaction with process.

Chapter XII, entitled "Breaking the Knowledge Acquisitions Bottleneck Through Conversational Knowledge Management," by Christian Wagner, City University of Hong Kong and School of Information Science (Hong Kong) and Claremont Graduate University (USA), investigates knowledge acquisition bottlenecks and proposes the use of collaborative, conversational knowledge management to remove them. The research presented within this study demonstrates the opportunity for more effective knowledge acquisition, through the application of the principles of Bazaar style, open source development. Also presented is the introduction of wikis as software that enables this type of knowledge acquisition. It empirically analyzes the Wikipedia to produce evidence for the feasibility and effectiveness of the proposed approach.

Chapter XIII, entitled "Effects of Managerial Drivers and Climate Maturity on Knowledge Management Performance: Empirical Validation," by Jang-Hwan Lee, Samsung SDS (Korea), Young-Gul Kim, Korea Advanced Institute of Science and Technology (Korea), and Min-Yong Kim, Kyunghee University (Korea), examines the effects of the organizational climate maturity on knowledge management performance, measured in terms of knowledge quality and knowledge sharing level. The influence of

managerial drivers, such as reward, top management support, and IT service quality, and their positive influence, such as climate maturity, are investigated.

Chapter XIV, entitled "Development and Validation of an Instrument to Measure Maturity of IT Business Strategic Alignment Mechanisms," by Deb Sledgianowski, Hofstra University (USA) Jerry N. Luftman and Richard R. Reilly, Stevens Institute of Technology Management (USA), empirically tested and validated a theoretical framework of the maturity levels of management practices and strategic IT choices that facilitate alignment. The framework, confirmatory factor analysis (CFA) validated six factors and identified 22 indices to measure strategic alignment maturity. A mixed model repeated measures analysis of variance (ANOVA) obtained significant results for both the main effect and interaction effect of differences for the six maturity factors across the eleven business units. The regression analysis found a positive association between overall strategic alignment maturity and respondents' self-rated maturity. All of these findings show great promise for the assessment instrument to be used as a diagnostic tool for organizations to improve their IT-business alignment maturity levels.

Chapter XV, entitled "A Lag Effect of IT Investment on Firm Performance," by Sangho Lee and Soung Hie Kim, Korea Advanced Institute of Science and Technology (South Korea), discusses the positive effects of IT investment on firm financial performance when a distinct range of characteristics is examined. Using a distributed lag model, the authors explore the relationship between IT investment and firm performance with consideration of the information intensity of the industry. The findings indicate both a positive effect and a positive lag effect of IT investment. The effects of IT investment in the high information-intensive industry are significantly larger than in the low information-intensive industry. Futhermore, a lagged effect of IT investment is larger than an immediate effect, regardless of the information intensity of the industry. It is concluded that firms in the high information-intensive industry need to be more cognizant of performance factors when investing in IT investment than in the low information-intensive industry.

Chapter XVI, entitled "The Institutionalization of IT Budgeting in Firms: Investigating Sources of Influence," by Qing Hu, Florida Atlantic University (USA) and Jing "Jim" Quan, Salisbury University (USA), introduces the perspective of "external institutional influence" for examining corporate IT budgeting processes, in addition to the internal affordability perspective. Using firm level IT and financial data of publicly traded companies in the financial sector, the authors show that the two most significant sources of influence on corporate IT budgets are the firm's IT spending level of the previous year (internal) and the IT spending level of the perceived industry leaders (external). They conceive that as IT becomes pervasive in all aspects of business operations and all sectors of the economy, IT budgeting processes have been, at least partially, institutionalized. Throughout this study, the implications of this institutionalization are discussed and future research directions are suggested.

Chapter XVII, entitled "A Metadata Model and Related Framework for Unstructured Document Management in Organizations," by Federica Paganelli, Maria Chiara Pettenati, and Dino Giuli, University of Florence (Italy), proposes a metadata model, the DMSML (document management and sharing markup language), to enable and to ease unstructured document management by supporting the design of document management systems (DMS). Typically, DMS systems lack effective functions for automatic document management, which is a strategic problem for organizations. The authors contend that the extensive use of this metadata language will render organizational information explicit, promoting information reuse and interoperability, in a more profitable way than what is guaranteed by proprietary DMSs.

Chapter XVIII, entitled "Relevance and Usefulness of Corporate Web Site Disclosure Practices," by Ram S. Sriram, Georgia State University (USA) and Indrarini Laksmana, Kent State University (USA), investigates whether corporations are following the "best disclosure practices" when presenting business reports on their Web sites. The authors use recommendations made by the Jenkins Committee (1994) as

a benchmark to evaluate disclosures on corporate Web sites for value, relevance, and quality of information. Using 26 items recommended by the Jenkins Committee and Meek, Roberts, and Gray (1995), they compute a disclosure score in order to indicate best reporting practices. The findings within this study reveal that most corporations do not follow "best disclosure practices" when reporting information on their Web sites. The conclusions suggest that in order for Web site disclosures to be deemed valuable, relevant, and useful to investors, corporations must make major improvements.

Chapter XIX, entitled "The Role of Impulsiveness in a TAM-Based Online Purchasing Behavior Model," by Xiaoni Zhang, Northern Kentucky University (USA), Victor R. Prybutok, and Chang E. Koh, University of North Texas (USA), investigates consumer online purchasing behavior using an augmented technology acceptance model. In particular, the authors' conjecture that Web use leads to intention to purchase online. For this study, the authors developed a survey instrument to collect data and use structural equation modeling to validate the research model. The conclusions of the study confirmed all but one of the hypotheses. The unconfirmed hypothesis was one that links social norms and online buying behavior. This is that the positive relationship between consumer impulsiveness and online purchasing behavior suggests that online stores should design their Web sites to attract impulse purchases.

Chapter XX, entitled "Home-Based Telecommuting: Technology's Role," by Ellen Baker and John Crawford, University of Technology (Australia) and Gayle C. Avery, Macquarie, Graduate School of Management (Australia), examines the role of technology in home-based telecommuting (HBT), and the implications of this role for organizational IT departments and for managers of telecommuting employees. The authors address questions such as: Does technology both facilitate and hinder home-based telecommuting?

Technology has become the foundation of all types of organizations in today's information society. It facilitates and improves communication within and outside of the organization; it streamlines business processes and aids in decision making.

Innovative Technologies for Information Resources Management provides a collection of the latest research related to effective utilization and management of information technology to coordinate and use information resources. Practitioners and business professionals will find concrete advice on how to maximize their IT investments, their knowledge management initiatives, and their training programs. This innovative volume is a must read for anyone interested in gaining a more thorough understanding of how to successfully manage and enrich their valuable technology and information resources.

Chapter I
A Post–Implementation Case Study and Review of Enterprise Resource Planning (ERP) Implementations:
An Update

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ABSTRACT

Enterprise resource planning (ERP) systems, if implemented correctly, have shown that a firm can gain strategic and tactical advantages over their competition who do not implement such systems. However, with failure rates estimated to be as high as 50% of all ERP implementations, companies can be negatively impacted by a poorly performing ERP system. The research on ERP has focused on events leading to the selection, evaluation, and implementation of the ERP system. The intent of this updated research effort is to capture new theories that can help practitioners successfully manage ERP systems by performing a post-ERP implementation examination of eight corporations and a pertinent research review. This chapter is based on a qualitative research design involving case-study methodology. The propositions derived from the case study form a broad set of considerations that influence the success of an ERP system.

INTRODUCTION

In our continued analysis of enterprise resource planning (ERP) systems, we continue to find organizations that have had great strategic and tactical success stories using ERP. However, the research clearly shows that the implementation of ERP systems is anything but easy. Many projects suffering from cost overruns, failure to meet pre-implementation goals or outright abandonment have been documented (Grant, Harley, & Wright, 2006; Hendricks Singhal, & Stratman, 2006; Liang & Xue, 2004; Muscatello, 2006; Olson, Chae, & Sheu, 2005; Yu, 2005; Yusef, Gunasekaran, & Althorpe, 2004). ERP systems promise to computerize an entire business with a suite of software modules covering activities in all areas of the business. Furthermore, ERP is now being promoted as a critical link for integration between all functional areas within a firm's supply chain, and has shown to be a significant contributor to a corporation's success if implemented correctly. ERP systems improve efficiency within the four walls of an enterprise by integrating and streamlining internal processes (Anderson, 2000; Davenport & Brooks, 2004; Koch 2001; Nicolaou & Bhattacharya, 2006; Somers & Nelson, 2004).

The ERP implementation efforts of many manufacturing companies have resulted in partial failure and in some cases, total abandonment. Many researchers have found that ERP implementation failure rates exceed 50% (Chen, 2001; Muscatello, 2006; Olson et al., 2005). An American Production and Inventory Control Society (APICS) Conference Board report issued in June 2001 stated that 40% of participants failed to achieve their business case after having implemented ERP for at least 12 months (Salopek, 2001). In a recent survey by Deloitte Consulting LLC, 25% of the 64 Fortune 500 companies surveyed said they suffered a drop in performance when their ERP systems went live (Muscatello, Small, & Chen, 2003). This is after believing that they had successfully installed the system. A recent study conducted by Professors Austin and Nolan of the Harvard Business School reveals that a remarkable 65% of executives believe ERP systems have at least a moderate chance of hurting their business because of implementation problems (Cliffe, 1999). Most of the research to date focuses on pre-implementation activities, and provides some answers to a successful "path forward" for firms wanting to implement an ERP system. Research shows that some firms have successfully implemented ERP systems with some excellent performance improvement (Anderson, 2000; Gefen & Ragowski, 2005; Melnyk & Stewart, 2002; Millman, 2004; Yusef et al., 2004). However, since many ERP systems fail to meet their objectives after going live (Cliffe, 1999; Salopek, 2001; Somers & Nelson, 2004; Yusef et al., 2004), it is logical to conclude that there must be post-implementation improvements being performed by firms committed to using ERP as a successful business tool. This research seeks to uncover new information about the successful implementation and management of ERP systems by analyzing eight firms who have multiple years' experience, with varying degrees of success, with ERP systems. Table 1 provides a literature review of ERP research.

The gap that exists in current research has to do with the post-implementation ERP effects on a business. What processes, programs, duties, and so forth, changed in the post-ERP implementation? What interdisciplinary effects were observed? What are the observed ongoing effects? This research extends the theories on ERP implementation by exploring the selected case studies both pre- and post-implementation.

METHODOLOGY

Case-study research methodology has been highly recommended by many researchers as an ideal tool for improving conceptual and descriptive understanding of complex phenomena, and has been used successfully for analyzing ERP

Table 1. ERP implementation literature review

Research Area	Application	Literature Support
Strategic Assessment of ERP and Management Support	ERP adoption should be seen as a business decision rather than a pure technology decision. Top level managers must understand and appreciate the strategic value of ERP and be willing to provide unswerving support for the project.	Nicolaou, and Bhattacharya, 2006; Somers and Nelson, 2004; Davenport and Brooks, 2004; Yusuf, Y. et al, 2004; Kumar, et al, 2003; Carton and Adam, 2003; Chen, 2001; Anderson, 2000; Davenport, 2000; Brakely, 1999; Griffith et al., 1999; Ng and Ip, 1998; Shulman, 1998; Vasilash, 1997; Volkoff et al., 1997.
ERP Project Scope	"Scope creep" can create a project that never ends. The functional departments and processes that will be effected by the ERP installation should be selected at the beginning of the project and jealously guarded against additions.	Yusuf, et al, 2004; Kumar et al, 2003; Sarkis and Sundarraj, 2003; Chen, 2001; Holland and Light, 1999; Trepper, 1999
Process Reengineering	Companies need to integrate their core processes, combine related activities and eliminate those activities that do not add value prior to adopting the any new manufacturing or information technology.	Muscatello 2006; LIang and Xue, 2004; Somers and Nelson, 2004; Muscatello, 2002; Nah, et al, 2001; Al-Mashari, 2000; Chalmers, 1999; Davenport, 1993; Dickey, 1999; Hammer and Champy, 1993; Hammer and Stanton, 1999; Jenson and Johnson, 1999; 1999; Smith, 1999.
ERP Skill Assessment and Training Needs	Formal assessment of the knowledge and understanding of ERP principles for all levels of employees is required to evaluate the amount of training required. It is also critical in establishing who has the ability to learn and change and if they can survive in the new organization.	Grant, et al, 2006; Yu, 2005; Olson, et al, 2005; Yusuf, et al, 2004; LIang and Xue, 2004; Kumar, et al, 2003; Muscatello 2002; Cliffe, 1999; Koch, 1999; Kropp, 1994;.
ERP Package and Module Selection and Subsequent Technical (Information Technology) Issues	If the firm decides to implement an ERP, the information gathered in the needs assessment will provide a ready checklist for configuring an ERP system with all the necessary modules and their associated subsystems. If the expertise is not located internally it should be solicited from a third party.	Nicolaou, and Bhattacharya, 2006; Olson, et al, 2005; Somers and Nelson, 2004; Kumar, et al, 2003; Chen, 2001; Nah, et al, 2001; Davenport, 2000; Booker, 1999; Holland and Light, 1999; Koch, 1999; Lail, 1999, Shulman, 1998; Travis, 1999, Trepper, 1999.
Economic/Financial and Strategic Goals of ERP	Many ERP projects proceed without a formal analysis of costs and benefits. Major strategic benefits such as improved response to customer demands, improved and streamlined internal and external communication, and improved customer-supplier relationships should be factored into the expected benefits.	Hendricks, et al, 2006; Olson et al, 2005; Millman, 2004; Davenport and Brooks, 2004; Carton and Adam, 2003; Melnyk and Stewart, 2002; Chen, 2001; Davenport, 1998; Herr, 1994; Koch 1999; Maxwell, 1999; Schaeffer, 1999; Vasilash, 1997.

Table 1. continued

Research Area	Application	Literature Support
Economic and Strategic Justification of ERP	Economic and strategic justification for an ERP project, prior to installation, is necessary because of the enormous investment and risk involved. Moreover, the justification process helps identify all the potential costs as well as the strategic and economic benefits that can accrue from the ERP implementation.	Gefen and Ragowski, 2005; Olson, et al, 2005; Davenport and Brooks, 2004; Millman, 2004; Chen, 2001; Cliffe, 1999; Cotteler et al., 1998; Herr, 1994; Koch, 1999; Schaeffer, 1999; Vasilash, 1997.
ERP Implementation Costs	Many firms budget for these systems without adequate appreciation for the full costs of an implementation. Systems integration costs are often more difficult to predict. Often training and education costs are grossly underestimated.	Hendricks et al, 2006; Millman, 2004; Kumar, 2003; Sarkis and Sundarraj, 2003; Bradley et al., 1999; Koch, 1999; The Meta Group.
ERP Project Management and Team Structure	A project management structure that includes an executive steering team, a full-time project manager, a project management team and process teams is recommended.	Muscatello 2006; Olson, et al, 2005; Somers and Nelson, 2004; Kwasi and Salam, 2004; Kumar, V., Maheshwari, B., and Kumar, U. 2003; Nah, et al, 2001; Dong, 2001; Cotteller et al., 1999; Koch, 1999; Lewis, 1993; Trepper, 1999; Vasilash, 1997, Volkoff et al., 1999; Welti, 1999.
Top Management Support	Top management commitment is much more than a CEO giving his or her blessing to the ERP system and then moving on to other projects. Management commitment should look beyond the technical aspects of the project to the organizational requirements for a successful implementation.	Olson, et al, 2005; Yu, 2005; Somers and Nelson, 2004; Davenport and Brooks, 2004; Chen, 2001; Cotteller et al., 1999; Dong, 2001, Herr, 1999; Maxwell, 1999. Oliver, 1998.

issues (Flynn, Sakakibara, Schroeder, & Bates, 1990; McCutcheon & Meredith, 1993; Meredith, 2002; Muscatello, 2006; Sarkis & Sundarraj 2003; Stuart, McCutcheon, Handfield, McLachlin, & Samson, 2002; Yin, 1994). The case study method also offers many benefits, such as the ability to directly observe causality, and combine evidence and logic to build, develop, or support theory that is not available using other research methods (Maffei & Meredith, 1995). In contrast to survey research formats, it allows for more meaningful follow-up questions to be asked and answered,

and can result in more extensive findings and insights that are valid, generalizable, and rigorous (Meredith, 1998).

ERP implementation is an expensive and extensive undertaking involving all activities related to planning, justification, installation, and commissioning of the installed system. An ERP system extends across the entire organization and even beyond to cover integral partners in the supply chain. Furthermore, ERP projects can take two, three, or more years to fully implement (Kumar et al., 2003; Olson et al., 2005; Parker, 1999; Yusef

et al., 2004). All of these factors contribute to the complexity of ERP installations, and make snap-shot/cross-sectional approaches unsuitable for investigating the entire ERP implementation process. We adopt a case-study methodology to create propositions based on a longitudinal analysis of post-implementation factors that contribute to the successful installation and management of an ERP system. However, unlike the majority of studies in this area, which focus on single case studies or survey information based on a specific ERP process or implementation plan, we develop propositions based on ERP implementations at eight diverse manufacturing facilities.

Selection of organizations is a very important aspect of building theory from case studies. While the cases may be chosen randomly, random selection is neither necessary, nor even preferable. Given the limited number of cases that can be studied, it has been suggested that researchers choose extreme situations and polar types in which the process of interest is transparently observable (Eisenhardt, 1989). Of the eight ERP implementation projects included in this study, four were successful; two have been partially completed with low to moderate success; and two were eventually abandoned with very little gain. It was difficult to assess whether the abandoned projects should be included in a post-implementation study since obviously, their post-implementation was a failure. However, after reviewing the supporting documents and conducting preliminary interviews we decided to include them, since they believed they had implemented the ERP system and abandoned it after the project team was disbanded. One of the authors of this study served as a team member on six of the eight projects, with different roles on each project. His roles were those of executive sponsor, project manager, subject-matter expert, and project team member. On the remaining two studies, the author had follow-up access to the project charter, plan, reengineering records, scope, quality plan, meeting minutes, consultants, project manager, team members, and executive sponsors.

Multiple methods were used to generate the data including the principle author's observations and constant interactions with ERP project team members during and after implementation. As an integral member of the pre- and post-implementation project team for six projects and as a post-implementation advisor to the other two businesses, the principle author had unlimited access to historical documents and other records, financial data, and operations statistics. Open-ended interviews were also held with corporate officers, divisional managers, project leaders, superusers and various project team members. These interviews permitted the project participants to identify and frame the important issues and factors that affect ERP implementation success, as also suggested in Maffei and Meredith (1995). This approach is consistent with the recommendation that, in an area where theory is relatively undeveloped, researchers should use an inductive approach to the process of identifying issues for inclusion in the study (Flynn, Schroeder, & Sakakibara, 1994; Hensley, 1999; Spector, 1992).

COMPANY BACKGROUND AND DATA

Four of the companies covered by this study were divisions of larger companies; four were stand-alone companies. They represent a range of firm sizes ($55 million to $3.5 billion in annual revenues), products, types of manufacturing (continuous process, batch, and job shop) markets, and organizational arrangements. The companies also had different prior experiences with manufacturing and information technology. The financial performances of seven of the eight companies were below the expectations of their corporate headquarters. Company G had average profits compared to the industry. Four companies (A, B, E, and F) were recording consistently declining profits. Company C was just breaking even in a growing market and Companies D and H were los-

ing money. In addition, they were all experiencing problems with excessively high inventory levels and low inventory turnover rates. The on-time delivery performance of six companies, (A, B, C, E, F, and G) was below the average for their respective industries. In contrast, Companies D and H had on-time delivery performances better than the industry. Corporate and divisional management for all of the companies recognized the need for immediate strategic and operational responses to these problems.

All eight of the companies entered their ERP decision process under threat of punitive action from corporate headquarters or the company's executive management team. Companies A and G had been threatened with widespread divisional management changes if the decline in profitability was not reversed. Company B's corporate management had stated that it would close down the division and transfer the work to a foreign division of the company. Executive management of Company C had threatened to find an external source for this division's products, and the corporate management of Companies D and H has indicated that it was going to close the division/company if the losses continued. Company E's management required improvements or underperforming divisions would be closed or sold. Executives at Company F required improvement or the acquisition plan would be scuttled, leaving smaller opportunities for the middle management. Corporate management of four of these companies had recent encouraging experiences with enterprise system (ES) installations at their headquarters or in other divisions; they were favorably disposed to ES solutions for streamlining divisional operations. Experienced internal managers and consultants, vendors, board members, or other professionals who had an understanding of ERP systems influenced the companies who were not divisions or subsidiaries. Corporate management at all firms viewed integrated enterprise systems as a means of improving efficiencies and communications across all their divisions and between the divi-

sions and corporate headquarters. They were also the primary selectors of the project sponsor and senior project team members.

A detailed business profile and the findings of each case study are shown in Table 2. To maintain anonymity, the names of the corporations have been removed. The intent of this case analysis is to infer relationships between project interdependencies and project performance. Therefore, each case is akin to a laboratory or complete survey experiment (Meredith, 1998).

Propositions and Theoretical Framework

The author derived eight propositions based on the eight case studies. Each proposition will be presented and the end of the discussion.

Participants were very vocal about the need to assess the skill and training level of the existing employees after the implementation. There was a general dismay at the lack of ERP and business knowledge residing in companies that implemented ERP systems. One participant stated: "People don't understand how the whole company operates, just their little corner of the world. They need to understand that an ERP system requires timely and accurate data in order to perform the planning functions. They view transactions as an afterthought and not 'real work' like production. This mentality is killing our ERP system."

Three companies (C, D, and F) performed no formal review of their existing employees' skill levels until after the implementation. Companies A and B did the skill review with in-house senior managers who had successfully transformed other divisions and two managers with multiple ERP systems installations. Three companies (E, G, and H) used outside consultants to assess the current skill level, ability to grow, and amount of education and training necessary to grow. The assumption from most management is that after implementation, a person is fully trained.

Table 2. Company profiles and analysis

Company	A	B	C	D	E	F	G	H
Type of Business	Chemicals	Inorganic coatings	Electronics assembly	Centrifugal and static foundry	Specialty paint and coatings	Specialty heat resistant steels. Metals.	Health and safety products	Steel products, fasteners & specialty construction materials
Operation type	Manufacturing	Manufacturing	Manufacturing/ Distribution	Manufacturing	Manufacturing	Foundry & fabrication Also reseller	Manufacturing/ Distribution	Manufacturing
Category	Fortune 500 division	Fortune 500 division	Fortune 500 division	Division of $300MM corporation	Fortune 500	Small Private Company	Fortune 500	Large Private Company
Annual Sales (millions)	$90	$75	$200	$55	$3,500	$60	$2,200	$800
Market Share	30%	65%	30%	15%	15%	28%	14%	4%
Primary Markets (B2B, B2C)	B2B	B2B	B2B B2C	B2B	B2B B2C	B2B	B2B	B2B
Type of Manufacturing	Continuous process	Batch/repetitive	Batch/ repetitive	Job-shop	Batch/repetitive	Job shop	Batch/repetitive	Job-shop, batch/ repetitive
Number of Employees	87	131	145	106	1,228	311	944	512
Finished goods	High	High	High	Low	High	Average	High	Low
WIP	Low	High	Low	Low	High	High	Average	High
Raw Mat'l	High	High	High	High	High	High	High	High
Inventory Turnover Rates	Low compared to industry	Low compared to other divisions in company and Industry	Slightly below industry	Low compared to industry	Low compared to industry	Low compared to other divisions in company and Industry	Slightly below industry	Low compared to industry
On-time (in full) Delivery Performance	60%	78%	62%	76%	85%	62%	90%	83%
Industry on-time delivery performance	85%	70%	85%	60%	98%	90%	99%	80%

Table 2. continued

Company	A	B	C	D	E	F	G	H
Impetus for Process Change	Declining profits (40% over a 3 year period)	Declining profits & below corporation targets.	Just breaking even in a growing market.	Losing money	Declining profits, loss of market share.	Declining profits & below corporation targets.	Moderate profits compared to industry.	Losing money. Old plant & ideas. Unionized
Corporate Stance	Improvement or wholesale management changes	Improvement or closure of the division with transfer of work to another country	Improvements or will consider outsourcing	Improvements or closure	Improvement or sell or close under performing divisions	Improvement or no acquisitions	Improvements and growth or wholesale management changes and/or outsourcing	Improvements or closure
Estimated ERP cost (millions)	$1.00	$1.20	$3.00	$0.70	$57	$0.55	$90	$22
Year of ERP Implementation	1998	1994	1997	1998	1998	1998	1997	1999
Estimated Implementation time	1 year	1 year	1.5 years	1 year	2 years	1 year	3 years	1.5 years
Actual Implementation time (years)	2	2.5	3	Abandoned	3	Ongoing	3	Ongoing
Budgeted Investment (millions)	$1.00	$1.20	$3.00	$0.70	$57	$0.55	$90	$22
Expected savings (millions/year)	$1.00	$1.25	Not Available	Not Available	$12.50	$0.30	$17.50	$6.00
-Inventory	$400,000	$500,000	Decrease	Decrease	$5.50	$0.20	$10.00	$3.00
-AP DPO	$150,000	-	-	-	-	-	-	-
-Mfg Efficiency	$250,000	-	Decrease	-	$3.00	-	-	-
-Direct Labor	$100,000	$500,000	Decrease	Decrease	$4.00	$0.10	$5.00	$2.00
-Overhead	$100,000	$250,000	Decrease	-	-	-	$2.50	$1.00
-Customer Service increase	To 95%	-	To 95%	-	To 95%	-	-	-
-Mkt Share	-	-	-	-	-	-	Increase	-
Modules/Sub-Systems								
General Ledger (GL)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

Table 2. continued

Company	A	B	C	D	E	F	G	H
Accounts Payable (AP)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Accounts Receivable (AR)			Yes	Yes		Yes	Yes	
Budgeting	Yes				Yes		Yes	
Sales Order Processing	Yes				Yes	Yes	Yes	
Master Production Schedule	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Material Req. Planning	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Inventory	Yes	Yes			Yes	Yes	Yes	Yes
Capacity Req. Planning	Yes	Yes		Yes	Yes	Yes	Yes	Yes
Shop Flow Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Statistical Process Control			Yes		Yes		Yes	
JIT/Kanban	Yes		Yes	Yes	Yes	Yes	Yes	Yes
Order Entry/ Billing	Yes	Yes	Yes		Yes	Yes	Yes	
Demand Management			Yes		Yes		Yes	
Distribution			Yes		Yes		Yes	Yes
Advanced Planning		Yes			Yes		Yes	Yes
Warehousing		Yes					Yes	
Forecasting		Yes	Yes		Yes		Yes	
Existing Process Systems	MRP	MRP II	MRP, SFC	None	MRPII	Manuel	MRPII, SPC	MRPII, Legacy Accounting/OE
ERP Skills Assessment	Internal	Internal	None	None	External	None	External	External

Table 2. continued

Company	A	B	C	D	E	F	G	H
No. of division employees	87	131	145	106	1,228	311	944	512
No. (%) of employees involved in the ERP implementation	14 (16.1%)	12 (9.2%)	14 (9.7%)	9 (8.5%)	96 (7.8%)	25 (8.0%)	77(8.2%)	26 (5.1%)
Estimated project cost (millions)	$1.00	$1.20	$3.00	$0.70	$57	$0.55	$90	$22
Actual project cost (millions)	$1.22	$2.10	$3.00	$0.70	$67	$0.75	$87.50	$23
Actual/Estimated	122%	175%	100%	100%	118%	136%	97%	105%
New Hardware requirements	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Interface with legacy systems	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Cost & Efficiency Improvements (millions/yr)	$1.195	$1.925	$0.10	Not Applicable	$9.30	$0.50	$14.70	$1.30
Inventory savings	$.70 (50%)	$.38 (40%)	-	-	$4.3 (20%)	-	$7.70 (22%)	$1.30
Mfg Efficiency	Reject rate reduced by 25%	Eliminate 2 warehouses	-	-	$3.30	-	-	-
Direct Labor	$0.36	$1.00	-	-	$1.70	$0.05	$3.90	-
Overhead	$0.14	$0.25	$0.10	-	-	-	$3.10	-
Market share before ERP	30%	65%	30%	15%	15%	28%	14%	4%
Market share after ERP	35%	70%	Not available	Not applicable	16%	28%	16%	3.5%

Table 2. continued

Current status of Firm	Company A is still in business and has increased market share and profits faster than their competition. They are expanding into TQM and Lean Manufacturing principles	Company B is the largest producer in a market that is replaced by plastics. They feel their ERP system has allowed them to remain competitive	Company C lags the market in both sales and revenue. Only the accounting modules of the ERP system are implemented	Company D closed its doors in 1999. Fortunately for the researchers, we were able to locate several of the senior managers and ERP implementers
	Company E enjoys and increased reputation in the market for both low price and high service	Company F has declined in profitability and has now implemented plans to use off-shore manufacturing	Company G has a strong financial statement and enjoys profits higher than the industry average. They have also implemented Six-Sigma improvement practices	Company H is losing money and closed a division in 2000.

This reasoning is misguided because it assumes that because an employee has gone through an ERP training program, they now understand the business philosophy behind an ERP system. This analysis found that in all eight firms, process and job functions changed so radically in the areas of customer service, production scheduling, purchasing, inventory, and logistics that some employees who were deemed adequate or better performers before the implementation were not able to satisfactorily grasp the new procedures. Human resource administrators in all eight companies stated they had significantly changed the job descriptions, requirements, and interview procedures after implementing ERP. All of the firms felt they had grossly over estimated the abilities and current job knowledge of at least a few of their employees.

Also, after the "go live" date, five firms (A, B, C, E, and G) reported that they implemented more functionality of their ERP systems, and had to conduct further training and education of their employees. Some of the post-implementation functionality implemented included advanced planning systems (APS), distribution requirements planning (DRP), desktop report writers, online costing systems, Internet integration, engineering configurators, and bolt-on software, such as timekeeping systems, amongst others. This caused a further gap in the abilities of current employees, and lead to management having to go through the painful process of reevaluating employees again. However, six firms (A, B, C, E, F, and G) all stated that without the continuous upgrade in employee skills, through hire/fire, training and education, or outsourcing, their ERP implementation would have failed, been less successful, or taken longer and been more expensive. Several researchers have also noted the need for new or additional training and education requirements for ERP implementations (Grant et al., 2006; Liang & Xue, 2004; Nah, Lau, & Kuang, 2001; Somers & Nelson, 2004).

Proposition 1. *Firms who address the gap in employees' abilities and performance after the ERP implementation, through an ongoing analysis, will have a greater likelihood of achieving their strategic and tactical goals than those who do not.*

Proposition 2. *Firms who implement ERP systems will significantly change the education, training, and experience requirements for future hires.*

All eight of the companies performed "needs" assessments. However, there were some differences in their approaches. Company D used an in-house team and examined software packages from various vendors. Seven companies (A, B, C, E, F, G, and H) used independent, third-party consultants to assist in their assessments and used the results of their reengineering efforts to develop the configuration for their ERP packages. They performed a checklist assessment provided by the consultants to determine the best-fitting software. Company B used a similar checklist and was aided by an outside consultant on their selection of a package. Since they had not yet performed their process reengineering, they selected a package based only on an evaluation of their current processes. After Company B's reengineering efforts, changes had to be made to the chosen ERP system to incorporate the requirements of expected future processes. The checklists used by these companies included questions on

1. Current IT systems (including hardware)
2. Type of business (Continuous, repetitive, batch, job shop)
3. Market analysis (Demand management, forecasting, customer relationship management, etc.)
4. Scheduling (MPS, MRP, and BOM requirements, shop floor scheduling, etc.)
5. Logistics (Warehousing, transportation scheduling, etc.)
6. Purchasing (EDI, Internet, integration to inventory and MRP, etc.)
7. Inventory (Transactions, bar codes, package types, analysis, etc.)
8. Performance measurements (Types of measurements)
9. Financial and accounting (GL, AP, AR, Credit, online banking, depreciation, aged inventory, budget control, costing, etc.)
10. Other

All companies came to the conclusion that they needed to install modern information systems, and that this was at least part of the answer to their problem. This conclusion was reached after examining current trends in the market place and after careful consideration of IT needs for their current or reengineered processes, their current IT systems (including hardware), and available IT solutions. The firms all reached several common conclusions about their existing systems that suggested a need for the implementation of new information technologies and ERP systems. We list some of these conclusions drawn by our study participants as well as supporting research for each conclusion:

- The existing systems required multiple points of input and there was significant duplication, with the same data being entered at multiple points in the system (Chen, 2001; Davenport, 1998; Muscatello, 2006)
- The organization's information and manufacturing technology needs were not adequately being met by the existing systems (Chalmers, 1999; Cliffe, 1999; Hendricks et al., 2006; Millman, 2004; Olson et al., 2005).
- Maintenance and support for the existing systems required significant effort, both in terms of time and human resources (Capron & Kuiper, 1998; Gefen & Ragowski, 2005; Griffith, Zammuto, & Aiman-Smith, 1999; Nicolaou & Bhattacharya, 2006).
- The enterprise had islands of information, and many of these systems were incompatible

(Davenport & Brooks, 2004; Hendricks et al., 2006; Muscatello et al., 2003).

- Too much information was stored informally and "fire fighting" and "expediting" had become the norm (Davenport, 1998; Dickey, 1999; Kumar et al., 2003; Yusef et al., 2004).
- In too many instances, employees were unable to respond easily and quickly to questions or information requested by key customers or suppliers (Escalle, Cotteleer, & Austin, 1999; Hendricks et al., 2006; Jenson & Johnson, 1999; Millman, 2004; Olson et al., 2005).

The companies expected the ERP systems to provide the required crucial links between factory floor operations and information requirements across all the support functions of the business. The fact that these systems could also be extended to cover partners in the supply chain was also appealing to these companies. The decision to implement ERP was also due, in large part, to the influence exerted by corporate management.

Although all eight companies felt that their "needs assessment" efforts helped them to configure and select ERP systems that would provide a good fit with their operations, it is clear from the post-implementation respondents that "needs assessment is ongoing in an ERP project." The six firms who had some success with their ERP implementation added additional hardware and/or software after the project "go live" date. In two instances, the main information systems had to be upgraded due to an unforeseen increase in the usage of the system. Also, five firms (A, B, C, E, and G) decided to install additional modules and/or peripheral devices, such as radio frequency (RF) controllers, advanced planning modules, payroll systems, electronic data interchange (EDI), and Internet electronic commerce capabilities. These additional tools were deemed unnecessary or too costly at the beginning of the project. However, after implementation, the value of these technolo-

gies was uncovered and subsequently, added to the business system.

Proposition 3. *A firm's ability to successfully implement an ERP solution requires an ongoing assessment and implementation of technical and functional capabilities beyond the initial scope of the ERP project.*

In all eight cases, the manufacturing-marketing interface became much more scrutinized after the implementation of ERP. Current research shows this to be an issue in many organizations (Calantone et al., 2005; Parker, 1999; Yusef et al., 2004). Our study found that the implementation of an ERP system magnifies the diverse perspectives and motivations of manufacturing and sales.

The causes for this increase in potential conflict arise from a variety of factors. First, there is an increased scrutiny of inventory investment, since it is one of the leading cost-reduction areas used to justify the implementation. Second, salespeople are rewarded for increasing volume, and this was a project justification factor for all but firm C. In six firms (B, C, D, F, G, and H), manufacturing and sales did not have common performance measurements or goals. Manufacturing was judged on labor cost models, leading to a big run size, low changeover philosophy. The sales function was judged on total sales dollars and gross margins, leading to a high stocking philosophy. It was also observed that in five firms (A, C, D, F, and H) there was no formal notification system of changes to the sales plan such as incentive programs, advertisement, and so forth. This lead to inventory spikes and stock outs due to manufacturing's mandate to lower inventory.

Our study found that post-implementation issues between manufacturing and sales were resolved in several ways. First, five firms (A, B, C, E, and G) created joint performance objectives for all levels of management in the areas of manufacturing and sales. The manufacturing

managers had a review component consisting of total sales dollars, gross margins, lost sales, and customer complaints related to customer service delivery issues. The sales managers had a review component consisting of total inventory dollar investment, schedule changes after freezing the master scheduling, and activity-based product costing. As one executive from firm E described it, both manufacturing and sales had "skin in the game." The same five firms (A, B, C, E, and G) all felt that after they implemented joint performance measurements, manufacturing and sales worked in greater harmony, and morale increased in both groups.

Firms (A, B, C, E, and G), who relied on product forecasts, took an integrated role to forecasting. The sales managers were given a forecast variance, plus or minus, that they were expected to adhere to. Manufacturing managers were required to meet the forecast, plus or minus variance, without raising product costs. This created a measurement system that both manufacturing and sales had input into, and the consequences were established. This performance objective helped minimize the after-the-fact arguments between manufacturing and sales. In summary, the extended theory of ERP implementations reveals that the process changes forced by an ERP implementation, if acted upon, will strengthen key interfaces, and improve the general communication between manufacturing and sales (Gefen & Ragowski, 2005; Hausman, Montgomery, & Roth, 2002; Hendricks, et al., 2006; Millman, 2004; Olson et al., 2005).

Proposition 4. *Firms that use ERP functionality to improve performance objectives shared by manufacturing and sales will strengthen the manufacturing-sales interface.*

Proposition 5. *Firms that use ERP functionality to create relevant performance objectives for sales forecasting will strengthen the manufacturing-marketing interface.*

Proposition 6. *ERP functionality will strengthen the manufacturing-sales interface and increase morale in both areas.*

Six firms (A, B, C, E, F, and G) found that the implementation of an ERP system had a dramatic impact on purchasing's role in the corporation, regardless of whether the firm had a centralized or decentralized purchasing function. Five firms (A, B, C, E, and G) reported that the increased pressure to reduce total inventory dollar investments and total product costs caused a greater role for purchasing. In six firms (A, B, C, E, F, and G), purchasing went from a quasi-clerical function to a highly skilled professional function because of the emphasis placed on material requirement plans, just-in-time deliveries, and the increased cost of material shortages due to the minimization of raw and component inventory.

Six firms (A, B, C, E, F, and G) agreed that purchasing's role became more strategic after the implementation of the ERP system because of the overall impact to the effective management of the supply chain and the direct impact to product costing, financial performance measures (inventory turns, etc.), and shop floor disruption costs. Interestingly, those same six firms (A, B, C, E, F, and G) showed an increase in the amount of time-purchasing managers were involved in marketing, financial, and operations planning meetings. This also corresponded with an increase in participation from nonpurchasing managers in purchasing meetings, creating more formal integrated purchasing teams. This is interpreted as further proof that purchasing's strategic and tactical value increases with the implementation of an ERP system.

Proposition 7. *Purchasing's strategic and tactical value increases with the implementation of an ERP system*

Proposition 8. *The use of and need for integrated purchasing teams increases with the implementation of an ERP system*

CONCLUSION, IMPLICATIONS, AND FUTURE RESEARCH

Many researchers still believe that firms implementing ERP systems would benefit from a better understanding of how to implement an ERP system and how will it change their business. This new analysis includes the new, relevant research previously inaccessible to the authors. This chapter still finds, after an intensive review of current literature, both academic and practitioner, that the "proven path" to ERP success is still in its infancy, and more research is needed to build a solid prescription that firms can follow. Again, we purposely stayed away from areas that have been researched in an attempt to provide new insight into the transformation process that takes place with an ERP implementation.

While this study is exploratory in nature, the results continue to provide a number of insights that contribute to ERP strategy research and practice. First, it demonstrates that training and education cannot be slighted, even after the "go live" date of an ERP implementation. Also, firms implementing ERP systems must realize that future employees will need to have a significantly greater skill set than previous employees, and that human resources must react to the change with ever increasing tactical and strategic training initiatives. Second, each firm has to remain flexible after the "go live" date and tune the technical and functional capabilities of the system. Also, a firm should remain flexible and be willing to revisit current processes to establish a better fit between business processes and the hardware and software technology.

The third contribution is the suggestion that an ERP system will increase the harmony between manufacturing and marketing. To receive business benefits from an ERP system, manufacturing and marketing need to understand that they both strongly influence the likelihood of success. While this perspective is advanced in the emerging manufacturing strategy literature, it is not found to be uniformly prevalent in practice (Hausman et al., 2002). Hence, firms should strive to increase the harmony between manufacturing and marketing, by integrating performance metrics, to achieve the benefits of ERP.

Fourth, this study highlights the increasing strategic and tactical role purchasing is responsible for in the new supply chain models. The implementation of an ERP system should increase the visibility and authority of current purchasing managers and drive firms towards a more team-based purchasing process.

Despite the merits of this study, it has certain limitations that should be recognized. First, the study is exploratory and introduces new theory, which needs to be verified by further research. Second, we examined only eight companies, thus limiting our study. This research should spawn studies that examine different contextual factors that may expose different results, such as SIC codes, firm size, and international firms amongst others.

Clearly, the effects of an ERP system need to be studied further, especially in light of its pervasive system of choice amongst operation and service organizations. In summary, this study extends the theory and reveals new "lessons learned" for both researchers and practitioners interested in ERP.

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Chapter II
ERP Usage in Practice:
An Empirical Investigation

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ABSTRACT

This study presents the results of an exploratory study of Fortune 1000 firms and their enterprise resource planning (ERP) usage, as well as benefits and changes they have realized from ERP. The study empirically examines ERP in these organizations to provide insight into various aspects that firms can use to evaluate how they are managing their ERP systems. Findings provide information about functionality implemented, extent to which benefits are realized, extent of ERP-related organizational changes firms have realized, and the way firms measure ERP success. The study also addresses the extent to which various types of ERP software have been implemented and whether there is a relationship between type of software and benefits. Finally, it examines ERP-enabled change in light of organizational configuration.

INTRODUCTION

Enterprise resource planning (ERP) is a tool that enables organizations to streamline operations, leverage common business processes, and manage multiple operations, and is implemented through an integrated suite of software modules and a centralized database (Jacoby & Bendoly, 2003; Scott & Kaindl, 2000). Although the term ERP may be used to represent a variety of concepts, in this chapter, the term is used to constitute the seamless integration of processes across functional areas with the standardization and integration of various business practices in order to manage operations more effectively and to gain an overall view of the business (Boudreau & Robey, 1999; Jacobs & Bendoly, 2003; Mabert, Soni, & Venkatramanan 2000).

The transition to an enterprise resource planning framework is often a long, difficult, and costly process due to the nature and complexity of ERP systems. Many firms are grappling with the trade-off between the costs of implementing an ERP system and not having one (Stedman, 1999). For example, some have come to believe that "competitively and technically it's a must-do, but economically there is conflicting evidence, suggesting it is difficult to justify the associated costs, and difficult to implement to achieve a lasting business advantage" (Willcocks & Sykes, 2000, p. 32). However, in spite of many failures reported (Davenport, 1998; Kransner, 2000), there are many success stories, suggesting that if properly managed, organizations can and do realize significant benefits from ERP (Davenport, Harris, DeLong, & Jacobson, 2001).

With the abundance of conflicting information and the seeming propensity to report failures rather than successes in the literature, many firms that have not implemented may still be wondering whether ERP is right for them and whether the benefits touted by ERP vendors exist. Others that have implemented may be wondering if the benefits and changes they have achieved are consistent with that of other implementers and whether ERP was worth the effort. The purpose of this study is to examine empirically the organizational usage of ERP in order to provide insight into various aspects of usage that firms can use to evaluate their own ERP usage and what they are gaining from ERP. Although there is much empirical and descriptive work about ERP, there is little that assesses ERP after implementation is complete (Sarkis & Sundarraj, 2001). Although the former research provides valuable insights, it often overlooks the final and longest stage of ERP life in which firms begin to realize the impact of ERP. Much of what is known about ERP may only be a reflection of the state of ERP at or immediately after implementation. However, senior IT and business managers believe that the integration and usage of enterprise systems is one of the most important issues that they are now facing (Luftman & McLean, 2004). Much post-implementation ERP research provides mixed evidence about ERP's impact on overall organizational performance (Hitt et al., 2002; Hunton et al., 2003; Poston & Grabski, 2001). However, there is a need to explore the impact of ERP at various organizational levels, at the individual level, and at the ERP functionality level (Gattiker & Goodhue, 2002, Hitt et al., 2002). Thus, additional research that extends knowledge about post-implementation ERP is valuable.

The fundamental research question underlying this study is what is the state of post-implementation ERP in terms of benefits and changes organizations are able to realize? In answering this question, this study provides information about the extent to which benefits are realized, the extent of ERP-related organizational changes that firms have realized, and the way firms measure ERP success. It also addresses the extent to which various types of ERP software have been implemented and the relationship between the type of software and benefits. Finally, it examines ERP-enabled change and benefits in light of organizational configuration.

The rest of the chapter is organized in six sections. One is a discussion of the background for issues and questions examined followed by a brief discussion of the methodology for the study. A profile of respondents is presented in the fourth section, and data analysis and results are presented in the fifth section. The sixth section presents conclusions, implications of findings for practitioners, and directions for future research.

BACKGROUND

Firms implement ERP to help them integrate business processes and to share common resources across the organization (Zheng, Yen, & Tarn, 2000). ERP helps to do this through sets of integrated modules that allow companies to manage

multiple operations from a standardized platform (Boudreau & Robey, 1999). At the time of this study, SAP AG® held the largest market share in ERP software, with PeopleSoft®, JDEdwards®, Oracle®, and Baan® following.[1] ERP software provides modules to support all or most functional areas in an organization, including financial operations, purchasing, materials management, project scheduling, human resources management, production planning, and plant maintenance. Some software packages provide a comprehensive set of modules, whereas others provide a more limited set designed for optimizing the management of particular aspects of the organization (Scott & Kaindl, 2000). As a result, some organizations adopt functionality from various ERP software vendors in an effort to put together the best overall set of functionality, sometimes referred to as a best-of-breed strategy (Krumwiede & Jordan, 2000). However, this strategy can lead to integration problems and may result in lack of benefits if the software from various vendors is not compatible (Menezes, 1999; Palitza, 2001). There also seems to be conflicting evidence as to the extent to which firms adopt best of breed. Thus, we wondered both what functionality and what software packages firms are adopting and the extent to which they are following a best-of-breed approach. It is difficult to get a good picture of this aspect of the state of ERP implementation today because there are few, if any, articles that provide all this information in one study. Issues about software in use could become particularly relevant as ERP vendors begin to merge and as firms are forced to fewer sources for new software, upgrades to existing software, and support.

Regardless of the ERP software, firms implement them in order to achieve benefits, the most common being overall cost savings and, specifically, reduced cost of operations (Bingi, Sharma, & Godla, 1999; Hitt, Wu, & Zhou, 2002). ERP offers the potential for many beneficial organizational changes across many areas of the firm, including strategy, technology, culture, and organizational structure (Al-Mashari & Zairi, 2000; Murphy & Simon, 2002). Specific changes include reduction in silo behavior, integration of processes, greater collaboration and teamwork, and broader knowledge of employees about tasks and processes (Baskerville et al., 2000; Palaniswamy & Frank, 2000). However, it is difficult to determine the extent to which these benefits are realized, because even when success stories are reported, there is little evidence about the extent to which investments in ERP are paying off (Shang & Seddon, 2002).

Research indicates that far less than one-half of firms that have implemented ERP use metrics to assess their investment (Bradford & Roberts, 2001). More recent research indicates that the number of firms using standard financial metrics to assess ERP, such as return on investment (ROI), is larger than this (Mabert et al., 2003). However, approximately 30% of firms do not perform any type of capital investment analysis on their ERP systems beyond those performed for the initial justification of ERP at the time the system is purchased (Mabert et al., 2003). Because there are widely varying reports of ERP success and failure, and because financial metrics are the standard way that firms evaluate other investments, we believe that it is important for firms to understand the extent to which this is applied to ERP and to think through whether they should apply them to their own ERP investments. Thus, we examine not only the extent to which benefits are realized but also the extent to which firms measure ERP benefits and the types of metrics they are using in order to provide a clearer picture of how and whether firms are assessing ERP investments.

It is also important to understand what impacts the extent to which firms realize benefits. This study examines two key factors that may impact the benefits of ERP implementation: software type and organizational configuration. The ERP packages on the market today evolved out of responses to specific market or organizational needs (Welti, 1999). Some firms have sometimes

found it difficult to adapt the products to their own specific needs, even though vendors have revised and expanded the scope of their offerings (Jones, 2001). A recent anecdotal experience of the authors is an adaptation of an ERP product originally targeted for human resource management in a university environment to support everything from human resource management to student enrollment and admissions. Although the product works well, there were a number of configuration and training issues that had to be resolved in the adaptation of the product to another environment that may or may not have been present if it was adapted to only the human resource facet of the university.

Given that the software products represented in this study are the most widely adopted across industries, it is reasonable to assume that some firms may find differences in their abilities to realize benefits because of differences in the match between their business structures and the ERP software. In spite of the fact that ERP requires organizations to adapt their business processes to the practices embedded in the software, it seems that not everything will port equally well. Therefore, we explore the following proposition about the relationship between software type and a firm's ability to achieve expected benefits:

P1: ERP software type influences the extent to which a firm achieves ERP benefits.

Organizational configuration also may influence the extent to which a firm realizes ERP benefits (Hanseth, Ciborra, & Braa, 2001; Mezenes, 1999). Firms that do not consider fully the impact of their organizational configuration when they implement ERP may implement systems that do not adequately integrate their data and processes (Markus, Tanis, & van Fenema, 2000; Soh et al., 2000). Some organizational configurations are not suited for organization-wide deployment of a single ERP instance (Gattiker & Goodhue, 2004). Other configurations do not facilitate sig-

nificant enough changes for firms to realize ERP benefits. In addition, firms often implement ERP with changes to their organizational configuration in mind (Gattiker & Goodhue, 2000). Thus, we explore the following propositions:

P2a: Organizational configuration influences the extent to which ERP benefits, in general, are realized.

P2b: Organizational configuration influences the extent to which organizations are able to make changes after ERP implementation.

METHODOLOGY

The data for this study were collected using a mail survey in a field study during the summer of 2003. Fortune 1000 firms comprised the sampling frame. Because there are few published validated scales that specifically address ERP issues, the survey questions were derived from findings about the constructs of interest in the ERP literature (Jones & Price 2001, 2004; Shang & Seddon, 2002). Questions 1 through 8 and question 26 were checklist questions, where respondents were asked to check which response(s) best applied to them. Questions 9 through 25 were measured with a five-point Likert scale ranging from strongly disagree with the statement (response = 1) to strongly agree with the statement (response = 5). See Appendix A for questions used to measure constructs and demographics in this study.

Surveys were mailed to upper-level managers responsible for the information technology function of their organization, as indicated in a database obtained from Fortune. These respondents were chosen because these individuals have been shown to be appropriate respondents about organization-wide change efforts that depend on information technology (Terziovski et al., 2003). However, in some cases, this executive might not have direct knowledge about their firm's ERP.

We asked them in the survey cover letter that if this were the case to forward the survey to the individual who was most directly involved in ERP management at the senior level.

Fortune 1000 was selected as the sampling frame for several reasons. This study examines a variety of ERP issues. Thus, one criterion for a sampling frame was one that contained firms that have completed large-scale implementations, where a variety of functionalities was implemented across divisions of the organization. Both the scope and cost of this type of implementation suggests that the study should draw upon large firms. The Fortune 1000 database is a listing of information for the 1000 largest companies in the U.S., which is compiled and maintained by the publishers of the business magazine, *Fortune*. It includes companies with yearly revenues in excess of $1 billion U.S., and thus fits this criterion. In addition, we were interested in gathering data about a variety of software types. Because some software is more suited to one or more given industries, another criterion was to choose a sampling frame that is representative of a variety of industries. Fortune 1000 also meets this criterion. Finally, we wanted to select a group in which a large percentage of firms are using ERP. It is estimated that more than 70% of Fortune 1000 companies have implemented ERP systems (Barker & Frolick, 2003), thus meeting this criterion.

Of the 1000 surveys mailed, 70 were returned, representing a 7% response rate. Of the 70 returned surveys 20 were discarded because the contact person was no longer there, and either the company returned the survey unopened or the organization has a policy of not responding to surveys. Extrapolating the 20 out of 70 unusable surveys to the population indicates that 285 of the 1000 firms surveyed may fall into one of these categories. Using the remaining 715 as the population, the 50 usable surveys still represent a 7% response rate. Several companies telephoned the authors to indicate that they did not respond to surveys, and others returned the surveys unopened

with a stamp on the envelope indicating the contact person was no longer there. One telephoned to say that they were filing for bankruptcy protection and would not be responding.

One explanation for the low responses rate is the general difficulty of getting responses from executives at that level of the organization and a decline in the response rate of surveys, in general (Hambrick, Gelekanycz, & Frederickson, 1993). This response rate is consistent with those in other exploratory studies of post implementation ERP (Mabert et al., 2003). In the last several years, there has been more demand on executive time for information from academia, industry analysts, external stakeholders, and internal surveyors (Eisenhardt, 1989). Although there are a number of techniques for improving response rates, such as offering incentives, follow-ups, and telephone calls, these techniques have been shown to be relatively ineffective in mail surveys of executives at this level (Cycyota & Harrison, 2002). Thus, we did not use these techniques. Although a higher response rate is desirable, this sample does provide a set of response on which we can base an exploratory assessment of the constructs of interest.

However, assessment of non-response bias indicates that these respondents represent a cross-section of ERP adopters in this sampling frame (the Fortune 1000 companies). Non-response bias was assessed on the basis of two indicators: number of ERP users in an organization and the number of ERP modules implemented. Research suggests that these may be better indicators of the size of an ERP implementation than more traditional organizational size measures (Francalanci, 2001). Very large organizations that implement a broad scope of ERP functions may do so only for one or two business units that represent a smaller percentage of the total company size (Jones & Price, 2004). For example, a firm might have several thousand employees yet only implement in one division that have just several hundred employees. Furthermore, research indicates that ERP

implementations are not substantively different among large firms that are defined as having over $1 billion U.S. in annual revenue (Mabert et al., 2003). This is the size of all the firms in our study. Although there may be a variety of reasons for this finding, one is that organizational size may not be sufficient to capture differences. Other findings that there are differences in the ERP implementation experiences of large firms lends support for this (Hebert & Oppenheim, 2004; Songini, 2003; Swanton, 2003). These respondents represent a broad range of size of implementations in terms of number of users (Table 1). Roughly, they are equally distributed across five categories of size, although there is a somewhat larger percentage in the *less than or equal to 500 users* category (27%) than in the others.

Another indicator of ERP size is the number of modules (functionality) implemented (Francalanci, 2001). Because we are comparing across ERP packages and because ERP packages achieve functionality in varying degrees of submodules, we confine our assessment of functionality to the general modules (e.g., financial accounting, materials management, etc.) rather than drilling down into submodules such as master data, general ledger, or inventory control (Francalanci, 2001). The majority of our respondents (69%) have implemented between four and nine modules of functionality (Table 1). Another 21% has implemented 10 or more modules. Therefore, it appears that they represent a broad range of implemented functionalities. Because the sampling frame is comprised of large firms, it is not surprising that few have implemented only one, two, or three modules. Given the range of ERP users and modules implemented that are represented here, this distribution of respondents is believed to be representative of the sampling frame.

PROFILE OF RESPONDENT FIRMS

Because the unit of analysis is the organization, a profile of respondent firms is provided in order to help clarify the lens through which findings are interpreted (see Table 1).

Not surprisingly, almost all respondents have implemented the financial accounting and purchasing functions. This is consistent with evidence that accounting and purchasing are the two areas over which firms desire to gain the greatest control. Other functions that have been implemented widely include controlling, asset management, materials management, human resource management, and data warehousing. To achieve this functionality, a larger percentage of respondents (40%) use a combination of software types than individual packages. However, only 18% indicated that they chose the functionality in their packages based on best-of-breed criteria. Among respondents who do use a single software type, SAP is the one used most (30%), followed by PeopleSoft at 18%.

The majority of respondents had implemented ERP at least two years prior to the study. Years of use is roughly equally distributed between two to three years, three to five years, and more than five years. Furthermore, approximately 30% have done one upgrade, 23% have done two upgrades, and 21% have done three upgrades since the initial implementation. This is not unexpected, given the length of time that ERP has been in use in these firms and the relative frequency with which some software companies add new features to their product. These demographics indicate that respondents are from firms with moderate to substantial experience with ERP and that it has been in place long enough for them to have realized benefits and made ERP-related changes.

Table 1. Profile of respondent firms

Number of ERP users in the organization	Percent of Respondents
Less than or equal to 500	27
Between 500 and 1000	17
Between 1000 and 2500	23
Between 2500 and 5000	15
More than 5000	18

Number of modules implemented	Percent of Respondents
1 to 3	10
4 to 6	31
7 to 9	38
10 +	21

Functionality*	Percent of Respondents
Financial Accounting (e.g., general ledger, accounts receivable…)	98
Controlling (e.g., profitability analysis, product costing…)	52
Asset Management (e.g., depreciation, planning/acquisition of capital assets…)	76
Project Management (e.g., project planning, project tracking…)	36
Sales and Distribution (e.g., customer order management, product pricing data…)	48
Production Planning (e.g., master scheduling, bill-of-materials…)	42
Materials Management (e.g., master inventory data, materials tracking…)	64
Purchasing (e.g., requisitions, purchase orders, goods receipt…)	98
Plant Maintenance (e.g., maintenance schedules, equipment histories…)	34
Service Management (e.g., service contracts, warranty coverage…)	16
Human Resources Management (e.g., time accounting, payroll…)	70
Strategic Management (e.g., strategic planning & simulation, balanced scorecard…)	14
Data Warehousing (e.g., central storage of business data, data retrieval…)	50
Other (included Enterprise Portal, Warehouse Management, Trade Management, CRM)	10

* categories not mutually exclusive

Software packages used	Percent of Respondents
SAP only	30
PeopleSoft only	18
Oracle only	12
Baan only	0
JDEdwards only	2
Other only * (Lawson, Adage, SSA/CT)	6

Table 1. continued

Amount of time since implementation *	Percent of Respondents
Less than 12 months	14
Between 1 year and 18 months	8
Between 18 months and 2 years	4
Between 2 and 3 years	20
Between 3 and 5 years	22
More than 5 years	22

* numbers do not sum to 100% due to missing values

Number of upgrades since original implementation *	Percent of Respondents
0	18
1	26
2	20
3	18
5	2
10	2

* numbers do not sum to 100% due to missing values

DATA ANALYSIS

General Benefits and Software Package

Respondents indicated that benefits of ERP have met but not exceeded original expectations (see Table 2a). Extent to which benefits are realized was measured using a five-point Likert scale, where 1 is strongly disagree that they have realized the benefit and 5 is strongly agree that they have realized the benefit. These benefits have been realized in the form of cost savings overall, particularly in terms of reduced cost of operations. Furthermore, it does not appear that respondents simply are reporting their perceptions of whether benefits and savings are there. Table 2b provides insight into the extent to which respondents report using various tools to evaluate ERP success. Note that these questions address benefits in general. More specific benefits/changes that firms realized from ERP are addressed in detail in the following sections.

Well over one-half of the respondents (58%) indicated that they use ROI, and another 24% use NPV to assess ERP success.[2] These are not mutually exclusive categories, because respondents may use more than one financial measure. In fact, 24% report that they use two or three measures. Again, this paints a somewhat different picture than reports that indicate that few firms have formal financial evaluations of their ERP system results after their initial justification for purchasing the package (Mabert et al., 2003).

Closer examination of benefits indicates that the type of software package used may play a role in the extent to which firms realize ERP benefits, particularly with regard to cost savings. A one-way analysis of variance (ANOVA) was used to examine the relationship between the software package and benefits. Results are shown in Tables 3a and 3b. Because of the small number of respondents in the JDEdwards only (n = 2), Baan only (n = 0), and other only (n = 4) categories, these were removed from analysis. The remaining categories were SAP only, PeopleSoft only, Oracle only,

Table 2a. Extent to which companies realize ERP benefits

Benefit Realization	μ*	σ
Benefits met original expectations	3.73	0.92
Benefits exceeded original expectations	2.75	1.00
Benefits revised downward after implementation	2.54	1.45
Realized significant cost savings overall	3.54	0.99
Realized reduced cost of operations	3.67	0.85

Sample size = 50

* All responses measured on a scale of 1 to 5 where 1 = strongly disagree and 5 = strongly agree

Table 2b. Methods organizations use to evaluate ERP success

Method Used	Percent of Respondents*
Return on Investment (ROI)	58
Net Present Value (NPV)	24
Change in Return on Assets (ROA)	8
Other**	
Balance Sheets & Income Statement Impact	2
Internal Rate of Return (IRR)	2
Getting Decision Support Information Faster	2
Impact on Strategic Objectives	4
Strategic Necessity	2

Sample size = 50

* categories not mutually exclusive 24% reported using 2 or 3 measures

** listed by respondents

and any combination of software types. Because the sample sizes are unequal among categories, violation of the assumption of homogeneity of variance necessary for interpreting ANOVA results was a concern. Brown and Forsythe's test of homogeneity of variance was used because it has been shown to be best at providing power to detect variance differences (Conover, Johnson & Johnson, 1981; Olejnik & Algina, 1987). Results indicated that the assumption of homogeneity of variance held at $\alpha = 0.05$ for all benefits variables except Benefits Greater than Expected (p = 0.00089). However, Welch's ANOVA, which is more robust to violations of the homogeneity of variance assumption than the standard ANOVA

(Welch, 1951), provided results consistent with the standard ANOVA at $\alpha = 0.01$ and $\alpha = 0.05$. The standard ANOVA results are reported next and in Table 3a.

Wilks' Lambda for overall effect is significant at F = 2.62, p = 0.0021. This indicates that benefits differ among types of software used. Reduced cost of operations is the only benefit that varies significantly with software type at the $\alpha = 0.01$ level. Overall cost savings were not significant nor were the extent to which benefits were realized, exceeded, or revised downward. Thus, proposition P1 is somewhat supported. Note, however, that P1 addresses benefits in general. A more in-depth examination of specific ERP-related changes is provided in the section to follow. Tukey's Honestly

Table 3a. Analysis of variance results for assessment of relationship between realization of benefits and type of ERP software used

Dependent Variable	F-value	p
Benefits met original expectations	0.35	0.7904
Benefits exceeded original expectations	1.90	0.1429
Benefits revised downward after implementation	2.20	0.1016
Realized significant cost savings overall	2.36	0.0848
Realized reduced cost of operations**	7.42	0.0004

Sample size = 50
* Wilks' Lambda for overall effect = 0.43, F = 2.62, p=0.0021
** significant at α = 0.01

Table 3b. Mean and standard deviations of reduced cost of operations for each category of software type

Software Type	μ **	σ
SAP only	4.00	0.76
PeopleSoft only	2.63	0.74
Oracle only	3.50	0.55
Combination*	3.84	0.69

Sample size = 50
* As defined in Table 1
** Tukey's HSD test for differences of means indicates that the mean for reduced cost of operations is significantly greater for SAP only than for PeopleSoft only and that the mean for any combination of Software Type is greater than for PeopleSoft only at α = 0.05.

Significant Difference (HSD) test for differences of means indicates that the mean for reduced cost of operations is significantly greater for firms using SAP only than for firms using PeopleSoft only, and that the mean for any combination of software type is greater than for firms using PeopleSoft only at the α = 0.05 level (see Table 3b). One explanation may be the discrepancy in the extent of functionality implemented across firms that chose different packages. Although it may be tempting to conclude that one software package is better than another, further assessment of our findings does not support that conclusion. In this study, organizations that had only SAP implemented an average of 9.27 modules/functions, whereas those that had only PeopleSoft implemented an average of 4.67 modules/func-

tions. The average was 4.83 for those using only Oracle and 7.17 for those using a combination. Firms that are using only PeopleSoft may not be realizing as significant a reduction in cost of operations because they have not implemented across a wide enough range of functions to do so. Therefore, rather than serving as an advertisement for a given vendor, these findings suggest that the extent of functionality implemented may be a key indicator of the benefits an organization realizes from its ERP implementation. Although at first this may appear to be tautological, many firms choose not to implement the majority of ERP modules available in a package. While their decisions may be based on a variety of factors, including resources, financial constraints, and current needs, the underlying philosophy of ERP

is that it provides the capability to integrate the majority of processes organization-wide (Welti, 1999). ERP was not meant to be implemented piecemeal, and these findings suggest that ERP benefits are best realized when a greater number of modules are implemented. Further research is needed to compare the impacts of packages across equivalent scope of functionality implemented.

Specific ERP-Related Changes

In order to examine benefits more closely, we included questions on the survey that tapped respondents' perceptions of specific ERP-related changes in the organization (Table 4). The greatest changes include greater collaboration among functional areas within divisions and reorganization of processes. The least realized change is easier access to resources in other areas for cross-cutting projects. Thus, it appears that even though firms are doing more integration of processes across the organization and reducing silo behavior, there still may be hoarding or guarding of resources

within units. One explanation for this is that the collaboration and reorganization that firms have experienced have not been in place long enough to alter this type of behavior. Another explanation is that the reorganization has not been managed so that it impacts the deeper structure of organizational behavior. Thus, things may have appeared to change, but fundamentally they did not.

A closer inspection of these specific changes indicates that they may be grouped into distinct categories of change. For example, some relate to the organization as a whole (e.g., greater integration of processes across the organization), whereas others relate more to divisions within the organization (e.g., reduced silo behavior within divisions). Much research about ERP-enabled change addresses the changes in terms of the impact of each change item or in terms of somewhat arbitrary groupings of items (Shang & Seddon, 2002). Although identifying specific items may provide useful guidance to managers, any given item or combination of items may not apply to every organization. A list of individual items also is not likely to be comprehensive,

Table 4. Changes after ERP implementation

ERP Change	μ*	σ
Greater collaboration among functional areas in divisions	3.94	0.63
Reorganization of processes	3.88	1.11
Greater integration of processes across the organization	3.69	1.08
Reduced silo behavior within divisions of the organization	3.67	1.14
Reduced cost of operations	3.67	0.85
Reduced silo behavior across the organization	3.65	1.07
Greater collaboration across divisions of the organization	3.63	1.05
Greater integration of processes within divisions	3.50	1.29
People have a better view of the 'big picture'	3.43	0.89
More teamwork in the organization	3.41	0.86
More projects that cut across divisions/functional areas	3.22	0.96
Organization more receptive to change	3.12	0.95
Easier to access resources in other areas for cross-cutting projects	3.00	0.84

Sample size = 50
* All responses measured on a scale of 1 to 5 where 1 = strongly disagree and 5 = strongly agree

so that information about specific ERP enabled change may not inform our understanding of the impact of ERP as much as a validated grouping of items. Therefore, it seems best to examine individual items in terms of where they might fit in terms of larger groupings.

With this in mind, exploratory principle components factor analysis using Varimax rotation was used to determine whether and where these grouped together (see Table 5). Factor analysis enables the reduction of a larger number of items to a smaller, more manageable, and perhaps more informative set (Hair et al., 1998). Factor analysis is a powerful tool for this, because it facilitates better assessment of the properties of sets of measures than simpler tools such as correlations. It not only allows assessment of the correlation among items but also uses the correlation matrix to derive factor loadings that represent the cor-

relation between an item and the construct it is thought to measure. Although factor analysis does not directly constitute a test of construct validity, it does offer a way to construct an interrelated set of indicators meeting one of the conditions for construct validity—dimensionality. If one or more indicators measures more than one construct (i.e., the measure is multidimensional), then it is difficult to establish reliability, which is also a necessary component of construct validity. Thus, factor analysis provides a stronger basis on which to group items than either simple correlations or arbitrary groupings (Hair et al., 1998).

Although the sample size in this study is somewhat small, factor analysis can be conducted reliably when the number of items multiplied by four or five is equal to the sample size (Hair et al., 1998). Our set of 13 roughly meets these criteria.

Table 5. Factor analysis of changes after ERP implementation

	Factor 1	Factor 2	Factor 3	Factor 4
Factor Stats:				
Eigenvalue	2.97	2.42	1.69	1.63
% variance explained	22.86%	18.62%	13.00%	12.50%
Cronbach's alpha	0.84	0.73	0.41*	0.45*
ERP Change (factor scores in columns)				
Reorganization of Processes	0.84			
Greater Collaboration Among Functional areas	0.78			
Better View of 'Big Picture'	0.78			
Greater Integration of Processes across the Organization	0.77			
Reduced Silo Behavior across the organization	0.51			
Easier Access to Resources in other areas for Cross-cutting projects		0.78		
More projects that cut across divisions/functional areas		0.76		
Reduced cost of operations		0.66		
Greater collaboration among functional areas in divisions		0.61		
Reduced Silo Behavior within Divisions of the Organization			0.81	
Greater Integration of Processes within Divisions			0.75	
Organization more receptive to change				0.87
More Teamwork in the organization				0.75

* Pearson product moment correlations were used for these two factors rather than Cronbach's alpha because they only had two items each. The correlations were each significant at α = .01. For factor 3, p = 0.0038 and for factor 4, p = 0.0013.

However, findings should be interpreted in light of this potential limitation.

Using a standard criterion of Eigenvalue >= 1, there appear to be four distinct factors that explain 66.98% of the variance. A factor solution that explains at least 60% of the variance is considered sound when the underlying data are drawn from or are based on human perceptions, as they are in this study (Hair et al., 1998). Cronbach's alpha is a commonly used measure of reliability. This measure addresses reliability through the internal consistency, or homogeneity, of the items (Kerlinger, 1986). Using Nunnally's criteria of 0.70, Cronbach's alpha indicates that the first two factors have adequate internal consistency (Nunnally, 1978). Their Cronbach's alphas are 0.84 and 0.73, respectively. The next two factors have only two items each; thus, Cronbach's alpha could not be used. However, the Pearson product moment correlations for these indicate that the items are correlated significantly within each of the two factors (0.41 and 0.45, respectively). Items were grouped into factors based on having factor scores of 0.50 and above within the factor and not having factor scores of 0.40 or above on any other factor (Hair et al., 1998). All of the items in each factor had factor scores above 0.50 for that factor and less than 0.40 for the other three factors. Furthermore, the items that load together seemed to be logically consistent. In other words, it seems to make sense that the items that loaded together did so. For example, the items that loaded on Factor 1 all seem to address issues at a broader scope of the organization than other factors. Thus, there is both statistical support and logical support for the strength of each of the four factors.

Factor 1 appears to measure items related to the organizational level, such as reducing silo behavior across the organization and integrating processes across the organization. Factor 2 appears to measure items related the operational or functional level of the organization, such as *more projects that cut across functional areas* and *greater collaboration among functional*

areas. Factor 3 is related more to the divisional level of the organization with the items *reduce silo behavior within divisions* and *greater integration of processes within divisions*. Factor 4 seems to be related more to the individual (e.g., reception to change and teamwork).

Relationship Between Organizational Configuration and Benefits/Changes

Organizational configuration refers to whether the firm is organized by centralized headquarters control, lateral control by divisions, headquarters coordination of operations, headquarters control of financials only, or total divisional autonomy (Markus et al., 2000). A profile of the organizational configuration at the time of ERP implementation is shown in Table 6.

The relationship between organizational configuration and realization of benefits is examined to assess whether a given configuration(s) is better suited to realize ERP benefits (P2a). In addition, the relationship between organizational configuration and specific ERP-related changes is examined to assess the link between configuration and type of change (P2b).

A one-way analysis of variance (ANOVA) was used to assess the relationship between the five levels of organizational configuration and benefits. Again, unequal sample sizes among categories indicated a concern for violation of the assumption of homogeneity of variance necessary for interpreting ANOVA results. Brown and Forsythe's test of homogeneity of variance indicated that this assumption held at $\alpha = 0.05$ for all variables. Therefore, standard ANOVA tests were used to assess the relationships. However, Wilks' lambda for overall effect is not significant (F=1.32, p=0.1784). Therefore, organizational configuration is not related directly to the extent to which firms realize ERP benefits in general, and P2a is not supported.

Next, we assess whether organizational configuration is related to the specific type of ERP-

Table 6. Profile of implementations

	Percent of Respondents
Organizational Configuration at time of ERP Implementation	
Almost all decisions made centrally by headquarters	26.53
Lateral coordination among divisions without a high degree of control from headquarters	22.45
Headquarter coordination of operations with high degree of autonomy at the division level	40.82
Headquarter control only at the financial level	6.12
Total divisional autonomy	4.08

Sample size = 50
* 20% indicated they implemented ERP to achieve a different organizational configuration; of these 80% indicated that the new configuration had been achieved and 20% indicated that they were still working on the new configuration

related change that firms achieve. Brown and Forsythe's test indicates that the homogeneity of variance assumption holds for all variables except operational-level change ($p = 0.0063$). However, the Welch's ANOVA provided results consistent with the standard ANOVA at $\alpha = 0.01$ and $\alpha = 0.05$. Therefore, the standard ANOVA results are reported below and in Table 7a.

Wilks' Lambda for overall effect is significant at $F = 1.59$, $p = 0.0818$. This indicates that change does differ among organizational configurations. Organizational-level change is the only change that varies significantly with organizational configuration (Table 7a). Tukey's HSD test for differences of means indicates that the mean for organizational-level change is significantly greater for firms that have lateral coordination among divisions without a high degree of control from HQ than either those with HQ coordination of operations with a high degree of autonomy at the division level and total divisional autonomy at $\alpha = 0.05$ (Table 7b). Tukey's HSD test also indicates that the mean for organizational-level change is greater for firms that have almost all decisions made centrally by HQ than for those that have total divisional autonomy. Thus, P2b is supported. This is not surprising, because it is expected that highly centralized firms are focused on organizational-level change, whereas autonomous divisions are expected to be focused

on change at the divisional level. Another explanation for this may be that some organizational configurations do not benefit necessarily from ERP at the organizational level. None of the firms in the HQ control only of financials or in the total divisional autonomy configurations indicated that they had plans to change their configurations. Thus, it is not surprising that these highly decentralized, autonomous firms are less focused on organizational-level changes than ones with more centralized or integrated configurations. However, this does not mean that the former do not benefit from ERP, just because they are not changing and integrating their entire organization around a single package. This is partly supported by the findings that there was no difference among configurations on either the organizations' abilities to realize benefits in general or on the realization of change at the operational, divisional, and individual levels.

CONCLUSION, FUTURE RESEARCH, AND IMPLICATIONS FOR PRACTICE

This study provides an exploratory assessment of ERP usage in large organizations from a cross section of implementation size. Factors examined include both the extent to which overall benefits

Table 7a. Overall analysis of variance results for assessment of relationship between ERP changes and organizational configuration*

Dependent Variable	F-value (overall)	P (overall)	Significant Difference on individual ANOVAs
Organization-Level Changes	5.04	0.0069	Significant (F=5.04, p-0.0020)
Operational-Level Changes	0.56	0.6901	Not significant
Division-Level Changes	0.46	0.7624	Not significant
Individual-Level Changes	0.30	0.8783	Not significant

Sample size = 50

* Wilks' Lambda for overall effect of organizational configuration = 0.57, F = 1.59, p = 0.0819

Table 7b. Mean and standard deviations of organization-level changes for each category of organizational configuration

Organizational Configuration	μ *	σ
Almost all decisions made centrally by HQ	4.00	0.71
Lateral coordination among divisions without a high degree of control from HQ	4.07	0.83
HQ coordination of operations with a high degree of autonomy at the division level	3.29	0.69
HQ control only at the financial level	4.00	0.20
Total divisional autonomy	2.30	0.14

Sample size = 50

* Tukey's HSD test for differences of means indicates that the mean for organizational-level changes is significantly greater lateral coordination among divisions without a high degree of control from HQ than either HQ coordination of operations with a high degree of autonomy at the division level and total divisional autonomy at α = 0.05.
The mean for organizational-level changes is also significantly greater for firms where almost all decisions are made centrally by headquarters than total divisional autonomy at α = 0.05.

are realized and the types of changes firms are realizing from ERP, as well as the relationship among benefits/changes and organizational configuration. Findings provide several implications that both support and extend what is known about ERP. However, one caveat in interpreting these findings is that they should be interpreted in light of a small sample size. Another caveat is that this was an exploratory study; therefore, the findings should be interpreted as starting points, or thought provoking ideas, for future exploration.

Limitations and Directions for Future Research

One limitation of this study is that it provides only one perspective in each organization—that of either the CIO or the senior ERP manager. One avenue for future research is to examine the issues raised in this study from multiple perspectives. For example, an examination of the perspectives of users from a cross section of functional areas or business units in addition to that of managers may be useful. Another avenue for future research is to assess the various types of changes (as illustrated in Table 5) across industries or perspectives in order to determine both the antecedents of them and the conditions under which they are influenced most. Another limitation is that the organization is the unit of analysis. Our findings suggest that there are differences in ERP-enabled changes among various levels of the organization. Therefore, an examination of the constructs in

this study using either the levels suggested in this study or others, such as business units or processes, may provide deeper insight into ERP usage. Furthermore, a cross section of users, line managers, and executives could be surveyed within each level of analysis. Another avenue for future research is to do a cross-industry comparison of ERP usage with an emphasis on whether there are differences among organizations based on software packages and the extent to which the package was implemented.

Implications for Practice

However, regardless of the limitations, this study does extend our current knowledge of ERP usage. It confirms some intuitive and/or widely accepted knowledge about ERP, and it provides some non-intuitive or surprising insights. One of the more widely held conclusions that is supported by these findings is that the largest percentage of functionality implemented is for financial activities and for purchasing. Although this finding may seem trivial at first, it does have implications for practice. The information we hold largely about the functionality implemented is based on the early days of ERP implementation before it became as widely used as it is today and when reports of ERP focused largely on what was being done rather than on the long-term impacts. One might expect that as ERP has matured as a technology, and as more and more firms have adopted it, they might be using it more for management activities such as strategic management or to integrate project management across the organization. The implication for practice is that although the breadth of ERP usage has increased, perhaps it is not being used as deeply as it could be to attain even greater benefits.

Another finding that is consistent with current knowledge about ERP is the extent to which various packages are used. However, although some ERP packages are used more widely than others, they are not necessarily better in terms of the benefits a firm is able to realize with them. The number of modules implemented may be a better indicator of the ability to attain ERP benefits. One lesson for practitioners from this is that the extent to which they are able to integrate and leverage key processes may impact the success of the ERP more than choosing a popular package. An implication is that if they are not realizing the benefits they expected, then they may need to assess their benefits in light of the extent of the integration that their implementation allows.

One finding that does not support widely held beliefs about ERP is that a substantial number of firms are using traditional financial metrics such as ROI or NPV to assess the investment they have made in ERP. One lesson for practitioners that arises out of this finding is that organizations find these metrics important. An implication from this is that if other firms are assessing their ERP investments in this way, then they may have a different, perhaps more measurable, view of ERP that could give them an advantage in managing it.

Another finding is that realization of benefits is not tied to organizational configuration; any configuration can realize benefits from ERP. However, organizational configuration may influence the types of changes that an organization can affect with ERP, if those changes are viewed at different levels of the organization. One level that seems particularly impacted by configuration is the organizational level. One lesson for practitioners is that ERP may not be a one-size-fits-all solution. An implication of this is that if a firm is not able to bring about the changes it believed it would, it may do well to examine these changes in light of its organizational configuration. Another implication is that firms may need to look more closely at where ERP is affecting change and benefits. Perhaps some failures are not necessarily failures at all but simply an indication that the changes and benefits that ERP enables are at lower levels or in different pockets of the firm.

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ENDNOTES

[1] SAP AG is a registered trademark of SAP AG in Germany and several other countries. Peoplesoft is a registered trademark of Peoplesoft, Inc., Pleasanton, California. JDEdwards is a registered trademark of J.D. Edwards World Source Company, Denver, Colorado. Oracle is a registered trademark of Oracle Corporation, Redwood, California. Baan is a registered trademark of Baan Company, Barneveld, the Netherlands.

[2] Return on investment (ROI) and Net present value (NPV) are commonly used financial ratios that allow for evaluation of investments in terms of the current value of future cash flows from the investment. NPV uses a rate of return determined by the company's actual cost of capital. ROI is the ratio of the net cash receipts of the investment divided by the cash outlays of the investment.

APPENDIX A

Questions to Measure Study Variables

1. Which of the following Enterprise Resource Planning (ERP) packages does your organization currently use?

SAP ☐ PeopleSoft ☐ Baan ☐ Oracle ☐ JDEdwards ☐

Other (please specify) _____

If you checked more than one option above, please answer the following questions, else skip to question 2:

1a. Did your organization choose functionality based on 'best of breed'? ☐ yes ☐ no

1b. Is there one package that is predominant in your organization? ☐ yes ☐ no

1c. If you answered "yes" to 1b, please specify which one, and answer the rest of the survey about that package _____

If you answered "no" to 1b, please answer the rest of survey about your overall use of ERP.

2. Which ERP functionality has your firm implemented?

☐ Financial accounting (e.g., general ledger, accounts receivable, etc…)
☐ Controlling (e.g., profitability analysis, product costing, etc…)
☐ Asset management (e.g., depreciation, planning and acquisition of capital assets, etc…)
☐ Project management (e.g., project planning, project tracking, etc…)
☐ Sales and distribution (e.g., customer order management, product/service pricing data, etc…)
☐ Production planning (e.g., master scheduling, bill-of-materials, etc…)
☐ Materials management (e.g., master inventory data, materials tracking, etc…)
☐ Purchasing (e.g., requisitions, purchase orders, goods receipt, etc…)
☐ Plant maintenance (e.g., maintenance schedules, equipment histories, etc…)
☐ Service management (e.g., service contracts, warranty coverage, etc…)
☐ Human resources management (e.g., time accounting, payroll, employee evaluation, etc…)
☐ Strategic management (e.g., strategic planning & simulation, balance scorecard, etc…)
☐ Data warehousing (e.g., central storage of business data, etc…)
☐ Other (please specify) _____

3. How long ago did you complete implementation of your ERP package?

☐ < 12 months ago
☐ 1 year to 18 months ago

☐ > 18 months ago, but < 2 years ago
☐ > 2 years ago, but < 3 years ago
☐ > 3 years ago, but < 5 years ago
☐ > 5 years ago

4. How many upgrades have you completed since the original implementation? _____

5. Approximately how many ERP users does your organization have? _____

6. Which of the following best describes the configuration of your organization?

☐ Almost all decisions made centrally by headquarters
☐ Lateral coordination among divisions without a high degree of control from headquarters
☐ Headquarter coordination of operations with high degree of autonomy at the division level
☐ Headquarter control only at the financial level
☐ Total divisional autonomy

7. Was ERP implemented to achieve a different organizational configuration?
If you answered 'yes' to question 7, please answer the following question. Else skip to question 9.

8. Has this been achieved?

☐ yes, for the most part
☐ no, we're still working on this
☐ no, we've decided either to postpone this or not to do at all

Please mark the choice that most closely describe your organization with regard to the following:

☐ 9. Benefits of ERP have lived up to original expectations
☐ 10. Benefits of ERP have been greater than we originally expected
☐ 11. We have revised our projected ERP benefits downward since implementation
☐ 12. ERP has enabled us to realize significant cost savings

Our organization has used ERP to:

☐ 13. More tightly integrate processes across the entire organization
☐ 14. More tightly integrate processes within 1 or more divisions
☐ 15. Reduce silo behavior across the organization
☐ 16. Reduce silo behavior in pockets of the organization
☐ 17. Reorganize processes (e.g., movement to purchasing by family of items)
☐ 18. Reduce cost of operations
☐ 19. Have greater collaboration across units
☐ 20. Have greater collaboration across functions
☐ 21. Place more emphasis on team efforts

☐ 22. Be more receptive to change

☐ 23. Make it easier to get access to people or resources in other units for projects that may overlap departments/functions

☐ 24. Place more emphasis on projects that cut across functions/departments

☐ 25. Place more emphasis on making sure everyone understands the "big picture" rather than just their own tasks

26. Which of the following do you use to evaluate ERP success?

☐ return on investment   ☐ change in return on assets   ☐ net present value   ☐ not applicable

other (please specify) _____

Chapter III
Improvement in Operational Efficiency Due to ERP Systems Implementation:
Truth or Myth?

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ABSTRACT

ERP systems are expected to provide many benefits, including improved business efficiency. However, they are also blamed for several business problems and failures. Past studies have analyzed investments in ERP systems based on net income, return on investment, new present value or change in market value of a firm. We argue that an analysis of more direct measures—intangible or tangible—would enhance confidence in the efficacy of ERP systems. We investigate the impact of ERP systems implementation on operational efficiency of medium sized firms in the pharmaceutical and chemicals industry. Our analysis of the data indicates that for a majority of the firms improvement of operational performance expected due to ERP systems did not materialize.

INTRODUCTION

IT Investments

Since 1990, the information era has exploded, witnessing many new information technology (IT) initiatives, including Y2K compliance; e-commerce; IT-enabled mega mergers of information-intensive companies such as AOL and Time Warner, WorldCom, and MCI; global outsourcing of IT and IT-enabled services; supply chain integration; and euro conversion. Many IT landmarks

have been achieved during this period: more than 4 billion Web pages on the Internet; creation of software to combat cyber worms, viruses, and warfare; millions of distributed databases; and widespread utilization of data warehouses and data mining for decision support systems. To support these IT initiatives and to achieve these landmarks, IT budgets of most companies during this decade increased substantially (Seewald, 2002). There is, however, a growing criticism of escalating IT investments (Mears & Dubie, 2002) and their lack of justification (Krochmel, 1999).

Enterprise Resource Planning (ERP) Systems

ERP systems are software systems to support and to automate the business processes, providing timely and accurate enterprise-wide information for decision making. ERP systems have a long history of evolution. The production scheduling, material ordering, and product shipment systems evolved from manual reorder point systems for material procurement to computerized materials requirement planning (MRP) to manufacturing resource planning (MRP-II) systems that integrated MRP and capacity requirements planning to manufacturing execution systems (MES) that further integrated MRP-II and shop floor and device control systems, and finally to ERP systems. Much of the streamlining of materials procurement process was achieved by MRP and MRP-II. By the late 1980s, tens of thousands of firms were using MRP-II systems (Rondeau & Litteral, 2001). The SAP R/3 modules and submodules consisting of sales and distribution, materials management, warehouse management, quality management, production planning for process industries, financial accounting, controlling, project system, and office communication were expected to reduce inventories, improve cash management, and cut down operating expenses. Kalling (2003) recently provided a theoretical framework in which resource-based views (RBV)

are advanced to understand how ERP can provide sustainable competitive advantage. The RBV is not universally accepted as a final explanation of competitive advantage. Some believe that dynamic capabilities, not resources, are the source of competitive advantage. It is possible that ERP provides both unique resources as well as dynamic capabilities in the form of improved information and decision making to improve competitive advantage.

ERP Systems Investments

To avoid struggling with integrating myriad IT applications, many companies implemented ERP systems that required substantial investment of time, internal resources, and capital, resulting in significant organizational change (Dorien & Wolf, 2002). Often, ERP system implementation is accompanied by other improvements and enhancements in existing legacy systems. Due to many simultaneous changes that accompany ERP system implementation, it is hard to attribute any performance changes after ERP system installation solely to ERP systems. However, ERP system implementation is, by far, the most criticized aspect of IT investments. ERP systems require outlays ranging from a few million dollars to several hundred million dollars (Mabert et al., 2001). Despite high expenditures, ERP implementations have resulted in problems. Rushed software installations and inadequate training are blamed for well-publicized troubles with ERP. In 1999, soon after the rollout of its ERP system, Hershey Food Corp., in the third quarter of that year, lost $60.4 million due to problems in customer service, warehousing, order processing, and timely shipments to retailers. ERP implementation problems of Whirlpool Corporation and W. L. Gore & Associates Inc. also have received considerable attention (Collett, 1999). The bankruptcy of FoxMeyer (a drug distribution company) in 1996 is directly attributed by many to flawed implementation of ERP systems. Some skeptics equate spending on

ERP systems to pillage perpetuated by the Big 5 accounting firms (Krochmel, 1999).

LITERATURE REVIEW: BUSINESS VALUE OF INVESTMENTS IN IT AND ERP SYSTEMS

Business Value of IT Investments

Many have studied the linkage between firm performance and IT expenditures (Bharadwaj, 2000; Brown et al., 1995; Brynjolfsson & Hitt, 1996; Hitt & Brynjolfsson, 1996; Shin, 2001). The interest in organizational performance and IT expenditures is confined not only to the manufacturing sector and profit-oriented enterprises; it also includes the service sector and not-for-profit organizations. The connection between IT infrastructure investment and productivity growth in U.S. federal government agencies has been investigated in Lehr and Lichtenberg (1998). The association between productivity in the service sector and IT infrastructure investment is documented in David et al. (1996) and in Devaraj and Kohli (2000). Although the research findings vary in their conclusions, it is safe to say that the relationship of productivity and profitability to IT expenditures is far from conclusive. A comprehensive review of the research investigating the linkage of productivity and business performance with IT infrastructure investment can be found in Chen (2000). Recently, Hu and Plant (2001) raised the issue of the direction of causal links between IT investment and financial performance. They questioned if it is superior financial performance that enables firms to invest more resources in IT or if it is the investment in IT resources that results in superior financial performance.

Most of the prior studies utilize broad measures of productivity, performance, and IT expenditures. For example, firm performance is typically measured by net income, return on assets, and return on equity (Hitt et al., 2002; Shin, 2002), while Tobin's *q* (Hitt et al., 2002) and abnormal stock price reactions (Hayes et al., 2001) have been used to investigate the impact of IT expenditures on financial performance. IT expenditures typically are measured by total outlays for various operational, tactical, and strategic IT initiatives. In Hitt et al. (2002), the number of PCs and processing power available in millions of instructions per second (MIPS) is used to measure IT infrastructure. Because of the use of broad measures to study the linkage of IT with profitability and productivity, controlling for all other contributing factors becomes critical. Several researchers have recognized the importance of isolating the effect of IT expenditures on profitability and productivity. A major reason for conflicting results in prior literature is the level of control of extraneous factors. A theoretical support for mixed empirical results is provided by Thatcher and Oliver (2001). They show that IT investments for reducing the design and development cost of a product or service may have ambiguous effects on a firm's productivity.

In Bharadwaj (2000), IT capability (taking the resource-based value approach) is hypothesized to have a positive impact on firm performance. IT capability is determined by integration of IT infrastructure, human IT resources, and IT-enabled intangibles such as customer orientation and knowledge assets. By using the methodology of matched samples (treatment and control), the author found that the profit ratios in each of the four years (1991-1994) were significantly higher for the companies regarded as IT leaders than for the companies not considered to be IT leaders. The cost ratios (e.g., total operating expenses to sales ratio and cost of goods sold to sales ratio) were significantly lower for the IT leaders in all four years.

Much of the prior research suffers from two weaknesses: (1) use of broad (macro) measures of profitability, productivity, and IT expenditures; and (2) disregard for variations in size, structure, culture, conduct, and performance across indus-

tries and firms within an industry. Systematic differences exist in regard to IT deployments in different industrial sectors: IT capital investment to total capital investment varies between 20.7% in wholesale trade to only 0.9% in the agriculture sector. Similarly, the productivity gains vary considerably across business segments. The productivity gains from 1995 to 1999 for IT-producing industries were 12.22%, compared to 2.3% for non-IT industries (Stiroh, 2001).

Business Value of ERP Systems Investments

ERP systems implementation now has a history of more than 10 years in organizations from diverse industries and of all sizes. ERP systems research, however, is in its infancy. Many case studies (Sieber et al., 2000) and implementation frameworks (Al-Mudimigh et al., 2001) exist, but very little empirical investigation of ERP systems is reported. Productivity paradox in this area continues to haunt practitioners as well as researchers. The dichotomy of efficiency vs. effectiveness continues to elude a confirmatory vote on the success or lack of success of ERP systems. On the efficiency front, the near consensus seems to be of success. On the effectiveness front, there is no clear answer, primarily because the benefits that ensue from ERP implementations are intangible and long-term in nature. Effectiveness cannot be measured easily by the usual criteria of return on investment and net present value. To alleviate this concern, Hayes et al. (2001) have studied the effect on market value of companies when they announce impending ERP implementations. They found an overall positive reaction to initial ERP announcements. Reaction is most positive for small and healthy firms and for larger ERP vendors like PeopleSoft Inc. and SAP Inc.

Hitt et al. (2002) focus on the business impact of ERP investment. Using a large sample of SAP software adopters and nonadopters and computer assets data available from Computer Intelligence

InfoCorp, they tested if SAP adopters' performance ratios, productivity, and market valuation are higher than those of nonadopters. Somewhat anomalously, return on equity measured as a ratio of pretax income to equity was lower for SAP adopters. Similar non-intuitive results were found in prior, during, and post adoption performance—return on assets, return on equity, profit margin, and asset utilization decreased after SAP implementation. Results concerning market reactions to SAP implementations are positive. This large sample research still leaves the business value of ERP systems open to debate. Poston and Grabski (2001) report reduced financial performance after ERP implementation. They found that in the first, second, and third years after implementing ERP, ratio of selling, general, and administrative (SGA) expenses to revenues and ratio of cost of goods sold (COGS) to revenues did not decrease. Furthermore, net income also did not increase. On a positive note, they found that the number of employees per dollar of revenue decreased following ERP implementations. Table 1 summarizes the prior empirical research into impacts of ERP implementations.

RESEARCH FRAMEWORK AND METHODOLOGY

Return on equity (ROE) (calculated as the ratio of net income to average common equity) is utilized typically for measuring the financial consequences of various changes. The DuPont Model of disaggregation of ROE illustrates the correlation between operational performance and financial performance. In this model:

$$ROE = \frac{\mathrm{Re}\,venues\,\text{-}\,Expenses}{Sales} \times \frac{Sales}{Assets} \times \frac{Assets}{Equity}.$$

This disaggregation allows the understanding of the effect of various strategic changes on financial performance (Selling & Stickney, 1990).

Table 1. Summary of prior research into financial consequences of ERP implementation

Authors	Data Period	Data Source	Sample Size	Research Questions	Performance Measures	Summary of Findings
Hayes, Hutton and Reck (2001)	1990-1998	Lexis-Nexis Academic Universe, CRSP database	86 firms	Does ERP announcement result in better market return? Do company size and health and vendor size affect market reaction?	Standardized cumulative abnormal returns	• There is significant reaction to ERP announcement • Market reaction is most favorable to small/ healthy firms • Market reaction is more positive for large vendors
Hitt, Wu and Zhou (2002)	1986-1998	SAP license agreements, Compustat database, Computer Intelligence Info-Corp database	1,117 SAP implementations	Does SAP result in better performance, productivity and stock market valuation?	Labor productivity Return on assets Inventory turnover Return on equity Profit margin Adjusted value added Adjusted output Tobin's q	• SAP adopters have better performance ratios, productivity and market valuation, but lower return on equity. • Greater performance during ERP adoption than before or after
Hunton, McEwen and Wier (2002)	Case study, 1995 – 1999 data	Analysts' earnings forecasts	63 financial analysts	Does ERP announcement result in higher earnings forecasts? Do company size and health affect earnings forecasts?	Revision of earnings forecasts after announcement of ERP implementation	• Significant difference in forecasts due to ERP announcement • Revisions most favorable to small/healthy firms
Poston and Grabski (2001)	1992-1997	Public Relations Newswire and Computstat database	50 firms	Does ERP implementation result in higher firm performance?	S &A, COGS, number of employees per revenue $	• Number of employees/ revenue is decreased due to ERP, all other metrics showed no improvement

Figure 1. Performance improvements due to ERP systems
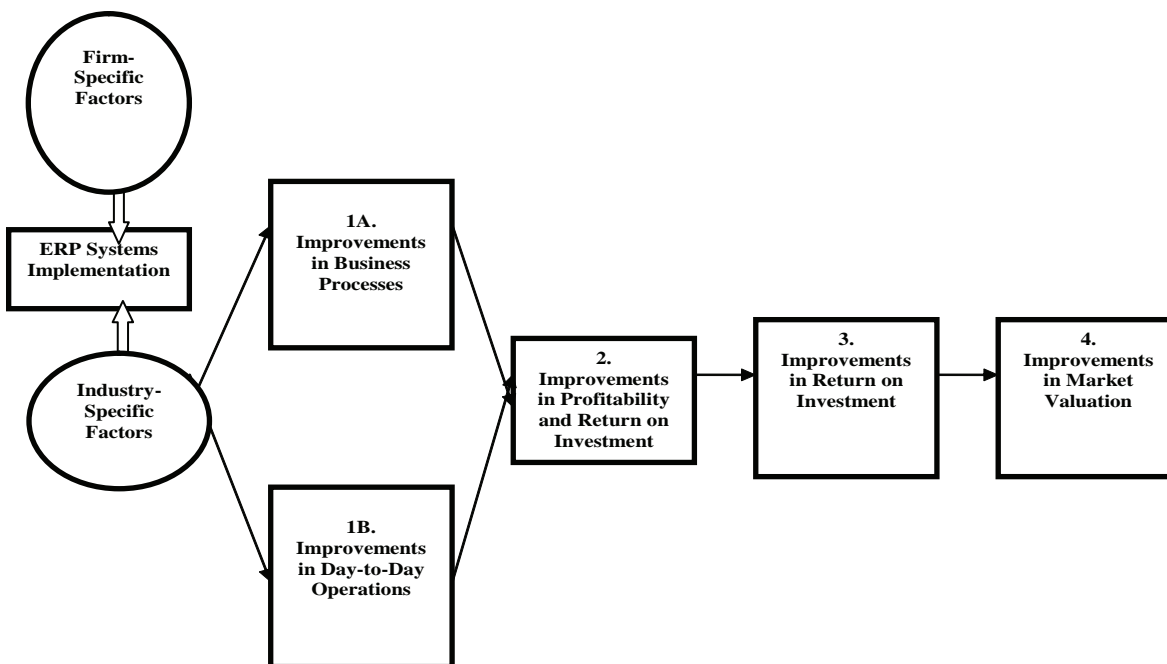
Based on the DuPont Model of factoring of ROE, Figure 1 depicts our conceptualization of the consequences of ERP system implementations. ERP systems are expected to improve both the day-to-day operations (short-term impact) and business processes (long-term impact). Operational improvements are easier to quantify and include improved inventory control, improved cash management, and reduction in operating costs. Business process improvements reflect intangible (hard to quantify) and long-term benefits such as improved customer responsiveness, improved customer satisfaction, on-time delivery, and improved decision making. Improvements in both operations and business processes will lead to improvements in profitability and market valuation of the firm. Improved profitability can be measured in terms of return on investment and equity. In Figure 1, arrows denote *leads to*. Firm-specific factors like size, structure, culture, mission, IT budget, and management style are one set of intervening variables. Another set of

intervening variables is industry-specific factors like type (service or manufacturing), and structure (monopoly, duopoly, oligopoly). In assessing the efficacy of ERP systems, we first must understand and measure the improvements in operations and business processes. Only then can we reach valid conclusions about improvements in profitability, return on investments, and market valuations, since several other organizational factors can impact them concurrently with ERP systems implementation. Much of the ERP systems implementation research in the past has focused on such gross and indirect outcomes. The more direct measures—intangible or tangible—would enhance confidence in the efficacy of ERP systems. Intangible direct measures can be improved customer satisfaction or confidence, enhanced employee morale, and so forth. Tangible direct measures can be reductions in inventory control costs, improvement in cash management, reduction in operating costs, and so forth. Kudyba and Vitaliano (2003) study the linkage between

IT investments and profitability by focusing on operating activities alone and go on to analyze the connection between operating margins and IT investments. Our focus is on specific tangible measures such as cash management, inventory control, cost of goods sold and selling, and administrative expenses. Rather than focusing on net income, return on assets, and return on equity, we investigate the operational efficiencies represented by inventory cost reduction, manufacturing cost reductions, and improved cash management. Instead of combining all IT initiatives and studying their impact on firm performance, we investigate the effect of implementing ERP systems alone. We also avoid the problem of aggregating dissimilar industries by focusing only on the chemical and pharmaceutical industries.

The benefits of ERP systems include streamlined business processes, improved planning, improved decision making, and reduction of inventories. A recent survey (Mabert et al., 2000) of about 500 business executives reveals the following performance outcomes of ERP: (1) quickened response time, (2) increased interaction across the enterprise, (3) improved order management, (4) improved customer interaction, (5) improved on-time delivery, (6) improved supplier interaction, (7) lowered inventory levels, (8) improved cash management, and (9) reduced direct operating costs. Performance outcomes 1 through 6 are difficult to operationalize and measure. In this chapter, we concentrate on the last three performance outcomes and evaluate if the claimed benefits of ERP systems are realized. Deloitte Consulting (1998) reports similar anticipated benefits due to ERP systems. Mabert et al. (2001) confirm cost saving as the first step in a sequence of performance outcomes generated by ERP systems. Bjork (2000) provides details about the linkage of reduced inventories with ERP system implementation.

Often, exaggerated claims of the benefits of ERP systems are accepted as truth. At times, it is hard to separate the marketing hype of ERP systems and the realistic expectations of the benefits of these systems. The CIO of Millennium Chemicals reported that, due to implementation of SAP, the company reduced finished goods inventory by 40% and, consequently, saved the company $15 million a year (Whiting, 2000). The report is factually correct—in December 1995, finished goods inventories of Millennium Chemicals were $337 million, compared to $188 million in December 2000. However, sales for the year 2000 were $1,793 million compared to $3,849 million in the year 1995. Total assets also decreased from $10,043 million at the end of 1995 to $3,220 million at the end of 2000. By computing inventory to sales ratio and inventory to total asset ratio, however, a totally different conclusion emerges. Without a systematic examination of the consequences of ERP systems, the veracity of the claimed benefits cannot be ascertained. Clearly, these claims of improvement in operational efficiency due to ERP system implementation need a systematic scrutiny.

DATA COLLECTION METHODOLOGY

We examine the impact of ERP system implementation on the operational efficiencies of medium-sized chemical and pharmaceutical firms.

- Consciously, we focus only on manufacturing rather than service industry. Within the manufacturing sector, chemical and pharmaceutical firms characterize process manufacturing in continuous flow (assembly line) process configuration for standardized products, as opposed to discrete manufacturing for customized products. Continuous flow process is relevant for production of standard goods (or low variety) in high volumes. Discrete manufacturing is relevant for manufacturing a wide variety of products (customized) in low volumes. Operating

decisions, such as facilities planning, quality control, manufacturing technology, and so forth, depend on the choice of continuous or customized manufacturing process. By limiting our investigation to continuous manufacturing process, we are able to control the previously cited differences.

- The size of a firm may have a significant impact on the level of success achieved by implementing an ERP system, as has been confirmed by several past studies in different contexts. By studying only medium-sized firms, we are better able to isolate the effect of ERP system implementation than by studying well-diversified firms, which are typically larger. The chemical and pharmaceutical companies in our sample are mid-sized ($428.5 million in average quarterly sales for the third quarter of 2002)

- The chemical and pharmaceutical firms are comparatively more information-intensive. In the year 2002, spending on IT as a percentage of revenues in these sectors was 4.3% and 5%, respectively—the highest among all the industries in the manufacturing sector. A recent survey reveals that more than two-thirds of chemical firms already have implemented ERP systems—the highest across all industrial segments (Seewald, 2002).

We examine the *before ERP implementation* and *after ERP implementation* operational efficiencies.

- This condition presumes an ability to establish a go-live date. Determining the go-live date of ERP systems for large companies can be problematic. Since ERP systems are complex, many large corporations do not switch to ERP for all of their operations at once. By limiting our investigation to mid-sized companies, the problem in determining the go-live date for the entire organization is significantly mitigated.

- The firms we analyzed are taken from a list of firms promoted by SAP (a leading vendor of ERP software) as success stories of medium-sized companies in the chemical and pharmaceutical industries. The list includes 49 chemical and 12 pharmaceutical companies. Our approach of selecting success stories to investigate the effects of IT is not new. For example, Bhardwaj (2000) studied firms considered as innovative users of IT by *InformationWeek 500*. Sircar et al. (2000) studied firms judged as technology innovators by IDC. By selecting the companies promoted by SAP as success stories, we may be making a stronger case for the benefits of ERP systems, compared to a purely random selection of firms implementing SAP.

- From the initial list of 61 companies, we were able to gather financial information for only 17 companies. One company, Agriem, was eliminated because it could not be found. The remaining 43 companies could not be included because of non-availability of data (13 companies on the list are privately held, nine are foreign companies [their shares are not traded in the US and they do not file financial statements with the Securities and Exchange Commission (SEC) in the US], 11 are subsidiaries or divisions of a larger parent company, and 10 are involved in merger and acquisition activities and no longer exist as a separate entity). Examination of these nine omitted and other non-US companies will certainly generalize results of this study and can test whether socioeconomic differences play a role in the success of ERP system implementations.

- For the resulting sample of 17 (14 chemical and three pharmaceutical) companies, we collected data on inventories, cash and cash equivalents, operating expenses excluding depreciation, sales and selling, and general and administrative expenses from the first quarter of 1993 to the third quarter of 2002.

Data are collected from 10-Q (quarterly financial statements) filings with the SEC and Compustat databases. Since the data covers more than 10 years, nominal amounts were adjusted using producer price indices of the primary four-digit SIC code of each firm. Producer price indices were collected from the Bureau of Labor Statistics. SEC filings, Lexis-Nexis, and other sources, including personal communications, were used to determine a SAP go-live date for each company.

We compare the pre- and post-ERP implementation levels of the stated operational performance measures of the 17. Appropriate adjustments for changes in price levels and scale of operations, as measured by quarterly revenues, were made.

RESEARCH HYPOTHESES

Given our measures of operational performance, the hypotheses to be tested can be stated as:

H1: Implementation of ERP systems will lead to significant decrease in total inventory levels.

H2: Implementation of ERP systems will lead to significant reduction in cash and cash equivalent position.

H3: Implementation of ERP systems will lead to significant reduction in cost of goods sold less depreciation[1].

H4: Implementation of ERP systems will lead to significant increase in operating income before depreciation.

H5: Implementation of ERP systems will lead to significant decrease in selling, general and administrative expenses.

DATA ANALYSIS

The time-series data we collected cover the first quarter of 1993 through the third quarter of 2002. All but Millennium Chemicals, Inc. has 37 quarters of data available for our tests. Millennium Chemicals had a significant merger activity in 1996; consequently, data from the third quarter of 1996 and later (25 quarters) are used.

The post-implementation sample size varies, depending on the date of ERP implementation in each firm. Every firm in our sample has at least 14 post-implementation quarterly observations. The general price level changes during this period make the nominal data unsuitable for comparison of pre- and post-ERP implementation levels of financial data. The producer price index of the primary four-digit SIC code of each company is used to adjust for price level changes. This adjustment has the effect of correcting for the upward trend in the nominal values of the variables we study. To correct for differences in scale of operations across different companies and over time, we divided the nominal values of inventories, cash and operating income, cost of goods sold and selling, and general and administrative expenses by quarterly sales. Adjustments are made for changes in scale of operations only. There was no need to make adjustments for changes in price levels, since dividing costs by sales results in a ratio, not a monetary value.

Available evidence suggests that the performance of a company suffers during the ERP implementation periods and that the full benefits of ERP are not realized until sometime after the ERP systems are implemented. It is well recognized that, due to the complexities of ERP systems and the changes in organizations' structures, policies, and procedures necessitated by ERP systems, performance of a company may go through a transitory phase—diminished performance during and for some time after an ERP implementation. Prior, during, and post adoption results of Hitt et al. (2002) point to changes in performance during

the implementation period. They analyze annual data between 1986 and 1998 resulting in a total of 13 annual financial observations. Further, since ERP implementation activity peaked in the late 1990s, very few post-implementation observations were available for most firms in this sample. For this reason, we believe that their results comparing a firm's performance during pre- and post-ERP implementation periods are tentative. However, they observe that financial performance improves during adoption periods and disappears during post-adoption periods.

To alleviate transitory changes affecting our results, we tested our hypotheses a second time after eliminating data for the quarter containing the go-live date and for the two quarters before and after that quarter. During this transitory period, performance of existing systems is expected to suffer. Removing data surrounding the go-live date may diminish some potential bias. None of the sample firms installed SAP software in the year 2000 or later. It must be noted that our analysis is based on quarterly data, thus providing us with a sufficient number of observations for post-ERP system implementation periods. Levene's test is used to test for homogeneity of variances before and after ERP implementation. The analysis of variance tests we used assumes variances are equal across samples. If the significance value for Levene's test was higher than 0.05, we used the results that assumes equal variances for both groups; otherwise, we used the results that do not assume equal variances for both groups. Now, we describe our data analysis according to each hypothesis.

H1: Inventories

Null Hypothesis: Post-Inventory level ≥ Pre-Inventory level

The results of our tests are summarized in Tables 2a and 2b. The three measures of inventory levels used in our analysis are (1) nominal

inventory levels, (2) inventory levels adjusted by producer price index of the primary SIC code of the company, and (3) inventory levels divided by sales.

In Table 2a, the number in each cell represents the number of companies for which post-ERP implementation level of inventory was less in a statistical sense (i.e., rejecting the null hypothesis) than the pre-ERP implementation inventory level. The null hypothesis, that nominal inventory levels have either remained the same or have gone up after ERP implementation, can be rejected for only four out of 17 companies using a level of significance of 0.01. That translates to a whopping 13 out of 17 companies potentially not experiencing a decrease in inventory level due to ERP implementation. The most illuminating conclusion from Table 2a is that for 14 out of 17 companies, the post-ERP inventories, adjusted for sales level, either have remained the same or have gone up.

Table 2b repeats the previous tests with five transitory quarters (the go-live quarter and two quarters before and after that quarter) removed from the hypothesis tests. These results do not support claims of better inventory management due to ERP systems use. The most illuminating conclusion is that for 15 out of 17 companies, the post-ERP inventories, adjusted for sales level, either have remained the same or have gone up.

H2: Cash and Cash Equivalents

Null Hypothesis: Post-Cash and Cash Equivalents level ≥ Pre-Cash and Cash Equivalents level

Table 3a shows test results for unadjusted cash and equivalents. The null hypothesis that cash and cash equivalents (with or without adjustments) are the same or have gone up after ERP implementation can be rejected for only five out of 17 companies using level of significance of 0.01. That translates to 12 out of 17 companies (almost 70% of the companies) potentially not experiencing a

Table 2A. Hypothesis 1: Inventory levels

	Number of companies for which rejected at 0.01 Level of Significance	Number of companies for which rejected at 0.05 Level of Significance	Number of companies for which rejected at 0.1 Level of Significance	Number of companies for which Not Rejected at 0.1 level
Inventories – Nominal	4	7	7	10
Inventories – Adjusted for price level changes	6	8	8	9
Inventories – Adjusted for sales level	1	3	3	14

Table 2B. Hypothesis 1: Adjusted inventory levels (transitory periods removed)

	Number of companies for which rejected at 0.01 Level of Significance	Number of companies for which rejected at 0.05 Level of Significance	Number of companies for which rejected at 0.1 Level of Significance	Number of companies for which Not Rejected at 0.1 level
Inventories – Nominal	4	7	7	10
Inventories – Adjusted for price level changes	6	8	8	9
Inventories – Adjusted for sales level	1	3	3	14

decrease in the cash and equivalents position due to ERP implementation. One important conclusion from Table 3a is that for 12 out of 17 companies, the post-ERP level of cash and equivalents either has remained the same or has gone up. These results do not support claims of better cash management due to ERP systems.

Tables 3b shows results for cash and cash equivalents after removing data for five transitory quarters. That translates to a whopping 13 out of 17 companies (almost 75% of the companies) potentially not experiencing a decrease in the cash and equivalents position due to ERP implementation. The most significant conclusion from Table 3a is that for 12 out of 17 companies, the post-ERP level of cash and equivalents either has remained the same or has gone up. These results again do not support claims of better cash management due to ERP systems.

H3: Cost of Goods Sold: Depreciation

Null Hypothesis: Post (COGS – depreciation) $\geq$ Pre (COGS – depreciation).

Depreciation is deducted from COGS to measure controllable manufacturing costs. The results in Table 4a shows that controllable manufacturing costs have not decreased for most companies. Note that we have computed results for (a) COGS adjusted for price level changes and (b) COGS adjusted for sales volume. When COGS is adjusted by sales volume, the results are even more compelling. The results in this table do not support the claim that ERP systems reduce manufacturing costs.

Depreciation is deducted from COGS to measure controllable manufacturing costs. The results

Table 3A. Hypothesis 2: Cash and cash equivalents

	Number of companies for which rejected at 0.01 Level of Significance	Number of companies for which rejected at 0.05 Level of Significance	Number of companies for which rejected at 0.1 Level of Significance	Number of companies for which Not Rejected at 0.1 level
Cash and cash equivalents	5	5	5	12
Cash adjusted for cost of goods sold excluding depreciation	5	5	6	11

Table 3B. Hypothesis 2: Cash and cash equivalents (transitory periods removed)

	Number of companies for which rejected at 0.01 Level of Significance	Number of companies for which rejected at 0.05 Level of Significance	Number of companies for which rejected at 0.1 Level of Significance	Number of companies for which Not Rejected at 0.1 level
Cash and cash equivalents	4	5	5	12
Cash adjusted for cost of goods sold excluding depreciation	4	5	6	11

in Table 4b show that controllable manufacturing costs have not decreased for most companies. When COGS is adjusted by sales volume, the results are even more compelling. The two tables clearly cast doubt on the claim that ERP systems will decrease cost of manufacturing.

H4: Operating Income before Depreciation

Null Hypothesis: Post-Operating Income before depreciation ≤ Pre-Operating Income before depreciation.

The results in Table 5a follow the pattern of results for other variables in Tables 2a, 3a, and 4a. These results show that for an overwhelming majority of the firms studied, operating income before depreciation has not increased due to ERP implementation. This conclusion is stronger when operating income is adjusted by sales volume. For 14 of the 16 companies, operating income before depreciation data of Ferro Corporation are

not available, and the hypothesis that operating incomes have remained the same or decreased after ERP system implementation cannot be rejected.

The results in Table 5b follow the pattern evident from the earlier results, as depicted in Tables 2b, 3b, and 4b. For an overwhelming majority of the firms studied, operating income before depreciation has not increased due to ERP implementation. This conclusion is stronger when operating income is adjusted by sales volume—for 14 of the 16 companies, the hypothesis that operating incomes have remained the same or decreased after ERP system implementation cannot be rejected.

H5: Selling, General and Administrative (SG&A) Expenses

Null Hypothesis: Post-SG&A ≥ Pre-SG&A.

Table 6a shows that the pattern of results obtained in the previous Tables 2a, 3a, 4a, and 5a continue

Table 4A. Hypothesis 3: Cost of goods sold minus depreciation

	Number of companies for which rejected at 0.01 Level of Significance	Number of companies for which rejected at 0.05 Level of Significance	Number of companies for which rejected at 0.1 Level of Significance	Number of companies for which Not Rejected at 0.1 level
COGS – Adjusted for price level changes	6	7	7	9
COGS – Adjusted for sales volume	2	3	3	13

Table 4B. Hypothesis 3: Cost of goods sold minus depreciation (transitory periods removed)

	Number of companies for which rejected at 0.01 Level of Significance	Number of companies for which rejected at 0.05 Level of Significance	Number of companies for which rejected at 0.1 Level of Significance	Number of companies for which Not Rejected at 0.1 level
COGS – Adjusted for price level changes	6	7	7	9
COGS – Adjusted for sales level	3	3	3	13

Table 5A. Hypothesis 4: Operating income before depreciation

	Number of companies for which rejected at 0.01 Level of Significance	Number of companies for which rejected at 0.05 Level of Significance	Number of companies for which rejected at 0.1 Level of Significance	Number of companies for which Not Rejected at 0.1 level
Operating Income – Adjusted for price levels	1	4	4	12
Operating Income – Adjusted for sales levels	2	2	2	14

Table 5B. Hypothesis 4: Operating income before depreciation (transitory periods removed)

	Number of companies for which rejected at 0.01 Level of Significance	Number of companies for which rejected at 0.05 Level of Significance	Number of companies for which rejected at 0.1 Level of Significance	Number of companies for which Not Rejected at 0.1 level
Operating Income – Adjusted for price levels	3	4	4	12
Operating Income – Adjusted for sales levels	2	2	2	14

Table 6A. Hypothesis 5: Selling, general and administrative expenses (SG&A)

	Number of companies for which rejected at 0.01 Level of Significance	Number of companies for which rejected at 0.05 Level of Significance	Number of companies for which rejected at 0.1 Level of Significance	Number of companies for which Not Rejected at 0.1 level
SG&A – Adjusted for price levels	5	6	8	8
SG&A – Adjusted for sales levels	1	2	2	14

Table 6B. Hypothesis 5: Selling, general and administrative expenses (SG&A)(transitory periods removed)

	Number of companies for which rejected at 0.01 Level of Significance	Number of companies for which rejected at 0.05 Level of Significance	Number of companies for which rejected at 0.1 Level of Significance	Number of companies for which Not Rejected at 0.1 level
SG&A – Adjusted for price levels	6	6	7	9
SG&A – Adjusted for sales levels	2	3	4	12

for SG&A. For half of the firms (eight), even at 0.1 level of significance, SG&A did not decrease after implementing SAP. But when SG&A expenses are adjusted for scale of operations, a vast majority (12 out of 14) of firms showed no statistically significant reduction of these expenses. Again, these results contradict claims of reduced SG&A due to ERP systems.

Table 6b confirms the pattern of results obtained in the previous Tables 2b, 3b, 4b, and 5b. For more than half of the firms (nine), SG&A did not decrease after implementing SAP. But when SG&A expenses are adjusted for scale of operations, a vast majority (three out of four) of firms showed no reduction of these expenses. Again, these results contradict claims of reduced SG&A due to ERP systems.

The results of these five hypotheses are very similar—they collectively suggest that despite successful implementation of ERP systems (as claimed by SAP), the companies we tested did not improve in many basic measures of operational efficiency. However, our results do not necessarily suggest the ineffectiveness of ERP systems. In the next section, we further discuss our results.

DISCUSSION OF RESULTS: IMPLICATIONS FOR RESEARCHERS AND PRACTITIONERS

A limitation of the current research is its limited sample. With passage of time, improved availability of data should make it possible to control for firm size and industry characteristics and yet base analysis on larger samples. A majority of the companies we studied showed no gains in operational efficiencies in terms of reduced inventories, improved cash management, reduced costs, or increased operating income. Surprisingly, many companies showed worsened performance in these measures. In each of the tests we made, the performance of the companies studied looked less attractive after adjustments for scale of operations. For seven of the 17 companies, there was a significant reduction in COGS—depreciation after adjustment for price levels. However, when the same variable was adjusted for scale of operations, only three companies showed performance gain (at 0.1 level of significance). It is well

recognized that due to the complexities of ERP systems and changes in organizations' policies and procedures necessitated by ERP systems, performance of a company may go through a transitory phase—slightly diminished performance during the period and a few periods after implementation. Even elimination of potentially turbulent periods during the time of SAP installation did not significantly change our results. Our results have more reliability, because we focused only on one ERP vendor—SAP. By doing this, we have avoided all the errors that may arise due to differences in the functionalities and features of different ERP software. Differences exist even in the implementation processes of different ERP systems. Poston and Grabski's (2001) study suffers from this problem, since their sample included implementations of SAP, Oracle, PeopleSoft, JD Edwards, and Baan.

Implications for Researchers

1. Our results do not suggest the futility of ERP systems. We merely tested some often-cited operational performance benefits due to ERP systems. Our negative conclusions do not suggest the ineffectiveness of ERP systems but that ERP systems research must expand its scope to include intervening variables that may affect their performance. The benefits of ERP systems extend beyond the tangible factors that we measured. These include improved customer satisfaction and improved decision making. The full benefits of these systems cannot be assessed with any finality until these hard-to-measure performance gains are included in the analysis.

2. One factor not controlled or studied in this research is that the organizations studied may or may not have changed their organizational processes, practices, structures, and cultures to realize maximum benefits from ERP implementation. This factor is linked with the extent of customization

that the ERP software goes through before it is implemented. Generally, there is inverse relationship—the more the software is customized, the less changes are made in the organizational processes, practices, structure, and culture. Literature abounds in emphasizing the need for organizations to embraces such organizational changes when complex and large systems like ERP are implemented. Common ERP implementation errors, as cited by Koh, Soh, and Markus (2000), include (1) failure to link the technology plan to the business strategic plan (Jordan & Krumwiede, 1999; Wilder & Davis, 1998); (2) failure to recognize the need for business change (Wilder & Davis, 1998); (3) failure to map out business processes before implementing the software; (4) system personnel and consultants not understanding the nature and value of well-controlled business processes (Glover et al., 1999); and (5) little or no organizational learning about the system (Sweat, 1999).

3. A prior study by Poston and Grabski (2001) compared pre-ERP implementation data with post-ERP implementation data three years after implementation (no data were collected for the implementation period, which was an average of 1.4 years). However, in our case, we did tests by including as well as ignoring data during the unstable period of six months following ERP implementation. That has provided an added insight into the impact of ERP systems. Our results with unstable periods removed did not change our conclusions significantly: The ERP systems did not improve operational efficiencies. Perhaps six months is not an adequate period for instability due to implementation of such a complex and massive enterprise system as SAP. Studies ought to be done over a much longer period (e.g., 15 years), ignoring data of one to two years prior to and after ERP implementation.

4. Several avenues for further research should be of interest. We did not control for the overall economic changes that have taken place during the periods we studied. Although we expect the effect of overall economic conditions on operational performance to be small, controlling for these differences during the periods we studied will certainly strengthen our results. The experience of non-US companies in implementing SAP will improve our understanding of socio-economic factors in influencing the success of information systems.

Implications for Practitioners

1. When expected benefits due to ERP implementation are not realized, one must notice that during the 1997-1999 period, many companies jumped on the ERP bandwagon primarily to take care of the much hyped Y2K problems. We knew then and we know now that there were much simpler and significantly less-expensive IT solutions available to fix Y2K problems.
2. Our results clearly show that the effectiveness of ERP systems is inconclusive. The jury is still out. CEOs and CIOs must analyze their situations thoroughly before embarking on such a huge undertaking as an ERP system. Thorough prior analysis must be done regarding a fit between an ERP system and the existing business processes. That would determine the number of changes required to either the ERP system or to the existing organizational processes and structure.
3. This study of 17 mid-sized companies in chemical and pharmaceutical industries reveals that for nearly two-thirds of the companies tested, no operational performance gains materialized. These results should not be interpreted as failure of ERP systems to provide expected benefits; instead, the need for incorporating hard-to-measure performance gains such as improved customer satisfaction, customer interaction, and improved decision making should be recognized. The conclusions regarding the efficacy of ERP systems based on return on investment, net present value, or increases in market value of a firm cannot be relied upon until the more fundamental questions regarding the benefits of ERP systems are resolved satisfactorily.

CONCLUSION

ERP systems integrate the separate and stand-alone information systems once used to support individual functional areas. They automate everyday business operations and enable use of (near) real-time information to improve decision making. The expected performance improvements due to ERP systems include quickened response time, increased interaction across the enterprise, improved order management, improved customer interaction, improved on-time delivery, improved supplier interaction, lowered inventory levels, improved cash management, and reduced direct operating costs. Enterprise resource planning (ERP) systems require substantial investment of time, internal resources, and capital, and result in significant organizational changes. Due to the high cost of ERP systems, many question their business value. A few well-publicized failures of ERP systems cause some to question their business value. A systematic empirical analysis of business value of and performance gains due to ERP systems is just beginning.

Most of the previous research focuses on broad measures of financial performance (return on equity, return on assets, net income) or security market performance (Tobin's q, abnormal returns, or financial analysts' forecasts). To understand the full impact of ERP systems, focused research questions, beginning with the most fundamental changes that are expected from these systems,

are necessary. In this chapter, we take such a focused approach and concentrate on the impact of ERP systems on some measures of operational performance.

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ENDNOTE

[1] Depreciation expense is an arbitrary recognition of an asset's acquisition cost over the life of the asset. The depreciation expense allocated to a period has no cash flow consequences beyond tax consequences.

Chapter IV
Consumer Perceptions of Mobile Advertising:
An Application of the Theory of Reasoned Action

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ABSTRACT

A two-stage approach is employed to examine the influencing factors of consumer behaviors in the context of mobile advertising. The first stage of the study evaluates the correlation relationship of consumer motives for receiving mobile advertising and their attitudes toward mobile advertising. The relationship between consumer intentions for receiving advertisements on their cellular phones and their subsequent actions upon receiving the mobile advertising is also investigated. A negative sentiment was revealed of cellular phone users toward mobile advertising. This represents a warning signal indicating that current practices of mobile advertising generally are ineffective and are in need of a careful reevaluation on the part of mobile commerce firms. The second stage of the research applies Fishbein and Ajzen's theory of reasoned action model to examine consumer behavior regarding mobile advertising. We found that positive actions on the received advertisements are significantly influenced by strong intentions, strong intentions are significantly influenced by favorable attitudes, and favorable attitudes are significantly influenced by strong motives. Implications for e-commerce application developers and marketers are discussed.

INTRODUCTION

The convergence of the Internet and wireless communications has led to rapid development of an emerging market for mobile e-commerce, or m-commerce. As the business impact of e-commerce has been witnessed in almost every facet of the business arena, the advancement of wireless Internet access capabilities is adding to the convenience and flexibility of the online shopping process. This growing trend of m-commerce has been confirmed by numerous industry research reports. Malhotra and Segars (2005) report the global market for mobile commerce would reach $20 billion in the year 2006. Increasingly, Web-enabled wireless devices and broadband connection services have allowed users to search, communicate, and purchase products from anywhere at any time. These powerful features are contributing to e-commerce's growth in the knowledge economy, as attention and time are becoming scarce resources for the consumers (Hague, 2004).

As wireless technologies and standards for security, bandwidth, and interoperability continue to advance, the impact of online shopping via wireless communication devices is becoming a crucial issue for marketers as they strive to design their organizations' marketing and other strategic initiatives. The development of m-commerce is also posing a new challenge for information system personnel. Information system departments often are called upon to implement powerful and flexible system capabilities to support or enable innovative business initiatives. For many practicing information system professionals, wireless communication is a new field. Different from wired communication networks, wireless networks are relatively more limited in processing power, transmission bandwidth, user interface (e.g., screen size), and security protection. For some time, concerns over these restrictions have kept wireless networks from becoming a serious option as a core information management component.

Advancements in all these areas, however, have been made to improve the technical capabilities of wireless communication as a viable vehicle for serious business innovation. Traditionally, the information system community has looked to various integrated frameworks that address the relationships between technology, user, and application domain for conceptual guidance. However, most existing literature on m-commerce is anecdotal reports that center on industrial development (Okazaki, 2005). Systematic empirical investigation into various aspects of m-commerce development is relatively limited. Clarke (2001) points out this problem, saying that "Despite tremendous interest in the melioration of m-commerce, there is little, if any, research that examines how to develop a comprehensive consumer-oriented mobile e-commerce strategy" (p. 134).

This study is partly a response to this calling. Our concern is with business practices and theory development in mobile commerce. The objective is to obtain a theory-based understanding of an important aspect of mobile commerce-mobile advertising. Basing our study on a well-established theory, such as the Theory of Reasoned Actions, facilitates a systematic inquiry of mobile advertising as a newly emergent phenomenon. Such an inquiry not only provides a better understanding of mobile advertising, it also generates additional new evidence for further validation of the theory.

The use of wireless communication services is becoming a global phenomenon. Cellular phones are increasingly becoming an essential vehicle for business and personal communications as well. These mobile phone users are being targeted by companies that seek to incorporate Internet-enabled operations into their advertising approaches. These companies must develop their business strategies based on an in-depth understanding of the distinct characteristics of their customers.

Guided by the theory of reasoned action developed by two social psychologists, Fishbein

and Ajzen (1975), this study examines consumer motives (beliefs), attitudes, intentions, and actions associated with e-commerce advertising through Web-enabled cellular phone services. A two-staged, empirical study is conducted to investigate consumer perceptions of and reactions to mobile advertising via cellular phones. The purpose of the first stage is to develop a theoretical framework by analyzing the survey data using factor analysis and canonical correlation analysis. This framework is then validated in the second stage using structured equation modeling.

In the next section, we present contrasting views over the future of e-commerce, unique features of m-commerce, and consumers' attitudes toward advertising. We also introduce Fishbein and Ajzen's Theory of Reasoned Action, and elaborate on its implications for mobile advertising. The research hypotheses designed to answer our research questions are then presented. In the section on research method, we describe the research framework and the approach to analyze the collected data. This is followed by the findings in the study. In addition to summarizing the research, the last section also documents the limitations that may negatively affect the validity, as well as the

generalization ability of the research, and presents our suggestions for future research.

CONTRASTING VIEWS OF ELECTRONIC COMMERCE

Despite a concern expressed in a Jupiter Research report about the likely slowing-down of online sales in the near future (Bhatnagar, 2005), most literature on electronic commerce (e-commerce) is still optimistic about the continuing growth of this relatively new business environment. This optimism is partly fueled by economic data from such sources as the Census Bureau of the Department of Commerce. For example, a recent announcement from the Department of Commerce reported that total e-commerce sales for 2006 were estimated at \$108.7 billion, an increase of 23.5% from 2005. Total retail sales in 2006 increased 5.8% from 2005 (U.S. Census Bureau News, 2006). During the period from the fourth quarter of 1999 to the fourth quarter of 2006, retail e-commerce sales as a percent of total quarterly retail sales have generally exhibited a growing trend, though not a smooth line on the chart (see Figure 1).

Figure 1. Estimated quarterly U.S. retail e-commerce sales as a percent of total quarterly retail sales: 4ᵗʰ Quarter 1999 – 4ᵗʰ Quarter 2006 (Source: http://www.census.gov/mrts/www/data/pdf/06Q4.pdf)
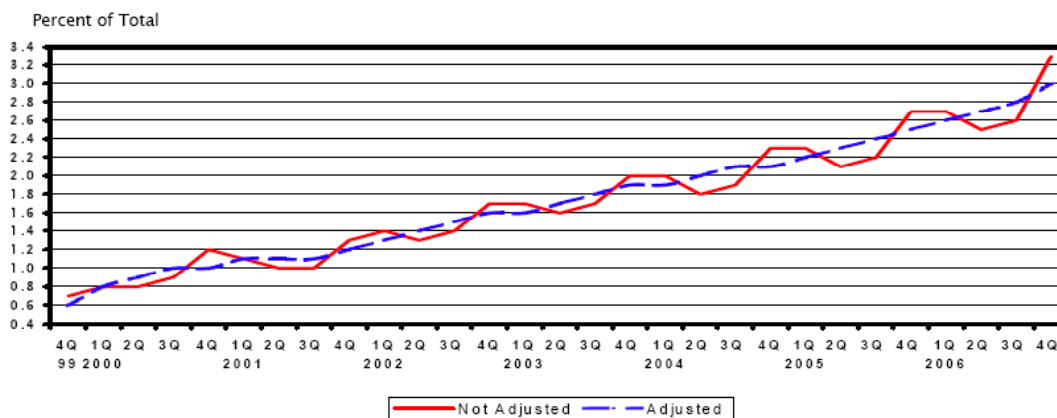
The optimistic prospect is also supported by various views about e-commerce's unique value propositions. The more reserved view contends that the economic impact of the Internet is limited to improvement of consumer convenience and expanded choices, rather than in more direct areas such as higher productivity and lower prices (e.g., Litan & Rivlin, 2001; Porter, 2001). The more enthusiastic view, however, holds that the Internet has virtually become a new platform for business activities and, thereby, is transforming many ways in which businesses interact with stakeholders. Joines et al. (Joines, Scherer, & Scheufele, 2003), for example, emphasize the strategic value of this new platform for developing advertising strategies, recognizing the fact that few of the Internet-based businesses are making profits. Among the unique features of the Internet-based businesses are interactivity, rich content, wide reach, personalization, convenience, and online shopping capabilities (e.g., online payment) (Joines et al., 2003; Turban, King, Lee, & Viehland, 2004). The difference between dissimilar views, however, appears to lie mainly in the prospect of rate of growth, rather than in the strategic role e-commerce is playing in all aspects of business activities.

UNIQUE CONSIDERATIONS OF M-COMMERCE

M-commerce is generally defined as the use of wireless communications networking technology as the primary interaction vehicle between buyers and sellers of products or services. Currently, the Web-enabled cellular phone is the most popular device used by customers of m-commerce. This definition accommodates a number of slightly different definitions found in the literature. For example, Siau and Shen (2002) defined m-commerce transactions as those conducted via mobile devices using wireless telecommunication networks and other wired e-commerce technologies.

In O'Dea's (2000) study, m-commerce was defined as an extension of e-commerce beyond the static terminal of the PC/TV to Web-enabled mobile and other wireless communication devices. As the wireless communication technology continues to advance along many directions (e.g., bandwidth, security, user interface, pricing strategy, etc.), the substantial growth potential of m-commerce in the near future has been predicted by both practitioners and academicians (Zhang, Yuan, & Archer, 2002).

Innovative business strategies are required to leverage the unique features of wireless communications in order to offer unique and appealing customer value. Contrasted with the traditional, wired telecommunication networks, a wireless communication infrastructure is relatively less expensive to construct in terms of capital requirement and time frame. This cost advantage is applicable to wide-area, metropolitan-area, and local-area network installations (White, 2004). Wireless communication devices are also more tightly tied to the users than desktop personal computers or fixed line-based telephones. This personalization capability has allowed m-commerce companies to bring customers more into their major business processes, such as new product development, in an attempt to produce outcomes that may enhance customer satisfaction and loyalty (Napier, Judd, Rivers, & Adams, 2003; Varshney & Vetter., 2002). In addition, when equipped with wireless cards and Web-browsing capability, wireless devices, such as laptop computers or even cellular phones, can be used to access internal as well external information resources with little concern of wiring for network connection.

Researchers have identified major advantages of m-commerce that are attributable to these unique features of wireless communications. For example, Wen and Gyires (2002) indicated the key ingredients of m-commerce to be portability, connectivity, usability, and ubiquity. Clark (2001) suggested four value propositions of m-commerce

that set m-commerce apart from conventional e-commerce: ubiquity, localization, personalization, and convenience. Frolick and Chen (2004) indicated that m-commerce contributes to overall business operations through real-time interactions with customers and immediate dissemination of decision support information to employees. Malhotra and Segars (2005) identified six unique capabilities that may help wireless Web become killer applications: immediacy, constantcy, personalization, ubiquity, timeliness, and context. Balasabramanian et al. (Balasabramanian, Peterson, & Jarvenpaa, 2002) emphasized three valuable characteristics of mobile commerce: location sensitivity, time criticality, and user control. In explicating major differences between m-commerce and e-commerce, Zhang et al. (2002) contended that "M-commerce is not simply a new distribution channel, a mobile Internet, or a substitute for PCs. Rather, it is a new aspect of consumerism and a much more powerful way to communicate with customers (p. 83)." Rather than treating m-commerce merely as an extension of e-commerce, a new way of thinking has been called for, in order to unleash the value of m-commerce associated with the role of mobility (Clark, 2001; Nohria & Leestma, 2001). From a strategic perspective, the potential of m-commerce can be realized only through the development of a mobile-specific business strategy (Clark, 2001).

CONSUMER ATTITUDE TOWARD ADVERTISING

Consumer attitude toward advertising is characterized by their favorable or unfavorable evaluation of advertising through mobile devices, is evaluative or affective in nature, and plays an important role in determining their intention and behavior when exposed to a specific advertising in a specific environment (Fishbein & Ajzen, 1975; Mackenzie, Lutz, & Belch, 1986). The positive as well as negative effects of consumer attitude toward advertising have been extensively researched in advertising and marketing. For example, Mitchell and Olson (1981) found that consumers' attitudes toward advertising affected their brand attitudes and purchasing willingness through their emotional feelings over the advertising itself. In general, consumers' attitudes toward advertising reflect the degree to which they identify with the advertising (Mackenzie et al., 1986; Shimp, 1981). In a study conducted to investigate the recall effect of outdoor advertisements, Donthu et al. (Donthu, Cherian, & Bhargava, 1993) found that better recall tended to be exhibited by the respondents with more positive attitudes toward advertising in general.

In contrast with the positive effect of consumer attitudes toward advertising advocated in the early research, the negative aspect has been revealed by more recent studies. The shifting began in the 1970s (Zanot, 1984), and became ever more significant in the 1980s and 1990s (Alwitt & Prabhaker, 1994; Mittal, 1994). The driving forces include such factors as increased awakening of consumerism, risk perception, self-defense, and the excessiveness of advertising activities (Cooper, 1994). These factors have been confirmed by more recent studies that investigated newer media as well as traditional media. For example, in examining six traditional mass communication media (television, radio, printed magazine, printed newspaper, yellow page, and direct mail), Elliot and Speck (1998) identified three phenomena associated with negative perception of advertising. First of all, the excessiveness of the amount of advertising was a matter of perception, rather than objective data. Secondly, consumers often look at advertising as an annoyance that interferes with the content reception. Thirdly, consumers often decide to regain control or avoid exposure to an unwelcome advertisement. A recent study conducted by Tsang et al. (Tsang, Ho, & Liang, 2004) also revealed the negative aspect of consumer attitude toward advertising in the context of mobile commerce.

THEORY OF REASONED ACTION

Originated in the field of social psychology, the theory of reasoned action (TRA) was developed by Fishbein and Azjen in the 1970s (1975). The purpose of the theory is to predict and understand the factors influencing an individual's behavior in a specific context. The theory, and its subsequent variation, the theory of planned behavior (TPB), have been applied to research in a variety of fields. In the field of management information systems, for example, Harrison et al. (Harrison, Mykytyn, & Riemenschneider, 1997) examined small business executives' intentions to adopt information technology for the purpose of establishing or enhancing sustainable competitive advantage. Mathieson (1991) compared TPB and technology acceptance model for predicting an individual's intention to use an information system. They concluded that TPB provided more useful information for information systems development. Mykytyn et al. (Mykytyn, Mykytyn, & Harrison, 2005) used TPB to examine the integration of intellectual property concepts into information systems education.

TRA provides a theoretical foundation for the linkage between four constructs: behavior, intention, attitude, and belief. Through exposure to an object, people link the object with its attributes with varying strengths. "The totality of a person's belief serves as the informational base that ultimately determines his attitudes, intentions, and behaviors" (Fishbein & Ajzen, 1975, p. 14). Influenced by belief, attitude refers to the favorable or unfavorable feelings or evaluations a person holds of an object or a behavior. Behavioral intention refers to "the strength of a person's conscious plans to perform the target behavior" (Mykytyn et al., 2005, p. 6). In TRA, intention is hypothesized to be the best predictor of a person's behaviors, which are observable acts of the person. As applied to the context of mobile advertising, the theory suggests that mobile phone users' beliefs or motives regarding mobile advertising

affect their positive or negative attitudes toward mobile advertising; positive attitudes may lead to strong intentions for the received advertisement; and that positive actions taken by the users upon receiving the advertisement (e.g., immediate reading vs. delayed reading) are, in turn, affected by the strong intentions. This study seeks to better understand consumers' responses to an emerging marketing practice, mobile advertising, using TRA as the theoretical guidance.

Research Questions

Motivated by the lack of systematic research about the use of mobile communication devices as an advertising medium, this study attempts to answer two general research questions:

1. How do cellular phone users perceive the advertisement received over Web-enabled cellular phones?
2. Can favorable behaviors be attributed to favorable intentions, positive attitudes, and favorable motives or beliefs in the context of mobile advertising?

Given the unique characteristics of the users and the technologies in mobile commerce, it is a great challenge on the part of e-commerce companies to be creative and devise truly appealing advertising strategies. If the findings based on empirical data confirm the applicability of TRA in this context, e-commerce companies would be strongly encouraged to first seek ways to help consumers develop favorable beliefs regarding their advertisements and strengthen the favorable motives and attitudes toward mobile advertising.

Two-Stage Research Design

This study employed a two-stage research approach. The first stage investigated the correlation relationship between motives and attitudes toward mobile advertising, and between intentions and

behaviors. A theoretical model was formulated as the outcome of this stage. The second stage assessed the applicability of the TRA to mobile advertising by examining the cause-effect relationships between the constructs contained in the theoretical model. The following two hypotheses were formulated to test the correlation relationships addressed in the first stage:

H₁: Consumer attitudes toward mobile advertising are not significantly related to their motives for receiving the advertisement on their Web-enabled cellular phones.
H₂: Consumer behaviors on mobile advertising are not significantly related to their intentions to receive the advertisement.

In order to assess consumers' general perceptions of mobile advertising, two descriptive statistics (means and standard deviations) were obtained to address the first general research question. To respond to the second general research question, correlation relationships were examined using canonical correlation analysis, after applying factor analysis to compress the number of variables. The findings from these analyses led to the formulation of the theoretical model that was then validated in the second stage. The statistics software program SPSS (Version 10.0) was used for the analyses in the Stage 1. The second stage used AMOS, a structural-equation-modeling software program, to validate the resultant model. The analysis assessed the causal effect of strong motives on positive attitudes, positive attitudes on favorable intentions, favorable intentions on positive behaviors, and positive attitudes on positive behaviors. The following four research hypotheses, stated in positive forms, were tested in the second stage:

H₃: Strong motives lead to positive attitude.
H₄: Positive attitudes lead to strong intention.
H₅: Positive attitudes lead to positive action.
H₆: Strong intentions lead to positive action.

The questionnaire consisted of six sets of questions, devised to gather data on motives, attitudes, intentions, behaviors, cellular phone usage, and demographical data. The first set had four questions that asked about consumer motives for receiving advertisements on their cell phones. These motives represented their beliefs in the potential benefits of the mobile advertising services. The second set of seven questions addressed consumer attitudes toward mobile advertisements. The three questions in the third set asked about the intentions for the received advertisements. The five questions in the fourth set covered the consumer actions taken on the received advertisements. The last two sets of questions gathered demographical and usage experience data.

A total of 400 questionnaires were distributed to gather data from three types of mobile phone users (college students, college employees, and business practitioners) in Taiwan during the months of June and July 2004. Similar to people in many countries in the more developed world, Taiwanese consumers have found cellular phones to be essential communication tools in their daily lives (Jih & Lee, 2004). The findings of the study, therefore, may have significance for building a more generalized theory in mobile commerce. Some returned questionnaires were discarded because of incomplete or apparently casual responses, resulting in 358 effective responses that were used for data analysis. The structure of effective samples consisted of 33% males and 67% females. The majority (95.5%) of the respondents had usage experience with mobile phones for at least 1 year and therefore can be considered experienced users for the purpose of this study. In general, there were more young consumers than their older counterparts-5.5% of ages 21 or below, 46.9% of ages 22 to 30, 27.1% of ages 30 to 39, and 11.9% of ages 40 or above.

The reliability and validity aspects of the survey questionnaire were assessed to ensure overall adequacy. Factor analysis was performed to assess

the dimensionality of the research constructs. When the questions representing each construct were analyzed separately, the analysis revealed only one factor (eigenvalue > 1) for each of the six model constructs (reception motives, positive attitudes, negative attitudes, intentions, positive behaviors, and negative behaviors), an evidence of unidimensionality of the set of questions that represented the construct. In addition, each construct had a fairly high factor-loading and extracted variance. An adequate convergent validity of the questionnaire was therefore concluded.

The discriminant validity of the questionnaire is another important indicator of the questionnaire adequacy. According to Fornell and Larcker (1981), a questionnaire's discriminant validity is adequate if the individual extracted variance of each of the two constructs exceeds the square of the correlation coefficient between the two constructs. The result in Table 1 indicates proper discriminant validity.

For reliability assessment, the Cronbach's α values were used as the reliability measures. Both Nunnaly's (1978) and Cuieford's (1965) criteria were considered. Nunnaly's criterion calls for basing the reliability assessment on the threshold value being at least 0.7. Cuieford, however, contended that for an inquiry highly exploratory in nature, the Chronbach's α values greater than 0.7 can be considered high levels of reliability, those between 0.35 and 0.7 considered acceptable, and only those with Cronbach's α values less than 0.35 should be discarded. All constructs in our questionnaire had the Cronbach's α values above 0.5, an indication of acceptable reliability. These analyses established the overall adequacy of the questionnaire.

FINDINGS

Consumers' Reactions to Mobile Advertising

In general, the study found that mobile advertising was not receiving an enthusiastic welcome from the cellular phone users in Taiwan. This lack of consumer interest could be witnessed from the low average scores on motives, attitudes, intentions, and actions. On a Likert scale of 1 to 5, with 1 standing for "Strongly Disagree" and 5 for "Strongly Agree," the strongest motive was for information acquisition with average of 2.75. This result indicated that consumers currently did not have much desire to receive advertisements over their cellular phones.

Table 1. Discriminant validity evaluation

Construct	Motives	Positive Attitudes	Negative Attitudes	Intentions	Positive Behaviors	Negative Behaviors
Motives	0.68					
Positive Attitudes	0.57	0.61				
Negative Attitudes	0.12	0.12	0.64			
Intentions	0.51	0.56	0.13	0.76		
Positive Behaviors	0.36	0.36	0.06	0.43	0.59	
Negative Behaviors	0.01	0.02	0.01	0.01	0.04	0.69
Note: Measures on the diagonal are extracted variance percentages. The rest are squared correlation coefficients.						

Similar responses were gathered on consumers' attitudes toward mobile advertising. The statements describing mobile advertising as annoying, excessive, and offensive received average scores of 3.41 or higher, an indication of generally unfavorable consumer attitudes toward mobile advertising. This result was consistent with the findings reported in a number of previous studies (Alwitt & Prabhaker, 1994; Mittal, 1994; Tsang et al., 2004; Zanot, 1984).

Behavior intention measures the strength of a person's conscious plans to perform the target behavior, which in this study measures consumer reception of mobile advertising. The TRA suggests that intention is the best predictor of a person's behavior. Our data found the current state of consumer intentions of receiving mobile advertising less than optimistic. The averages of intention measures for using mobile advertising were 2.54 for purchasing information, 2.35 for enjoyment, and 2.25 for forwarding to friends. This finding offered an alert to mobile commerce marketers, and suggested that being sensitive in their advertising practices to customer perception is imperative in engaging customers.

What did the consumers do when they received an advertisement on their cellular phones? The highest ranked action was to keep it aside for later browsing until they had a chance to do so (3.19). The second highest ranked action was "Immediate Reading" (2.90). It appeared that more people were putting off reading the mobile advertisements than those who read them upon receipt to their mobile phones, a sure sign of lack of consumer enthusiasm toward mobile advertising.

Factor Analyses

The questionnaire employed multiple questions to measure each research construct, with four questions for motives, seven for attitudes, three for intentions, and five for actions. Two constructs, attitudes and actions, were analyzed using factor analysis to reduce their numbers of questions. Two

tests were performed on each of the two constructs to evaluate the correlation between the observed values (Bartlett Sphericity) and its sampling adequacy (Kaiser-Meyer-Olkin coefficient). For the consumer attitudes, the χ^2 value was 744.487 (p value < 0.001) and the KMO coefficient was 0.775. The tests indicated the existence of correlation between observed values and adequacy of factor analysis. For the consumer actions, the χ^2 value yielded from the Bartlett Test was 763.782 (p < 0.001), and the KMO coefficient was 0.798. Both of these two analyses evaluations suggested the adequacy of conducting factor analysis on the consumer actions.

The principal component analysis was first used to extract two factors for the consumer attitudes, with accumulated extracted variance 62.98%. The varimax procedure of the orthogonal rotation approach was then performed to facilitate convenient labeling of the resulting latent variables. The reliability measures of both latent variables were more than 0.70, indicating adequate reliability by Nunally's (1978) standard (Table 2). Based on the variables (questions) included in each of the latent variables, the two factors represented positive attitudes and negative attitudes correspondingly.

As the same factor analysis procedures were applied on the consumer actions, two latent variables (Immediate Reading/Keeping and Delayed Reading) were produced with accumulated extracted variance 63.57% (Table 3). The reliability measures were 0.65 and 0.54, respectively. Although these Cronbach's α values would be considered low by the stricter Nunally's standard, they are acceptable by Cuieford's (1965) standard. Given the exploratory nature of the measures, we accepted the less strict Cuieford's rule, and used this result in the subsequent canonical correlation analysis.

Canonical Correlation Analyses

The first canonical analysis assessed the correlation relationship between the consumer motives for and attitudes toward receiving mobile advertising (H_1). As shown in Table 4, one set of canonical factors was identified. The four motives for receiving mobile advertising (information acquisition, enjoyment of browsing, novel attraction, and discount deals) were significantly related, with the two latent variables of attitudes toward mobile advertising (information helpful and interesting, advertisements offensive and annoying) at the significant level of 0.01. Hypothesis

Table 2. Factor analysis of consumers' attitudes toward mobile advertising

Factors	Questions/Variables	Factor Loadings		Reliability Coefficient Cronbach's α
		1	2	
Information Helpful and Interesting (positive attitude)	Mobile advertisements are interesting to me.	0.85	-0.11	0.78
	Receiving mobile advertisements is enjoyable.	0.84	-0.21	
	Mobile advertisements are a great source of timely information.	0.68	-0.01	
	Mobile advertisements are trustworthy.	0.67	-0.21	
Advertising Offensive and Annoying (negative attitude)	Mobile advertisements are offensive.	-0.23	0.80	0.71
	Mobile advertisements are annoying.	-0.23	0.78	
	Mobile advertisements are excessive and out of control.	0.02	0.77	
Eigenvalues		3.01	1.40	
Explained Variance %		42.98	20.01	
Accumulated Explained Variance %		62.98		

Table 3. Factor analysis of consumers' action on mobile advertising

Factors	Questions/Variables	Factor Loadings		Reliability Coefficient Cronbach's α
		1	2	
Immediate Reading and Keeping	Keeping the advertisement	0.81	0.01	0.65
	Reading the entire advertisement	0.79	0.22	
	Reading right away the advertisement	0.68	0.01	
Delayed Reading	Putting off reading the advertisement untill more time available	-0.05	0.86	0.54
	Putting off reading till too many advertisements have piled up	0.20	0.78	
Eigenvalues		1.95	1.23	
Explained Variance %		39.02	24.55	
Accumulated Explained Variance %		63.57		

Table 4. Canonical correlation between motives for receiving and attitudes toward mobile advertisements

Motives for Receiving Mobile Advertising	Canonical Factor	Attitude toward Mobile Advertising		Canonical Factor
	χ_1			λ_1
Information acquisition	0.736	Information Helpful and Interesting	Positive Attitude	0.993
Enjoyment of browsing	0.842			
Novel attraction	0.897	Advertisements Offensive and Annoying	Neg. Attitude	-0.452
Discount deals	0.802			
Extracted Variance %	0.675	0.595		
Redundancy	0.395	0.348		
ρ^2	0.585			
ρ	0.765			
Note: All canonical factors are significant at p < 0.01.				

Figure 2. Canonical correlation path diagram between motives and attitudes
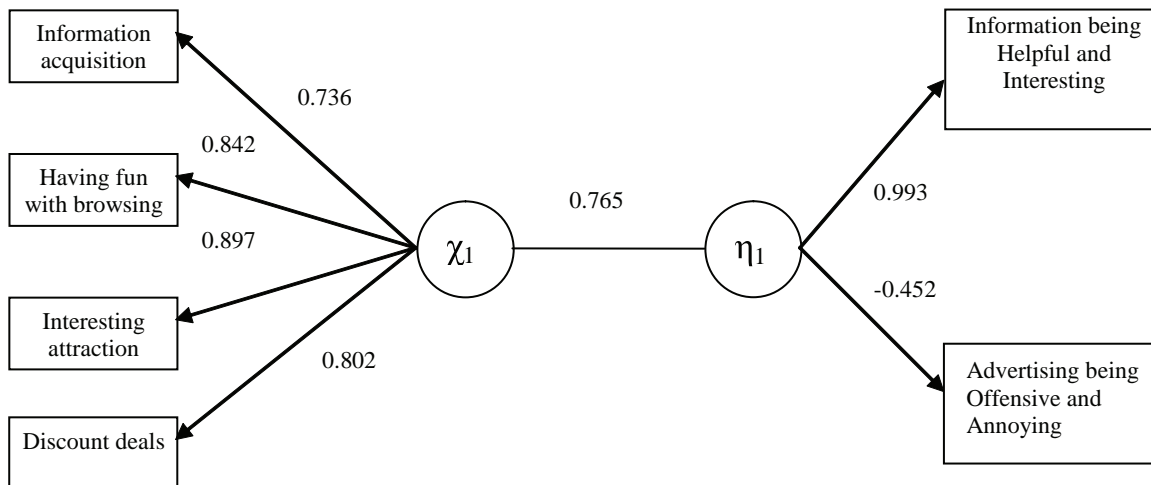
1, Consumers' attitudes toward mobile advertising are not significantly related to their motives for receiving the advertisement on their Web-enabled cellular phones, was rejected.

The canonical analysis between the intentions for receiving mobile advertising and the actions taken on the received mobile advertising also yielded one set of canonical variates. Three intention variables (looking forward to receiving,

basing purchasing decisions on the advertising, and likely to forward to friends) were significantly related with two action variables (read and act immediately, keep for later browsing) at the significance level of 0.01 (Table 5). The first action variable represents positive actions, and the second negative or passive actions. Based on this result, Hypothesis 2 (Consumers' behaviors on mobile advertising are not significantly related

Table 5. Canonical correlation analysis between intentions and behaviors

Intentions for Receiving Mobile Advertising	Canonical Factor	Actions on Mobile Advertising	Canonical Factor
	χ_1		λ_1
Looking forward to receiving	0.89*	Read and act immediately (positive action)	0.99*
Basing purchasing decisions on the advertising	0.90*		
Likely to forward to friends	0.81*	Keep for later browsing (passive action)	0.16
Extracted Variance %	0.752	0.512	
Redundancy	0.324	0.220	
ρ^2	0.431		
ρ	0.656		
*: $p < 0.01$			

Figure 3. Canonical Correlation Path Diagram between Intentions and Behaviors
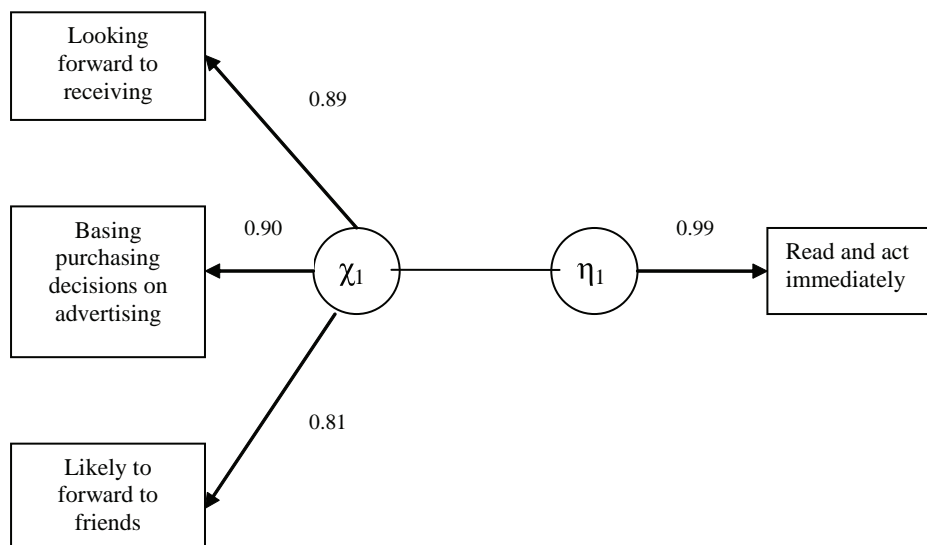
to their intentions to receive the advertisement.) was also rejected. Figures 2 and 3 graphically depict the results of the two canonical correlation analyses.

VALIDATION OF THE THEORETICAL MODEL

The results of data analysis in the first stage provided evidence for rejection of Hypotheses 1 and 2, and thereby argued for the existence of correlation relationships between consumer motives for and consumer attitudes toward receiving mobile

advertising, and between consumer behaviors and their intentions. These results were taken one-step further in the second stage of data analysis. Whereas the emphasis of the first stage was on the correlation relationship, the concern of the analysis in the second stage was with the causal relationships between the involved constructs. A software program designed to evaluate causal effects between research variables, AMOS, was used to validate the theoretical model formulated as a result of the analyses conducted in the first stage.

Four hypotheses (H_3 through H_6) were tested in the second stage. In addition to the three hypotheses (H_3, H_4, and H_6) that reflected the relationships suggested by the TRA, H_5 (positive attitudes lead to positive actions) was included as an alternative model. This alternative model

hypothesized that attitudes bypassed intentions to influence actions directly. The rejection of H_5 would strengthen the validity of, and increase our confidence in, the TRA.

The results summarized in Table 6 confirmed the applicability of the TRA to mobile advertising. All hypotheses but H_5 were significant with all model fitness indexes (GFI, AGFI, NFI, CHI, RMESA, and the $\chi 2$ value per degree of freedom) passing all evaluation criteria. These results indicated positive causal effects of strong consumer motives on positive attitudes toward receiving mobile advertising, positive attitudes on strong intentions, and strong intentions on positive actions. The rejection of H_5 indicated that attitudes did not bypass intentions to directly influence behaviors, a finding consistent with the proposition of the TRA that attitudes influence behaviors

Table 6. Results of model validation

Path	Hypothesis	Expected Sign	Revised Theoretical Model	
			Standardized Structural Coefficient	t-value
Strong Motives -> Positive Attitudes	H3	+	0.946	15.605*
Positive Attitudes -> Strong Intentions	H4	+	0.901	14.952*
Positive Attitudes -> Positive Actions	H5	+	0.040	0.209
Strong Intentions -> Positive Actions	H6	+	0.846	4.233*
Fitness Indexes	Criteria		Actual Fitness Value	Evaluation of Fitness
GFI	> 0.9		0.953	Good
AGFI	> 0.9		0.916	Good
NFI	> 0.9		0.954	Good
CFI	>0.95		0.970	Good
RMSEA	< 0.08		0.070	Good
$\chi 2$ / df	< 3		2.748	Good
*: p < 0.01				

Figure 4. The theoretical model

Significant: H$_3$,
H$_4$, and H$_6$

Insignificant: H$_5$
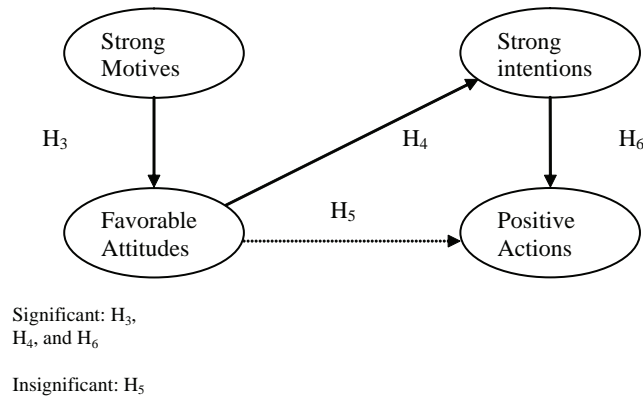
through intentions (Figure 4). The findings from this analysis also signal to the mobile commerce marketers that cellular phone users often have distinct characteristics, and their purchasing behaviors are often influenced by a multitude of factors (Clark, 2001).

CONCLUSION

A new field of multidisciplinary study, mobile commerce provides abundant opportunity for empirical research designed for addressing many issues related to consumer behaviors (Okazaki, 2005). Inspired by Fishbein and Ajzen's theory of reasoned action, this study was conducted to examine the influencing factors of consumer behaviors in the context of mobile advertising. The first stage of the study investigated the correlation between consumer motives for receiving and consumer attitudes toward mobile advertising. It also investigated the correlation between consumer intentions for receiving advertisements on their cellular phones and their actions taken on the mobile advertising that they received. A negative sentiment was revealed toward mobile advertising: all statements expressed in positive and active terms received below average ratings, and the statements expressed in negative and passive terms received above average ratings. The

findings suggest that mobile advertising is still an under-utilized aspect of mobile commerce, implying that current practices of mobile advertising are not effective and require a careful reevaluation to identify more innovative measures. The second stage of the research, however, uncovered some encouraging messages for marketers (Figure 4).

Using Fishbein and Ajzen's theory of reasoned actions model as the theoretical foundation, it was found that positive actions on the received advertisements were significantly influenced by strong intentions, strong intentions significantly influenced by favorable attitudes, and favorable attitudes significantly influenced by strong motives for receiving mobile advertisements. Mobile commerce marketers should be inspired by these findings. With the continued advancement of wireless communication technologies and the associated nontechnical measures, such as proper trust management, a substantial improvement in consumer perception and acceptance of mobile advertising in the future is not out of reach. However, mobile advertising professionals must incorporate unique features of mobile communication devices and the characteristics of the users in the advertising campaign design. It is vital to find value-adding approaches in order to transform negative beliefs and weak motives into positive expectations. The research findings reported in this chapter should not be overly generalized due to several

limitations. The first limitation is caused by somewhat low reliability measures of some constructs. Using more questions for the construct may alleviate this problem, but would do so at the cost of increasing the length of the survey instrument. Increasing questionnaire length may result in a reduced response rate. The second limitation is associated with the exclusive use of Taiwanese data in the analyses. The generalizability of the research findings may be limited due to the use of single-culture participants. The Web-enabled mobile commerce is emerging as a global phenomenon, with new participants joining from many parts of the world. More theory-based research conducted in different cultural contexts allows for cross-cultural comparison and contributes to theory development in the context of mobile commerce.

When interpreted from a customer-oriented perspective, the findings of this study suggest that mobile advertising companies should exercise due sensitivity with customer perception when designing mobile advertising strategies, and that new mobile advertising should be rolled out as an evolutionary rather than a revolutionary process (Malhotra & Segars, 2005). This observation is echoed by a similar warning voiced by Balasabramanian et al. (2002) saying that "Numerous failed business ventures attest to the fact that managers emphasize technologies over consumers at their own peril. This is particularly relevant in the context of m-commerce, where the technologies employed are usually of a cutting-edge nature and involve substantial investment, but the benefits to consumers are often nebulous" (p.359).

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Chapter V
Effective Product Customization on the Web:
An Information Systems Success Approach

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ABSTRACT

Product customization is an important facility that e-commerce offers to its users. On the Web, choice-board systems have become quite prevalent as the means by which users are able to customize their products. These systems allow customers to configure products and services by choosing from a menu of attributes, components, delivery options, and prices. In the context of a choiceboard environment, this research examines the impact of system and information quality and information presentation on interface satisfaction and decision satisfaction. Further, it examines the impact of the latter two sat-isfaction factors on overall user satisfaction and intention to use. The research reveals that improved system quality, vis-à-vis choiceboards, leads to better information and decision satisfaction on the part of the users. This in turn leads to higher overall satisfaction and intention to use. The research uses an experiment for data collection and examines these relationships using the structural equation modeling (SEM) approach.

INTRODUCTION

E-commerce continues to grow, and its iconic companies, such as Amazon, Yahoo, and Google, are now all billon-dollar firms employing thousands of people. The total impact of e-commerce, however, cannot be expressed in simple sales figures; rather, it lies in changing consumer behavior. Increasingly, consumers visit the Web site of a company to familiarize themselves with the firm's offerings and prices before deciding to buy. A Web site is becoming the gateway to a firm's brand, even in the case of off-line firms. Companies that realize the importance of their Web sites use technologies such as e-mail, FAQ, online customer support, bulletin boards, and search engines to assist customers in the buying decision process and, obviously, to persuade a purchase of their product.

The choiceboard is a recent addition to this repertoire of technologies, aiding consumers in the decision-making process (Andal-Ancion, Cartwright, & Yip, 2003; Bharati & Chaudhury, 2004a; Collins & Butler, 2003; Liechty, Ramaswamy, & Cohen, 2001; Slywotzky, 2000). A choiceboard is a system that allows customers to design their own products by choosing from a menu of attributes, components, prices, and delivery options (Slywotzky, 2000). For example, in the automobile industry (http://buyatoyota.com), users can "build" or customize a Toyota and then follow up with a local dealer. In the construction industry (http://kitchens.com), users can get help to design a kitchen and actually place an order. In the apparel industry (http://acustomtshirt4u.com), users can select color, fabric, and a suitable logo and lettering. In the entertainment industry (http://www.apple.com/itunes), customers at the iTunes music store can build customized CDs by selecting individual tracks from existing CDs. Finally, in information technology, the Web sites of most computer firms (e.g., http://www.ibm.com), present individuals with a basic configuration defined by a processor and then "flesh out"

the full configuration with choiceboards offering hard-drive size, memory, and add-ons such as CD/DVD drive, monitors, and printers.

Although choiceboard technology is being widely used to enhance the customer's experience, very little is known about the actual impact of this technology on overall user satisfaction or the intention to use the choiceboard. Similar concerns have been expressed for Web-based decision support systems (Bharati & Chaudhury, 2004b). In particular, it remains unclear how the provision of more information, facilitation of decision making through what-if analysis, and choice comparisons through the use of choiceboard technology affects user satisfaction and the intention to use.

In this research, the relationships are developed and operationalized between system-level factors (such as quality of the system and information in choiceboards, and presentation of information) and user's decision-making and interface satisfaction. Furthermore, the analysis investigates the relationship between information and decision-making satisfaction, with overall satisfaction and intention to use. The statistical analysis consists of path analysis, assessing a pattern of predictive relationships among the measured variables. This research employs the structural equation modeling (SEM) technique to analyze the data and then assess the pattern of predictive relationships.

The research views information systems' success in the new domain of e-commerce; and, in particular, in the context of choiceboard systems. It attempts to understand how choiceboards facilitate user decision making in the Web-based environment. It then develops a conceptual model that relates system-level factors, user satisfaction factors, and use factors. Specifically, it investigates interrelationships between components of user satisfaction–interface satisfaction, decision satisfaction, and overall satisfaction–and their combined impact on intention to use.

Literature Review

The research is related to multiple theories such as the consumer decision-making model (Mowen, 1995), consumer information-processing model (Bettman, 1979), cognitive decision-making model (Simon 1955), and information systems (IS) success model (Delone & McLean, 1992, 2002). According to Mowen (1995), a consumer transits through several phases (Figure 1) such as problem recognition, a search for alternatives, and an evaluation of alternatives before making a choice; that is, there is an information-processing phase and then a decision making one. In this process, a consumer tries to minimize cognitive effort required to make a decision and yet maximize the quality of the decision reached (Bettman, 1990). Furthermore, Bettman (1990) suggests that because of bounded rationality constraint (Simon, 1955), consumers actually will trade off decision quality for a reduction in information processing effort.

Consumers employ decision aids, such as calculators, spreadsheets, consumer guides, and Web-based comparison pricing, in order to lessen the impact of bounded rationality constraints on decision quality. E-commerce retailers are incorporating choiceboards on their Web sites to assist customers in several phases of the decision-making process (Bharati & Chaudhury, 2004a; Bharati & Chaudhury, 2004b). The information search phase, for example, is facilitated by easy revelation of product alternatives; and the decision-making phase of alternatives evaluation is made easier by price and feature comparison.

IS Success Model

Web sites have been extensively studied from different perspectives, emphasizing different aspects of Web-site quality. Timeliness aspects have been studied by Choudrie et al. (Choudrie, Ghinea, & Weerakkody, 2004), relevance has been studied by Barnes and Vidgen (2002), and accuracy aspects by Cao and Zhang (2002). Design aspects of a Web site, in terms of its attractiveness and appropriateness, have been studied by Cao and Zhang (2002). Diniz et al. (2005) and Yoo and Jin (2004) have researched into usability and reliability aspects of Web sites.

There has been, however, a gap in literature in terms of studies related to how Web sites have helped users make better decisions. The focus of Web site usability studies has not focused on studying a Web site as a decision tool. The IS success model (Delone & McLean, 1992, 2003), with its focus on issues relating to information processing and decision making and its previous research on Web-based DSS (Bharati & Chaudhury, 2004b), is useful in investigating the role of choiceboards in assisting users make appropriate choices. In the recent literature, this model has served as the basis for investigating similar research areas such as IS and service quality (Bharati & Berg, 2003). Delone and Mclean (2003) refer to about 285 research papers published in refereed journals that use their framework. The model has been empirically validated by Rai et al. (2002) and by Seddon and Kiew (1994)

The research on quality of information systems services (Jiang, Klein, & Carr, 2002; Jiang,

Figure 1. Customer decision process model (Mowen, 1995)
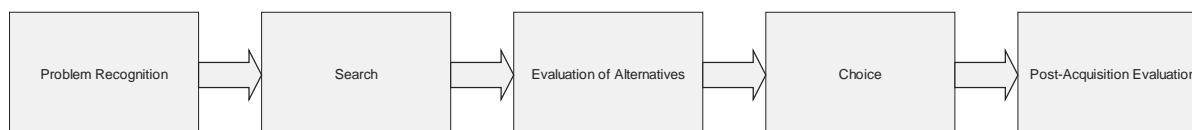
Klein, & Crampton, 2000; Kettinger & Lee, 1997; Kettinger & Lee, 1999; Pitt, Watson, & Kavan, 1995; Pitt, Watson, & Kavan, 1997; Van Dyke, Kappelman, & Prybutok, 1997; Van Dyke, Prybutok, & Kappelman, 1999; Watson, Pitt, & Kavan, 1998), and WebQual (Loiacono, Chen, & Goodhue, 2002) has also attempted to investigate this topic in a slightly different way.

Communications theory (Shannon & Weaver, 1949) was illustrated and modified in Mason's work (1978) to show that classes of information output are at the technical level, semantic level, and influence level. The IS success model (Delone & McLean, 1992, 2002) expanded the concept of levels of output to illustrate stages within those levels. Information is communicated to a recipient who is either influenced or not; he/she then impacts organizational performance. In other words, the information flows from its production to influence the individual and then the organization.

System quality and information quality, both singularly and jointly, impact use and user satisfaction. This research model is based on the IS success model and employs some of the constructs of that model, specifically at the technical level of system quality and information quality, in the context of choiceboards, and in their impact on different components of user satisfaction (interface satisfaction, decision-making satisfaction, and resultant overall satisfaction). User satisfaction then influences the intention to use. The next section explains the research model and hypotheses.

RESEARCH MODEL AND HYPOTHESES

The research model (Figure 2 and Table 3) shows that system and information quality, and information presentation, impact the different components of user satisfaction; and then, intention to use. The various constructs and the resulting hypotheses of the model are explained in this section.

System Quality

System quality is the individual perception of a system's overall performance, which is itself a manifestation of system hardware and software. Ease of use (Belardo, Karwan, & Wallace, 1982), convenience of access (Bailey & Pearson, 1983), and system reliability and flexibility (Srinivasan,

Figure 2. Conceptual model
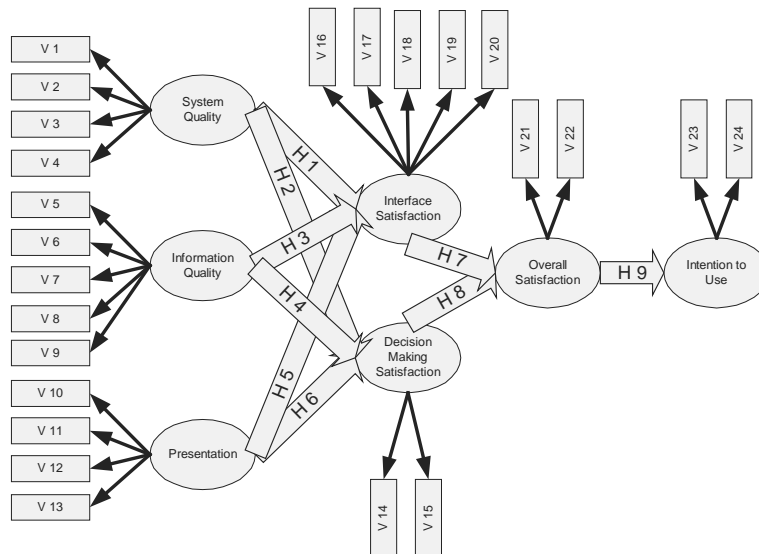
Table 3. Survey constructs and indicators

Construct Name	Item No.	Item Measured
System Quality	V 1	System reliability
	V 2	Convenient to access
	V 3	System ease of use
	V 4	System flexibility
Information Quality	V 5	Information accuracy
	V 6	Information completeness
	V 7	Information relevance
	V 8	Information content needs
	V 9	Information timeliness
Information Presentation	V 10	Presentation graphics
	V 11	Presentation color
	V 12	Presentation style
	V 13	Navigationally efficient
Decision Making Satisfaction	V 14	Decision confidence
	V 15	Decision effectiveness
Interface Satisfaction	V 16	Easy to work
	V 17	Useful format
	V 18	User friendly
	V 19	Does what I want it to do
	V 20	Clear and understandable
Overall Satisfaction	V 21	Extremely useful system
	V 22	Satisfactory in meeting user needs
Intention to Use	V 23	Possible to use
	V 24	Intend to use

1985) are measures employed for the service quality construct.

Information Quality

The user estimates the value of an information system after evaluating the quality of information it provides (Gallagher, 1974). Information accuracy (Bailey & Pearson, 1983; Mahmood, 1987; Miller & Doyle, 1987; Srinivasan, 1985), completeness (Bailey & Pearson, 1983; Miller & Doyle, 1987), relevance (Bailey & Pearson, 1983; King & Epstein, 1983; Miller & Doyle, 1987; Srinivasan, 1985), content needs (Doll & Torkzadeh, 1988), and timeliness (Bailey & Pearson, 1983; King & Epstein, 1983; Mahmood,

1987; Miller & Doyle, 1987; Srinivasan, 1985) are the measures employed in the information quality construct.

Information Presentation

In information presentation, the display of information based on formats, colors, and graphs vs. tables is examined (Vessey, 1994). The interface evaluation has included presentation, format, and processing efficiency characteristics of the interface (Swanson, 1985). The measures used for information presentation construct are graphics, color, presentation style, and navigational efficiency (Swanson, 1985).

Interface Satisfaction

The quality of the information system interface is measured in interface satisfaction. The indicators used to measure interface satisfaction construct are easy to work (Doll & Torkzadeh, 1988; Goodhue, 1990), useful format (Doll & Torkzadeh, 1988; Goodhue, 1990), user friendly (Doll & Torkzadeh, 1988; Goodhue, 1990), does what I want it to do (Davis, 1989; Goodhue, 1990), and clear and understandable (Davis, 1989; Goodhue, 1990).

Hypothesis 1: System quality will positively contribute to interface satisfaction.

Hypothesis 3: Information quality will positively contribute to interface satisfaction.

Hypothesis 5: Good Information presentation will positively contribute to interface satisfaction.

Decision-Making Satisfaction

Decision-making satisfaction is the systems' ability to support the user's decision-making and problem-solving activities. The systems' support to the individual in recognizing problems, structuring problems, and making decisions related to the goal of controlling a business process are part of the construct (Garrity & Sanders, 1998). The construct measures the decision-making satisfaction using decision effectiveness (Chervany, Dickson, & Kozar, 1972) and decision confidence (Goslar, Green, & Hughes, 1986; Guental, Surprenant, & Bubeck, 1984; Zmud, Blocher, & Moffie, 1983).

Hypothesis 2: System quality will positively contribute to decision-making satisfaction.

Hypothesis 4: Information quality will positively contribute to decision-making satisfaction.

Hypothesis 6: Good Information presentation will positively contribute to decision-making satisfaction.

Overall Satisfaction

Satisfaction is an important and widely used construct in the IS literature. Numerous researchers have modified the Bailey and Pearson (1983) user-satisfaction instrument. The construct of overall satisfaction, a result of interface and decision-making satisfaction, was measured using extremely useful system (Sanders, 1984) and satisfactory in meeting user needs (Alavi & Henderson, 1981; Sanders & Courtney, 1985).

Hypothesis 7: Interface satisfaction will positively contribute to overall satisfaction.

Hypothesis 8: Decision-making satisfaction will positively contribute to overall satisfaction.

Intention to Use

Intention to use a system has often been employed as an important measure of IS success (Chang & Cheung, 2001; DeLone & McLean, 1992; Lucas, 1978; Van der Heijden, 2004; Welke & Konsynski, 1980). Possible to use and intend to use (DeSanctis, 1982) have been employed to measure the intention of user to use the system construct.

Hypothesis 9: Overall satisfaction will positively contribute to intention to use.

RESEARCH METHODOLOGY

The instrument (Appendix A) was constructed based on prior research; most indicator items were adapted or borrowed from previously validated instruments. The survey was first pre-tested with a smaller sample and then subsequently refined. The survey was administered to subjects who

Table 1. Tests for unidimensionality, reliability, and convergent validity

No.	Construct	No. of Indicators	Unidimensionality: Goodness of Fit Index (GFI)	Reliability: Cronbach's α	Convergent Validity: Bentler Bonnet Δ
1.	System Quality	4	.99	.72	.97
2.	Information Quality	5	.97	.84	.95
3.	Information Presentation	4	.91	.82	.89
4.	Interface Satisfaction	5	.94	.87	.94
5.	Decision-making satisfaction* - System Quality - Information Quality - Information presentation	2	.95 .96 .91	.83	.92 .95 .90
6.	Overall Satisfaction* - Interface Satisfaction and Intention to Use	2	.91	.89	.93
7.	Intention to Use - Overall Satisfaction and Interface Satisfaction	2	.91	.74	.93
* A combined model was used for this construct.					

were undergraduate and graduate students at two different Universities. They were selected as subjects because they were users of, or familiar with, choiceboard systems. The experiment was conducted in a laboratory setting, with PCs running on the Windows operating system. The researchers, in conducting the experiment, adopted the following procedure.

First, the experimental procedure was explained to the subjects. Then, each subject was randomly assigned a Web site that employed a choiceboard that allowed the user to configure a product. The choiceboard sites were of a very similar nature, despite being owned by different firms. After configuring a product on the Web

site, each subject completed a survey questionnaire. The total sample for the experiment was 192 subjects.

Structural equation modeling (SEM) was used to analyze the data. SEM subscribes to a causal indicator model, with the operational indicators reflective of the unobserved theoretical construct. It allows the specification of measurement errors within a broader context of assessing measurement properties. Confirmatory factor analysis, content validity, unidimensionality analysis, reliability analysis, convergent validity, and criterion-related validity tests were conducted to evaluate the model and constructs (Anderson & Gerbing, 1988; Bollen, 1989; Chin, 1998).

DATA ANALYSIS

Confirmatory Factor Analysis

The measurement properties of the survey instrument were assessed with confirmatory factor analysis. A measurement model comprising of a weighted linear combination of the items in the scale was analyzed. In confirmatory factor analysis, each theoretical construct is specified and analyzed to assess the fit of the data with the measurement model (Ahire, Golhar, & Waller, 1996; Ravichandran & Rai, 1999; Venkatraman, 1989). For constructs with four or more indicators, these guidelines were followed. As some constructs have fewer than three indicators, these constructs were pooled with constructs having four or more indicators. This was done to ensure adequate degrees of freedom for estimation of the model.

Content Validity

Content validity is ensured when the constructs are defined using the literature. The construct should adequately represent and measure the domain of meaning that it is supposed to represent (Bohrnstedt, 1983). If all the items grouped together for each construct reflect the underlying meaning, then content validity exists (Dunn, Seaker, & Waller, 1994). Since there is no rigorous way to assess content validity, in order to ensure thoroughness, multiple items were used to measure the construct (Bohrnstedt, 1983; Churchill, 1979). The instrument employed in the research used several indicators for each construct that was derived from an in-depth literature review; and thus content validity was ensured (Bohrnstedt, 1983).

Unidimensionality Analysis

A multidimensional construct helps with content validity and is acceptable as long as the scales are unidimensional. A scale has to be unidimensional in order to have both reliability and construct validity (Gerbing, & Anderson, 1988). The condition for a unidimensional scale is that the items of a scale estimate one factor. The goodness of fit index (GFI) measures a good fit of the measurement model, as it indicates that all items load significantly on one underlying latent variable. There is no evidence of lack of unidimensionality when GFI is 0.90 or higher for the model. The GFI indices for all the scales are summarized in Table 1, and the results suggest that all the scales are unidimensional.

Reliability

Reliability of a scale is ensured if the scale is dependable, consistent, or stable (Gatewood, & Field, 1990). Cronbach's alpha coefficient was used to measure reliability, as the items of a scale explain the majority of the variation in the construct vis-à-vis measurement error (Cronbach, 1951). The results indicate that the scale is reliable because the alpha coefficient is greater than .70 (Table 1).

Convergent Validity

Considering each item in the scale as a different approach to measure the construct usually assesses convergent validity. This was measured using the Bentler-Bonett coefficient (∆) (Bentler and Bonett, 1980). The Bentler-Bonett coefficient (∆) value of .9 or above means high convergent validity. All the scales had a Bentler-Bonett coefficient (∆) of greater than .9 (Table 1).

Criterion-Related Validity

Criterion-related validity tests the degree to which the outcome is predicted by the constructs (Ahire et al., 1996; Venkatraman, 1989). Using SEM, the constructs are correlated with outcome constructs.

Table 2. Test for criterion-related validity

No.	Construct	Interface Satisfaction	Decision-making Satisfaction	Overall Satisfaction	Intention to Use
1	System Quality	0.66**	0.65**	-	-
2	Information Quality	0.54**	0.69**	-	-
3	Information Presentation	0.50**	0.44**		
4	Interface Satisfaction	-	-	0.49**	-
5	Decision-Making Satisfaction	-	-	0.51**	-
6	Overall Satisfaction	-	-	-	0.56**
** p<0.01					

As the correlation of the various constructs are positive and statistically significant (Table 2), criterion-related validity exists for these constructs.

SEM produces parameter estimates of links between the latent variables, and so, is also called latent variable analysis, or causal modeling. AMOS 4.0 and SPSS 10.1 (Arbuckle & Wothke, 1999) were employed for the SEM analysis.

RESULTS AND DISCUSSION

In summary, this research examined the impact of systems' quality, information quality, and information presentation on user satisfaction and intention to use in the context of choiceboard systems. The IS success model was used as the basis of the research model. The model was based on Shannon and Weaver's communication theory (1949), Mason's theory (1978), and the Delone and McLean (1992) model. The research model employed the constructs at the technical level, viz., systems' quality and information quality, in the context of choiceboards, and finally, its impact on different components of user satisfaction, such as interface satisfaction, decision-making satisfaction, and resultant overall satisfaction. The path coefficients calculated for the estimated model support the hypothesized relationships in both direction and magnitude with few exceptions. Overall, the statistical conclusions support the research model (Figure 3).

System quality is directly and positively correlated to interface satisfaction (H-1); so an increase in the quality of the system leads to an increase in satisfaction in using the interface. Information quality is directly and positively correlated to interface satisfaction (H-3); so an increase in the quality of the information leads to an increase in satisfaction in using the interface. Information presentation is not directly and positively correlated to interface satisfaction; (H-5) therefore, this hypothesis is not validated.

The path coefficients calculated for the estimated model also support the hypothesized relationships in both direction and magnitude in the case of decision-making satisfaction. Most of the hypotheses in the area of decision-making satisfaction have been validated using the data. System quality is directly and positively correlated to decision-making satisfaction (H-2); so an increase in the quality of the system leads to an increase in decision-making satisfaction. Information quality is directly and positively correlated to decision-making satisfaction (H-3); so an increase in the quality of the information leads to an increase in

Figure 3. Model with results

*** p<.01; ** p<.1; * Statistically insignificant
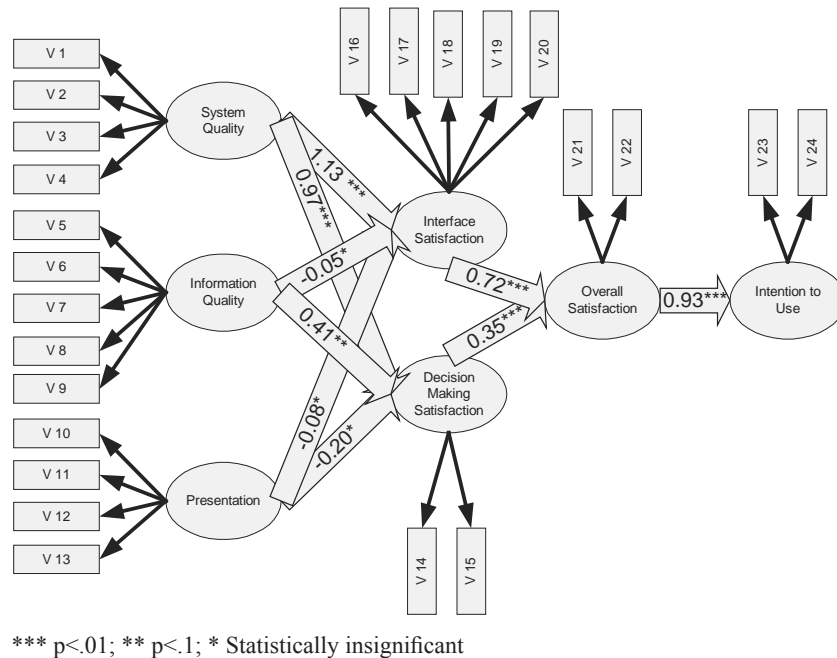
decision-making. Presentation is not directly and positively correlated to decision-making satisfaction (H-6); as this hypothesis is not validated.

System quality includes system ease of use, convenience of access, and system reliability. Thus, a net positive effect from these factors will result in a positive effect on interface satisfaction and decision-making satisfaction. In choiceboards, as in other systems, the ease of use of the system, convenience of access, and system reliability are important considerations for the user. Information relevance, accuracy, completeness, and timeliness constitute the construct information quality. Thus, a net positive effect from these factors will result in a positive effect on decision-making satisfaction. Choiceboard systems should provide relevant, accurate, complete, and timely information for better decision-making satisfaction.

Graphics, color, presentation style, and navigational efficiency measures information presentation. Therefore, information presentation measures how information is displayed. It was hypothesized that a net-positive effect from graphics, color, presentation style, and navigational efficiency would result in a positive effect on interface satisfaction and decision-making satisfaction. The data did not support this hypothesis.

The statistical conclusions support the hypotheses on user satisfaction. Interface satisfaction is directly and positively correlated to overall satisfaction (H-7); so an increase in interface satisfaction leads to an increase in overall satisfaction. Similarly, decision-making satisfaction is directly and positively correlated to overall satisfaction (H-8); so an increase in decision-making satisfaction leads to an increase in overall satisfaction. Overall satisfaction is also found to be directly and positively correlated to intention to use (H-9); so an increase in overall satisfaction leads to an increase in intention to use. The results from the research model also demonstrate the relative weight of system quality compared to information quality. Interestingly, decision-

making satisfaction of end-users, the quality of the system is more important than the quality of the information.

As with all regression and structural equation modeling techniques, correlation does not prove the causality of the relation. Since, however, these causal relationships are based on an established literature, and the theoretical grounding of the causality is adequate, it is reasonable to concur with the causality, where it has been validated (Gefen, Straub, & Boudreau, 2000).

MANAGERIAL IMPLICATIONS AND FUTURE RESEARCH

The research results empirically demonstrate the relationships between interface satisfaction, decision-making satisfaction, system quality, information quality, and information presentation. It also demonstrates the relationships among variables such as interface satisfaction, decision-making satisfaction, overall satisfaction, and the intention to use. These relationships are useful in influencing the intention to use among users of choiceboard systems. IS professionals need to understand these relationships to help their firms design choiceboard systems that are effective. This research provides an understanding of those interrelationships.

In the context of choiceboards, the quality of information influences decision-making satisfaction. So, for example, for a choiceboard system that allows users to develop their own holiday itinerary, the research suggests that users would value complete, accurate, and relevant information about holiday sites, weather, local costs, flights, rentals, and hotels. Similarly, users will have better decision-making satisfaction with timely, accurate, and complete information as they develop alternative scenarios for their holidays.

The research suggests that ease of use, convenience of access, and system reliability also influence the decision-making satisfaction of users. A choiceboard, other than just being available and accessible, should also be easy to use. A user should not feel overwhelmed by available choices. The research also suggests that ease of use, convenience of access, and system reliability and flexibility influences interface satisfaction. The quality of the choiceboard system makes an impact if it is user friendly, clear, and understandable. Interface and decision-making satisfaction influences if the choiceboard has been satisfactory in meeting user needs, which effects intention to use. For choiceboard users, it is not only important that the quality of the choiceboard system and the information it provides is adequate, but also that it provides them with interface and decision-making satisfaction. Thus, they will intend to use the choiceboard if they find it useful and it meets their needs. This research shows that choiceboard users are deriving satisfaction with the system in a more complex fashion. If the choiceboard provides them interface as well as decision-making satisfaction, such that there is overall satisfaction, only then will they be a repeat user.

The empirical data suggest that the presentation of information is not important to the user in decision making. The users are not particularly impressed by color, graphics, and presentation style, but are more interested in the pertinent information being provided to them via the system. This is an interesting result because in the recent past, there has been an increase in color and graphics on Web sites, but this presentation is of limited use if these Web sites are not able to provide the desired quality of information.

This research has examined the perceptions of users relative to their intention to use, and how that perception is affected by overall satisfaction, which, in turn, depends on decision-making satisfaction and interface satisfaction. Much of the model has been validated by the data. Even the hypotheses that were not validated provided interesting insights. Studies should be conducted using other Web-based systems to test if the results of the present study can be extended to

other situations. Qualitative studies can also be conducted to study choiceboard systems. These studies have the possibility of providing insight about choiceboard system users. These studies will help build a wider body of research, which is needed for designing effective choiceboard systems.

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Chapter VI

Fit Between Strategy and IS Specialization:
A Framework for Effective Choice and Customization of Information System Application Modules

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ABSTRACT

As organizations implement enterprise systems, the issues of whether to "build or buy" new IT modules, and if buying, how much to customize, continue to be key concerns. In this chapter, we develop a framework in order to better understand effective information system module choice and customization from a strategy perspective. Analysis of the strategic importance of the IS module can provide general guidance for the amount of specialization that is appropriate. To illustrate these ideas we apply them to four case examples.

INTRODUCTION

Over the past decade, there has been great interest in integrating organizations' information resources across their multiple business functions. This integration should provide better support for business processes, more efficient resource utilization (Emery, 1975; Gustin & Daugherty,

Table 1. Module categories

Module Category	Description
ES Module	- part of suite of integrated modules provided by a single ES vendor - generic - uses ES vendor's integration layer
Best-of-Breed Module -	provided by one of many module vendors - some specialization (e.g. towards industry) - requires separate integration layer and integration effort
Custom Module	- module developed for a specific organization

1995), and it should open new business opportunities (Rockart & Short, 1989; Venkatraman & Kambil, 1991). While there has been a general question about the business value of IT in the past and the so called productivity paradox (Brynjolfsson & Hitt, 1996; Brynjolfsson & Yang, 1997), more recent publications on this issue, however, provide evidence that IT can provide business value, and rather focus on how firms can apply IT to generate business value (Melville, Kraemer, & Gurbaxani, 2004). This chapter addresses an important aspect of how business value can be achieved in the context of the integration of packaged information systems.

To accomplish this type of integration, an organization has three general options. It could build its own custom information system solution to exactly meet its needs. It could purchase a collection of packaged information systems (each from a different vendor) that it would then integrate using middleware (a best-of-breed approach). Finally, it could implement an enterprise system (ES), (also known as an enterprise resource planning or ERP system[1]). An ES is a collection of packaged business software modules from a single vendor that offers "best practice" business processes, a common underlying database, and tight integration across all business functions (Davenport, 2000). By choosing among these three options and by deciding how much additional customization to apply, a firm will, in effect, make a decision about how "specialized" its IS modules

will be. By "specialized" we mean how unique to a particular business context.

In this chapter, we assume a strategic perspective and focus on the problem of deciding how specialized an information system (IS) module *should* be in the context of ES implementations. We argue that from a strategic point of view, the degree of specialization has two related consequences. First, we make a case that specialization is usually necessary if a firm hopes to leverage information systems for continued competitive advantage, since unspecialized modules can be obtained by competitors with relative ease. Second, specialized modules are more likely to exactly meet business requirements, thus improving business efficiency and/or effectiveness. These two consequences are related since competitive advantage often comes from having unique and valuable business processes which are supported by effective IS modules.

However, a problem arises because specialization does not come for free; in fact it can be quite expensive (Gill, 1999; Stedman, 1998). Excessive customization, as one form of specialization, has been associated with a number of failed ES implementations (Levin, Mateyaschuk, & Stein, 1998; Stedman, 2000), while other reports blame a lack of fit with the specific business requirements of the firm (Gattiker & Goodhue, 2002; Harris, 2000) as an obstacle to ES success. Thus, finding the right balance of specialization is critical, yet difficult to achieve.

"Perfect fit" with business requirements may not coincide with the optimum of specialization, as costs increase proportionally with increasing specialization efforts, but the margin of gained benefits eventually become increasingly smaller as the "perfect fit" is approached. Over-specialization, beyond this optimum, does not yield sufficient benefits to offset the costs, and can reduce a firm's bottom line. However, identifying a precise optimum in practice is difficult, as a variety of factors and stakeholders influence actual decisions to choose or customize IS modules.

Therefore, we take a strategic perspective and use the notion of strategic importance as an approximate but easier-to-use approach to determining the best amount of specialization by considering the impact of specialization on competitive advantage to the firm, using ideas from the resource-based view of the firm (Barney, 1991). From a strategic alignment perspective, it is important to create a "strategic fit" between the IT infrastructure and an organization's business and IT strategy to achieve business value (Henderson & Venkatraman, 1993). This leads us to a four-quadrant guide to IS module specialization. In order to assist the reader in understanding the value of this four-quadrant guide, we report evidence from four case studies that populate the four quadrants. The four-quadrant guide is useful for understanding and evaluating customization decisions made by the organization.

ESSENTIAL ELEMENTS OF A CONCEPTUAL FRAMEWORK

In this section, we briefly define and describe the essential elements of the framework for thinking about the module specialization issue.

The **components** of an organizational information system can be examined at different levels of granularity (Hopkins, 2000). The term "component" is still widely discussed and not yet formalized, even among researchers in the

field of component-based systems development (Crnkovic, Hnich, Jonsson, & Kiziltan, 2002). At its very essence, a component is a unit of composition. However, research on component-based systems development often takes on a very specific notion of what a component is, and tends to examine components at the level of objects, clusters of objects, or services (i.e., XML Web services). In our more inclusive view, an entire application or application module can also be considered an IS component. Since this study focuses on ES, we deemed it suitable and practical to examine IS components at the relatively coarse level of ES modules (e.g., SAP R/3's SD module for sales and distribution). Therefore, we use the term "module" throughout this chapter. Each best-of-breed application package can also be thought of as a module of an organizational IS, as can each custom developed application in an organization's IS portfolio. In keeping with this level of granularity, three broad **categories of IS modules** are distinguished in this framework (see Table 1): *enterprise system* (ES) modules, *best-of-breed*[2] modules, and custom built modules.

Specialization is the degree to which a system component is designed to exactly address the business needs of a particular organization. The overall degree of module specialization is dependent on a combination of two factors: *module choice,* and the degree of module *customization*. For instance, a best-of-breed module may already posses very specialized functionality geared towards firms in a certain industry without any customization. This module would be considered more specialized than a generic ES module. An organization may then decide to customize a chosen module and further increase its degree of specialization.

Module choice is simply the choice of which category of module (ES, best-of-breed, or custom) is chosen for a given business function, and which particular vendor (for ES and best-of-breed). ES modules are arguably the most generic modules, whereas best-of-breed modules tend to be more narrowly targeted towards a specific type of

organization, industry, or region, and are less comprehensive (e.g., they support only a specific business functionality, such as demand forecasting). A best-of-breed package is usually not at the center of the IT portfolio of an organizational IS (at least for larger organizations), and is typically integrated with other modules from other vendors using an independent third-party integration layer. ES, on the other hand, tend to play a central role in an organizational IS, and come with an often-proprietary integration layer provided by the ES vendor.[3] Custom developments are typically the most specialized solutions, as far as their initial development is concerned.

Customization is the modification of a best-of-breed or ES module, with the goal of providing a better match with existing or desired organizational processes and data. We assume that custom-built modules do not need customization, since they are designed to meet a particular organization's specific needs. ES or best-of-breed modules can be customized in two general ways. First, these modules are usually sold with mechanisms and tools to support some amount of modification of the standard "out-of-the-box" solution at relatively low cost by simply setting software switches or modifying tables that determine workflows. Vendors typically call this type of customiza-tion "configuration." Configuration only allows changes within certain boundaries limited by what the vendor has decided to include in the software. Some configuration is always required (Brehm et al., 2001), but it can vary substantially from one organization to the next. When these types of changes are judged insufficient, companies can engage in usually more expensive types of customization involving modifications, such as changes to the source code of programs or reserved tables. Note that in this chapter, we use the term customization to incorporate all means of closing these process gaps, including configuration and modifications.

Figure 1 demonstrates that as more customiza-tion is done to an ES or best-of-breed module, the module achieves a higher degree of specialization, or fit to the organization's specific needs. Taken to the extreme, a heavily customized ES solution may end up being almost as specialized as a custom-developed information system solution, as shown on the right of the figure. The issue of how heavily to customize ES is reflected in various articles in the trade press. Levin et al. (1998), for instance, point out that making too many changes is a source of problems, and that the choice to make minimal changes was one of the most important decisions made by an organization implementing the ES.

Figure 1. Approaches to attaining specialization
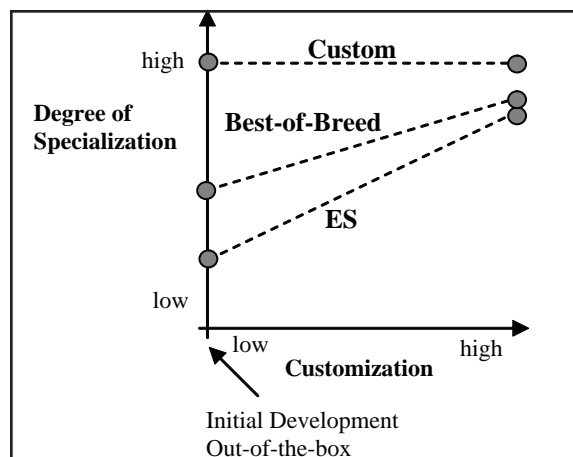
THE RELATIONSHIP BETWEEN MODULE SPECIALIZATION AND BUSINESS PROCESS REQUIREMENTS

As Figure 1 shows, the ultimate specialization of a module is a function of both the choice of category of the module (custom, best-of-breed, ES) and the amount of customization done (in the case of best-of-breed or ES). Stated differently, once a choice of best-of-breed or ES has been made (i.e. not a custom system), customization is a way to handle the problem of remaining mismatches between the organization's business processes and the process options provided by the ES or best-of-breed vendor. ES or best-of-breed modules employ business process and data definitions that often do not quite match the organization's needs. To close the gap, system modules must be customized or alternatively, the organizational processes must be altered to fit the system.

The organizational fit of an ES is an important factor for a successful implementation (Hong & Kim, 2002). To give an example, carpet is generally sold by the linear foot, and it is understood that a given purchase will be a continuous piece of carpet. Even though there may be 40 linear feet of a product in stock, an order for 30 linear feet cannot be filled if the inventory is in two rolls of 20 feet each. This means that a carpet inventory system must not only keep track of how many total linear feet of a particular product are in stock, but also the linear feet on each roll of each product. This is a business need that is not handled well by most ES systems. Therefore, a carpet business purchasing a new ES for its inventory function may choose to customize the ES so it will handle inventory in this way.

Importantly, all customization involves at least some **extra costs**. These fall into three general categories. The first is the development costs of planning and making the changes, and assuring that the changes are correct. For simple configuration changes within the bounds set by the ES vendor, these costs are relatively minor, but costs go up as more invasive modifications are performed. The second category is the cost of integrating the specialized module with other modules. The third is maintaining the customized module over time, including often being forced to redo customizations as later releases of the ES or best-of-breed software become available.

The **benefits of specialization** to the organization (either from custom IS module, or customized ES or best-of-breed modules) can include a reduction in process costs, better customer service, and better decisions based on more complete or more relevant knowledge (Schoemaker & Amit, 1994). Again using the example of the carpet inventory business, since customer demands for continuous pieces of carpet are relatively inflexible, a carpet company choosing to install an uncustomized ES will probably have to change its business process so that it can function without inventory tracking at the roll level on the ES. This would probably mean instituting some additional paper- or computer-based workarounds. Using these would likely slow the process of inventory checking, and introduce greater possibility of error. This would make the ES-supported business process more costly than an ideal process that could track inventory at the roll level without cumbersome workarounds. In addition, some of the information contained in the workaround systems might not be visible to the ES, creating blind spots in reporting that could degrade decision making or customer service. Thus, the benefits of specialization, in this case, would be lower inventory management and order handling costs and better informed decisions. While it is difficult to quantify these benefits, particularly the less immediate benefits, the literature provides some approaches to estimate these benefits (e.g., Taudes et al., 2000).

MODULE SPECIALIZATION AND STRATEGIC IMPORTANCE

An assessment of the strategic value of an IS module can give us some further insight into the appropriate amount of specialization, and lead to a less precise but more easily used guide. In capsule form, we suggest organizations should invest in specialization for IS modules that are strategically important. But it is also important not to overestimate the strategic value of IT (Carr, 2003). Firms need to focus spending on IT on areas that can indeed serve as a catalyst for strategic differentiation (Brown & Hagel, 2003). In this section, we develop the definition of the strategic importance of an IS module in more detail.

Uncustomized ES or best-of-breed modules. First, the resource-based view of the firm (RBV) tells us that to have sustained competitive advantage, a firm must have resources that must be *valuable*, *rare,* and *difficult to imitate* (Barney, 1991). A competitive advantage cannot be derived solely from a noncustomized, "out-of-the-box" packaged ES solution, as this solution is not going to be rare or difficult to imitate, since competitors can purchase the same package. This suggests that generic ES modules may be necessary to level the playing field if competitors have implemented them, or they may be advantageous when they operate as a utility (i.e. provide a good low-cost solution for everyone), but they won't generally be a source of sustained competitive advantage.

However, there are two ways that an uncustomized ES might contribute to a more sustainable competitive advantage. First, suppose the ES is part of a synergistic bundle of resources that provide competitive advantage, and at least one of the other resources is rare and very difficult for competitors to imitate. In this case, the ES may be critical for sustained competitive advantage, even though it is not itself difficult to imitate. Secondly, as it turns out, one possible rare and difficult to imitate asset that is synergistic with the ES asset might be the ability to successfully implement an ES, since they are notoriously difficult to implement (Deutsch, 1998; Wilder & Davis, 1998; Zeitz, 1996). Thus, if one firm could implement the ES and quickly make it effective, and another firm had great difficulty making an ES effective, the first firm might have competitive advantage over the second for some time.

Customized modules. The above discussion applies to an unspecialized IS module. Let us now consider the situation for a specialized IS module, either a custom system or a customized ES or best-of-breed. Such a system could very well provide competitive advantage that is difficult to imitate.

But now we are faced with the question "How much to customize"? Below, we will argue that the "strategic importance" of an IS module can be used as a guide in this question. What is meant by the strategic importance of an IS module? For an IS module to be strategic, (a) the business function to which it relates must be strategically important, and (b) the information system module must play an important role in that business function.

It may be possible to form a rough intuitive sense of a function's strategic importance, but more precise definitions are available. Schoemaker and Amit (1994) suggest that a firm's "strategic assets" are capabilities that, (a) explain a large part of the performance differences between firms in the industry, and (b) have been consciously developed by the firm, and (c) are relatively difficult to purchase or imitate. In other words, if the firm is conscious of the fact that capabilities related to a business function are strategically valuable, rare, and inimitable, then that business function is strategically important.

The role of information systems in supporting a business function is also an important question. A business function may have high-strategic importance without having a high involvement of IS. For example, a highly skilled and synergistic product design team may not use much IS in their design efforts. In this case, the strategic importance of the IS module would be low, even

Figure 2. Strategy/specialization matrix
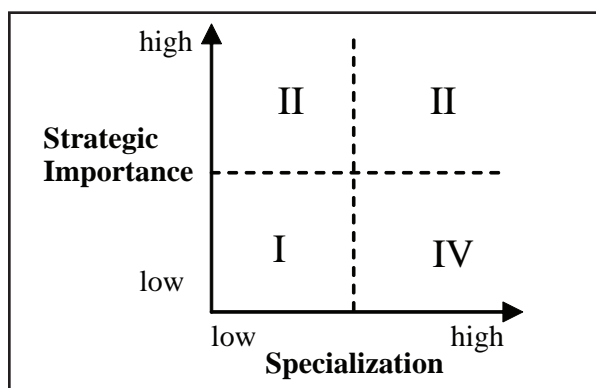
though the business function's strategic importance is high.

If an IS module is strategically important, any mismatches between the firm's desired business processes and those supported by the uncustomized ES would have a large negative impact. Therefore, knowing the strategic importance of the IS module gives a quick-if rough-guide to the appropriate amount of customization. While this assessment provides guidance of how much an IS module *should be* specialized from a strategy perspective, other factors can influence the actual specialization. One example are industry specific regulations: If existing or new regulations are required for firms in a certain industry (i.e., BASEL II in the financial industry) and the ES vendor has not yet addressed this issue, a firm may be forced to customize their ES solution, although this specialization does not provide any strategic benefit. The organizational environment (i.e., potential resistance to change) as well as project management (i.e., choice of consultants) may also contribute to decisions to perform ES module customizations. We, however, argue that any specialization activity that is not congruent with overall IT and business strategy needs to be carefully assessed and questioned. While some incongruent customization may be unavoidable in the short term (as in the case of new mandatory regulations), organizations should be developing a longer-term solution that realigns with the overall strategic direction (i.e., urging an ES vendor to incorporate new regulations in their standard solution).

What we are articulating is the importance of the fit between the strategic importance of the IS module and the amount of specialization. The previous discussion suggests that for best outcomes in terms of the benefit-cost ratio, an organization should make sure the specialization of its IT modules fits[4] or matches their strategic importance. This can be seen in the diagram in Figure 2, which shows four quadrants of *strategic importance – specialization fit.* The model suggests that the best outcomes would come from quadrants I (low strategic importance and low specialization) and II (high strategic importance and high specialization.) Poorer outcomes would come from quadrants III (high strategic importance and low specialization) and IV (low strategic importance and high specialization).

METHODOLOGY

Based on the findings from an initial study examining success factors of ES implementations, we identified the issue of IS module specialization, including ES module customization, and its link to strategic importance as an important aspect

of ES implementations. Given the sparseness of existing literature on this particular issue, we engaged in an exploratory case study focusing on the link between IS module specialization and strategic importance, with the desire to gain a richer understanding of this current and relevant phenomenon. For a study of this nature, the case research strategy is an appropriate approach (Benbasat, Goldstein, & Mead, 1987; Yin, 1994). This study employs a multiple case-study design. The multiple case-study design provides the opportunity to contrast customization activities between organizations, but also helps discovering common themes that transcend an individual case. Furthermore, a cross-case analyses forces the investigator to look beyond initial impressions made in one case and see evidence through multiple perspectives (Eisenhardt, 1989).

Case and Participant Selection

The four cases are drawn from two different studies. The first of these was broadly targeted at examining the factors that contribute to ES success, and included interviews with 22 CIOs, and project managers from 11 different organizations in the United States and Europe. Following this, four more in-depth case studies were conducted to focus more narrowly on the issue of customization. The participating organizations for the four cases were selected based on their availability, and on fulfilling a checklist of basic criteria. All organizations were using an ES as a core module of the overall IT portfolio, and had several months (>4) of experience with an operational ES module. In all of the cases, individuals participated in semistructured interviews. These individuals represented the IT leadership (CIO or director), ES project manager, ES project team members, and key users of the ES. In all cases, at least one interviewee, usually the CIO or ES project manager, was able to provide an overview of ES project, including its technical realization and strategic goals. In all cases, at least one in-

dividual was a high-level manager, such as VP, CFO, or CIO, with insights into the organization's competitive strategy.

Case Analysis

The basis for the analysis were interview transcripts and additional documentation provided by the participants (i.e., project plans). For each case, a detailed summary was created, which was returned to the participants for review. The participants had the opportunity to make corrections, clarify, or add relevant details. We used these summaries to determine the strategic importance for the IS modules for each case, and to make an assessment of the level of customization. We then chose four examples of modules representing each of the four quadrants of the strategy/specialization matrix (see Figure 2) to exemplify the strategic fit and the impacts of the choice.

CASE EVIDENCE

The strategy/specialization matrix is illustrated using examples from four case studies that have surfaced in our work on ERP implementations. Together, the system modules of these four firms populate all four of the quadrants in the strategy/specialization matrix of Figure 2. It is important to keep in mind that the unit of analysis is the IS module. System modules are placed into a quadrant, but an organization will have multiple modules, each of which could fall into any of the four cells in the matrix. For each quadrant, we chose a case and a specific module that exemplifies key characteristics and implications of IS modules in this quadrant.

Quadrant I: Low Importance, Low Customization

FastRestaurantCo (FRC) is a nationwide restaurant chain with revenues of approximately $1 billion

and about 1,000 restaurant locations. Individual restaurants, including their IT infrastructure, are essentially identical. The restaurants cannot operate without accounting and logistical support from headquarters. FRC distinguishes itself from other chains by the relationship structure between corporate headquarters and its restaurants, as well as a prominent and successful marketing campaign.

The CIO made an explicit decision that FRC is a "package shop" rather than a "custom shop," and is willing to change organizational processes if it helps to keep customization efforts and overall IT costs at a minimum. The move to an ES solution was prompted by the strong growth of the company, and the inability of the older legacy applications to scale to the new information processing demands. Especially accounting was pushing for a new system that could better meet the needs, but top management was also hoping that a packaged ES system could help to contain IT costs. In 1994 FRC implemented an accounting and a logistics module from Oracle's ES suite, and planned to add a human resources module in the future. The implementation was viewed as successful after some minor initial glitches. The initial problems were mainly attributed to insufficient testing and were solved within the first two months of operation, with little impact on the business.

FRC's management does not believe that competitive advantage is created in these areas covered by the ES system, particularly in corporate accounting. The CIO stated in an interview, "There cannot be much value added to writing a check, it can only be done more cost-effectively." As a result, very little customization was applied to the accounting module. The only area in which some customizations were applied was restaurant accounting. Here, some specific functionality needed to process accounting information between corporate headquarters and the individual restaurants led to some customization. According to statements made by the interviewees, the rela-

tionship of corporate management to restaurants and their owners is different from that of peers in the industry, which is viewed as one important strategic differentiator. However, FRC's corporate accounting-related business processes were not viewed as strategically important, and not particularly distinctive from other organizations in the industry.

Since very little customization was done, FRC's accounting ES modules fall into quadrant I. The main benefits were reduced IT costs, largely through significant reduction of data entry, and process improvements through "best practices" provided through the ES in the area of account consolidations. This, in turn, provided more time for accountants to focus their efforts on advising the stores on financial issues. In addition, potential future costs for adaptations to software upgrades for the ES were avoided. This is a "plain vanilla" case, where a generic solution is used because benefits from customization would not justify any significant specialization costs.

Quadrant II: High Importance, High Customization

LightCo is a manufacturer of lighting equipment with annual sales of about $1 billion. LightCo's products are largely commodity items, and approximately 65% of the production is made–to-stock, not to order. The interviewees indicated that LightCo's management does not view manufacturing as strategically important; however, its distribution capabilities are seen as a key differentiator. The commercial lighting business is largely a commodity business, and products are fairly standard and require relatively simple manufacturing processes. LightCo differentiates itself by being able to provide a very broad range of products with very short delivery lead times in order to accommodate the unpredictable schedules of construction projects. LightCo strives to be able to deliver exactly what was ordered to the right construction site at exactly the desired time. In

other words, LightCo differentiates itself from its competitors through better logistics, and particularly distribution capabilities not manufacturing capabilities. As one manager stated, "Anybody can bend a piece of metal and put a fixture in it." The IT director explicitly stated that sales and distribution are the areas where LightCo adds competitive advantage and therefore, information systems should be built to meet its specific requirements. On the other hand, finance and manufacturing provide a cost advantage only and consequently, generic systems should be purchased.

Thus, LightCo's management decided to implement an Oracle ES solution in the areas of finance and manufacturing, but to utilize a specialized solution in logistics. LightCo decided to continue using and further developing its own homegrown and highly specialized logistics system. Given their strategic importance, any departures from existing distinctive and successful processes could have a serious impact on the business. Only a highly customized version of the ES package would have allowed LightCo to use its process without jeopardizing its uniqueness. According to LightCo's assessment, this would have been more expensive than continuing to gradually improve their existing logistics system. Even if LightCo could convince an ES vendor to incorporate some of its unique processes into the standard ES package, this would potentially weaken their competitive position, since it would make these processes available to competitors.

LightCo's logistics IT module clearly falls in Quadrant 3, having high-strategic importance and high specialization. The implementation of the generic ES solution in the area of finance and manufacturing was viewed by the interviewees overall as a success. It led to better accuracy and visibility of information which helped to improve bidding processes and grading suppliers, along with cost savings from retiring a number of aging mainframe legacy applications. The in-house developed unique logistics and distribution system continues to be an integral part of its sales agents'

ability to secure orders and guarantee timely delivery to its customers.

Quadrant III: High Importance, Low Customization

Forest Products Corporation (FPC) manufactures construction materials such as joists, beams, plywood, and engineered lumber (Gattiker & Goodhue, 2000), with revenues of approximately $1 billion. FPC has an interesting history related to ES, as it launched two attempts at implementing SAP (R/3) in all 20 of its plants. The first attempt in 1995 was halted due to excessive customization, resulting in depleting the planned implementation budget after only 4 out of the 20 plants were implemented. Due to this negative experience, FPC decided in the second attempt in 1998 to avoid any customization and implement a "plain vanilla" ES.

About 3 years after the initial attempt began, a second ES initiative was started. The second attempt was launched after SAP released an improved version of the ES that addressed many needs of companies in this industry, including FPC. At the recommendation of a new set of consultants, an expedited implementation methodology (ASAP by SAP) was used, and plants were not allowed to modify the SAP R/3 modules. While the ES has led to many improvements, including reduced data entry costs and better customer service, the handling of nonstandard products was still not supported well by this solution. This caused major problems for one particular plant where the nonstandard products account for more than 20% of the total product volume, and thus have a significant business impact.

The rigorous limitation of customization worked well for other areas of the business where strategic importance was low, and business processes were adjusted to meet the systems processes. However, for a few plants whose manufacturing processes were unique and differed from those embedded in the ES, the new system

created performance problems. As customizations were prohibited, expensive manual workarounds needed to be established to compensate for the shortcomings. Here some customization could have resulted in substantial benefits. This led to a situation where an ES module with significant business impact—albeit only for this plant—was not customized. This provides an example of a module that is strategically important, but exhibits only low customization (Quadrant III). While overall customization costs were low, the opportunity for potentially important benefits from better specialization was ignored. As indicated by the interviewees, it is likely that in this case, the process gains would have outweighed the costs of customization.

Quadrant IV: Low Strategic Importance, High Customization

PumpCo is a European-based pump manufacturer. Its North American subsidiary has revenues of approximately $100 million. A key strategic differentiator for PumpCo is its flexibility in manufacturing. PumpCo has the ability to manufacture its products in any of its locations around the world, allowing it to dynamically choose the best location for fulfilling a customer order.

PumpCo implemented an SAP R/3 system at two plants: one in the United States and another in Canada. This implementation included general ledger, accounts payable, accounts receivable, inventory, purchasing, and manufacturing modules. This new plant-level ES had to be integrated with an existing global production and ordering system. The systems went live in early 1999.

Considerable time and effort was put into customizations, and the system ended up being highly customized overall. Many costly and arguably unnecessary customizations were made in the financial module, which is of low-strategic importance, as accounting and finance are not viewed as strategic differentiators. As the project manager stated, "What we ended up doing, is

taking what we already had and implementing it in SAP." As there were no clear guidelines on how to approach customization, PumpCo did not differentiate between strategically important and less important modules in deciding how much to customize. Customizations were usually granted whenever an end user demanded it. As a consequence, customization costs accumulated, and the entire implementation cost about twice the amount initially planned for the project. The implementation was considered only moderately successful by the interviewees, and faced major problems during implementation and the first few months of operation, with detrimental impact for the business. Substantial fixes to the ES were necessary to make the system work.

Despite these negative outcomes, however, some important benefits were realized in the end: better drill-down capabilities and more standardized reporting led to the identification of factors causing ongoing losses in the United States market for the past couple of years. Encouraged by these benefits and despite the initial difficulties, the global headquarters of PumpCo in Europe decided to implement an SAP system at the global level, and replace the existing global production and ordering system. The North American experience was viewed as a learning experience, and provided important input into how to improve project management and the approach to customization for the global implementation.

From a strategic perspective, the financial modules at PumpCo fall into quadrant IV. Modules in this quadrant are characterized by having extensive customization, even though the strategic importance is low. Process gains are marginal, but the costs of customization are significant. Therefore, customization costs outweigh the process gains. In this case, time and resources that could have been directed towards more important modules or project management were directed at customizations with questionable business value. This, in turn, may have made an important difference in the outcome of the proj-

ect, as the interviewees attributed the problems and the only moderate success of this project, to a great extent, to project management mistakes and customization recommendations by a key consultant.

IMPLICATIONS

The case examples of PumpCo and Forest Products Corporation illustrate some of the negative consequences that can occur when the specialization of IS modules is not based on strategic considerations (modules in quadrants III and IV). Conversely, the ES implementations at FastRestauarantCo and LightCo, where strategic considerations played a key role, encountered substantially fewer problems. Overall, both FRC and LightCo have a good fit between the strategic importance of their IS modules and their degree of specialization, as they fall into the two recommended quadrants I and II. The analysis suggests that IS planners should take into account the following steps in deciding how much customization to undertake.

1. Determine the strategic importance of each relevant IS module. For low-importance modules, be very skeptical of claims that a distinctive process is of high value. The presumption should be that these IS modules can likely be provided by an ES or best-of-breed with little or no customization.
2. For IS modules with high-strategic importance, consider each increment of customization independently. Be careful not to do away with important distinctive processes or capabilities by customizing too little.
3. Consider trends in the evolution of the standard solutions and the costs of customizing. For IS modules of low-strategic importance, new versions of standard systems may rapidly remove the need to customize. For IS modules of high-strategic importance,

advances in the standard systems may require rapid action to maintain an edge over competitors who might buy those standard systems.

While specialization is resource intensive and costly from an IS perspective, a lack of it can be costly from a business process point of view. Also, viewing customization as an "all-or-nothing" issue for the organization will most likely result in an ineffective overall solution. Instead, we suggest considering the situation for each IS module separately, with special attention to the strategic importance of each module.

LIMITATIONS

It is important to keep in mind that the success of an ES implementation does not only hinge on how the issue of specialization is handled. Even if from a strategic perspective an appropriate approach is taken, the success of the implementation can be jeopardized by other factors (Hong & Kim, 2002; Somers & Nelson, 2001), such as misguided project management. A variety of other factors can influence the actual choices and customization activities, despite having a strategic plan. This chapter is a case study that only reflects the experiences observed in these particular cases. Future research has to validate our exploratory findings, and establish to which extent they can be generalized.

CONCLUSION

Finding the right balance of specialization for IS modules is a difficult task, as it is difficult to formalize and measure what the optimal degree of specialization is. However, linking IS module specialization with its strategic importance appears to be one way of addressing this issue. This chapter provides an explanation of why strategic

importance is a reasonable criterion for guiding specialization efforts, and how it should be applied. The chapter also illustrates the relevance of the issue, and provides some evidence that ES projects can be unsuccessful if organizations do not find the balance between cost and benefits of specialization for each module individually.

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ENDNOTES

[1]   ES are often referred to as enterprise resource planning (ERP) systems. The term ERP may appear to be used very frequently. It, however, can be misleading, particularly the word "planning." ERP alludes to a certain limited range of functionality (extending MRP/MRP II systems), and does not represent the history and key characteristics of this type of IS appropriately. Davenport (Davenport, 2000) and other researchers, therefore, prefer the term enterprise system. Further indication, that "enterprise systems" may in fact be a more suitable term, is that the Americas Conference on Information Systems (AMCIS) track "Enterprise Resource Planning" was recently renamed into "Enterprise Systems" for similar reasons.

[2]   Best-of-breed components are "packaged" components (i.e., application modules) pro-

vided by a third-party vendor. These usually require additional integration efforts that are the responsibility of the implementing organization, not the ES vendor.

[3] This is even true for PeopleSoft applications that use, for instance, the BEA Tuxedo transaction processing monitor as their integration layer. While the integration layer is developed by a different vendor, PeopleSoft provides it—and tunes it—as part of the application package.

[4] The concept of fit has been used to explain organizational and, more specifically, information system performance by many authors (e.g., Huizing, Koster, & Bouman, 1997, Tavakolian, 1989, and Zigurs & Buckland, 1998).

Chapter VII
The Progression of Client–Vendor Relationships in Offshored Applications Development

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ABSTRACT

This chapter presents an evolutionary framework for the establishment and progression of client-vendor relationships in the context of offshored applications development. It is argued that such a relationship typically begins as a cost-reduction exercise, with the client contracting out simple, structured applications to one or more offshore vendors. Over time, the client assigns increasingly complex applications to selected vendors, and cultivates loose, trust-based, network-like relationships with them. As offshored applications continue to evolve and become business-critical, the client may seek to regain control by establishing a command-based hierarchy. This may be achieved through part- or full-ownership of a vendor organization, or by starting a captive offshore subsidiary. Thus, the initial client objective of cost reduction is ultimately displaced by one pertaining to risk control. Pertinent prior research is used to justify the proposed framework. This is followed by a case study that describes how a specialty telecommunications company is pursuing just such an evolutionary path.

INTRODUCTION

Strategic-level managers, such as CEOs, CIOs, and CTOs, have lately been under great pressure to seek out fresh approaches to control infor- mation technology (IT) costs and demonstrate higher returns on technology investments. A recent International Data Corporation (IDC) study on vertical market IT spending concluded that end users worldwide spent $1.16 trillion on

information technology in 2006, and estimated this figure to grow to $1.48 trillion by 2010 (Lu, Koch, Folco, Dillon, Maceska, & Gibin, 2007). Of this projected statistic, software and services were expected to cost about 62% (more than $900 million), the remainder attributed to hardware costs. One increasingly popular response from decision makers to the high costs of IT has been offshoring; the shift of development, maintenance, operations, or call center work to low-wage offshore locations.

This chapter focuses specifically on offshored applications development, and how its attributes shape the evolution of relationships between clients and vendors. Many organizations have recently intensified efforts to offshore their development work, citing growth strategy, speed to market, and productivity as major reasons, using captive/subsidiary units, independent offshore providers, or hybrid approaches as common business models (The Software & Information Industry Association, 2006). Assertions in the practitioner literature regarding the relative merits and demerits of these models are often mutually contradictory. Academic research has provided some valuable lessons on the management of IT outsourcing, with advocates of various approaches employing transaction cost economics, resource dependency, strategic choice, stakeholder theory, organizational learning, and institutional theory to propound their arguments and test their assertions (Barringer & Harrison, 2000). However, these management prescriptions have been neither formulated nor tested in the specific context of offshored applications development. The implicit assumption underlying this omission appears to be that valid arguments for the general IT outsourcing/offshoring context must also apply to applications development, regardless of task attributes. Most theories also embody static views of client-vendor relationships. They advocate either partnerships/alliances, a network-oriented, trust-based perspective (e.g., Oza, Hall, Rainer, & Grey, 2006; Willcocks & Choi, 1995), contracts

and transactions, a market-oriented, enforcement-based perspective (e.g., Barthélemy & Quélin, 2006; Richmond & Seidmann, 1993), or a mix of both (e.g., Koh, Ang, & Straub, 2004; Sabherwal, 1999). The inherent problem with static perspectives is that they do not acknowledge the potential need for relationships to change and evolve flexibly in dynamic business environments (Tan & Sia, 2006). Some studies that have explored the evolutionary nature of outsourcing have nonetheless confined themselves to specific, narrow aspects of relationships such as duration (Goo, Kishore, Nam, Rao, & Song, 2007), discontinuation (Whitten & Leidner, 2006), and the growth of social relationships within projects (Cata & Raghavan, 2006). A maturity model delineating the likely stages of growth for client-vendor relationships has been proposed elsewhere (Gottschalk & Solli-Sæther, 2006). However, its exclusive focus on fulfilled objectives in each stage as pivotal end points for an opportunity-centric transition to the next stage precludes a deeper discussion that needs to address imperatives, including potential risks of opting not to undertake each such transition.

This chapter contends that for offshored applications development, the ostensible choices of management approaches represent not only progressive but also imperative stages for the client in the evolution of its relationships with one or more vendors. The process by which clients and vendors coordinate with each other changes dynamically, depending on shared experiences, organizational learning achieved, mutually adjusted expectations, shifting needs, and, significantly, impediments in continuing with past relationship modes. While several alternative evolutionary paths for this relationship may be feasible, each with its own set of antecedents, process dynamics, and consequences, the discussion here makes the case for one likely path. In this path, a given client organization successively evolves through specific offshoring stages, not all necessarily with the same application development vendor.

Specifically, a client's experimentation with offshoring begins with reduced development costs as the desired goal. Over time, interplay between the intrinsic task characteristics of application development and the unique attributes of offshoring broaden and evolve the client's goals. The risks and compulsions associated with these evolving goals inexorably alter the nature of the client-vendor relationship in distinct stages. The rationale for this path is supported with logical argument, evidence from the published literature, and an original case study for illustration.

STAGES IN OFFSHORED APPLICATIONS DEVELOPMENTS

Like all buyers and suppliers, offshore vendors and clients essentially interact in one of two ways, transactional/market exchanges or relational exchanges. A transactional exchange is usually a short-term contract, characterized by free-market price mechanisms and the need for enforcement. A relational exchange implies a longer-term relationship with ongoing interactions. Relational options include long-term contracts, networks, and hierarchies. Long-term contracts resemble the short-term variety, except that they address many more contingencies and consequences. Networks emphasize interorganizational trust, association, and solidarity. Hierarchies refer to rather rigid structural relationships based on formal authority and command, usually stemming from ownership of one organization by another.

As mentioned earlier, the published literature has focused almost exclusively on contracts and networks as mutually exclusive types of client-vendor relationships in the offshoring/outsourcing context. This chapter will show that applications development offshoring initiatives usually begin as transactional exchanges but end up in the relational realm. The evolutionary path that client-vendor relationships will tend to follow consists of three stages. In the first stage, a client contracts out some application development to an offshore vendor, with the objective of reduced costs. Success at this experimental stage may result in short-term contracts being replaced by fewer, long-term ones. Stage two arrives when the changing nature of tasks, together with the relationship attributes, make it difficult for both client and vendor to continue in a purely contractual vein. The need for closer working ties and greater trust brings about a network-like relationship. With the increasing vendor dependence that this engenders, the importance of the client's original cost-reduction objective is gradually displaced by a strong desire to manage vendor risk. Paradoxically, therefore, the very success of a network-style relationship causes the original success criteria to give way to new ones. This ushers in stage three. In a bid to regain tighter vendor oversight and control, the client seeks to establish a structural hierarchy with the vendor. Doing so may be impractical if there are multiple vendors or if a structural relationship is infeasible for other reasons, so one option in the third stage is for the client to establish a new captive offshore subsidiary.

Stage 1: Contracts

Labor costs constitute the single major source of application development expenses. The abundant availability of qualified software engineers in low wage countries typically drive a client organization's exploratory efforts to seek out an overseas vendor, with the objective of significantly reduced development costs (Matloff, 2004). Preliminary contact with a prospective offshore vendor has the attributes of a highly efficient, classic free-market exchange. Both parties, unconstrained by prior contact experiences or future relationship expectations, are fully focused on negotiating the current transaction, with a view to maximizing their respective short-term utilities. Such an exchange tends to yield the best possible outcomes for both client and vendor, but only in the presence of perfect information, that is, complete knowl-

edge about each other's objectives, strengths, and weaknesses.

All information services markets, however, are beset by the presence of information monopoly or asymmetry (Park, 1996), which is the exact opposite of perfect information or complete knowledge. Geographical, cultural, business, and regulatory differences, inherent to the offshoring context, exacerbate this asymmetry (Ramarapu, Parzinger, & Lado, 1997). The vendor faces a rather limited amount of risk from this asymmetry. Depending on its past experience with other clients, the vendor may or may not possess an understanding of this client's application context or its industry's business processes. The vendor may also have concerns regarding its interactions with the client, or the latter's financial stability. However, the client's lack of familiarity with the vendor's business environment exposes it to many more risks, including shoddy development processes and practices, poor product quality, poor documentation, incomplete or inappropriate solutions, and business process integration issues. The lack of information transparency thus affects the client more severely than the vendor.

The larger and more complex the application, the higher the development risks (Barros, Werner, & Travassos, 2004). To reduce these risks and minimize the impacts of any detrimental outcomes, therefore, the client organization follows a cautious approach in identifying initial work to send offshore. This implies small applications or components of low complexity, for which specifications can be completely communicated, and whose development process is highly structured. Such applications call for little vendor supervision, and no need for a window into the vendor's internal processes. A transaction-oriented, contractual relationship between client and vendor suffices as the control mechanism, thereby, keeping interorganizational coordination costs incurred by the client to a minimum.

Unpleasant experiences with these initial applications can quickly end the client's experi-

mentation with offshored development. On the other hand, successful initiatives not only result in reduced costs, but also heighten the client's awareness of offshoring's potential to sustain or even raise software quality (Khan & Fitzgerald, 2004). This emboldens the client to outsource more applications to the same vendor or even to new vendors (Benamati & Rajkumar, 2002). Heightened client awareness, though, is accompanied by the expectation that vendors will put in the effort into acquiring a deeper understanding of its business processes and information needs. In turn, vendors rationalize the extra effort required from these fresh expectations with their own long-term goals of being assigned progressively higher-level work or serving larger markets. Successful outcomes that result from these mutual commitments serve to supplant the client's original objective of reduced costs with the realization that it may be able to reap collaborative synergies with vendors by moving beyond the scope of simple applications into higher-end development (King, 2005). Collaborative efforts on more complex tasks can yield innovative outcomes, including new solutions, new approaches to problems, unique value-added propositions, and ultimately, original sources of competitive advantage for the client (Dyer & Singh, 1998). Accordingly, the client entrusts more-complex applications to selected vendors, with less structure and more room for creativity and innovation. As enhanced complexity necessitates a closer working relationship, the client may "move to the middle" by replacing several short-term contracts with a handful of long-term contracts (Clemons, Reddi, & Row, 1993), essentially substituting transactional interactions with fewer relational mechanisms.

However, long-term contracts increase interorganizational coordination costs by placing greater collaborative and enforcement burdens on the client. They also hinder collaborative innovation because both client and vendor may be reluctant to share valuable, firm-specific resources with unfettered, autonomous, distant partners (Goes

& Park, 1997). Their mutual independence and freedom of action outside the limited terms of the contract, even a long-term one, causes both organizations to continue to be wary of each other's intentions and actions. Thus, beyond the simplest applications, the continued use of purely contractual arrangements is ineffective because contracts merely replace the traditional in-house project risks with a different set of more perilous vendor risks. Despite initial successes, therefore, the probability of eventual failure remains significantly high (Natovich, 2003).

Ongoing offshoring relationships also bring asset specificity, dependence, measurement difficulty, and uncertainty into play. Asset specificity refers to investments by relationship partners in information or physical assets that have little value outside the context of that specific relationship. With higher application complexity, both vendor and client invest ever more time and energy into understanding each other's unique processes, and increasing asset specificity is inevitable. Asset specificity, and the resultant dependence, give rise to opportunism, the tendency of one partner (usually the vendor) to take advantage of the fact that the other partner has invested too much in the relationship to walk away from it (Lonsdale, 2001). The awareness of such an exit barrier for the client may tempt the vendor to exhibit opportunism in the form of cost escalation, unreasonably high charges for services not explicitly mentioned in the contract, assigning inexperienced staff to the project, reduced quality and service levels, or holding the client captive to obsolete or inappropriate technologies.

Measurement difficulty translates into inscrutability of the vendor's work processes. Since both short-term and long-term contracts are much more conducive to the measurement of outcomes rather than processes, the vendor's internal practices remain largely hidden from the client. This may trigger not just opportunism of the kind discussed previously, but also vendor manipulation of internal project management data, to deflect culpability in problem situations. Finally, uncertainty refers to the prospect of unanticipated developments in the technological, business, or political environments, which are of particular concern, given the global nature of offshoring relationships.

Client organizations are aware of these pitfalls. In efforts to preempt problems that might stem from asset specificity, dependence, measurement difficulty, and uncertainty, some attempt to anticipate as many contingencies as possible, and to incorporate them into intricate contracts. However, the preemptive use of contingent contractual clauses is a futile exercise. With consultants and legal experts in tow, such organizations can eventually get to the point where the sheer overheads of administering these contracts make them untenable. Alternatively, the mistrust engendered by minutiae can vitiate their relationships with offshore vendors. The intensification of these dysfunctional dynamics provides a window for network-style relationships to replace contracts.

Stage 2: Networks

As application complexity increases, the efficacy of contractual mechanisms breaks down. The client's success with unstructured, intricate projects is more dependent on the vendor's internal practices and methods than before. This creates the need for better scrutiny of the vendor's processes that contracts alone are unable to provide, given their enforcement-oriented nature. Higher-task complexity necessitates joint coordination and a closer, more cooperative working relationship. Pronounced differences in location, culture, business processes, and regulatory practices stemming from the very nature of offshoring magnify these imperatives. A network-like linkage based on trust, solidarity, shared values, and open communication therefore represents a better option for the client because it engenders procedural coordination, vendor self-enforcement, and reciprocity (collaboration and cooperation). The establishment of such a relationship also tends to

foster product and process innovation (Ritter & Gemunden, 2003).

Interorganizational networks, such as joint ventures, alliances, associations, and consortia, typically consist of three or more organizations. However, a client-vendor dyad with soft interorganizational boundaries can exhibit working interfaces and other properties similar to those of classic networks. The major advantage of network-like relationships over purely contractual mechanisms for offshored development work would be an enhanced facilitation of the codification and communication of technological skills and organizational knowledge (Park, 1996). In particular, underlying, tacit knowledge is more successfully exchanged due to the mutual trust, strong social ties, and shared values/systems in such relationships. This has been confirmed both in the IT domain (Pardo, Cresswell, Thompson, & Zhang, 2006), as well as in general (Dhanaraj, Lyles, Steensma, & Tihanyi, 2004). For IT projects, the process of knowledge integration among collaborating organizations is also facilitated by social relationships and social capital (Bhandar, Pan, & Tan, 2007). The successful codification and transfer of tacit, undocumented knowledge is crucial for more complex applications, as it provides the offshore vendor a better grasp of the client's general business context and unstructured aspects of task requirements. Although such knowledge exchanges increase coordination costs even more (Sobrero & Roberts, 2001), they are accompanied by the joint creation of new knowledge, a higher order benefit (Sharma, 1997). Both tacit knowledge transfer and new knowledge creation are invaluable in the development of more complex applications, and necessary for synergistic innovations to emerge (Hardy, Phillips, & Lawrence, 2003).

Procedural coordination, a key attribute of network-style relationships, enhances the effectiveness of existing contractual client-vendor exchanges when used as a secondary linkage mechanism (Sobrero & Schrader, 1998). The complementary advantages it provides are highly effective, even if the original contractual exchanges were highly customized (Poppo & Zenger, 2002). Studies of IT outsourcing have shown that trust, another critical attribute of networks, is preferred over contracts, particularly when contractual hazards are perceived as high (Barthelemy, 2003). In an empirical study, IT outsourcing projects were found to often begin with simple, outcome-oriented controls in place, but performance problems usually led to the introduction of additional controls oriented towards trust, vendor behavior, and clan-like affiliation (Choudhury & Sabherwal, 2003). Another empirical study, focused on software offshoring by small firms, found that clients attempted to mitigate the high inherent transaction costs of contracts through embedded network ties in the form of mutually trusted individuals or "liaisons of knowledge flows" (Carmel & Nicholson, 2005). The importance of trust in interorganizational collaboration is well documented elsewhere too, both for IT outsourcing (e.g., Jennex & Adelakun, 2003; Lanfield-Smith & Smith, 2003; Sabherwal, 1999; Willcocks & Choi, 1995) and in general (e.g., Vangen & Huxham, 2003; Zaheer, McEvily, & Perrone, 1998).

Stage 3: Hierarchies

The introduction of trust and clan-like affiliation represents a step up from an exclusive reliance on contracts. However, network-style client-vendor relationships, by themselves, or in conjunction with long-term contracts, by no means represent the stable state. The very network attributes that serve to bring the client and vendor together in a closer working relationship, that is, trust, reciprocity, effective knowledge transfer, and vendor self-enforcement, ultimately render it ineffective. Eventually, more authoritative mechanisms are needed, and the appropriate relationship is a command-oriented hierarchy. This may be achieved in one of two ways. The first entails the client

acquiring a formal stake in a vendor organization through part- or full- ownership, that is, vertical integration. In the second approach, the client sets up a captive offshore subsidiary of its own (Preston, 2004).

Neither of these two culminating stages may be feasible for every client organization. Contextual attributes often play large roles in decisions to strengthen or relinquish control of interorganizational activities. For example, a study of IS outsourcing in city governments found that a variety of political, budgetary, and human resource factors, unique to these institutions, influenced their decision-makers to actually increase the amount of contractual outsourcing relative to work undertaken in-house or otherwise controlled tightly, given conditions of asset specificity and uncertainty (Miranda & Kim, 2006). In another instance, a study of interorganizational R&D relationships reported that it would be in the interests of clients that were currently in relational exchanges with vendors to lapse into formal contractual modes, under conditions of increased ambiguity, but without concomitant increases in volatility (Carson, Madhok, & Wu, 2006). Notwithstanding such contingent and contrarian contexts, the following discussion justifies the eventual need for authoritative mechanisms, under more general and typical conditions.

The primary impetus for the transition from Stage 2 to Stage 3 comes from continuing changes to the attributes of offshored applications, to the point where higher complexity will be increasingly accompanied by criticality to the client's business processes (Jensen, 2004). This is but a natural outcome of a close working relationship in which client-vendor synergies are constantly being explored. Business criticality poses enhanced risks, including the loss of core competencies to industry competitors (Hoecht & Trott, 2006). It necessitates greater checks and balances on the vendor than are feasible through the network. Trust and reciprocity alone become insufficient to maintain a healthy relationship, and institu-

tional control mechanisms are needed (Miles & Snow, 1984). The resulting swing towards monitoring and formalization, however, threatens the autonomy of the partner organizations, even as they are highly interdependent (Van de Ven & Walker, 1984). The implementation of new checks, balances, and controls also imposes even higher coordination costs, which destabilize and ultimately break the network (Park, 1996). Thus, networks, like contractual markets in the previous stage, eventually unravel in the face of ever-changing attributes of offshored applications. Key empirical evidence for this comes from a study that found that partner commitment in outsourcing relationships actually declines with the age of the relationship, increasing the chances of conflict (Lee & Kim, 1999).

Trust, a fundamental basis of network-like arrangements, is known to be particularly fleeting in knowledge-sharing relationships. The progression of such relationships is more importantly affected by procedural justice than by trust (Daellenbach & Davenport, 2004), and by structures that propagate goal congruence, particularly in the presence of opportunism (Jap & Anderson, 2003). In a study, opportunism was found to be reduced more by formalizing policy than by encouraging cooperation (Dahlstrom & Nygaard, 1999). Procedural justice, goal congruence, and formalization are all attributes associated more closely with hierarchical relationships than networks.

In a seminal research study, equity-based mechanisms (e.g., part or full ownership of one organization by the other, etc.) were found to benefit partner organizations in a relationship more than non-equity mechanisms (Zollo, Reuer, & Singh, 2002). Likewise, in a study of strategic alliances, equity-based alliances were found to promote greater inter-firm knowledge transfer (Mowery, Oxley, & Silverman, 1996). As has been noted, application development offshoring entails a high degree of knowledge sharing and transfer. A study of vertical partnerships found that linkages that support the extensive integration of the

structures and management of both organizations were more successful from the perspectives of both parties (Donada, 2002). Another study, focusing on asymmetric partnerships in particular, found that effectiveness and competitive advantage were higher when the leader organization utilized authoritative coordination mechanisms (Hernandez-Espallardo & Arcas-Lario, 2003).

In other evidence, transaction cost economics theory (Williamson 1975, 1985) predicts that a preponderance of transactions, in which assets utilized have relatively little value outside of the transaction (high asset specificity), will lead to an integration of assets. The firm that stands the most to lose from a hold-up (i.e., the client) by the other firm will tend to want to acquire the assets of the other. It has also been shown that in an interorganizational relationship where the two firms hold complementary assets, the sum total of these assets lead to synergies or increasing returns to scale, and therefore, there is a natural tendency for integration, or, for both sets of assets to be acquired by one firm (Hart, 1995).

Last, but not least, the introduction of a hierarchy alleviates internal political concerns in the client organization regarding loss of valued in-house technical expertise and skills to offshore vendors. The establishment of a hierarchy brings these skills back into the client's fold and under its control, albeit possibly at arms length. This regained expertise may now be leveraged by the client and sold to other organizations, thus providing an added source of business revenue.

Depicting the Stages as Trade-Offs Between Coordination Costs and Vendor Control

From the client's perspective, a visual explanation for the evolution through the three stages may be provided by mapping each stage on a two-dimensional graph, using coordination costs incurred and vendor control achieved as the perpendicular axes (Figure 1). Most client organizations initiate

offshore applications development in hopes of reduced development costs. Lack of prior experience with offshore vendors leads them to select well-structured applications of low complexity at this exploratory stage. This translates into the need for a simple relationship characterized by low coordination costs and little need to control the vendor's internal processes. Contractual markets best fit these modest circumstances. Repeated small successes may encourage the client to increase the frequency and complexity of offshored work, and pursue longer-term contracts, but markets in general remain the most efficient and effective relationship mechanism. Coordination costs may rise somewhat with the need to enforce various contractual bells and whistles, but the need for monitoring vendor processes remains low, given the outcome-measurement nature of contracts. In the Figure, therefore, Stage 1 (Contracts) is placed in the Low-Low quadrant.

With increasing complexity of knowledge-intensive work entrusted to the vendor, constraints such as asset specificity, asymmetry, measurement difficulty, and opportunism kick in. The client attempts to counter these by exerting greater influence on the vendor, through co-optation and closer working relationships, but with a concomitant rise in coordination costs. The additional resources expended by the client in an attempt to exercise influence, however, do not always translate into successful vendor control. This is because the vendor essentially represents an autonomous organization, despite the new closer working relationship with the client. The fundamental dilemma of a network is that while higher coordination costs are a given, the corresponding control achieved may or may not be greater, depending on the effectiveness of the informal dynamics in the network. In other words, the client's influence or control over the vendor's actions, processes, and outcomes may vary greatly. This uncertainty makes the network unsuited as a steady state relationship mechanism, should the client wish to entrust high-end, business-critical

jobs to the vendor. Stage 2 (Networks) is therefore depicted in the center relative to the horizontal (coordination costs) axis, but spans a large part of the vertical (vendor control) axis.

Both success and failure with the network approach create a common result, the client's desire to wield greater control over the vendor. Success breeds the alluring prospect of higher-order, strategic benefits to be enjoyed by leveraging the vendor for even more complex work. And, unlike with projects of low complexity, network failure with moderately complex work presents the prospect of a sunken investment, something that the client wishes to prevent, again by tightening linkages with the vendor. Both outcomes, therefore, lead the client to seek greater formal control, and the informal network thus tends to evolve to a formal hierarchy. As the Figure shows, Stage 3 (Hierarchies) falls in the High-High quadrant, where the client incurs the high costs of vertical integration as a trade-off for reduced risk in terms of ability to control the vendor.

OFFSHORE DEVELOPMENT FOR ETRUS: A CASE STUDY

This section provides an illustration of the proposed evolutionary framework for offshored applications development, in the form of a case study. The narrative describes how the interactions of a real-world client organization with various offshore development vendors have successively mirrored the three stages of contracts, networks, and hierarchies. It highlights the interplay among various factors influencing this evolution, including constantly changing objectives, internal imperatives, and external compulsions on both sides. While the specific circumstances of this case are unique, the broader lessons it offers are consistent with the proposed evolutionary framework. In order to maintain confidentiality yet preserve the essence of the case, the identities of the client and key vendor organizations have been disguised, and other descriptive statistics and facts carefully distorted.

Figure 1. Coordination costs vs. vendor control: A trade-off
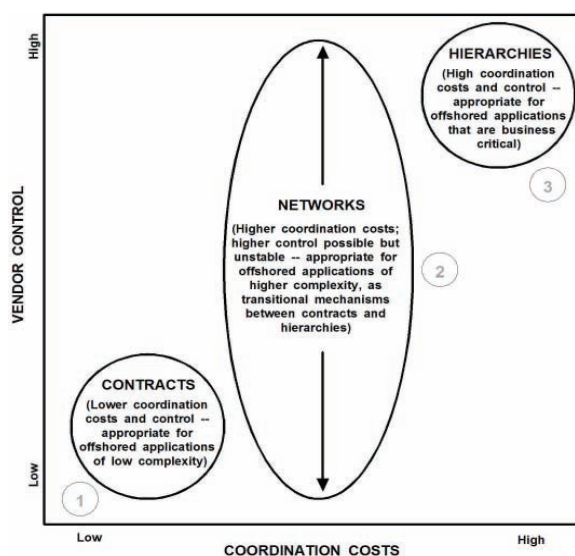
Etrus Corp. is a 13-year-old specialty telecommunications company whose expertise lies in identifying and relieving critical stress points and bottlenecks that impede its business customers' network performance. Using a mix of systems, software, and services, it helps its customers make maximum use of their applications that drive their businesses, while minimizing the total cost of their network ownership. Originally established as a "Delaware Corporation" in the high-end IP-based optical niche market, the company has since grown tremendously to approximately $400 million in annual sales, largely through a series of acquisitions and mergers, including 11 in the past 8 years. It has also carefully crafted technology and business partnerships with major telecom players, such as Cisco, in order to offer a fuller range of solutions for its customers. Comprising of 1,500 employees, it now occupies specific niches across the breadth of telecommunications and serves customers on every major continent. These include cable service providers, telecommunications companies ("telcos"), such as Verizon, British Telecom, MCI, and AT&T, government agencies, and private corporations with their own networks. Its products and services include multiplexers, aggregators, switches, integrated platforms/systems, and specialized network layer services/enhancements, some of which have won prestigious industry awards. Essentially a design and engineering firm, Etrus envisions and builds new off-the-shelf products for both the horizontal and vertical market, with customized variations for individual customers. Its contemporary rivals include Cisco, its business partner, as well as Lucent and Nortel. Along the way, Etrus has also acquired ISO 9001 certification.

Etrus' foray into applications development offshoring began with two conversion-oriented projects. These were precipitated by Etrus' series of acquisitions of other specialty telecommunications companies about three years ago. The new product development processes of both Etrus and the acquired companies had depended extensively on an industry standard product-management software tool from Agile that enabled them to manage the cost of their products and to track various aspects of their supply chain, for example, tracking parts and materials for manufacturing. While this platform compatibility between the acquiring and acquired companies was definitely a positive feature, these companies were all using different versions of the Agile software, and therefore, essentially employing somewhat different design, documentation, and manufacturing standards. Thus, an important objective was to get the data of the acquired companies into the structure and standards followed by Etrus, so that the consolidated data could be managed centrally in an integrated manner. One of the conversion projects, therefore, entailed upgrading the software used by an acquired partner to a more modern and recent version, by converting its design and database structure and content to be compatible with that used by Etrus. The other project actually entailed rolling a more recent version back to an older version, in the case of a different acquired partner who was using a more modern version of the software than Etrus. While these conversion tasks were highly structured and fairly straightforward, they could not be fully automated, as the conversion process consisted of some decision points, choices, and new data creation. In addition, as Etrus had decided to leverage the opportunity created by both conversion efforts by adding new functionality to the off-the-shelf product, this called for some custom programming.

Both conversion projects were outsourced to a Silicon Valley based vendor called Blue Ridge, which has technology and business relationships with Agile, and which entrusted the projects to its offshore subsidiary in India. Etrus' selection of Blue Ridge was based on the latter's expertise with Agile software, and on its apparent application development process maturity. This maturity was evidenced by its ISO-9001 certification, and its achievements related to the Software Capability Maturity Model (SW-CMM), developed by

Carnegie-Mellon University's Software Engineering Institute (SEI). While the principles of SW-CMM continue to be followed by organizations worldwide, the model itself has been superseded by a newer one called Capability Maturity Model Integration (CMMI), also from SEI. The original SW-CMM focused on software development processes. Its structure was characterized by five levels of increasing maturity that were Level 1–Initial, Level 2–Repeatable, Level 3–Defined, Level 4–Managed, and Level 5–Optimizing. Organizations at Level 5 epitomize highly mature, efficient, productive, innovative, and proactive development processes. Blue Ridge used a proprietary extended framework that focused on key processes, and its unique internal governance mechanisms periodically monitored ongoing projects to provide directional guidance as well as issue resolution. It had previously successfully employed its skills and methodology with Fortune 100 customers, and prided itself on being able to provide clients with total visibility of up-to-the-minute performance metrics and execution status of ongoing projects.

Blue Ridge completed each project in about 4 weeks at a cost of approximately $20,000. Both development projects were deemed to be resounding successes. In the words of Etrus' VP of Engineering Services, the conversion work, together with the custom built features from Blue Ridge "dramatically reduces the time to take a product from design to large-scale production, giving Etrus vastly more revenue and market share. This enables us to achieve aggressive new product launch objectives through supply chain collaboration, so critical to our success. We couldn't have asked for better support from Blue Ridge."

These initial small experiments with application development offshoring represented the first offshoring stage for Etrus. The successful culmination of contracts with Blue Ridge set a positive internal tone within Etrus, and bolstered the confidence of its IT managers in offshored development. As the company continued to grow rapidly through acquisitions, the IT group decided that it would be best to focus in-house resources on tasks associated with new product development, and offshore more of the other routine application development work. However, the fast pace of corporate change and the quick adaptation expected from IT meant that the internal IT staff had very little time available to engage collaboratively with vendors to jointly generate specifications that were clear and detailed enough for the latter to take over and complete the development process. This constraint prevented many new offshoring projects from being initiated in the first place. The solution that was agreed upon was to look for "parcels" of work that were both complex enough to leverage the cost and quality benefits of offshored development, and at the same time, structured enough to not set the internal IT group back in terms of time spent working with the vendor to generate excessively detailed specifications. This approach would also require the careful selection of vendors whose strengths matched up to the attributes of specific projects. The first such opportunity came about in the shape of a need to customize and implement an internal business application, an off-the-shelf engineering and design information system oriented around engineering resources and portfolio management, built on a popular technology platform. The rest of the Etrus case study describes the characteristics of this particular development project, how the offshore vendor was selected and managed, the outcome of the development effort, and a discussion of its implications.

This project represented a moderately complex application whose deliverables consisted of the system setup, the standard template setup and custom template design, the standard reports setup and custom report design, and some custom workflow programming logic. It entailed a different technological platform than the other two projects, and Blue Ridge was deemed not to possess the ideal expertise for this job. Consistent with the

aforementioned need to carefully select a vendor whose strengths matched up with the attributes of the application to be developed, the project was instead awarded directly to Fiore, a leading offshore-based global IT firm. Fiore's strengths range across the full technology-life-cycle spectrum, including business and technology consulting, research and development, implementation, and process ownership/operations. For its applications development business line, Fiore owns and operates sophisticated, mature offshore development facilities. Aside from Fiore's excellent reputation, Etrus had had prior contacts with Fiore's R&D group, who had designed and developed some components of their standard product offerings in the past. As Fiore was well placed in the high-end, engineering software niche, Etrus' IT managers believed that Fiore possessed the background and skills to successfully deliver this application, which was more complex relative to the first two that they had offshored earlier.

The application, when complete, would provide Etrus with the resource loading and skill prediction requirements across their entire engineering portfolio. It would enable them to load up all their engineering projects that they had in the pipeline, track their status, their project plans, and the skills that it was going to take to get them done. This project portfolio information could then be rolled up and mapped onto the skills sets of individual product designers and engineers, to yield accurate estimates of how many people of each skill set they would need over the next couple of years, and the personnel budgets that all of this would entail. It would also enable Etrus to build the background or foundation to support the product development commitments that their sales people were making to their customers, and to reconcile market realities with their planning processes.

At a higher level of complexity relative to the prior offshored development projects, the development of this application called for closer communication and interaction between client and offshore vendor. However, even as this project was underway, Etrus' internal resources, including IT, were under severe strain due to other pending corporate acquisitions. It was decided, therefore, to focus as much of the iterative dialog with the vendor as possible in the initial stages of the development life cycle, and to then hand over the process entirely for Fiore to manage, up until the end product was ready. Fiore's project leads, who were technical specialists, worked closely with Etrus' internal IT staff in the initial stages. This minimized the number of contact points between client and vendor in the later stages of development, thereby enabling Etrus to function within their time constraints, but also ensuring that each contact point served as an intensive knowledge transfer linkage. Once the leads had internalized the specifications and the deliverables, the client would then be ready for them to move the actual development work offshore to Fiore's premises, and to manage it from there.

Thus, in the requirements analysis stage, Etrus' internal IT staff not only provided the vendor with documents containing detailed requirements specifications, but also some graphical mock-ups of key deliverables such as input/output screens and reports. These prototypical screens and reports were then subjected to iterative changes based on short, rapid feedback cycles between Fiore and Etrus. While the technical context was well documented and communicated to the vendor in this manner, the transfer of business-domain knowledge or the organizational context, that is, knowledge of the client's business processes, was not given as much attention. Both client and vendor agreed that the application, while moderately complex in effort, represented a fairly structured task with few unknowns, for instance, the hardware, software, and the technical architecture for the project had already been decided by Etrus. And, aside from some examples of how "things were done" at Etrus, it was not really necessary to get into details of the business knowledge in order for Fiore to complete the project, despite the fact that the two organizations had no prior interactions.

This was also the reason why the project leads from Fiore were technical specialists rather than business or process specialists.

Since the moderate level of application complexity also called for some degree of vendor control, Etrus chose to anchor this control to outcome-oriented measurable standards for the vendor to follow. This was consistent with the fact that the technical architecture had already been set by the client. The contract therefore spelled out both timelines and quality standards. An example of the latter was specifications pertaining to the expected number of rework cycles and other measures of operational efficiencies, such as software bugs. These standards were based on Etrus' objective assessment of the project's complexity, and its own historical data from other internally developed applications. Also added to the contract were specific deliverables associated with checkpoints. One example of a deliverable at a checkpoint would entail running the set of custom workflows through a series of test processes to ensure that the set touched all the right spots in the workflow.

Enforcement of standards, while not strictly followed through formal audits, was built into these checkpoints as threshold gates. If deliverables were determined not to have met certain standard levels, exit clauses would kick in, enabling Etrus to revisit the contract or to stop the project altogether. Essentially, the client could then choose to take all the work that had been done to date, together with documentation, and to finish the project themselves, or hand it over to another vendor. Fiore would then be paid for work done to that point and no further. The intent of these clauses, though, was not based on an adversarial premise, they were placed in the contract largely as mechanisms to document the expectations of quality that both client and vendor were committed to, essentially, as vendor guidelines. Further, although the contract focused on deliverables rather than process, it did not contain any provisions for special rewards or incentives for work

that exceeded standards or was completed ahead of schedule. The message to Fiore was, "We don't have the time to accomplish this ourselves, so as long as you can manage the project and demonstrate the deliverables and the milestones, we'll be perfectly happy."

While the client, due to various reasons, including time constraints and the nature of the development work, maintained a clearly outcome-oriented stance, the vendor, on the other hand, was CMM-certified at a high level, and took pride in following strictly established, documented, and publicized processes. Despite the fact that Fiore was a big player for whom this project represented, at best, a small foot in the door, it proceeded to apply high process standards for itself, including rigorous testing and documentation. This was over and above its self-enforcement of the deliverable-oriented contractual terms that had been set by Etrus. These respective outcome- and process-oriented approaches of client and vendor had a decidedly synergistic effect; the end result was a development project that came in at only slightly higher than the funds budgeted ($45,000 vs. $41,000), took less time than expected (6 weeks vs. 2 months), and that was regarded as successful by the client, despite an unplanned switch of offshore project managers in the middle of the development effort. The vendor's process orientation ensured the continuity that was needed at the point of this switch, and the carefully crafted deliverables-oriented measures that had been set by Etrus helped Fiore carve the path to an unambiguous end point. When the project was complete, the in-house IT staff at Etrus was unanimous in its opinion that although the work could have been done internally, it would have been more unpredictable, entailed a longer learning curve, cost approximately 50% more, and probably would not have been of as high a technical quality.

Etrus' successful experience with Fiore represents the second stage in its evolutionary experiences with application-development offshoring. This stage was characterized by higher complexity

work, a closer relationship with the vendor, and a greater focus on process. Ironically, though, as the IT staff at Etrus now considers a full-fledged role for offshored applications development, some of the key factors that worked to its advantage in its recent project are the ones that it thinks will work against it in the future. Specifically, the dynamics of the telecommunications industry are changing, and the acquisition and consolidation mania is beginning to slow down. This implies that the IT staff will be less engaged in putting out acquisition-related fires, and be more available to leverage offshoring by sending increasingly complex applications out for development. While the benefits of offshoring more complex applications are likely to be of a higher order, the need for ever-closer working relationships between client and vendor IT personnel is also expected to be greater. The higher the application complexity, the greater is the need for joint, iterative activities in any development effort. While the internal IT staff may finally have more time available for such collaborative client-vendor activities, the uncertainty embedded in complex applications usually also results in several rounds of changes to initial specifications, as possibilities are explored, knowledge is exchanged between client and vendor, and implications continually clarified. With vendors who flaunt high-level CMM certifications, this creates two problems. One has to do with the enormous level of detail needed in initially documented specifications, because CMM processes require extensive documentation. The second has to do with the communications, documentation, testing, and recertification costs of reworking these specifications with each round of changes. In other words, while vendor CMM certification provides reliability and confidence in the end product, it also adds a tremendous overhead burden to the cost structure. The net result can be that any incremental gains or values from initial offshoring work are offset by the high coordination costs of adhering to process-

oriented standards, such as CMM, as the work gets more complex.

For these reasons, Etrus has decided to disengage itself from Fiore. It has committed itself to establishing a captive (subsidiary) offshore application-development facility of its own in the near future, so that it can better leverage the higher-order benefits of offshoring and, at the same time, maintain some control over what would otherwise be exorbitantly high vendor coordination costs. Doing so will take Etrus into the third and final evolutionary stage for offshored development.

DISCUSSION AND IMPLICATIONS

Using a theoretical framework and a supporting case study, it has been argued that client-vendor relationships in offshored applications-development contexts evolve first from transaction-oriented, price-based contracts, to loose, informal, but fewer, networks based on trust and vendor self-enforcement. Subsequently, the growing complexity and criticality of applications introduces the need for greater checks and balances, and this necessitates a hierarchical arrangement, part- or full-client ownership of a vendor. While this final stage may not actually be feasible for every client, essentially, a cost-reduction game is replaced by one of risk control.

There is somewhat of an irony in the position taken by this chapter that a formal hierarchy ought to succeed a network-like stage in a client-vendor relationship. Vertical integration as a control-oriented, preferred organizational response to external uncertainty was first proposed in a classic work a long time ago (Thompson, 1967). Many years later, however, it was argued that creating a hierarchy entails mechanisms considered unnecessary and overkill, difficult to establish, or too costly to sustain. In its place, the network, with its freedom of exit attributes, was then propounded

as a superior response to dynamic, unpredictable environments (see for example: Achrol, 1997).

The knowledge of a natural progression can help decision makers on either side of an offshoring relationship. On the client side, senior business and technology executives can make more informed judgments regarding the viability of offshoring beyond the short term, given the kind of commitments that such vendor relationships will ultimately entail. The resultant better decision process will prevent organizations that are ill equipped to cope with the concomitant costs, from embarking upon offshoring complex or critical projects. It will also enable organizations that do possess such a capability, to be better prepared for the internal changes that will accompany changing relationship structures with vendor organizations. At the least, the clarity resulting from understanding the sequential stages of interorganizational processes will encourage executives to work up candid assessments of why they might be interested in offshoring in the first place.

On the vendor side, the implications of a relationship progression are perhaps more profound. With the realization that clients will seek to regain control as applications evolve to become complex and critical, decision makers in vendor organizations are faced with fundamental questions pertaining to organizational mission, culture, and employee work autonomy. For example, should they even let client-vendor relationships progress to such points, or plan to stay with lower- and mid-level work? The greatest dilemma here is for the creative, decentralized, organic types of offshore vendor organizations. On the one hand, they may value the empowerment that their internal environment provides them. On the other, this empowerment may be threatened when put to good use for higher-level work.

For researchers interested in pursuing the progression of offshoring relationships further, this chapter offers a couple of different directions for more rigorous empirical inquiry. The most obvious one is the implicit proposition that as

a client-vendor offshoring relationship is established, ages, and matures, vendor oversight is first conducted through (possibly increasingly complicated) contractual mechanisms, then through loose, trust-based, affiliation-solidarity networks, and finally a client-controlled hierarchy. An alternative investigation scheme would avoid using relationship age as the progression benchmark, and instead look for evidence of the three stages by employing application complexity as a surrogate for relationship maturity. If either of these two methods reveals the existence of such stages, then the next logical step would be to test whether hierarchies as the interorganizational structure of choice in mature relationships are really more effective than other alternative mechanisms.

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Chapter VIII
Understanding Information Technology Implementation Failure:
An Interpretive Case Study of Information Technology Adoption in a Loosely Coupled Organization

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ABSTRACT

This chapter uses the theory of loose coupling to explain failure in the adoption of an information technology aimed at improving collaboration across one organization's internal boundaries. The research details an interpretive case study of a single organization, MacGregor Crane, in which relatively autonomous individuals are only loosely connected in terms of their daily interactions. The company implemented Lotus Notes© in an attempt to increase collaboration. However, this effort failed because employees in various units, particularly engineering, were reluctant to share information across unit boundaries. In light of these findings, it is suggested that the successful implementation of a collaborative IT within a loosely coupled organization should involve the reconsideration of the organizational members' roles and functions.

INTRODUCTION

In this postindustrial era, firms are becoming more dependent on horizontal collaborations of diverse groups rather than vertical chains of command (Barley, 1996; Kellogg, Orlikowski, & Yates, 2006). To facilitate such horizontal collaborations, organizations have relied on information technologies (IT) to support coordination among peers. However, in many cases, the implementation and use of collaborative technologies have led to mixed results. This can be comprehended by recognizing that the successful implementation and use of IT in an organization is greatly influenced by an organizational culture supportive of high trust, willingness to share information, and commitment to organizational goals. To this end, typical barriers to the successful adoption of IT in organizations can be found in political friction between organizational roles (Mähring Holmström, Keil, & Montealegre, 2004; Orlikowski, 1992).

This chapter is based on a study conducted at MacGregor Crane, an organization in the business of developing and constructing shipboard cranes. MacGregor Crane includes a number of organizational members who largely work in parallel from one another. MacGregor Crane fits the general description of a "loosely coupled" system, a description that underlines how organizational members have great latitude in interpreting and implementing directions despite the presence of other organizational members. Weick (1979) stresses the autonomy of individuals and the looseness of the relations linking individuals in an organization. Whereas loosely coupled systems are characterized by both distinctiveness and responsiveness (Orton & Weick, 1990), a potential downside for loosely coupled systems is poor collaboration among organizational members. The IT project initiated at MacGregor Crane was aimed at dealing with this problem.

The use of IT for coordination is more complex than suggested in the academic and practitioner literature (for a discussion, see Kling, 2002). Coordination, as the management of dependent activities (Crowston, 2003; Malone & Crowston, 1994), is central to organizing, and as more and more organizations become flat and outsourced, many organizations look to new technologies to help them with organizing. Looking for solutions to the problems of lack of collaboration among organizational members, MacGregor Crane turned to IT as a possible solution. MacGregor Crane decided to launch a project aiming at delivering a collaborative technology, Lotus Notes®, which was expected to increase collaboration both within and across professional boundaries.

The goal of this chapter is to explain an organization's failure to successfully implement a technology targeted at increasing collaboration between organizational members. More specifically, our core research question asks: "Why was MacGregor Crane unsuccessful in fostering collaboration supported by Lotus Notes®?" We suggest that loose coupling (Meyer & Rowan, 1976; Weick, 1979) is a particularly appropriate theory to answer this question, as MacGregor Crane fits the general description of a "loosely coupled" organization.

The chapter is structured as follows: "Literature" discusses organizational change, collaborative technology, as well as loosely coupled systems. In "Case: MacGregor Crane", details about our inquiry at MacGregor Crane are provided. More specifically, this section describes the selected site and the research approach, followed by an account of MacGregor Crane's Lotus Notes® implementation. A discussion of the case study findings is presented in "Discussion," followed by concluding remarks in "Conclusion."

LITERATURE

The relation between IT and organizational change has always been a central concern for IT practitioners and academicians. While new

IT shape organizational behavior and structure, the role and meaning of IS is largely shaped by organizational circumstances. The two are inextricably intertwined: there is a reciprocal relationship between ITs and organizations, each shaping the other (see e.g., DeSanctis & Poole, 1994; Kling & Iacono, 1989; Monteiro & Hanseth, 1995; Orlikowski, 2000). In other words, contemporary organizations are entangled with technology. One cannot understand organizations without understanding technology, or understand technology without understanding organizations. Clearly, IT have the capacity to enable change in various ways: the ways in which organizational work is executed (DeSanctis & Poole, 1994); the effectiveness and efficiency of an organization (Fiedler Teng, & Grover, 1995); the knowledge demanded for the execution of various tasks (Ehn, 1988); the organizational and occupational structure of work (Barley, 1986; Kling & Iacono, 1984; Orlikowski, 1996); and the possibilities for collaboration (Evans & Brooks, 2005; Zuboff, 1988). Collaboration and coordination, as a type of organizational change often associated with the use of IT, is of interest here.

Collaborative Technology Implementations

Many scholars interested in organizational communication and coordination have focused on interfirm networking and the IT infrastructures supporting it (e.g., Patrakosol & Olson, 2007). While it is accepted that innovation tends to occur in highly interacting and collaborative organizations (Miles & Snow, 1986), it should also be noted that innovation is dependent on a well-working integration of technological resources (Kodama, 1995).

The impacts resulting from the implementation of collaborative technology have been investigated quite frequently by both practitioners (e.g., Kiely, 1993; Schlack, 1991) and academics (e.g., Brown, 2000; Fidas, Komis, & Avouris,,

2005; Karsten, 1999; Orlikowski, 1992; Tung & Tan, 2000; Vandenbosch & Ginzberg, 1996-97; Wong & Lee, 1998). Lotus Notes®, as a widespread collaborative technology, has gathered much coverage. Notes provides electronic messaging to improve communication; it provides shared databases to improve collaboration; and it supports calendaring and group scheduling to improve coordination. Vandenbosch and Ginzberg (1996-97), in their review of collaborative technology implementations, claimed that only a few studies have acknowledged the positive impact of these technologies on organizational collaboration. Maybe surprisingly, these authors contend, "most studies have not found substantive effects" (p. 68). From their review, Vandenbosch and Ginzberg (1996-97) concluded that four factors are necessary for the implementation of such technologies to enhance collaboration: (1) organizational members must have a need to collaborate; (2) organizational members must understand the technology and how it can support collaboration; (3) the organization provides appropriate support for the adoption, implementation, and continued use of the technology; and (4) the organizational culture supports collaboration.

In another thorough and more recent account of the research that has been conducted on the impacts of collaborative technology, Karsten (1999) reviewed 18 case studies involving the implementation of Lotus Notes®. After studying these implementations according to many dimensions, Karsten concludes that the four criteria put forward by Vandenbosch and Ginzberg (1996-97) are not strong indicators of the extent to which Lotus Notes® may lead to collaboration or not. More particularly, Karsten stated that although these factors may be considered as "lessons that can be helpful in planning implementation projects, […] the evidence provided by the case studies did not support the conditions nor the belief in the inherent collaborative model [of Notes]." Karsten rather emphasizes other issues likely to influence the relationship between collaborative

IT and collaboration, among which the difference between technology as a product and "technology-in-use" (Orlikowski, 2000; Orlikowski, Yates, Okamura, & Fujimoto, 1995), and the kind of "care" needed in bringing about desired changes (Ciborra, 1996).

Both Orlikowski and Ciborra emphasize the need of understanding the organizational context and, to this end, loosely coupled organizations present us with a particular challenge. We need to understand the complexities involved in enacting communication and collaboration, and the forces working for and against this. To do this, we turn our attention to the theoretical perspective of loose coupling.

Loosely Coupled Systems

Organizational theorists refer to the relationships between two separate organizational entities as coupling. Coupling refers to how events in one organizational entity affect another organizational entity. Weick (1979) has discussed coupling as being based upon the number of variables shared between two separate entities; coupling may be "tight" or "loose" depending on the importance and commonality of variables.

Viewing organizations as "loosely coupled" systems underlines how individual participants have great latitude in interpreting and implementing directions. In his description of loosely coupled systems, Weick (1979) stresses the autonomy of individuals and the looseness of the relations linking individuals in an organization. The central information activity is resolving the equivocality of information about the organization's environment. This "sense making," as described by Weick (1995), is largely done retrospectively, since one cannot make sense of events and actions until they have occurred. Current events are compared with past experience in order to construct meaning:

[…] the goal of organizations, viewed as sense making systems, is to create and identify events
that recur to stabilize their environments and make them more predictable. A sensible event is one that resembles something that has happened before. (Weick, 1995, p. 170)

The enacted environment is seen as an output of the meaning-construction process, and serves as a guide for future action. However, once the environment has been enacted and stored, people in the organization face the critical question of what to do with what they know. While shared interpretations in an organization are a compromise between stability and flexibility, some equivocal features still remain in the stored interpretations. Equivocality is central in all organizing, and people in organizations are

[…] people who oppose, argue, contradict, disbelieve, doubt, act hypocritically, improvise, counter, distrust, differ, challenge, vacillate, question, puncture, disprove, and expose. All of these actions embody ambivalence as the optimal compromise to deal with the incompatible demands of flexibility and stability. (Weick, 1979, p. 229)

Clearly, this is very different from mainstream organization theory, and Weick (1976) states that "people who are steeped in the conventional literature of organizations may view loose coupling as a sin or something to be apologized for (Weick, 1976, p. 6).

Meyer and Rowan (1976) express fears that loose coupling can often lead to decoupling. Decoupling involves the valuing of ceremonial practices over efficiency. Management in a decoupled atmosphere will use tactics of avoidance, discretion, and overlooking to assure that individual participants maintain face. These values can sometimes be valued higher than efficiency.

Loosely organized systems can suffer from a lack of shared context and thus, a lack of shared interpretations among organizational members on various work related issues. Organizations with a high degree of heterogeneous and specialized

workforce, working in geographically dispersed teams, may suffer the most from this lack of shared context. If not dealt with in a proper manner, this can become an obstacle for organizational innovation. One possible way of dealing with this is to create a shared context virtually, by means of new IT. The role of IT in such an arrangement is that of a "boundary object," as described by Bowker and Star (1999):

Boundary objects are those objects that both inhabit several communities of practice and satisfy the informational requirements of each of them… [They] are weakly structured in common use and become strongly structured in individual-site use. (Bowker & Star, 1999, p. 297)

As boundary objects, IT applications may be used in loosely coupled organizations as tools for promoting better coordination. The concept of loose coupling can be a potentially fruitful set of ideas to draw from when trying to make sense of collaborative technology (i.e., here a boundary object). Accordingly, we propose to investigate the current case while taking into account the theoretical perspective of loose coupling. We expect that this perspective will be useful in understanding the organizational change related to collaboration and coordination within the organization under study.

CASE: MACGREGOR CRANE

Selected Site

MacGregor Crane is one of many companies which agreed to be studied by the first author's research group. MacGregor Crane was founded at the end of the 17th century to manufacture industrial products. It now develops and manufactures shipboard cranes, and delivers them around the world. MacGregor Crane focuses exclusively on hydraulic cranes, which gradually have replaced

electric cranes and now totally dominate the world market. MacGregor Crane decided early to focus on hydraulic cranes, and have had good results during the last few years.

At the start of our inquiry, MacGregor Crane had 235 employees at its headquarters (of a total of 250 employees in the whole organization). The most important "professional roles" assumed by its employees included management, accounting, sales, and engineering[1]. Organizational members perceived these professional roles as very distinct from one another. Ties between these organizational roles were loose in that limited collaboration existed across professional boundaries. Within professional boundaries, however, ties were stronger; people in the same professional role generally collaborated and agreed on key issues. Thus, MacGregor Crane resembles an organization that Weick (1979) considers as a loosely coupled system. As suggested by Orton and Weick (1990), loose coupling combines the contradictory concepts of "connection" and "autonomy," and should thus be regarded as a dialectical concept (Van de Ven & Poole, 1995).

Research Approach

To preserve a dialectical interpretation, it has been suggested that greater familiarity with a few systems was more valuable than lesser familiarity with many (Orton & Weick, 1990). With this in mind, a case study supported by a qualitative approach (Eisenhardt, 1989; Miles & Huberman, 1984) was conducted at MacGregor Crane. This case study was grounded in the interpretive epistemology (Klein & Myers, 1999; Walsham, 1995). According to Walsham (1993), this approach to information systems research is predominantly "aimed at an understanding of the context of the information system and the process over time of mutual influence between the system and its context" (p. 14). Hence, a basic ontological assumption is that there is no fixed relationship between information technology

and organization. Rather, it is assumed that the dynamics of technology and organization unfold in an ongoing mutual shaping process, which is never determined by any single factor alone.

The question of generalizability has often been a problematic issue for qualitative researchers (Johnson, 1997). On that respect, Walsham (1995) argues that the nature of generalization in interpretive study is clearly different from what it is in the positivist tradition. He identified four types of generalization, among which the "development of rich insight" constitutes one[2]. Walsham also maintains that generalizability, in the context of small numbers of case studies, relies on the plausibility and cogency of the logical reasoning used in describing the results from the cases, and in drawing conclusions from them (Walsham, 1993). In the present case, generalizability will thus be established by the plausibility and cogency of the analysis upon which rich insight will be generated.

Data collection techniques included document analysis and semi-structured interviews. Documents were analyzed to provide the researchers with a better understanding of MacGregor Crane's business situation. Two types of documents were considered. First, an overall IT-strategy document has been made available to the researchers. Second, documentation with regard to the Lotus Notes® implementation (project documentation, user manual, training manual, etc) were also studied. These documents provided sufficient knowledge for the researchers to ask informed questions during the interview process.

Interviews were conducted on two separate rounds. First, 11 interviews were conducted during a 2-month period in 2000. Interviewees included managers, controllers, engineers, marketers, salespeople, and one secretary. These interviews included questions regarding the start of the project, the use of the Lotus Notes® application, and the problems that were encountered. A second round of interviews was conducted during another 2-month period in 2004, with 20 interviewees.

These interviews included questions related to the reasons behind the abandonment of the Lotus Notes® application (at this point, Lotus Notes® had been replaced with an html-based Intranet.) The interviewees from this second round were the same as in the first round, plus additional engineers and sales personnel. Also, each interview from either round lasted between 30 and 60 minutes, and was tape-recorded and later transcribed.

The content of all the interview transcripts was then read to identify issues and topics, as they were framed by organizational members. These issues and topics were then analyzed and aggregated to arrive at a set of themes that were common or recurring. All the data were then reexamined and recategorized in terms of this new set of common themes. Such an iterative analysis of data and themes allowed us to reflect better on the experiences and interpretations of the organizational members involved in this implementation. Our analysis offers insight into the dynamics behind this software implementation.

The Implementation

Just like many companies in its industry, MacGregor Crane used cross-functional teams for product development, and to some degree, also for sales and marketing. These teams were composed of members from multiple functional units who joined and left the team based on their level of interest and required input. This was not considered as a problematic issue in the past, but as each functional unit became more and more specialized, the need for better coordination grew to be urgent. Because organizational members from different departments were involved to greater and lesser degrees as an idea moved through various stages of development, information needs varied for each unit and individual involved in the process. To keep all projects moving, people joining a project team were required to gain knowledge of the current project quickly and efficiently. The Lotus Notes® implementation project was

launched to deal with communication and coordination issues, and to provide the organization with a shared context. While this implementation project covered a long period of time, it can be subdivided in two distinct phases.

Project's Initial Phase

During the early phase of the project, from spring 1997 to August 1998, it was anticipated that the existing work procedures and practices could be improved in three specific ways by the use of the Lotus Notes®. First, the project manager perceived a need for better dissemination of general organizational information, such as news concerning new employees, new policies, or new deals for the organization. Overall, this objective was successfully met. Second, the project manager had identified a need for a better collaboration among engineers. Because engineers were skilled in many different areas, the project manager's ambition was for engineers to learn from each other:

There are so many areas we can improve here, and I felt that initially, a good start would be to focus on improving the way in which we handle information at this place. This is particularly important when it comes to information concerning the development work; after all, it is the core of things here.

Although most engineers claimed that the Lotus Notes® would be useful to their work, they could not clearly explicate how this would be the case. Engineers were used to handling unstructured information. When asked to describe parts of their work routines and reasons behind decisions in the development process, engineers had much difficulty in doing so. Rather than identifying the most important factors they were considering in their work, they would instead provide a series of examples of individual circumstances, with no easily identifiable underlying procedures. Still, although engineers had difficulty in articulating *how*

Lotus Notes® had increased the extent to which they collaborated with one another, they asserted that this goal had been successfully met.

A third way that Lotus Notes® was expected to improve work procedures was by increasing support to the salespeople. For some time, the project manager had discussed the need for more efficient technical support for the salespeople. The project manager had perceived that sales personnel needed access to more updated and detailed technical information in their meetings with potential clients. With better information, the project manager speculated, salespeople would be better informed about the needs of each one of their potential clients, which would in turn significantly increase their chances of selling products to the client base. As one salesperson said:

We [the salespeople] have seen how we can improve our work and our sales if we only had more support from the engineers. I'm not sure how that would work, we will need to sort that one out […] but we need to deal with this to stay competitive.

This goal, however, was not met. The engineers did not welcome this idea of sharing technical knowledge about the company's products, at least not in a formal way imposed by the technology. Although none of the engineers raised critical comments against the idea as it was presented, they did not contribute with any substantial information for this purpose through Lotus Notes® and were cautious about such initiative. One of them commented:

I'm not saying that we're against this idea; I'm just saying that we need to be careful before we embark on a path when we really can't say where we are going to end up. I'm all for new technology – I'm an engineer! But I mean […] we need to consider the consequences, and as far as I can tell, nobody has really done that yet.

At the end of the day, we do need to produce something. Clearly, we need to discuss things and plan ahead and the like [...] but we also need to produce, we cannot just talk about it.

Overall, there had not been additional collaboration between engineers and salespeople. This was disappointing, as the dissemination of general organizational information and the improved collaboration between engineers through the use of the Lotus Notes® had been quite successful. Emphasizing the first two goals that had been successfully met, the project manager expressed his positive feelings over the initial period of the project. The failure to increase collaboration between the engineers and other organizational members was rationalized by a potential lack of resources for the project. Generally satisfied with the "Lotus Notes® experience," the project manager felt compelled to pursue the project and to step up its ambitions:

I felt we had come a long way with a limited budget. Now, I would say it would be reasonable to assume that we would come even further with more resources available for the project.

The management agreed to set up a proper budget for the continuation of this implementation project, and a consultant was hired to work full time on this project. During the next phase, the goal was to push the "Lotus Notes® experience" further, and to focus on the collaboration among organizational units.

Project's Later Phase

During the project's later phase, which started in August 1998 and ended in November 1999, the idea of increasing collaboration between engineers and other organizational members was reinstated, although somewhat reformulated. Again, expectations were materialized through three particular goals. First, there was a desire to have the sales

personnel reporting customers' reactions and comments to the engineers. In this case, the assumed flow of collaboration was from the sales personnel to the engineers, that is, reverse to what it was in the initial phase of the project. The planned effect, therefore, was to have salespeople supporting the engineers with information about how their products were received on the market. Nevertheless, the engineers, again, resisted taking part in such collaboration. Their resistance was based on their fundamental belief that external opinions could only have marginal influence on the development of cranes; what mattered were issues concerning functionality and safety. As noted by one of the engineers:

We are responsible for our products and [...] you have to consider that we are dealing with high tech equipment to be used in milieu where people rely on the safety and the functionality of our equipment. Our customers cannot begin to understand all the issues involved in the development of cranes, and the same can be said about our salespeople. If we were to ask the market or the customers about how to develop our products, I wouldn't want to be on a construction site where that crane was used! Functionality and safety go together, you can't separate them in the development process. We need to put these issues in focus and if we don't, well, then we're not doing our jobs.

Thus, the engineers did not welcome the idea behind the proposed collaboration. The position the engineers took on this issue came as a surprise to the other organizational members involved in the project.

A second way Lotus Notes® was expected to foster collaboration was through the sharing of key ratios between accounting personnel and sales personnel. Among the accounting group at MacGregor Crane, there were very explicit ideas about what key ratios were important and how they should be interpreted and acted upon. Key ratios were measures of success, or lack of success, in

various organizational areas. For example, an important key ratio measured the sales success for specific products. Although the implementation of Lotus Notes® should have resulted in MacGregor Crane having more detailed and up-to-date information about its sales through these key ratios, the expected collaboration between accountants and sales people was not realized. Lack of shared norms, along with resistance from the sales personnel to share information, contributed to this setback.

Finally, a third way of cultivating collaboration was to increase partnership between accountants and managers. The project manager believed that it would be beneficial if all managers could get access to more timely information. Most managers shared his opinion and thus welcomed the idea of being able to act quicker, informed by timely information. However, despite the fact that such timely information eventually became available on Lotus Notes®, managers did not take advantage of it. The project manager believed that this had to do with the managers' minimal experience with IT. Even though the technology was available for all managers, they did not use it in any substantial way.

Overall, the later phase of the project encompassed efforts that did not result in any actual changes. The project was based on the idea that an increased collaboration among key organizational roles would contribute to the organization's capability to reach its goals. This collaboration was

Table 1. Anticipated and unanticipated organizational outcomes

Period of Project	Domain of Organizational Change	Expectations	Outcomes
Project's Initial Phase	Organizational	Better dissemination of information	Better dissemination of information
	Engineering	Increased collaboration within professional boundaries	Increased collaboration within professional boundaries
	Sales and Engineering	Increased collaboration across professional boundaries through the convey of technical support	Insignificant increased collaboration across professional boundaries because of lack of buy-in from the engineers
Project's Later Phase	Sales and Engineering	Increased collaboration across professional boundaries through the convey of customers' feed-back	Insignificant increased collaboration across professional boundaries because of lack of buy-in from the engineers
	Accounting and Sales	Increased collaboration across professional boundaries through the standardization of key ratios	Insignificant increased collaboration across professional boundaries because of lack of shared norms and resistance from sales personnel
	Accounting and Managers	Increased collaboration across professional boundaries allowing more timely organizational action	Increased collaboration across professional boundaries because of lack of buy-in from the managers

resisted, though, from the engineers, from the sales personnel, and from the managers, as they all perceived that their work practices would be changed in a way they did not feel comfortable with. The project, as a whole, is summarized in Table 1. For each phase of the project, three domains of organizational change are highlighted with their associated expectations and outcomes.

Epilogue: Project Termination and Technology Rejection

In November 1999, MacGregor Crane realized that they were not going to establish any deep collaboration between organizational units mediated by the Lotus Notes® application. In order to enable a certain degree of information flow between organizational members, an html-based Intranet was launched. It was developed in a hierarchical structure reflecting the organizational structure at MacGregor Crane. The current design has been more or less the same since March 2001, when the organizational units got their own links in the Intranet.

One person from each department was selected to be in charge of keeping the information related to the department up to date. All suggestions for changes had to go through this person. While e-mail addresses are included in the Intranet, there are no other means of interaction available.

Organizational members rarely gave any suggestions on the content and the form of the Intranet. As some of the respondents commented:

Since I came here, I have not really seen any changes being made really. I haven't been asked about it either. Well, they do send out e-mails where they ask us all to come up with suggestions. We have all received them, but I haven't replied.

I guess we are all so used to the way in which it is designed. I guess we are not really coming up with suggestions for how to change it. I sure am not. I am just used to seeing it in its current design.

By 2004, most organizational members seemed to feel that the current design was well working. The notion of the Intranet being a digital version of "what is already there" seemed to be a dominant view among organizational members. Moreover, there were not many people that formulate any alternatives.

Security was another reason why the html-based Intranet was not leveraged. Because of the diversity of people working at MacGregor, many organizational units were concerned with keeping critical information out of the Intranet. Some project members were not formal employees at MacGregor Cranes, which led to a constant reflection over how much access to critical data was allowed:

Now that we are working with a number of outsourced businesses, we cannot give as much access to people [working in those businesses] as we give to people who work here. And you can't justify this by telling it like it is. I can't go telling some contractor that they can't get the information they are asking for since they will not be working here in 3 months, that we will be taking in someone else. I can't tell them things like that. So you constantly need to pay attention to information flows in relation to non-MacGregor people.

In general, the value of the Intranet was perceived as low. It constituted a bleak compromise to the Lotus Notes® alternative, one that did not offend any parties. Although, on the surface, MacGregor was using this technology with the potential of improving communication and coordination between its organizational units, it in fact failed to do so.

DISCUSSION

Overall, increased collaboration through Lotus Notes® was not realized, as the implementation project did not result in a system that was used

in the way it was expected. It was clear that there were a lot of resources put into the project[3], but everyone involved in it described the final results as poor. Ironically, while there was a wide support for the idea that Lotus Notes® was going to foster greater organizational collaboration and coordination, the many attempts to increase this were met with resistance every time it involved more than one organizational unit. Closer examination of our data revealed that such resistance was not that explicit to begin with. In fact, the engineers even expressed that more collaboration was welcome. Reflecting on this situation, the project manager commented:

Clearly, we were a bit naive about all this. I mean, who is willing to stand up and say: 'I don't think collaboration is such a good idea!' Turned out that none of the engineers did anyway. But that was their message, in effect: 'We don't like this idea of collaboration at all!' Now, I don't want to point fingers at anybody [...] but if they would have been more open about their opinions we could have saved a lot of money.

In fact, it appears that many organizational members had a cautious reluctance to increase collaboration through information technology. These organizational members, however, did not communicate their apprehension to the project manager. As the project manager noted, questioning the underlying idea of increased collaboration was not something that was "politically correct," that is, this was something the engineers felt uncomfortable vocalizing. There is something "honorific" behind a statement like "increased collaboration," and to argue against this can be interpreted as an irrational act.

Why did not the use of Lotus Notes® lead to further collaboration across professional boundaries? The four conditions suggested by Vandenbosch and Ginzberg (1996-97) to foster greater collaboration were all met to some degree. First, there was a strong need for collaboration, as it was

in the nature of MacGregor Crane's business to use cross-functional teams for product development, sales, and marketing. Second, there was a mixed understanding of the technology in the organization. Among engineers and sales people, there was a good understanding of the technology and how it could support collaboration, as training had been provided and faithfully attended by these groups. However, the management did not use the technology to any great extent, which hindered a wider collaboration. Third, there was firm support, at least at the explicit level, behind the implementation; the project manager was given additional resources necessary to pursue the project and to step up its ambitions. Finally, the collaborative culture at MacGregor Crane was relatively strong prior to the Lotus Notes® implementation, as organizational members were used to being part of teams involving multiple functional units which were dismantled and recreated over time. However, this collaborative culture was developed within professional teams, and there was not much collaboration between these teams either prior to or after the completion of the Lotus Notes® project. Overall, none of the four conditions proposed by Vandenbosch and Ginzberg (1996-97) can be invoked to explain the lack of collaboration. This uncovers the often paradoxical character of organizational life, as it is not uncommon for IT to result in unpredictable organizational consequences. The unpredictable and ubiquitous nature of IT's organizational consequences forces us to introduce new ways of thinking about how to study, explain, and anticipate these consequences (for a discussion, see Robey & Boudreau, 1999). For this purpose, we turn our attention to the theoretical lens of loose coupling.

Organizational Collaboration in the Context of Loose Coupling

Loose coupling recognizes the needs of individuals within an organizational culture to adjust their

understanding of the organization before they can adjust to their changed role as individuals within the organization. This adjustment was not done by the different organizational groups at MacGregor Crane. The barriers to adjust their understanding of the organization, and also their own role within the organization, were especially evident among the engineering team. The organizational structure was, to a large extent, the product of engineering-centered processes. As many organizational members routinely mentioned, MacGregor Crane was an engineering firm since its inception. Resolving the equivocality of information about the role and meaning of Lotus Notes® (Weick, 1979) was sought within the limits of this existing organizational structure. While the ambition from the project manager was to change the organizational structure, this organizational structure was the starting point against which organizational members would interpret and make sense of the newly implemented technology. Through sense making (Weick, 1995), users compared the situations before and after the implementation of Lotus Notes® within the organization. It is clear that these users had great latitude in interpreting and implementing directions, albeit within the boundaries of existing organizational structure.

All organizational structures do not necessitate tight coupling, and some managerial initiatives, like decentralization, delegation, and professionalization, build some looseness and flexibility into such structures. For some organizations, this may be a necessary structure, especially when managers do not have the basic understanding to closely supervise specialized employees; in such a case, they will typically encourage horizontal collaborations rather than vertical chains of command (Barley, 1996; Kellogg, Orlikowski, & Yates, 2006). Looking at this project through the lens of loose coupling, we can appreciate the tension in the horizontal collaboration involving loosely coupled organizational roles. While one of the presumed strengths of a loosely coupled system

is that it can adapt to its environment by relying on the collective intelligence of its constituent parts, this study illustrates how loosely coupled constituent parts may also resist change.

Loose coupling exists for a good reason, and any effort to intervene, to move towards tighter coupling or further decoupling (Meyer & Rowan, 1976), has to present the organization with rational arguments. While loose coupling often occurs because of a high degree of ambiguity in the decision tasks (March, 1994), efforts to disrupt such a situation by implementing a new IT application may be interpreted as inappropriate. This was the case at MacGregor Crane, most notably in the way in which the engineers resisted the project.

This tendency of resistance among the engineers was magnified by the way in which the project was managed. The project was managed in a top-down approach, guided by an overall ambition that was not reconsidered in the light of organizational resistance. A more suitable approach to the lack of shared context typical of loosely coupled organizations requires increased acknowledgment of the needs and preferences expressed by all organizational roles.

The constituent parts of a loosely coupled organization could serve as the tentacles in the process of IT adaptation. This was not done at MacGregor Crane, as the implementation of Lotus Notes® was conducted such that managerial intentions were not changed in the process. Even in the light of a seemingly obvious failing course of action, the original ideas were not questioned. A similar view is presented by Mintzberg (1994), who argues that strategies that emerge from the "managerial mind" may not be as efficient as those emerging for the organization's grass roots (p. 241). He describes top-down strategizing as intrusive and upsetting, as episodic exercises that are more likely to introduce discontinuities and errors than to serve the organization well. His basic argument is that organizations need to promote learning at the "lowest levels" to adapt to changes in the environment. The lowest levels, in

the current case, are the loosely coupled elements, for example, the various teams. Managers of the Lotus Notes® implementation were not sensitive to the various teams.

A reason for the lack of collaboration resulting from this implementation can be found in the way MacGregor Crane identified loose coupling as a problem to deal with, rather than as a resource to draw from. From the point of view of "grass root" adaptation, loose coupling could be interpreted as a resource to exploit. Contrasting Weick's ideas of loose coupling with top-down, highly control-oriented managerial narratives on how to align strategy and infrastructure in modern corporations, Ciborra (2000) describes the ideas inherent in loose coupling as an organizational ideal. He argues that IT should not be imposed on loosely coupled elements, but rather that the diversity inherent to organizations should be seen as a resource to draw from.

Related to the notion of knowledge intensity of the product, it was obvious that there existed a belief among MacGregor Crane's organizational members about core activities and peripheral activities among the loosely coupled elements of the company. Knowledge intensity, as defined by Ciborra (2000), depends upon (1) the number of actors that are sources or recipients of product-related knowledge, and (2) the amount/complexity of the knowledge generated or required at each stage of the development, launch, and market-ing of a product. Among the multiple stages of development of MacGregor Crane's products, the engineering stage was considered to be the most important, i.e.,that is, the core activity. Moreover, this activity solely involved the engineers, and no other group. Thus, perhaps paradoxically, the ambition to control the IT project at MacGregor Crane, along with the resistance to reconsider what organizational activities were central and what activities were peripheral, contributed to the lack of collaboration resulting from the IT implementation.

Acknowledging the powerful dialectic be-tween the needs of the organization and the needs of the individuals (or group of individuals), the idea of loose coupling underlines the dynamic relation between the loosely coupled elements on the one hand, and the organization as a whole on the other. As opposed to the linear, push/pull structuralism of the top-down hierarchical or-ganization, loose coupling facilitates dynamic grouping of staff and physical resources for specific purposes, followed by re-coupling as needs and purposes change. In consequence, it provides recognition of the needs of individuals and groups within an organizational culture to adjust their understanding of the organization before they can adjust to their changed role as individuals within the organizational culture. In light of this research's findings, we suggest that the successful implementation of a collaborative IT within a loosely coupled organization should involve the reconsideration of the organizational members' roles and functions. This did not happen at MacGregor Crane.

CONCLUSION

The problems in managing complex technology projects are not new; a number of studies have pointed to the difficulties of integrating coordi-nation technologies into work practices, raising issues such as a lack of critical mass, inadequate training, inappropriate expectations, and struc-tural and cultural problems (Alavi, Kayworth, & Leidner, 2005-6; Markus, 1987; Orlikowski, 1992).

The later phase of the project was concerned with efforts that did not result in any actual changes, as the project as a whole was based on the idea that an increased collaboration among key organizational roles would contribute to the organization's capability to reach its goals. This collaboration was refused from the parties involved, as they all perceived that their work

practice would be changed in a way they did not feel comfortable with. In theory, collaboration was welcome among all organizational members, but in practice, people refused to change their work practices.

In this project, thus, there were no well-controlled changes made when it came to the organizational adaptation of the Lotus Notes® application. MacGregor Crane faced a situation where resources were put into an IT project that was not well controlled. The "Lotus Notes® experience" at MacGregor Crane underscores how IT and organization are connected to each other, and how their role and their meaning depend on this connection. This connection is of crucial importance: change one element and you also change the other. Out of this change, new meaning arises, which redirects the organization. This is something that needs to be recognized and to be put on the managerial agenda. At MacGregor Crane, this was not the case. Ironically, while MacGregor Crane identified a central problem for all loosely coupled organizations as a starting point for the Lotus Notes® project, the problem concerning coordination, it was this very problem that led to the overall project failure.

The loosening of the ties between organizational constituents presents us with a particular managerial challenge, and the theoretical perspective of loose coupling can be a powerful tool in the hands of IS researchers trying to gain a better understanding of the complexities involved in such situations. Nevertheless, it is not the only approach. Stucturation theory, or other theoretical approaches embedding a dialectical interpretation (Robey & Boudreau, 1999), could have also shed light on the organizational change triggered by collaborative information technology (Evans & Brooks, 2005). However, we believe that, given MacGregor Crane's organizational structure, its investigation through the lens of loose coupling constituted a particularly good fit.

While more empirical work is necessary to completely understand IT adaptation, we be-lieve that this chapter offers a useful beginning. Understanding the couplings between organizational elements, and the potential for collaboration between them, allow us to learn more about the limits of IT-related organizational communication and collaboration. The current postindustrial era, fostering market globalization, rapid technological change, and shortened product life cycles, influences the way work is done and how people collaborate (Kellogg, Orlikowski, & Yates, 2006). Given that these changes are on the rise, the extent of collaboration between organizational elements and the use of IT fostering communication and collaboration will thus continue to increase over time. It is thus imperative for us to understand this phenomenon better.

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ENDNOTES

[1] It should be noted that the engineering role is formally described as being organized in "design and development," "production," and "material administration." We chose to include these administrative units in the same role as they are all concerned with engineering tasks and are not distinct roles in practice.

[2] As to the other three types of generalization discussed by Walsham (1995), they are: generation of a theory, development of concepts, and development of implications in particular domains of action.

[3] The project manager did not want to state precisely how much resources were put into the project; he only stated that it was "way too much."

Chapter IX

The Impact of Communication Medium on Virtual Team Group Process

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ABSTRACT

Organizations must provide appropriate work group structures and communication technologies in order for work groups to function effectively and efficiently. This study investigated the hypotheses that team structure (e.g., fully collocated teams vs. virtual teams) and communication mode (i.e., face-to-face vs. videoconferencing) will impact virtual team group processes (e.g., team orientation, workload sharing, proclivity to seek and exchange information) that evolve. Furthermore, these group processes will dictate team member information exchange patterns (e.g., across all team members vs. only within collocated subgroups), which subsequently impact team productivity (i.e., accuracy and timeliness) and group process satisfaction. Four-person teams worked in either face-to-face (i.e., fully collocated group) or videoconferencing (i.e., dispersed subgroups) settings to develop detailed design documentation for specified enhancements to a hypothetical university information system. Results indicated that the dispersed subgroups exhibited more within subgroup collective behaviors and engaged greater within subgroup information exchange as compared to fully collocated teams, where more teamwide collective behaviors and information exchange were observed. Furthermore, greater team collective behaviors gave rise to greater information exchange and activation among team members. Finally, information exchange and activation were associated positively with productivity and process satisfaction.

INTRODUCTION

The most distinctive features of virtual teams are that they cross boundaries of space (i.e., geographically dispersed) and that team interaction is mediated through communication technologies such as videoconferencing and e-mail. In contrast, conventional teams are fully collocated, and team interaction is conducted in a face-to-face fashion (Bell & Kozlowski, 2002; Olsen et al., 2002). The formation of virtual teams facilitates the incorporation of a wide range of knowledge and expertise possessed by individual members into a collective body of knowledge needed to conduct effective group problem-solving activities typical to decision making, product engineering, and software development contexts (Graetz et al., 1998; Kraut et al., 2002). Much of the past research on virtual teams is somewhat disjointed because of the tendency of each study to focus on a narrow range of issues, such as (1) media ability to convey both verbal and nonverbal information (Burke & Chidambaram, 1999; Yoo & Alavi, 2001); (2) social presence, or media ability to promote awareness of team member presence (Burke & Chidambaram, 1999; Yoo & Alavi, 2001); (3) extent of information sharing (Graetz et al., 1998); (4) type of information exchanged — task-related and nontask-related (Kahai & Cooper, 1999); (5) perceived utility of computer-mediated technology (Townsend et al., 2001); and (6) group cohesion (Yoo & Alavi, 2001). The summary in Table 1 indicates that more recent virtual team research has begun to investigate issues related to virtual team member interactions.

Table 1. Recent research on virtual teams

Author(s)	Study's Key Finding(s)
Brown et. al., (2004)	1. Personality type affect the individual's disposition to trust, perceived trustworthiness, communication, and thereby affects willingness to collaborate and productivity
Kirkman et. al., (2004)	1. Highly empowered teams had higher levels of process improvement and satisfaction than were less empowered teams.
Paul et. al. (2004)	1. Collaborative conflict management style positively impacted satisfaction with the decision making process, perceived decision quality, and perceived participation of the virtual teams
Huang et. al., (2003)	1. A GSS with an embedded goal-setting structure lead to better team cohesion, better team commitment, better collaboration climate, better perceived decision quality and generated more decision alternatives
Piccoli and Ives (2003)	1. Behavior control mechanisms typically used in traditional teams have a significant negative effect on trust; 2. Trust declines in instances of reneging and incongruence.
Andres (2002)	1. The face-to-face setting exhibited greater productivity and interaction quality
Burke & Chidambaram (1999)	1. Computer-mediated and face-to-face teams reported differences in perceived social presence; 2. Communication effectiveness was significantly greater for face-to-face groups
Mannecke & Valacich (1998)	1. Established groups discussed less unique information than ad-hoc groups; 2. Information sharing was positively related to the quality of group decisions; 3. Members using the computer-mediated systems were less satisfied than those communicating face-to-face.

The sample of studies depicted in Table 1 indicates a focus on the impact of trust, cohesion, team commitment, communication effectiveness, information sharing, and conflict management on virtual team productivity (i.e., accuracy and timeliness) and satisfaction. None of these studies addressed issues that would arise in a setting where the overall team is comprised of multiple dispersed subteams. In other words, how would groupwide support and participation (i.e., team collective behaviors) and information exchange patterns (i.e., local vs. teamwide) develop if, instead of dispersed lone individuals, teams comprised of virtual subgroups were examined? Would participation be more teamwide typical to fully collocated face-to-face teams, or would communication exchanges predominate locally within dispersed subgroups?

This study extends recent research on virtual teams by addressing in a path analytical model team collective orientation and information exchanges that lead to the activation of new information and ultimately greater team productivity and satisfaction related to a software design task solution in fully collocated teams (i.e., face-to-face) and virtual teams (i.e., geographically dispersed subgroups). In the following sections, social presence, social identity, and group process theories are used to hypothesize differences in teamwide collective effort and communication patterns that result from the extent of team member collocation. Then, the software development literature is used to discuss the relevance of collective efforts and information exchange patterns for software development productivity and process satisfaction. Previous research has noted that software development activities are characterized as highly task interdependent and require teamwide collective effort and information exchange in order to facilitate expertise integration essential to team productivity and satisfaction (Andres & Zmud, 2001; Byrd et al., 2004; Kraut et al., 2002). Next, using relevant research findings, hypotheses are presented. This is followed by a discussion of the findings and suggestions for future research on investigating communication technologies and management strategies to support the use of virtual teams.

Social Presence

Social presence refers to the ability of a communication medium to allow a group member to maintain awareness of the presence of the other group members and the feeling that the group is involved jointly in mutual communicative interaction (Short et al., 1976; Sia et al., 2002; Yoo & Alavi, 2001). The extent of social presence associated with a communication medium is a function of the amount of communication channels available to transmit rich information. These channels include verbal cues, facial expressions, gaze, gestures, posture, physical proximity, and back-channeling cues. These cues give rise to greater team member awareness and indicate attentiveness and agreement or disagreement with information that has been transmitted or received. Team member awareness should give rise to greater team collective effort through team member proximity and awareness of team member availability. These channels also can act as a coordination mechanism for communicative flow that facilitates maintenance of coherent information exchanges that can further reinforce communication efficacy and, ultimately, greater activation of new information and shared understanding needed for group task success. In summary, social presence theory suggests that fully collocated team members should experience greater frequency of team collective behaviors and teamwide information exchanges as compared to teams comprised of dispersed subgroups.

Social Identity Theory

Social identity theory (Scott, 1999; Suzuki, 1998; Tajfel & Turner, 1986) suggests that factors such as physical differences, differences in values, and

geographical separation can lead subgroups (i.e., in-group membership) to differentiate themselves from other subgroups (i.e., out-group membership). Behavioral outcomes of subgroup differentiation are lower identification with, recognition of, affinity toward, and motivation or willingness to communicate with and cooperate with out-group members. Social identity theory suggests that fully collocated team members should exhibit greater in-group membership behaviors as compared to noncollocated subgroups (Scott, 1999). Greater in-group membership creates a sense of mutual task outcome interdependence, which results in teamwide collective behaviors needed to realize successful team task accomplishment (Mortensen & Hinds, 2001; Scheepers et al., 2002). In addition, during problem solving, differentiation among dispersed subgroups also can lead to increased in-group or out-group polarization and, ultimately, reduced team collectivist behaviors (Sia et al., 2002). Team collectivist behaviors are diminished when subgroup polarization induces more viewpoint stubbornness, argumentativeness, and one-upmanship behaviors. In addition to teamwide collective behaviors, in-group members exhibit a greater tendency to engage in more information exchange with in-group members as compared to out-group members. Suzuki (1998) noted that psychological distance leads to intergroup (or subgroup) differentiation and subsequently dictated communication patterns. Greater information seeking was conducted among members with greater in-group identification as compared to information seeking among members with greater out-group identification. In summary, social identity theory suggests that fully collocated team members should exhibit greater team collectivist behaviors and information exchanges as compared to teams comprised of dispersed subgroups.

GROUP PROCESS

Previous research has defined effective group process as the process of engaging in cooperative and collective behaviors and relevant skills sharing and information pooling, all of which are impacted significantly by the structural arrangement of the workgroup (Drach-Zahavy & Somech, 2001; Sia et al., 2002; Watson et al., 1998). Work group structural arrangements dictate the communication modes that can be utilized (i.e., technology-mediated or face-to-face), ease of accessibility to team members for communication and collaboration, and potential frequency of interactions. Team collectivist behaviors facilitate increased group or team productivity through team member willingness to recognize team member contribution viability, consider alternate viewpoints, share workload, and engage in teamwide information exchange (Watson et al., 1998). Recognition of team member contribution viability occurs when team members actively seek the input of other team members and when there is objective groupwide assessment of suggestions posed. Under such conditions, team members are more likely to offer a greater number of alternative strategies that give rise to the activation of new information or ideas. During group/team information exchange, the distribution of speaking turns determines the extent to which information is pooled. Information pooling and activation are evidenced by two predominate group communication patterns among group members: **reach testing** (i.e., short sequences in which group members deal with a variety of proposals before moving on to the next subtask) and **spiraling** (i.e., iterations of teamwide refinement of a proposed idea that had received positive evaluations when first discussed) (Bonito, 2000, 2001). Reach testing is essential to the process of identification and consideration of alternative solutions. Spiraling is essential to the process of pooling information and new information activation resulting from comprehensive analysis of solution proposals.

Figure 1. Causal path model of communication medium, group process, information activation and exchange, and virtual team performance
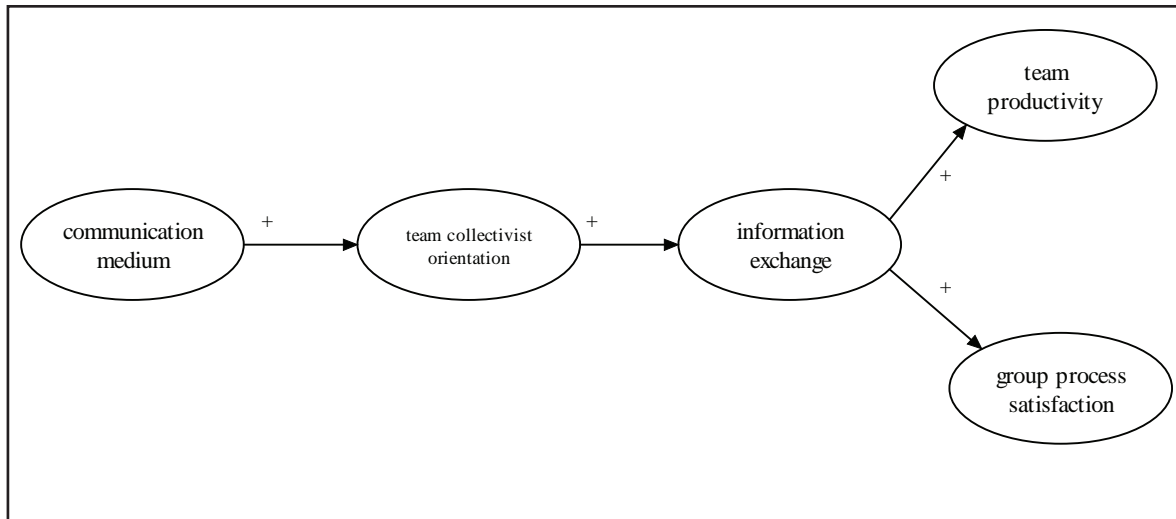
Group problem solving is optimal when pooled information leads to a more comprehensive model of the problem that is then analyzed to gain greater understanding and activate new information derived from the newly gained understanding of the problem (Bonito, 2001). Past research on problems encountered during software development tasks suggest that team collective behaviors and effective information exchanges are essential to software project success (Andres, 2002; Andres & Zmud, 2001; Byrd et al., 2004; Waterson et al., 1997; Wong et al., 1998).

SOFTWARE DEVELOPMENT PROJECT SUCCESS

Software projects can experience communication breakdowns that are attributable to changes in personnel, conflicting cognitive orientation and goals, conflicting assessments of the problem space, technology, and so forth (Armstrong & Cole, 2002; Byrd et al., 2004; Waterson et al., 1997; Wong et al., 1998). In fact, in the majority

of recent software project management research, the three most recurring salient problems associated with software development tasks were (1) the thin spread of application domain knowledge, (2) fluctuating and conflicting requirements, and (3) communication and coordination breakdowns. Software project success is highly dependent upon knowledge acquisition, role clarification, information sharing, and skill integration (Byrd et al., 2004). Armstrong and Cole (2002) found that distributed software development work groups experienced misunderstandings in communications and conflict. Communications often were fragmented, with gaps and misunderstandings among geographically dispersed group members. In other studies (Andres, 2002; Andres & Zmud, 2001), superior team productivity has been observed when software development team members exhibited groupwide communication, cooperation, and balanced team member contribution (i.e., collective effort and equitable workload sharing).

These issues suggest that the communication medium utilized to support the software

development activity must adequately facilitate a team collectivist orientation, information exchange/pooling, and workload sharing. This would be essential in order to reach consensus on the software requirements and to clarify any existing instances of role ambiguity. Finally, the communication medium used also must allow the transmission of socio-emotional content needed to support factual information along with personal interaction needed to implement conflict resolution when addressing divergent alternative solution proposals, interests, goals, and cognitive orientations.

HYPOTHESES

This study suggests that communication media characteristics (e.g., high or low social presence) can impact the extent of team collectivist orientation that subsequently impacts the teamwide propensity to seek and share task-related information across team members. The extent of shared/pooled information then will impact team productivity and process satisfaction. Figure 1 depicts these causal paths.

Social identity theory (Tajfel & Turner, 1986) suggests that group identification will be accompanied with a sense of shared task outcome interdependence, which creates a need to construct a team collectivist orientation (i.e., recognition of input from others and workload sharing) in order to assure a positive group outcome. Proximity and subsequent in-group identification should offer fully collocated team members a greater potential to develop a team collectivist orientation among all team members. A sense of shared outcome fate will motivate fully collocated team members to value team member input and to engage in synergistic and cooperative efforts. Alternatively, teams comprised of dispersed subgroups will have greater difficulty developing a sense of teamwide collectivist orientation (i.e., across all subgroups) and, instead, will exhibit greater team collectiv-

ist orientations among local subgroup members as compared to across all dispersed subgroups. Minimal collective behaviors among dispersed subgroups would occur because of more attention and communication between local subgroup members and less attention paid to nonlocal out-group members. In addition, proximity is essential to psychological awareness of team member presence needed to utilize team member availability and to maintain effective workload sharing aimed at addressing shared outcome task interdependence (Ocker & Yaverbaum, 1999). Low social presence experienced by dispersed team members when communicating with videoconferencing technology also can lead to the tendency to remain stubborn and/or to refrain from negotiation of individual viewpoints, because reprisals from out-group members are not anticipated or are perceived to be minimal and consequently ignored (Purdy & Nye, 2000). In summary, social presence can dictate the extent of team member utilization and consideration as a function of team member awareness. Subgroup identification/membership can dictate the extent of a willingness or a tendency to engage in team member utilization as a function of physical separation and local shared task outcome interdependence. Therefore,

Hypothesis 1: Groups working in the face-to-face setting will experience greater teamwide (across subteams) collectivist orientation than in the videoconferencing supported setting.

A team collectivist orientation is essential to ensure that workload is shared equitably and that new information is available to all members who require it (Bonito, 2001). Under conditions of high team collectivist orientations, input of groupwide information is assured, because team member input is encouraged, valued, and objectively considered. Any information possessed by a single member (or subset of the group) will be distributed to other members in order for it to be

useful to the group as a whole. The distribution (i.e., exchange) of information can be conceptualized as a collaborative activity, where members recall ideas posed during past group discussions, thereby creating shared knowledge essential to deriving an optimal solution. This increase in critical groupwide discussions and the resulting shared information can lead to the activation of related information that no one member previously considered (Watson et al., 1998). Alternatively, in the absence of a team collectivist orientation, dominant discussants emerge, the motivation to offer alternative solutions is diminished, and the activation of new information is inhibited. Finally, lack of ease of accessibility to team members for communication and collaboration, and diminished potential frequency of teamwide interactions inherent in the subteams within team configuration of the virtual teams presents a greater challenge in the development of team collective behaviors that then could lead to fewer instances of information exchange and activation of new information. As noted earlier, team collectivist orientation is evidenced by greater teamwide mutual support and participation. The collective behaviors result in greater information activation, exchange, and integration. The collective behaviors also ensure that dominant discussants do not emerge, that team member contribution viability is acknowledged, and that reciprocal information exchange and effort are present. Therefore,

Hypothesis 2: Team collectivist orientation will be related positively to information activation and exchange.

During group work, team structure can assume a variety of configurations (e.g., fully collocated, partially collocated, and fully dispersed) (Graetz et al., 1998; Kraut et al., 2002; Mortensen & Hinds, 2001; Ocker & Yaverbaum, 1999; Scheepers et al., 2002; Sia et al., 2002; Townsend et al., 2001) with each configuration having a differential impact on the resulting group processes (e.g., task inter-

dependence, outcome interdependence, information exchange patterns, participation equity, team member support, workload sharing). As discussed earlier, team member collocation gives rise to in-group identification, which results in greater in-group workload sharing, team member support, and information exchange, as compared to out-group identification (Drach-Zahavy & Somech, 2001). In addition, group collaboration resulted in increased activation, exchange, and integration of information, which lead to better team productivity. In these studies, group performance exceeded individual performance when member knowledge was pooled. Paulus and Yang (2000) noted that knowledge or idea exchange followed by groupwide reflection enhanced creative group cognition and facilitated further idea generation and information activation. Consequently, greater workload sharing, information exchange, and activation associated with fully collocated groups should experience superior team productivity and innovation. Effective software development group process involves knowledge acquisition and the sharing and integration of that knowledge (Armstrong & Cole, 2002). Software design teams must acquire knowledge regarding the problem domain, user requirements, and software design and development approaches (Waterson et al., 1997). Increased information activation and exchange provides an opportunity for clarification of task requirements and knowledge integration derived from optimal allocation of information and effort that would lead to an appropriate and timely software design solution. Dennis (1996) noted that technology-mediated information exchange was considered to be less credible and salient and, subsequently, was often ignored and not processed during decision making. Therefore,

Hypothesis 3: Information exchange will be related positively to team productivity.

Effective information exchange and activation can give rise to a sense of task enrichment (i.e.,

fair, efficient, coordinated) and a sense of process satisfaction and collective efficacy (i.e., belief that task success is attainable). In other words, the task context is perceived to be meaningful, fulfilling, and empowering (Bangerter, 2002; Cappelli & Nikolai, 1998). Satisfaction with group communication also can be dependent upon assessments of a group member's individual participation and other group members' participation, what was said, and how often (Cappelli & Nikolai, 1998; Kirkman et al., 2004). Group process satisfaction was highest when there was greater groupwide collective effort to provide substantive information exchange and effort during task execution. This suggests the following hypothesis:

Hypothesis 4: Information exchange will be related positively to group process satisfaction.

METHOD

Participants

In this study, 48 subjects were drawn from a population of Management Information Systems undergraduate students familiar with the Systems Development Life Cycle approach to software design and knowledge of the C++ structured programming language. Recent research has noted that novice programmers exhibit skills that are comparative to expert programmers, when the program functional requirements are of moderate complexity and when the problem domain is well understood (Wong et al., 1998; Yoo & Alavi, 2001). A pretest validated that the subjects possessed the skills necessary to complete the experimental software design task within a three-hour period. The students were assigned randomly to a four-person design team that then was assigned to either the face-to-face or virtual team condition but not to both. The virtual team was configured as two dispersed subteams. In the face-to-face setting, the two subteams sat across from each other at a conference table. For their participation, each design team was eligible to receive a $100 award for the highest team productivity score under each of the experimental conditions (i.e., face-to-face and dispersed videoconferencing).

Experimental Manipulation

The experimental manipulations involved the use of a two-way audio-videoconferencing system. The virtual team setting was comprised of two geographically dispersed subteams, each comprised of two collocated team members, where face-to-face communication was possible within subteams, and videoconferencing was used to communicate across the virtual subteams. In the pure face-to-face setting, both subteams interacted in a fully face-to-face setting while seated at a conference table. Each subteam possessed both teamwide shared information and unshared information needed by the other subteam in order to complete its portion of the overall software design and documentation task. In both settings (face-to-face and virtual), the two subteams were required to communicate the other's task requirements and to collaborate with each other throughout the entire execution of the task. At the end of the task execution, each subteam was required to submit its own complete and consistent paper documentation of the software design. Any portion of the solution not possessed by both subteams was ignored. This restriction was imposed in order to prevent the subteams from subdividing the tasks and from working independently of each other. The subteams were not allowed to physically exchange any documents created by the other subteam during task execution or during the break session. Compliance to this restriction was verified after viewing videos of the task execution.

Experimental Task

The teams were required to enhance the functionality of a hypothetical university information system. The experimental task required each team to construct software design documentation that included (1) a hierarchy chart, (2) a list of function prototypes, and (3) a pseudocode for each function identified as part of a solution to the problem. These activities are typical of software design and coding activities conducted within organizations and exhibit the same form of team collaboration, communication, and decision-making requirements (Sommerville, 2000). The enhancement required the development of software modules that would determine athletic participation eligibility status and scholarship award amounts based on a student's classification, credit hours acquired, and grade point average. In addition, the system's enhancement was also required to provide queries regarding a student's athletic participation eligibility and scholarship award. The final enhancement requirement provided automation to parking fee calculations for a parking garage. The experimental task duration was 2.5 hours with a 10-minute break scheduled during the mid-point of the experimental session. As stated earlier, a pretest validated that the average time to complete the experimental software design task by a four-person team was approximately three hours. During the break, there was no communication between the two subteams, only within the subteams.

Independent and Dependent Variables Communication Mode

In the videoconferencing setup, a two-way audio-video system comprised of a video camera and a microphone mounted on top of a 32-inch color monitor was used to connect the two dispersed subteams. Communication mode (i.e., face-to-face or videoconferencing) was the only exogenous variable. The face-to-face mode was considered to be higher in social presence (Short et al., 1976) and backchannel communication feedback features (e.g., gaze, gestures, utterances, facial expressions) that maximize monitoring people's reaction to transmitted information (O'Conaill et al., 1993). Communication mode was a manipulation and, therefore, was not measured. Contrast codes were used to assign each individual team member to a specific communication mode (i.e., videoconferencing vs. face-to-face group outcomes) (James & Williams, 2000; Short et al., 1976).

Team Collectivist Orientation. In order to capture team collectivist behavior during the three main phases typical to software development (i.e., problem analysis, design, and coding) (Sommerville, 2000), three 20-minute sessions were used to collect observational data. These sessions were conducted during the first, middle, and last segments of the experimental task (Heyman et al., 2001; Shaughnessy et al., 2003). Team collectivist orientation was rated independently by two observers while viewing videotapes of the experimental task. Team collectivist orientation was measured using a seven-point scale with four items adapted from the Group Style Inventory by Watson, Johnson, and Merritt (1998). Previous research on group process, team climate, and work group communication was used to derive items for the team collectivist orientation scale. The scale (see Appendix A) included items that assessed the extent to which dominant speakers emerged; viewpoints were negotiated; contribution was encouraged and valued; and workload was shared. Inter-rater reliability was significant and high ($r = 0.86$ and $p < 0.001$), and the scale reliabilities (Cronbach's alpha) were 0.89 (for rater 1) and 0.93 (for rater 2).

Information Activation and Exchange. The three 20-minute sessions used to collect observational data for team collectivist orientation were used to collect data for information activation and exchange during the problem analysis, design, and coding phases of task execution (Heyman et

al., 2001; Shaughnessy et al., 2003; Sommerville, 2000). Information exchange was defined as definitive instances where a new idea or question related to the task solution was posed, and there was a resultant sequence of exchanges characterized as assessment and negotiation of the proposed idea or the activation of new information considered for implementing the solution. For example, "How many text data files should we use? That depends on the rate that data will change. But are we using text data files or database tables? Does it matter? No, let's keep it simple and use text data files. OK. OK. Yeah, good idea," is considered to be a definitive information activation and exchange sequence. One point was tallied when the information exchange sequences involved at least three group members (i.e., groupwide exchanges). Information exchange points were tallied by two observers while viewing videotapes of the experimental sessions. The inter-rater reliability for information exchange scores proved to be reliable ($r = 0.88$ and $p < 0.001$).

Team Productivity. The team productivity measure was determined by assessing the completeness of the required design documentation. A research assistant, unaware of the study's objectives, computed team productivity as a combined score on the completeness of file design, specification of function prototypes, and pseudocode for each function. Credit was given only to design documentation that was consistent between both subteams. A point was awarded for each correct specification of any data value of a specific data file, correct output and input data value of a program module (i.e., function or subroutine), and correct specification of program statement needed in a specific program module. Any part of the solution not developed, documented, and submitted by both subteams was ignored.

Group Process Satisfaction. The group process satisfaction questionnaire elicited individual team member responses regarding the extent to which, while executing the task, the group process was efficient, coordinated, fair, confusing, and satisfying. This 5-point Likert scale (see Appendix A) was adapted from questionnaire items used by Green and Tabor (1980). The scale reliability (Cronbach's alpha) for the group process satisfaction scale was 0.82.

RESULTS

Given that the goal of this study was to examine the total effects of cause variables on effect variables by taking into account both direct and indirect effects, path analysis using a series of regression analyses was chosen as the data-analytic strategy for testing the proposed causal path model depicted in Figure 1 (Pedhazur, 1997). Statistics for team collectivist orientation, information exchange and activation, and team productivity were examined at the group level ($N = 12$) and cross-level inference (James & Williams, 2000) was performed to examine the relationship between the extent of group-level information exchange and individual satisfaction with the group process resulting in $N = 48$. Cross-level inference is a hypothesis about how variation in situations or group level phenomena (e.g., extent of groupwide information exchange) is related to variation on an individual level construct (e.g., individual satisfaction). In cross-level inference, a group level score is assigned to each group member, because the situation is constant for all members of the group not unlike how one crosses levels from group membership to the individual in ANOVA by assignment of a group mean to an individual. However, ANOVA merely tests for differences in group means while theorizing about what causal chain of underlying factors affected by the treatment resulted in group mean differences in the outcome variable. In contrast, the cross-level inference allows for the designation of these underlying factors and for the assessment of the magnitude of the linear relationship between the underlying factor and the outcome variable. In other words, regressing the cross-level operator on an individual level

Table 2. Means, standard deviations, correlations, and reproduced correlations

Variables	M	SD	1	2.	3	4.	5
1. Communication Medium	0	1.01	.	(.94)	(.73)	(.54)	(.25)
2. Team Collectivist Orientation	17.21	5.34	.94**	.	(.78)	(.58)	(.26)
3. Information Exchange	29.67	6.42	.72**	.78**	.	(.74)	(.34)
4. Team Productivity	12.08	5.63	.61**	.70**	.74**	.	
5. Group Process Satisfaction	17.94	3.90	.19	.16	.34*	.06	.
6. Ability	87.48	6.09	-.04	.04	-.03	.09	-.10

*Note. Correlations reported are based on N = 48   * p < .05   ** p < .01*
The original correlations are reported in the lower half of the matrix. The reproduced correlations of relevant variables are reported in the upper half of the matrix.

construct determines the amount of variation in the individual level outcome variable that is specifically associated with variation in the situation or group level phenomena that greater defines the group context (James & Williams, 2000).

The model proposes that the mode of team communication (i.e., virtual vs. face-to-face) indirectly affects both overall team productivity (i.e., both subteams) and individual satisfaction with their teamwide group process through its effect on team collective behavior and information exchange patterns. Four regressions were used to test the model. In each regression analysis, all variables occurring prior to or at the same point in the conceptual model were included in order to verify both direct and indirect effects specified in the path model. Only significant cause effect variables were included in the final regression on the effect variable. Ability (i.e., a score received from a C++ programming class) was considered as a covariate to productivity, but there was no significant bivariate correlation. Table 2 presents the means, standard deviations, original correlations, and reproduced correlations of the variables in the study.

The reproduced correlations in the upper half of the matrix in Table 2 represent the direct and indirect effects (i.e., all path segments that link any two variables in the causal model) among the

exogenous and endogenous variables (Pedhazur, 1997). Reproduced correlations were computed utilizing the standardized beta coefficients of all direct and indirect path segments that linked the two variables. As Table 2 shows, the reproduced correlations duplicate the observed correlations with minimal discrepancies, suggesting a good fit between the hypothesized model and the observed data. Structural equation model analysis measures of model data fit indicate that the proposed model structure closely resembles the simple bivariate correlations. A root mean squared residual (RMR), a measure of observed reproduced correlation discrepancy of 0.03 (RMR < 0.05 indicate good fit) and a normalized residual index (NRI) of 0.93 (NRI = 1 indicates perfect fit) suggests that the specified model fits the data (Anderson et al., 1985). Figure 2 depicts the path coefficients (standardized betas) for the hypothesized causal relationships.

Pedhazur (1997) suggested that standardized coefficients can be considered measures of effect sizes, and betas of 0.10 or greater indicate a substantial effect size. Hypothesis 1 predicted that increases in a communication mode's social presence would lead to higher team collectivist orientation. A regression analysis was conducted with communication mode as the independent (exogenous) variable and team collectivist orienta-

Figure 2. Path analysis results of the hypothesized model
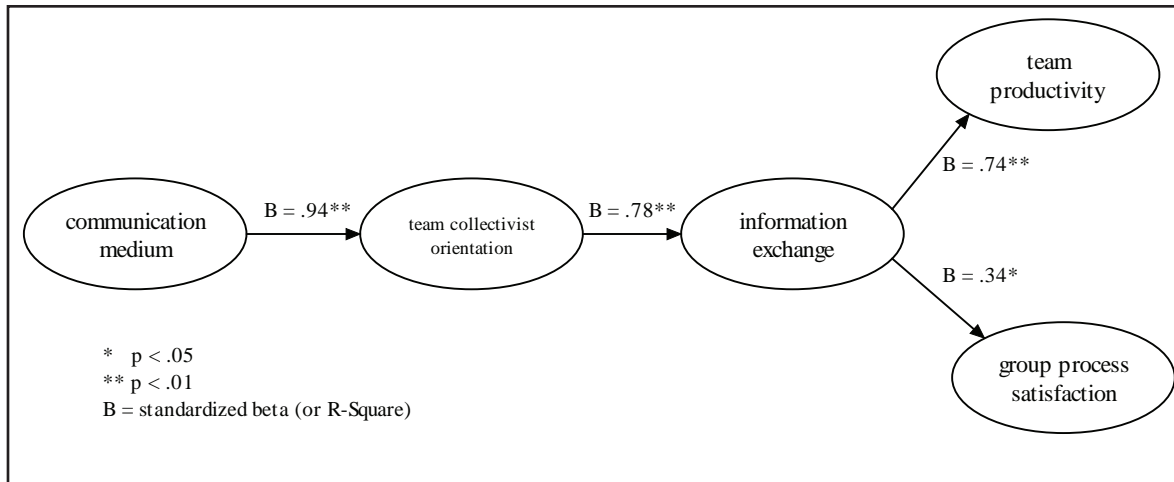
tion as the dependent (endogenous) variable. As hypothesized, communication mode was related positively to team collectivist orientation (standardized beta = 0.94, $p < 0.01$). Communication mode accounted for 94% of the variance in team collectivist behaviors across all teams. Apparently, the face-to-face settings exhibited a greater tendency to work collectively, elicit the ideas of others, and critically evaluate and negotiate alternative ideas and opinions.

The second hypothesis predicted that increases in a team collectivist orientation would lead to increased information exchange. To test this segment of the causal path model, a regression analysis was conducted with team collectivist orientation as the independent (exogenous) variable and information exchange as the dependent (endogenous) variable. The results indicated that team collectivist orientation was positively related to information exchange (standardized beta = 0.78, $p < 0.01$). Team collectivist orientation accounted for 78% of the variance in information activation and exchange. Team members in the face-to-face setting were observed engaging in more team collectivist behaviors that lead to more information pooling and activation of new information across subteams as compared to the physically separated

subteams in the videoconferencing setting. Thus, Hypothesis 2 was supported.

To test Hypothesis 3, a regression analysis was conducted with information exchange as the independent (exogenous) variable and team productivity as the dependent (endogenous) variable. As predicted in Hypothesis 3, the results indicated a significant positive relationship between information exchange and team productivity (standardized beta = 0.74 $p < 0.01$). Information exchange and activation accounted for 74% of variance in team productivity. Increases in information exchange were associated with higher team productivity. Finally, a regression analysis, performed with information exchange as the independent (exogenous) variable and group process satisfaction as the dependent (endogenous) variable, was used to test Hypothesis 4. For Hypothesis 4, the results indicated that there was a significant positive relationship between information exchange and group process satisfaction (standardized beta = 0.34, $p < 0.05$). Cross-level inference indicates that differences in group-level information exchange accounted for 34% of the variance in individual group process satisfaction. The experimental subjects were more satisfied with team processes that exhibited greater information exchange and activation.

DISCUSSION

The findings of this study suggest that technology-mediated communication can significantly impact the extent to which a virtual team can function as a collective group and the extent to which information can be pooled effectively and further refined through groupwide dialogue. The results support the notion that a communication medium can create a team collectivist orientation that can influence the extent of and patterns of information exchange. Further, the nature of the information exchange patterns is found not only to enhance team productivity but also to engender group process satisfaction. These findings support the results of recent research that noted that communication effectiveness (Brown et al., 2004; Burke & Chidambaram, 1999; Mannecke & Valacich, 1998) and cohesive interactions (Andres, 2002; Huang et al., 2003) are essential for improved virtual team productivity. Higher team collectivist orientation was found to promote greater information redistribution and critical examination of existing information needed to integrate information previously presented and to activate new information that is critical to effective decision making and problem solving. The observed group process satisfaction derived from increased information exchange likely can be attributed to a sense of group potency (or group efficacy) that makes task execution appear to be coordinated, fair, easy to accomplish, and satisfying.

One significant contribution of this study is the finding that collocated virtual team members spent more time interacting with each other and tended to forget the presence of their other geographically dispersed team members. In other words, collocation can create groups within a group. Specifically, the virtual teams exhibited greater in-group identification within their dispersed subteams in contrast to teamwide identification exhibited by the face-to-face teams. Apparently, team members collocated within a dispersed subteam identified more with each other than with members of their dispersed counterpart. Observation of the videotaped sessions and the statistical results show that the videoconference-supported group tended to engage in more information exchange among individuals collocated within subteams with limited periodical question-answer exchanges at the groupwide level. In addition, there was a greater tendency for one dispersed subteam to request reclarification of ideas proposed by the other dispersed subteam. These requests for reclarification can be construed as a lack of trust in the credibility of the other subteam's ability and proposed ideas. Comparatively, the high social presence associated with the face-to-face group resulted in a greater tendency to seek suggestions and opinions and to engage in more teamwide communication. It is clear that a greater sense of social presence or proximity, inherent in a face-to-face setting, created a higher sense of team member presence and availability for information exchange and also minimized the emergence of one or two dominant speakers. In addition, the face-to-face group members were more critical of alternatives posed and made fewer requests for reclarification of ideas presented as compared to the dispersed virtual subteams. Virtual team members may have experienced a lower sense of belongingness to the overall team. The observed behaviors in this study suggest that the trust issues found in previous research (Brown et al., 2004; Paul et al., 2004) may be related to in-group/out-group differentiation or perceptions of separateness among virtual teams members.

The superior team productivity experienced by the face-to-face groups suggest that physical proximity promotes greater awareness of the presence of other group members needed to motivate greater groupwide information seeking, sharing, and integration. In contrast, the geographically dispersed groups engaged in more within-subgroup communication resulting in minimal information sharing and integration, which ultimately diminished productivity and group process satisfaction.

The within-group communication apparently lead to subteam stubbornness of viewpoint and competitive behaviors devised to influence the design according to their subteam's cognitive representation as opposed to development of a groupwide consensus that would lead to a more timely project completion. It is concluded that the face-to-face groups experienced greater productivity, because they were more prone to offer new information and to negotiate other members' viewpoints. In contrast, lower productivity experienced by the videoconferencing groups could be attributed to the fact that they engaged in less groupwide dialogue, appeared to have less confidence in the correctness of information exchanged, and were less concerned with reprisals that could result from viewpoint stubbornness.

The greater group process satisfaction experienced by the face-to-face groups suggests that face-to-face communication is better suited to the development of a positive social context. High social presence associated with face-to-face groups apparently provided a setting where mutual eye gaze and nods helped to reduce disruptions in communication and to engender feelings of personalization and message clarification that would encourage behaviors aimed at maintaining a cooperative climate and feelings of group well being. Finally, the observation of the video-taped sessions revealed a general tendency for the face-to-face groups to express disagreement with solution alternatives posed, but yet these groups reported a greater sense of group process satisfaction than that of the videoconferencing group. This suggests that greater social presence may have reduced argumentativeness or the tendency to openly express negative opinions regarding another's suggestions possibly through the potential immediacy of reprisal or the motivation to maintain a positive team orientation. This study also extends current virtual team research through its use of path analysis to identify and depict the structural relationship among issues that arise from virtual teams structured as dispersed collocated subteams. As the study shows, there are within collocated subteams as well as within overall virtual teams, dynamics that dictate the extent of collaboration, information exchange and activation, and, ultimately, team productivity and satisfaction.

As with all the studies, there are certain limitations that must be acknowledged. First, it is important to recognize that this research took place in a contrived setting that used student subjects subjected to an experimental manipulation. This limitation constrains the generalizability of the results to real-world virtual teams. However, student subjects often represent a variety of backgrounds, behaviors, and skills similar to organizational members, and usually reflect a typical working software development professional (Andres, 2002). Although task size and duration were relatively small, the task exhibited conceptual complexity typical of real-world large software development applications. In addition, this task-related limitation is inherent to such empirical studies and can't be avoided. However, the experimental setting does not capture all of the possible environmental factors that would define typical real-world settings. Finally, limited sample size is known to result in low observed power tests for some of the statistical tests. In this study group level, analysis was conducted at $N = 12$, and cross level inference was conducted with $N = 48$. Sample size should be at least 10 times the largest number of predictors associated with a predicted variable (Hulland, 1999). This study has conformed to this requirement in that all endogenous variables have only one exogenous predictor. Small sample sizes can lead to the conclusion that there are no differences between the treatment groups when, in fact, differences are present. This study did not encounter any problems typical to relatively small samples. It is believed that, despite the stated limitations, this study makes some valuable contributions to the existing body of knowledge and practice on virtual teams.

CONCLUSION

The purpose of this study was to assess the relative effectiveness of the use of videoconferencing technology to support a virtual software design team. The results indicate that managers must find innovative ways (e.g., task facilitator) to promote greater teamwide and coordinated information exchange. Managers also should find ways to instill confidence in the knowledge and ability of dispersed team members and to promote a greater sense of group membership despite the apparent psychological and physical distance present when supporting virtual teams using videoconferencing technology. In addition, managers should be aware of the potential for within subteam dynamics as well as across subteam dynamics to arise when virtual teams are comprised of multiple dispersed subteams. The study's results also suggest that information exchange patterns are not a direct outcome of a communication medium but are, instead, a function of the group process and structure imposed by the communication media used. In effect, a group problem-solving context can be shaped by the characteristics of the technology used to support group communication.

While there is a growing amount of research about technology-supported work groups, there seems to be an omission of the consideration of the psychosocial context (e.g., team collectivist orientation, information exchange patterns) created by communication technology used to support group work. Future research aimed at acquiring a greater understanding of the social and psychological aspects of group work will help to gain more leverage from the use of technology-supported work groups. Future research also should address other contextual factors (e.g., task interdependence, task type, project phase) that might moderate the impact of the communication medium used to support distributed work groups. Upon the identification of relevant technical and group process issues in communication medium use, task execution strategy then can be modi-

fied in order to overcome any shortcomings of videoconferencing technology as compared to face-to-face settings. The findings of this study mark a step toward understanding virtual team interactions that more greatly resemble real-world virtual teams that tend to be comprised of groups within groups (i.e., geographically dispersed collocated groups) engaged in problem solving and design tasks.

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APPENDIX A

Team collectivist orientation - When observing the teams on this project, to what extent did

___One or two members dominate the discussion more than they should?
___Members remain stubborn in their viewpoints?
___Members with good ideas did not seem to speak up?
___Members seem to work as a group

The **team collectivist orientation** items were rated on a five-point (1-7) Likert scale.

Group process satisfaction - How would you describe your team's software development process?

☐   efficient   ☐   inefficient
☐   coordinated   ☐   uncoordinated
☐   fair   ☐   unfair
☐   confusing   ☐   understandable
☐   satisfying   ☐   unsatisfying

The **software development (or group) process satisfaction** items were rated on a five-step semantic differential scale with the anchors shown previoiusly.

Chapter X
Understanding the "Mommy Tracks":
A Framework for Analyzing Work–Family Balance in the IT Workforce

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ABSTRACT

Despite the recent growth in the number of women in the American labor force, women are still under-represented in the IT workforce. Key among the factors that account for this under-representation is balancing work-family issues. This article presents a framework for analyzing work-family balance from a field study of women employed in the American IT workforce. The findings are examined through the lens of the individual differences theory of gender and IT to show the range of ways in which work-family considerations influence women's IT career decisions. The framework is used to support the theoretical argument that women exhibit a range of decisions regarding career and parenthood: the non-parent, the working parent, the back-on-track parent, and the off-the-track parent. These findings illustrate an identifiable theme that crosses geographical regions and timeframes; societal messages are complex and difficult to digest and are processed in different ways by different women, yet they contribute to the decisions women make about their professional and personal lives.

INTRODUCTION

In the transition to an information-based global economy, the lines between work and home are blurring as technology reshapes the workplace and as the nature of home life evolves. This evolution of domestic life has brought a shift in societal thinking about mothers working outside the home (McRae, 1996; Trauth et al., 2003). The National Council of Women's Organizations (2003) estimates that 63% of women with children under the age of six and 78% of women with children ages six to 17 currently are employed in the labor force. Yet, there is still an under-representation of women in the IT workforce. A study produced by the Information Technology Association of America (ITAA) Blue Ribbon Diversity Panel (2003) found that representation of American women in high-tech employment fell from 41% to 34.9% between 1996 and 2002. This number is significantly low, considering that during the same period, the percentage of women in all occupations in the U.S. was 46% (Bureau of Labor Statistics, 1996, 2002). Thus, although the number of women in the labor force is increasing, the number of women in the IT workforce is noticeably lower.

Key among the factors that account for the under-representation of women in the IT workforce is balancing work and family. Some researchers have speculated that IT work is not an ideal fit for working mothers because of long work hours, increased conflicts with family responsibilities, and the difficulty of returning after maternity leave to an industry with ever evolving technologies (Kuosa, 2000; Webster, 1996). Thus, the question remains: Does the nature of IT work with regard to work-family balance negatively influence female participation in technical careers? Hence, the purpose of this chapter is to empirically explore the influence of work-family balance on American women's participation in the IT workforce.

The reasons for doing so are twofold. First, although both women and men report issues with work-family balance (Greenhaus & Parasuraman, 1999; Milkie & Peltola, 1999), the literature shows that women as a group tend to contribute more time to domestic duties and are more likely to make career sacrifices than men as a group (Hochschild, 1997; Hochschild & Machung, 1989; Perlow, 1998). The National Council of Women's Organizations (2003) found that, on average, women contribute 35.1 hours a week to domestic duties, while, on average, men contribute 17.4 hours a week. Furthermore, women average 11.5 years out of the paid labor force for care-giving responsibilities, whereas men average only 1.3 years. Thus, while men and women both report issues with work-family balance, they exhibit different response behaviors (Mennino & Brayfield, 2002). Second, the literature suggests that women in the IT workforce report higher levels of stress from work-life imbalance than their male counterparts (Duxbury et al., 1992; Gallivan, 2003; Igbaria et al., 1997). Therefore, while men and women both report stress related to IT work, they exhibit different behaviors in response to that conflict. Consequently, it is important to investigate more deeply the work-family balance issues facing women in the IT workforce and their variety of responses[1].

In this chapter, we investigate the particular ways that women in the American IT workforce experience and respond to issues of work-family balance by using the Individual Differences Theory of Gender and IT. We expand a work-family balance framework initially presented in Quesenberry et al. (2004) to articulate the ways in which individual and environmental factors influence female responses to issues of work-family balance. Finally, we develop a set of proactive responses in order for public policy and employers to address the challenges of balancing work and family.

LITERATURE REVIEW

A dichotomized view of women's motherhood choices permeates the working mother literature and tends to present two stereotypical women: the devoted mother and the cold careerist. Mason (1988) discusses two types of women: those who work to live and those who live to work. The former place an importance on children at the expense of a career and do not compete for high status or male-dominated positions. Rather, they gravitate toward female-dominated fields. Women who live to work are motivated by career status and feel that equality means competing with men for their jobs. Nevertheless, these women encounter difficulty, because the rules have not changed to include them. De Marneffe (2004) explains that dramatic shifts in women's lives have created the potential for motherhood to be a chosen activity, something that was not always possible for women. Yet, at the same time, the increase in motherhood choices can create challenges for women. De Marneffe adds that decisions about motherhood can create tension around a woman's point of identity and its relationship to other aspects of herself, such as her need for other aspirations, her need to work, and her need for solitude.

In response, a number of researchers have studied the relationship between work and family that moves away from a dichotomized motherhood view and presents a more diverse view of women. Peters (1997) argues that stay-at-home mothers and working mothers are not mutually exclusive roles. In this sense, Boyd (2002) argues that stay-at-home mothers also work, whether it is paid work (such as part-time work) or unpaid work (such as work in the home or community). Working mothers are also active inside the home, despite their career responsibilities. Engberg (1999) argues that maintaining work-family equilibrium presents such a challenge for women that the problem is perhaps not so much the glass ceiling as it is the sticky floor. In summary, while a superficial examination of the literature on female work-family balance might lead to a dichotomized view of a choice between career and family, a deeper investigation demonstrates a more diverse perspective on women with regard to their choices about work-family balance.

Work-Family Issues in the IT Workforce

Studies of the IT workforce are mixed on the question of whether the IT workplace is a conducive or unfriendly environment for working mothers. One stream of research points to the IT industry as having a pragmatic approach to working practices that can have a positive impact on working mothers. These practices include innovations in teleworking, job sharing, and technical advances in office communications that allow caregivers to spend more time in the home (Lynch, 2000). Furthermore, studies have found that working mothers in IT leverage technology such as mobile phones, conference call devices, and e-mail in order to balance the demands of the job with the needs of their children (Quesenberry & Trauth, 2005; Zimmerman, 2003).

An alternative stream of research highlights several difficulties associated with work-family balance in the IT workforce. Trauth's (1995, 2000) study of women in Ireland's emerging IT sector found positive views of women working in IT, because the industry had not had time to develop traditional gendered patterns. Yet, despite these more accepting societal views, many working mothers in her study found it difficult to manage work-family conflicts (Trauth, 1995, 2000). Similar findings resulted from Trauth's (2002) and Trauth et al.'s (2003) study of women in the Australian IT workforce; despite shifts in societal views about working mothers, balancing work and family was still found to be difficult for women in IT. Participants in this study found it challenging to manage domestic responsibilities while trying to keep pace with a rapidly changing field (Trauth, 2002; Trauth et al., 2003). Webster (2002) also

Table 1. Constructs of the individual differences theory (Trauth et al., 2004)

High Level Construct	Sub Category Construct
Personal Data	Demographics (e.g. Age, Race and Ethnicity) Lifestyle (e.g. Socio-economic Class, Parental Background) Workplace (e.g. Job Title, Technical Level)
Shaping and Influencing Factors	Personal Characteristics (e.g. Educational Background, Personality Traits and Abilities) Personal Influences (e.g. Mentors, Role Models, Experiences with Computing)
Environmental Context	Cultural Attitudes and Values (e.g. Attitudes about IT and/or Women) Geographic Data (e.g. Location of Work) Economic and Policy Data (e.g. about the Region of Work)

argues that family structures and female roles may vary across countries, but overall, women continue to be the primary provider for domestic and childcare responsibilities. Webster (2002) adds that this is "particularly hard to reconcile with the working rhythms of IT work" (p. 6) and may not be conducive for many women.

Researchers also highlight several female consequences associated with work-family balance in the IT workforce. Mennino and Brayfield (2002) found that female employees in male-dominated occupations make more family trade-offs and fewer employment trade-offs than employees in other occupations. In addition, work-family conflicts appear to have the most negative effect on women's performances in computer-related fields during the early career choice and advancement to management stages (Ahuja, 2002). Coincidently, Igbaria and Chidambaram (1997) found that women in IT tend to be younger, have shorter job tenure, have fewer years in the industry, and hold lower positions than men. Ahuja (2002) reports that women may have to neglect certain family obligations to be eligible for promotional opportunities similar to those of men. Baroudi and Igbaria (1994) point to family-related constraints as a partial explanation for the under-representation of women in managerial positions. Likewise, Sumner and Werner (2001) found the burden on family-career balance from overtime and administrative tasks to be a barrier to women in management.

This review of the literature reveals two themes that warrant further investigation. First, today's working mothers in IT are not necessarily at the extremes of devoted mother or cold careerist. Rather, they represent a range of women along the career-family spectrum with a variety of perspectives and experiences. Hence, further study is needed to understand this diverse range of perspectives and experiences. Second, there is little consensus in the IT literature as to whether or not the industry is compatible with work-family balance. Thus, additional investigation would contribute to a deeper understanding of the work-family factors influencing women in the IT workforce.

THEORETICAL FOUNDATION

The guiding theory for this research is the Individual Differences Theory of Gender and IT proposed by Trauth (2002) and Trauth et al. (2004; 2005; 2006) that focuses on differences among women in the ways they experience and respond to characteristics of IT work, the IT workplace, and societal messages about women and IT. This theory focuses on women as individuals having distinct personalities, experiencing a range of

sociocultural influences, and, therefore, exhibiting a range of responses to the social construction of IT. Thus, the theory elucidates the differences *within* rather than *between* the sexes and examines issues at an individual rather than a group level of analysis. The Individual Differences Theory of Gender and IT explores three key constructs: personal data, shaping and influencing factors, and environmental context (Trauth et al., 2004) (see Table 1).

The goal of the overall research program, of which this particular study is a part, is to engage in field-based theory testing by examining the particular ways that female IT professionals are influenced by and react to the social shaping of both gender identity and IT. Thus, the objective of this chapter is to contribute to a deeper understanding of specific individual and environmental factors that influence American women in their professional development and current working lives as IT professionals by examining one particular factor: work-family balance. Hence, the following research questions are explored: (1) What are the work-family balance issues facing women in the IT workforce? and (2) How do women respond to these issues when making decisions about their personal and professional development?

METHODOLOGY

Trauth (2001) explains that epistemology and methodology delineate a way of seeing and researching the world and, consequently, are fundamental considerations in research design. As a result, researchers must choose an epistemological approach that best reflects the research question(s) and the nature of the phenomenon of interest (Klein & Myers, 1999; Orlikowski & Baroudi, 1991). An interpretive epistemology and qualitative methodology are employed in this study, because the intent is to discover the deeper structure around work-family balance by investigating the perspectives of women in IT

work. Thus, the intent of the study is to qualitatively test a proposed theory about gender and IT by exploring interview data as they relate to the research questions.

This chapter reports on one aspect of a multi-year, multi-site field study of women working in IT, whose goal is to investigate the female under representation in IT through the lens of the Individual Differences Theory of Gender and IT[2]. The research design is based on Trauth's (1995, 2002) previous interpretive field studies of women in technical careers in Australia, New Zealand, and Ireland. Open-ended, in-depth interviews, lasting approximately 90 minutes are conducted with female practitioners and academics in the IT workforce. The interviews are tape recorded for subsequent transcription and data analysis. The coding scheme was developed using open coding techniques based on the interview guide and is oriented toward analyzing interview data for further refinement of the Individual Differences Theory of Gender and IT. The constructs emerging from the coding fall into the constructs of objective data (e.g., demographics), shaping and influencing factors, and emergent themes. Additional details about the coding scheme can be found in Trauth et al. (2004).

The data in this chapter represent interviews with 57 female practitioners in the IT workforce that were conducted between October 2002 and August 2004. The participants represent a range of geographical locations, ages, demographic backgrounds, educational backgrounds, levels of management and job classifications, relationship statuses, and family compositions[3]. The women work and live in three different geographical regions of the U.S.: the Northeast (Boston, Massachusetts), the Southeast (Research Triangle/Charlotte, North Carolina), and the Mid-Atlantic (central Pennsylvania). Eighteen of these interviews were conducted in Massachusetts, 25 in North Carolina, and 14 in Pennsylvania. The women ranged in age from 21 to 58 with the average age of 40.6 years. The racial/ethnic identity

of the participants included European Americans, African Americans, Asian Americans, Hispanics/Latinas and Middle Eastern women. The degree concentrations ranged from traditional MIS, CS, and engineering programs to psychology, nursing, communications, and liberal arts. In addition, job titles included CIO and vice president of IT, program/project manager, systems integrator, software architect/engineer, quality assurance engineer, IT administrator, Web developer and consultant, and small business owner. Furthermore, 35 of the women were married, two were in a committed relationship, 14 were single, and six were divorced/not remarried. Thirty-two of the women had one or more children, and 26 of the women did not have children.

ANALYSIS OF WORK-FAMILY BALANCE IN THE IT WORKFORCE

What emerged from the analysis of life histories of women in IT is a framework of decisions about work-family balance. The inspiration for the work-family balance framework came from an interview with a 47-year-old Web site manager and mother of two who argued for variation in the way we view women in IT.

Maybe we need to have a whole new model of how to run a corporation with people who want to go home at night and have dinner with their family. How are you going to do that? I came [to this interview] because I have strong views and I hope they're not the usual things you've gotten. … Most of my college girlfriends went to the top and then had kids. I had the kids kind of early and now I'm soaring and I don't want to be held back. … I just want people to see that there are other avenues. [emphasis added] [Elsie]

The work-family balance framework is comprised of four categories of women in the IT workforce: the non-parent, the working parent, the back-on-track parent, and the off-the-track parent. It is important to note that the categories in this framework are by no means static or limiting. These categories are dynamic in nature and are

Table 2. Work-family balance framework distribution

Work-Family Balance Framework	# of Participants	% of Participants
Non-Parent	**26**	**45.5**
Single	13	50
Married/Partnered	11	42
Divorced/Not Remarried	2	8
Working Parent	**26**	**45.5**
Single	1	4
Married/Partnered	23	88
Divorced/Not Remarried	2	8
Back-on-Track Parent	**5**	**9**
Single	0	0
Married/Partnered	3	60
Divorced/Not Remarried	2	40
Off-the-Track Parent	**0**	**0**
TOTAL	**57**	**100**

used only to analyze data to support the Individual Differences Theory of Gender and IT.

The Non-Parent: Balancing Work-Family Issues without Children

The non-parent category is comprised of women employed in the IT workforce who do not have children. The non-parent represents 26 women, or 45.5% of the women interviewed for this chapter (see Table 2). These women are single, married, partnered, and divorced, and range in age from 21 to 53, with an average age of 37.8 years. The non-parents consist of two groups of women: women who have not yet had children and women who are not having children. This is important to note this distinction, because not all non-parents are young, single women who have not yet reached a point to have children. Rather, many non-parents are women who have made conscious decisions not to have children. For instance, Claire, a 41-year-old senior quality assurance engineer, explained, "I have chosen not to have kids because I am not maternal." Likewise, Emily, a 53-year-old Web consultant, and her husband made a calculated decision not to have children because of a chronic problem with his ongoing medical surgeries.

Despite this range of explanations regarding motherhood, one common theme arose regarding work-family balance: the non-parents acknowledged their ability to balance more easily the work-family issues in the IT workforce than their coworkers with children. The non-parents felt that they were more able to adjust to the temporal aspects of IT work, including longer work days and late hours. Francie, a 26-year-old software engineer, explained that the ability to work late and long hours is particularly essential during project deadlines and software builds, because her managers are able to count on her being in the office. She also felt that it is very difficult for woman in IT to have a child and a career. In addition, many non-parents felt more able to participate in

after-hour networking events than coworkers with children. Julie, a 38-year-old network specialist, explained that she felt like an outsider when she first moved to central Pennsylvania. Yet, she was able to adjust her schedule more easily to spend time networking with coworkers, which eventually led to a heightened sense of community. In addition, several participants also commented on the freedom they enjoyed by not having to make work-child trade-offs. Linda, a 51-year-old systems developer, said that she was glad to not "have any of those really awful life trade-offs" to make.

Although non-parents have chosen to not have children and tend to acknowledge the increased ability to balance work and life, it does not mean that they are all workaholics who are focused exclusively on themselves or their careers. Many of the non-parents talked about their values regarding personal life and time spent away from the office. They spoke of elder care, responsibility for nieces and nephews, other family commitments, and pets. For instance, Claire uses her technical skills to mentor young girls in various youth societies in order to get them interested in IT. These themes demonstrate that being a non-parent does not preclude having a personal life.

Another theme raised by the non-parents is the societal message about motherhood. This was explored through discussion of national, state/regional, and organizational cultural attitudes toward women and women working. Many non-parents spoke about a cultural message that female family obligations should take precedence over professional obligations. Thus, they should assume domestic childcare roles, and men should assume professional income-earning roles. Betty Jean, a 37-year-old systems integrator, explained that her perception of stereotypical gender roles in North Carolina suggested that women should "date, get married, and have kids." The only acceptable jobs are domestic or traditional female occupations. Francie summarized this message by explaining:

Typically, the family obligations take precedence over the professional obligation. … I think typically [the societal view] is, that, when the woman has a child that she should stay home and take care of them. The male would be the financial supporter. [Francie]

From a personal development perspective, the non-parents spoke about the difficulties reconciling their own identities with what they perceive to be a societal stereotype of women. For instance, Nancy, a 48-year-old Web consultant, spoke about the pressures she feels to have children, despite the fact that it conflicts with her own personal desires.

[Speaking about a traditional view of society] a woman's place is to make the home and raise the kids and cook the meals and clean, and all that kind of thing. It really was very clearly what I saw happening in our house [growing up], and what I saw happening on TV. … There was always this kind of disconnect, it was like I could not imagine not having kids, and yet it was not like I really wanted to, it was just, that's what you did. [Nancy]

The women also spoke about the difficulties reconciling their professional development within views of women working. Many non-parents explained that they had strong professional aspirations and felt that a societal view of women working did not fit with their goals. For example, Julia, a 43-year-old consultant, explained that she chose not to have children, because she did not want to forgo her career ambitions.

I knew very early on that I didn't want children, because I saw from my mother's own example how much of her aspirations that she put aside. … I saw how much effort went into raising me and my three brothers. And I knew that there were things that I wanted to do [and I could not do it and raise children]. I was not willing to give up my hope

that one day I would [be extremely successful in my career]. [Julia]

The non-parents also spoke of the difficulties reconciling their professional development, particularly in job attainment, with that of a socially constructed view of women as primarily mothers. Many non-parents discussed the difficulty they faced in obtaining IT jobs because of attitudes toward women working in IT. For instance, Janet, a 50-year-old IT manager, spoke about a female coworker of childbearing age who was held back by gender stereotypes. During an interview she was told "well you are young, you are going to get married and have children anyway, so there is really no point" in hiring you. When Janet was asked if gender stereotypes in society influenced women's career attainment in the IT industry, she responded:

I think a woman interviewing a woman would not be worried about her having a baby and leaving, but maybe it is more prevalent to me as coming from a man. … I think because women are a little bit more understanding of, maybe the biological clock, or the need to have children, or the desire to have children. … I do not think men see that as easily. [Janet]

The Working Parent: Balancing Work-Family Issues Concurrently

The working parent category is comprised of women who have children and a career in IT. The working parent represents 26 women or 45.5% of those interviewed for this chapter (see Table 2). Working parents are women who do not fit the working parent dichotomy found in the literature, because they place a value on both family and career. Working parents represent a range of ages and relationship statuses including single, partnered, married, and divorced. Furthermore, the working parents represent a range of motherhood scenarios including raising one or more children

(biological, adopted, and foster) and vary in age from 27 to 57 years old.

The working parents typically are motivated by both financial and personal desires to simultaneously work and raise their children. Although these women acknowledge the financial benefit of working in IT, an overwhelming sentiment is that they seek employment because of the personal value they place on being active and continuing to grow as a professional. For instance, Irene, a 57-year-old IT strategic planner, explained, "I get a sense of accomplishment and a personal sense of satisfaction from working." In addition, Donna, a 39-year-old quality assurance analyst, was asked how important work was in her life.

I think [having a career] is very important for me. ... It's important to keep my mind active to keep challenged and to like what I do. When I stop having fun at this job, that's probably when I'll decide it's time to move on. I think it's very important to stay active. [Donna]

Although many working parents value a professional career, they also acknowledged the difficulties associated with doing so. The women frequently spoke about the work-family balance issues that arise, particularly with regard to the temporal arrangements of IT work, such as a 24/7 workday where employees are always accessible. For instance, Irene explained that she did not take maternity leave when her son was born because of the high value she placed on her professional life.

I didn't take a maternity leave [when my son was born], which was a big thing in 1971. ... I realized that I did not want to be a stay-at-home mom and I wanted to go back to work. ... As it invariably happens, I was on an application where I was on call. It was difficult. I think having a family or any responsibility, it could be an elderly parent or it could be anybody, but certainly a child [is difficult]. [Irene]

Candace, a 41-year-old systems developer, felt that there was a growing tendency in the last few years for employees to work extra hours and to be "constantly available by computer or phone." She feels this paradigm is not compatible with home life but is due mainly "to advances in technology making it possible for people to be continuously on call."

A common and recurring theme raised by the working parents related to the importance of work flexibility. The women spoke about the benefits of work programs such as job sharing, part-time work, and manageable commutes. For instance, Kimberly, a 38-year-old project manager working with enterprise resource planning packages who had the ability to telecommute, was one of the first women at her IT consulting firm to be promoted to manager while on maternity leave. She valued the four-day work week that gave more time at home. Rose, a 47-year-old director of IT, feels that telecommuting is key, because it gives her more control and allows her to "bring in some income but at a schedule that was much more convenient" to her. Helen, a 44-year-old systems designer, stressed the importance of working part-time while her children were still in grade school. Ivanna, a 40-year-old user administrator, explained that she left a job and moved to another state in order to have a more flexible commute.

Another prevalent theme expressed by working parents is the importance of supportive partners and spouses, a factor that supports the constructs of personal influences of significant people in the Individual Difference Theory of Gender and IT. Many working parents spoke about how their partners and spouses share an active role in child rearing, domestic responsibilities, and community volunteer activities. For instance, Allison, a 46-year project manager, spoke about spouse support as she worked full-time and attended night school in a technology program while pregnant with their second child. Rose discussed the importance of her husband's support and the domestic shift that has occurred in their household since the birth of their daughter:

My husband, I don't think, would have married anybody who wanted first and foremost to be an at-home mom. And he has been very supportive ... and he's probably been my biggest advocate. ... I've even seen a real change in him. This was a guy that was very devoted to work, that would spend many hours at work, had no outside interests other than work. ... [Now] he is spending a lot more time at home. He is taking a lot more responsibility for our daughter. ... That to me is evidence that his view of the world has changed. I know that he and I are in constant communication when he was working over who is going to be home at what time to make sure [our daughter] was being cared for. Who is going to be home when she is ill? How do you take care of those dynamics? Well, you know, we would really share and figure out how you really deal with this. [Rose]

Many working parents spoke about the societal pressures and mixed messages they receive about raising children and working outside of the home. The participants highlighted the societal messages that women should be stay-at-home mothers and not work outside of the home. Rose, who is Japanese American, explained that her culture puts "a lot of emphasis on the Japanese woman staying home and taking care of the children" and taking on duties like finances and keeping certain traditions alive. Sandra, a 49-year-old IT manager, had a supervisor who told her, "you should be home making your children better people" rather than working outside of the home. Also, Pamela, a 27-year-old systems administrator in central Pennsylvania explained:

I do not encounter a whole lot of people thinking that I am dumb because I am a woman, because I have kind of proven myself. What I encounter is bias against the fact that I work and I am a mom. I have had engineers tell me to "go home and be with my kid." ... [A coworker once approached] me when I was pregnant, like eight months preg-

nant, he comes up into my office and goes, "so, after you have your baby, are you staying home with him?" ... And I said, "No, I am planning on coming back to work." And he is like, "That is the problem with people's kids today." He says, "Mothers don't want to take care of their children," and he walks out. [Pamela]

Other environmental influences on personal and career development of working parents came from their parents. Pamela's father, for example, had a significant effect on her development as an IT professional.

My dad and I were constantly battling. He did not want me to go to college. He wanted me to stay working at the grocery store that I worked at until I got married and had kids and then quit and stayed home with the babies. And that was not my idea of what I wanted to do. So we always argued when I was in high school. ... And then right before I left for college, he was like, "You realize I cannot help you pay for college, because I have got to help pay for your brother's college. He's going to be a breadwinner someday." ... [With regard to future plans] mainly, I saw myself as doing, I guess doing very well in my field. I always wanted to be a professional. I guess I always, I kind of wanted to get married and have kids someday. But that seemed like distant, distant future. ... I never wanted to be, and I still never want to be in the position where I depend on somebody else. [Pamela]

The working parents spoke of the difficulties of reconciling their professional development, particularly in job attainment with societal images of women working in IT. They noted the negative stereotypes associated with being a working parent and the influence it had on their careers. Sandra discussed a negative stereotype of working parents that she encountered in a job interview and the impact it had on her career:

[The interviewer] said, "Well you are going to quit anyway." He said, "You are going to get pregnant and quit. Then we will have to hire somebody else, or train somebody else to fill in while you are on maternity leave." I said, "I already have two children and I am not [currently] married and I am not planning on having anymore children." And he said, "You will. You will get married and you will get pregnant and then we will be stuck here." I was not hired for that position. [Sandra]

To overcome these societal views of women, the working parents shared accounts of having to work harder and longer hours than coworkers in order to dispel the negative stereotypes of working mothers. For instance, Joanne and her husband juggle childcare responsibilities; it does not fall only on her shoulders. The idea that it does is "just more of a perception than a reality." Carol, a 41-year-old IT course developer, adds that there is a misconception that female workers will leave a company to take care of their children or that their minds will be on their children during the day. Ivanna uses her own situation as evidence that working mother stereotypes are misconceptions. She has three children and an adopted niece and nephew yet does not miss or leave work more than her male counterparts.

The "Back-on-Track" Parent: Balancing Work-Family Issues Sequentially

The back-on-track parent is comprised of employees who, for a variety of reasons, took time away from work to raise children and then later returned to the IT workforce. The back-on-track parents represent 9% or five women interviewed for this chapter (see Table 2). The back-on-track parents are older in age, ranging from 44 to 58, with an average age of 50.2 years. All of these back-on-track parents were in committed relationships during their employment break so that the

main source of income came from their partner or spouse.

A common theme arising from the back-on-track parent interviews was the idea that women should take time away from work to stay home, because it was the right thing to do. This idea seems to stem from societal messages that the women received during their childhood and adult lives. Initial analysis demonstrates that these messages vary by geographical regions included in the study and by the associated cultural backgrounds. For example, Jill, a 44-year-old IT instructor, expressed the societal pressures in central Pennsylvania that she receives about motherhood and working. She feels that women are run ragged, because they are expected to be responsible for household work, family budgets, and childcare responsibilities. Although Sue, a 53-year-old IT coordinator from central Pennsylvania, eventually returned to work, she felt that she was supposed to follow the path in life of going to school, getting married, and then staying home with kids.

I wound up going to a two-year college, because I really didn't think that getting into sports was something I was supposed to do. I felt more pressure to go into business and get married and become a secretary or something like that. … So I went to a two-year associate Catholic college and took business, so I got an associate degree in business and then got married, had kids, the whole [thing]. [Sue]

Although societal pressures about motherhood and careers affect women in non-technical and technical careers alike, there is a common shared experience of the back-on-track parents that relates specifically to the IT workforce. This theme relates to the amount of skill preparation required for re-entry into the IT workforce. Sue explained that after returning to the IT workforce, she felt like she was in catch-up mode and that she had to be able to absorb and understand new technology

quickly. This difficulty of returning to IT work has caused the back-on-track parents to develop plans of action to ease the transition. Hence, the back-on-track parents reflect the influence of personal characteristics that translates into personal success strategies. For instance, Elsie spoke specifically about the amount of intense work that was required to re-enter the IT workforce. Consequently, she developed a success strategy that involved diligently working to prove herself as a viable employee despite the fact that she is 10 years older than her cohorts; that is, Elsie left the labor force for 10 years, and her coworkers at the equivalent stage in their careers are 10 years younger than she. In doing so, Elsie puts in extra hours on the job and seeks out additional on-the-job training in order to get her technical skills up to speed. Yet, she also feels pressured constantly to demonstrate that her prime working years are her 40s and 50s rather than the typical 30s and 40s.

I feel like [fellow coworkers] are all going to retire when [they are] 55 because [they have] worked since [they] were 22. I started at 38. I want to go all the way; I don't want there to be any limits to what I contribute. I have got to work until [I am] 65 because I did not start [my career at a young age, so], I have got to make up [time]. So, I am going to be at this company a long time, but I do not want them to know my age, because they will think [I am too old]. [Elsie]

The stories of back-on-track parents demonstrate that balancing work-family issues in IT work is a constant responsibility that pulls women in several directions at once. Environmental context complicates the pressures women feel in decisions about their professional and personal lives. Likewise, long, irregular work hours associated with IT careers make it difficult to balance work-family issues. Thus, taking time away from the IT workforce is a temporal solution to these conflicts. Leaving the workforce for an extend period of time

allows women to balance family responsibilities during the early years of their children's lives and to return to their careers at a point in time when their children are more self-sufficient.

The "Off-the-Track" Parent: Balancing Work-Family Issues by Egression

The fourth type of parent is the off-the-track parent, comprised of employees who permanently leave the IT workforce upon having children. We have not captured data regarding the off-the-track parent, because our participants are drawn from women currently employed in the IT workforce. However, for purposes of conceptual completeness, we include this category in our framework and intend to capture data about this category at a future point in time.

DISCUSSION

The term *mommy track* typically is used to refer to a variety of organizational arrangements that allow women the opportunity to balance more easily the conflicts between work and home (Schwartz, 1989). Yet, much debate centers around the wisdom of having such a track. Proponents argue that corporations should become more flexible and develop arrangements that allow employees, both male and female, to focus their efforts on career as well as family. Opponents argue that the mommy track can be a negative for women in management in that those who choose such a track will be penalized later (Konrad & Cannings, 1994). Findings presented in this chapter support the existence of many different roads to female career fulfillment. Thus, the work-family balance framework is a mechanism for articulating the complexities facing women and their decisions about motherhood and careers in IT. In this way, the research presented here provides a mechanism for developing more sophisticated

insights into the under-representation of women in the IT workforce.

Contribution to Theory

Our research shows that work-family tradeoff considerations are much more nuanced than what is commonly depicted in the literature. Rather, women represent a range of work-family situations that contain varying issues and concerns. Specifically, this research is an example of the application of the Individual Differences Theory of Gender and IT in order to go beyond the identification of societal messages that operate at the group level and also to understand the response variations among women when examining the topic of work-family balance (see Table 3 for a detailed analysis of the data-theory connection).

Contribution to Literature

This chapter is consistent with other results from research on gender and IT and the role of family. Over a decade ago, Trauth (1995) investigated the role of work-life balance in the under-representation of women in the Irish IT workforce, and the themes from the Irish women are echoed in the female voices in this chapter about the American IT workforce today. In both studies, the participants spoke in great length about the challenges of balancing the demands of work and home in the IT industry. The women also dealt with this challenge in a number of ways. Some women elected not to have children at all, some women opted to balance a career and family, and other women chose to sacrifice their careers. These themes are found elsewhere in the literature (Ahuja, 2002; Baroudi & Igbaria, 1994; Igbaria & Chidambaram, 1997; Mitroff et al., 1977; Sumner & Werner, 2001; Trauth 2001, 2002; Trauth et al., 2003; Webster, 2002) that the work-family balance in a technical industry is challenging yet rewarding.

This chapter also supports the findings that women in the IT workforce receive mixed soci-

etal messages about a woman's role with respect to career and family. Trauth's (1995) Irish study found evidence that women receive a variety of societal messages about motherhood decisions in Ireland. One Irish woman explained that it is "still frowned upon for a woman to work" (Trauth, 1995, p. 136). Trauth (2002) also found evidence of a variety of societal messages to which women in the IT workforce are exposed about motherhood decisions in Australia and New Zealand. A woman in New Zealand described societal messages she received about women working in the IT workforce, in which coworkers told her, "I don't think women should be working" (Trauth, 2002, p. 105). These remarks are only a small representation of the range, depth, and variety of overt and subtle societal messages that women receive about career and family. Yet, the remarks illustrate an identifiable theme that crosses geographical regions and timeframes — that societal messages are complex and difficult to digest and are processed in different ways by different women, yet they contribute to the decisions women make about their professional and personal lives.

Contribution to Practice

Before [having a baby], I used to think if you want to work, work, and if you want to have kids, have kids; if you want to do both, fine and quit complaining about it. If you've run into problems, then that's your problem. It wasn't until I had a baby that I realized, you know what, these issues are a little bit bigger than that. There are real issues here, and I just remember because my husband just went back to work. His life was like on pause for five days, and then he resumed, and my life was like on pause, and then forever changed. And that's when I realized, I don't know, I just had a big transition at that time. [Sharon]

Warren and Tyagi (2003) report that if a woman has a child, it is the single best predictor that she will end up in financial collapse. Likewise, the

Table 3. Work-family balance framework factors

High Level Construct	Sub Category Construct
Non-Parent	
Personal Data	Range of Ages from 21 to 53 (Demographic) Range of Racial/Ethnic Identities – Primarily Caucasian and African American (Demographic) Range of Relationship Statuses (Lifestyle) No Children (Lifestyle) Range of IT Job Titles (Work)
Shaping and Influencing Factors	Importance of Personal Time (Personal Characteristics) Easier to Balance Temporal Nature of IT Work (Personal Influences) Easier to Devote Time to Social Networking (Personal Influences)
Environmental Context	Range of Environmental Contexts (Geographic Data) Rejected Messages to Assume Domestic Child-Care Roles (Cultural Attitudes and Values and Geographic Data) Personal Development Conflict (Cultural Attitudes and Values) Professional Attainment Conflict (Cultural Attitudes and Values)
Working-Parent	
Personal Data	Range of Ages from 27 to 57 (Demographic) Range of Racial/Ethnic Identities (Demographic) Range of Relationship Statuses (Lifestyle) One or More Children (Lifestyle) Range of IT Job Titles (Work)
Shaping and Influencing Factors	Financial and Personal Motivation to Work (Personal Characteristics) Value Flexible Work Arrangements (Personal Characteristics) Difficult to Balance Temporal Nature of IT Work (Personal Influences) Value Support Networks (Personal Influence – Significant People)
Environmental Context	Range of Environmental Contexts (Geographic Data) Conflict from Messages to Assume Domestic Child-Care Roles (Cultural Attitudes and Values and Geographic Data) Personal Development Conflict (Cultural Attitudes and Values) Professional Attainment Conflict (Cultural Attitudes and Values) Perceived Pressure to Work Harder (Cultural Attitudes and Values)
Back-On-Track Parent	
Personal Data	Older in Age from 44 to 58 (Demographic) Primarily Caucasian Racial/Ethnic Identities (Demographic) Committed Relationship Statuses as Married or Partnered (Lifestyle) Range of IT Job Titles (Work)
Shaping and Influencing Factors	Motivated to Building Technical Skills (Personal Characteristic – Success Factors)
Environmental Context	Range of Environmental Contexts (Geographic Data) Accepted Messages to Assume Domestic Child-Care Roles (Cultural Attitudes and Values and Geographic Data)

average middle-class family no longer can afford a home unless both parents work. Clearly, issues of work-family balance should be considered as initiatives are taken to improve female participation in the IT workforce. As this research has demonstrated, the Individual Differences Theory of Gender and IT provides a conceptual mechanism to enable a deeper understanding of diverse employee needs. Of utmost importance to practice is the realization that not all women, indeed not all employees, have the same work-family balance issues and, therefore, do not have the same needs or concerns with regard to their careers. Likewise, we do not advocate special

considerations given to any group of individuals, as it is highly likely that such a plan of action would weaken these groups in the labor force. Rather, our findings suggest that a more robust and flexible conceptualization of career tracks with multiple avenues will benefit a wider range of IT workers, both men and women, as the traditional view of a career is one that no longer reflects the needs and concerns of workers.

Expansively adapting possible career tracks in the IT workforce also would benefit employers. Bailyn et al. (1997) explain that making an explicit link between people's personal needs and business goals can be a catalyst for changing work practice that will benefit both the company and the employee. A crucial step in this process is to think expansively about how changing particular work practices would help business and help employees. The research lens of the Individual Differences Theory of Gender and IT demonstrates that programs such as flex-time, compressed work weeks, teleworking, job sharing, and referral services for child and elder care would create additional options for employees balancing work and life demands.

CONCLUSION

In this chapter, we show how the Individual Differences Theory of Gender and IT is used to help us to understand the range of factors influencing decisions about a career in the IT workforce. In order to assist in this analysis, we present a work-family balance framework of IT career decisions that reflect the current literature about work-family decisions as well as empirical data on this topic. Specifically, our analysis demonstrates that there are several explanations for the gender gap in IT and illustrates the ways in which factors related to family responsibilities influence IT career decisions. Findings from this chapter show that greater consideration is needed of a range of factors,

including work-family decisions, in an attempt to better understand the gender divide in the IT workforce and workforce issues in general. This study was limited to examining the work-family perspectives of women in the IT workforce. It did not include the role of men or the roles of noncustodial stepparents and foster parents. Finally, this study is limited to an American perspective. These limitations represent areas for future research in order to further develop the work-family balance framework. Future application of the Individual Differences Theory of Gender and IT to other constituencies will contribute continued recommendations to research and practice.

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ENDNOTES

[1] There are two caveats to this discussion. First, while the authors acknowledge it is also critical to understand work-family balance from a male perspective, this is outside of the scope of our chapter. Second, while some same-sex couples are included in this research project, the data set is not yet large enough to enable meaningful analysis. Thus, the discussion relates only to heterosexual couples.

[2] This chapter is from a study funded by a National Science Foundation Grant (EIA-0204246).

[3] The 57 interviews included in this chapter represent a mid-point of data collection and analysis efforts. In total, 120 interviews will be conducted.

Chapter XI
Perceptions in Computer–Supported Collaborative Learning:
Interaction of Cultural Diversity, Group Size, and Leadership

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ABSTRACT

Computer-supported collaborative learning (CSCL) has received increasing research attention owing to advances in e-learning technology and paradigmatic shifts in the educational arena. Owing to the growing diversity in student population in terms of nationality, the role of cultural diversity becomes greatly pronounced, and must be addressed. In this study, a laboratory experiment with a 2×2×2 factorial design was conducted, to investigate the interaction effects of perceived cultural diversity, group size, and leadership, on learners' performance and satisfaction with process. Contrary to an expected negative relationship between perceived cultural diversity and performance, a positive relationship emerged as a result of leadership. Leadership lowered learners' satisfaction with the process in perceived homogeneous groups (as compared to perceived heterogeneous groups) and smaller groups (as compared to larger groups).

INTRODUCTION

The promising capability of e-learning and communication technology has opened the door to new opportunities for collaborative learning, a learning process where two or more people work together to create meaning, explore a topic, or improve skills (Roberts, 2005). This learning method has been promoted to be more effective in achieving meaningful learning over other traditional instructional strategies because it supports learner's knowledge construction process by embodying active cooperation and teamwork in problem solving (Alavi & Leidner, 2001; Khalifa, Kwok, & Davison, 2002). Most of the groupware applications serve as a systems development platform on which computer-supported collaborative learning (CSCL) can be facilitated by embedding cognitive principles to support distributed discussions among learners. A substantial amount of empirical evidence demonstrates that CSCL tends to yield more desirable learning outcomes than nontechnology-enabled collaborative learning (Salovaara, 2005).

As a consequence of globalization, there are a growing number of institutions worldwide offering virtual education programs that often incorporate CSCL activities as part of the programs. These activities are no longer constrained by time or geographical location. Accordingly, the role of cultural diversity becomes enhanced and must be addressed, as there is a growing diversity in the student population in terms of nationality. In spite of the advantages brought about by collaborative learning technology, heterogeneous groups face challenges triggered by members' perception about the cultural diversity. However, very little research has examined the effects caused by cultural diversity from a perceptive aspect in the context of CSCL (Daily & Teich, 2001). Furthermore, as indicated by the small group literature, there are potential interaction effects on teamwork efficiency owing to perceived cultural diversity, leadership, and group size (Stephen & Stephen,

2001). This study seeks to gain insights into the possible interactions among these factors on learning performance and satisfaction with process. The knowledge will provide important practical guidelines for CSCL design and usage.

The remaining parts of this chapter are organized as follows. The next section provides a review on related theories and previous studies. In the following section a research model is presented, with research hypotheses derived. The design of the research method is discussed in next section. The final section contains data analysis. Section 6 discusses the findings and their implications.

LITERATURE REVIEW

Learning in CSCL

Communication effectiveness will be improved when task needs are matched to a medium's ability (Maruping & Agarwal, 2004; Zigurs, Buckland, Connolly, & Wilson, 1999). Feather (1999) suggests that individuals will prefer learning in the virtual environment if they require more time to think about a question before answering, find it hard to speak out in a traditional class, albeit possessing contributions, or like some degree of anonymity. The anonymity, text recording, and multiple access characteristics supported by communication technology should result in relatively higher rankings in parallelism, rehearsability, and reprocessability, yet lower rankings in symbol variety and immediacy of feedback, as compared to the traditional face-to-face setting (Dennis & Valacich, 1999). Anonymity will allow students to freely express themselves and overcome their inhibitions (Bargh & McKenna, 2004). The computer-mediated communication tools in the CSCL are found to be effective in overcoming the lack of peer interaction in the classroom (Li, 2002). Group members' comments are recorded as text and they can be revisited repeatedly; such a

feature is expected to enhance learning effectiveness, especially for nonnative speakers (Herring, 1999). Moreover, through embedding concurrent inputs by multiple users, CSCL offer a unique opportunity to eliminate production blocking in brainstorming, particularly as group size increases (Valacich, Jessup, Dennis, & Nunamaker, 1992). The results of these features are more evenly distributed participation among members and decreased domination in discussion, and less centralized leadership (Daily & Teich, 2001).

Perceived Cultural Diversity

Individual's cognitive process in learning is associated with the culture in which the individual grows up because culture provides norms, rules, and values of behaviors (Hofstede, 1997). Culture affects the way individuals communicate and make predictions about the interaction (Ji, Zhang, & Nisbett, 2004). Hofstede (1997) has referred to national culture as the collective programming of the mind that distinguishes the inhabitants of one country from another. In the current study, heterogeneous groups, whose members are of different (national) cultural backgrounds, are expected to bring together and make available a wider variety of skills, information, and experiences that could potentially improve the quality of collaborative learning (Rich, 1997). Heterogeneous groups inherit a diversity of thoughts and perspectives, which may lead to high creativity and innovation, and a greater range of ideas than homogeneous groups (Jehn, Northcraft, & Neale, 1999; Watson, Kumar, & Michaelson, 1993). Such groups are inherently less prone to the "groupthink" syndrome (Janis, 1982).

Nevertheless, some characteristics of culture can impede collaborative learning, such as language, cognitive style, and learning style (Palich & Gomez-Mejia, 1999; Swann, Polzer, Seyle, & Ko, 2004). For example, members of the team who participate using a language that is not their native would need to attempt to familiarize themselves with terms, conditions, norms, and other aspects taken for granted by those of the native language (Stahl & Elbeltage, 2004). In this way, cultural diversity may bring about communication barriers, thus negatively affecting the collaborative learning process (Watson et al., 1993). Studies have shown that heterogeneous groups have lower quality solutions, higher conflict, and individuals who dominate the discussion (Pelled, 1996). These highlight the challenges brought about by heterogeneity in collaborative learning in the *face-to-face* setting. Nevertheless, the phenomenon is found to be dissimilar in *computer-mediated* environments (Daily & Steiner, 1998). Functions in CSCL (such as anonymity and parallel access) can enable more effective collaborative learning activities in heterogeneous groups by smoothing the communication process and providing greater opportunities for contribution to all members (Daily & Teich, 2001). It is found that heterogeneous groups identify more unique ideas, deliver better performance, and have higher satisfaction with process than homogeneous groups in computer-mediated environments (Daily & Steiner, 1998).

In spite of these advantages brought in CSCL, heterogeneous groups' potential could not be realized without taking care of members' emotion, which is triggered by their perception about the cultural diversity in the groups, particularly during their initial contacts. The Self-Categorization Theory further explains how cultural backgrounds of members could trigger a corresponding categorization (Hogg, Cooper-Shaw, & Holzworth, 1993), which in turn fosters miscommunication and misunderstanding (Palich & Gomez-Mejia, 1999). Differences in cultural backgrounds are observable in the computer-mediated communication, even though the social presence is limited (Wellman, Salaff, Dimitrova, Garton, Gulia, & Haythornthwaite, 1996). According to Augustinova, Oberlé, and Stasser (2005), people may participate in group activities very differently, depending on how they perceive themselves

relative to other group members. If an individual perceives himself/herself to be interacting in a heterogeneous group, anxiety is commonly triggered, which can spark negative relations (Pelled, 1996). Moreover, if this member does not belong to the dominant culture in the group, he/she would consider himself/herself to be in a low-status position, which could lead to lower participation as well as satisfaction (Weisband, Schneider, & Connolly, 1995).

Group Size

In the context of computer-supported collaborative learning, group size has been identified as an important factor that requires more investigation with respect to interaction (Strijbos, Martens, & Jochems, 2003). Interaction patterns and learning benefits differ between dyads (two members), small groups (three to six members) and large groups (seven or more), especially if participation equality or shared products are required (Wilkinson & Fung, 2002). Previous studies reported mixed results associated with increase in group size in the context of computer-supported collaboration (Easley, Devaraj, & Crant, 2003; Mullen, Anthony, Salas, & Driskell, 1994). With fewer individuals, a small group may lack the ability to evaluate potential solutions (Schultz, 1989). However, teamwork literature shows that the size of the team has an inverse relationship with team performance; this decrease in performance and satisfaction is caused by production blocking, evaluation apprehension, and social loafing (Easley et al., 2003). Production blocking refers to the situation when an individual cannot contribute his/her ideas because another group member is talking. Evaluation apprehension is the likelihood that a member tends not to speak due to the fear of disapproving by others. Social loafing is the tendency of individual group members to reduce their work effort as groups increase in size. The effects of these three factors grow as group size increases (Leidner & Fuller, 1997).

When members give up their share of the task, there is a loss to the group.

The parallel-input mechanism supported in CSCL is able to mitigate production blocking, which would normally occur in large groups (Grohowski, McGoff, Vogel, Martz, & Nunamaker, 1990). Anonymity does not exist in dyads, and is very difficult to realize even in three-person groups. Therefore, the effects of anonymity could be maximized in large groups, and consequently help attenuate process losses featured in large groups due to evaluation apprehension (Dennis & Wixom, 2001). However, as group size increases, the increase in individual anonymity makes it more difficult to assess each member's contribution; hence, individuals will withhold efforts and feel less motivated to participate. As a result, an increase in group size increases social loafing and coordination barriers among group members (Liden, Wayne, Jaworski, & Bennett, 2004).

Leadership

Through their influence actions, leaders have been found to affect collaboration and hence, the performance and satisfaction of other members (Napier & Gershenfeld, 1985). Leadership is crucial in studying distributed groups, since virtual systems are most effective when collaboration among learners is achieved (Alavi & Leidner, 2001). In the context of group support systems, a leader is able to improve the group process by facilitating interactions among members and maximizing positive group dynamics (Hostager, Lester, Ready, & Bergmann, 2003). Certain leadership roles are particularly important in distributed learning groups. There are four dimensions of leadership in distributed groups, namely, communication, understanding, role clarity, and leadership attitude (Kayworth & Leidner, 2001). The communication dimension provides continuous feedback, engages other members in regular communication, and provides a clear, detailed picture of the task at hand. Although leadership has been defined in

various ways, in this chapter, leadership is studied from the communication dimension via the functional perspective. The functional perspective assumes that leadership is a process, and the role of a leader is to keep the group focused on the assigned learning task, and make sure that all members of the group have an opportunity to participate in the collaboration (Skala, Slater, & Adams, 2000). Since a group is advantaged by the collective resources of all members, it is important to enable any member who wishes to contribute to do so. Therefore, the leader, whose role is to keep the group on the assigned learning task, and to make sure an opportunity for all group members to participate in the collaboration, exercises a strong effect on both the members' behaviors and the group activities.

The strength of using a "peer leader" is that the presence of authority figures, such as teacher, often inhibits open and active contributions from other group members (Stephan & Stephan, 2001). This chapter focuses on peer leadership. A leader is able to avert groupthink by remaining neutral and emerging dialogue and new ideas (Hellriegel, Slocum, & Woodman, 2001). Interestingly, however, morale also tends to drop (Napier & Gershenfeld, 1985; Nemerowicz & Rosi, 1997). A possible reason is that members tend to be happier with the collaboration process when they can participate freely; nonetheless, such "open" environments are usually achieved at the expense of time taken for task accomplishment. Moreover, it has also been noted that roles in groups are worked out through communication with other members (Knippenberg & Hogg, 2004; Zander, 1971); when one participates more actively, he/she

is more likely to be perceived as leader, even without an explicit leadership assignment.

RESEARCH MODEL AND HYPOTHESES

Research Model

Figure 1 depicts the research model. Since individual (vs. group) learning outcomes are of primary concern to this study, the dependent variables are defined to be user's performance, and satisfaction with process, which are the most widely studied outcome measures (Daily & Teich, 2001; George, Easton, Nunamaker, & Northcraft, 1990). In the field of educational psychology, exam performance is a well-adopted measure of learning performance, which reflects the level of knowledge and materials acquired or mastered by a learner (Susman, 1998). Another variable focused in this chapter is satisfaction with process. In line with Alavi's (1994) work, this variable concerns learners' evaluation of their participation in the collaboration. Satisfaction with process has been found to be a strong predictor of participation process success and collective learning effectiveness (George et al., 1990; Swann et al., 2004; Tyran, 1997). Satisfaction with process is accessed according to learners' satisfaction with the quality of his/her own contribution, and the overall relevance of all contributions in the collaboration process in meeting the learning expectations (Tyran, 1997). Overall, this study aims to address the possible interactions among users' perceived cultural diversity, in their groups, group size, and leader-

Figure 1. Research model

| Perceived Cultural Diversity Group size Leadership | → | Performance Satisfaction with process |

ship, on their learning performance (encapsulated in Hypotheses 1a, 1b, and 1c in the next section) and satisfaction with process (encapsulated in Hypotheses 2a, 2b, and 2c in the next section) within the context of CSCL.

Performance

Users participate in group discussion differently, depending on their perception about their relative status to other group members (Augustinova et al., 2005). When users perceive themselves interacting in a heterogeneous group, they tend to categorize themselves according to their cultural origins (Pelled, 1996). Individuals of minority subgroups subject themselves to a lower status and consequently, feel less engaged and contribute significantly less to the collaboration, as compared to others (Weisband et al., 1995). Therefore, there is generally a negative relationship between perceived cultural diversity and performance. In particular, in heterogeneous groups without a leader, the peer effects stem from interactions among students according to their perceived status; learners will very likely be more cautious about speaking out, due to fear of losing credibility in the group (Stephan & Stephan, 2001). This being the case, it is quite plausible that learners would prefer learning from others to contributing their own ideas (Wellman et al., 1996). However, the most effective means to learn in collaboration is through providing elaborated explanations of ones own understanding to others (Alavi, 1994). For this reason, individual learner's performance is affected negatively. On the other hand, the leader of a learning group takes the responsibility for keeping the group focused on the assigned task and ensuring that all members have an opportunity to participate during the collaborative learning session. To achieve this, the leader of a heterogeneous group can invite members to express their ideas and facilitate them to participate in the collaboration, thus, enhancing the collaborative learning performance. In other words, adding leadership

to a heterogeneous group dampens the negative effects of diversity on performance.

Hypothesis 1a: The effect of perceived cultural diversity on learners' performance will be less negative in groups with leadership than in groups without leadership.

As mentioned, there is generally a negative relationship between perceived cultural diversity and performance. However, it is posited that the negative relationship is more significant in larger than smaller groups. The underlying reason is that the anonymity enabled in larger groups increases the likelihood of social loafing and, therefore, individuals will withhold efforts and feel less motivated to participate in the collaborative learning process (Liden et al., 2004). In contrast, individuals in smaller groups, where anonymity is hardly achieved, may be more likely to participate and hence, benefit from the collaboration (Kaye, 1992).

Hypothesis 1b: The effect of perceived cultural diversity on learners' performance will be less negative in smaller groups than in larger groups.

There is a positive relationship between the presence of leadership and the performance, because leadership is found to ensure opportunities to all members to participate and express their ideas (Hostager et al., 2003). On the other hand, social loafing, the phenomenon that states the efforts of individuals seem to decline as group size increases, results in a generally inverse relationship between performance and group size (Easley et al., 2003). Small groups generally mean greater member involvement, with fewer social loafing phenomena. The leader is able to play a role in reducing or even eliminating social loafing in large groups by motivating members to participate. Therefore, the positive effect of leadership on performance is anticipated to be more pronounced in large groups as compared

to small groups (social loafing is much less a problem in smaller groups).

Hypothesis 1c: The effect of leadership on learners' performance will be more positive in larger groups than in smaller groups.

Satisfaction with Process

In the presence of leadership, members tend to feel that they gain less access to participation as compared to their leader (Nemerowicz & Rosi, 1997); hence, leadership generally possesses a negative effect on satisfaction with process. On the other hand, perceiving themselves in a heterogeneous group, learners tend to experience anxiety and uncertainty in their ability to interact and contribute in the group, thus resulting in a low level of satisfaction with the collaboration process (Weisband et al., 1995). However, by emphasizing to members that they should respect and be open with one another, leadership in heterogeneous groups is able to create a motivating climate that leads to productive discourse. This climate helps release learners' anxiety of being in heterogeneous environments, and significantly addresses the negativity brought about by leadership on learners' satisfaction with process (Napier & Gershenfeld, 1985). In contrast, in homogeneous groups, satisfaction of group members tends to decrease in the presence of leadership as compared to the condition without leadership, since these individuals have no need to deal with the said anxiety.

Hypothesis 2a: The effect of leadership on learners' satisfaction with process will be less negative if learners perceive they are in heterogeneous groups than the condition when learners perceive they are in homogeneous groups.

In comparison with smaller groups, members in larger groups face more difficulties in participation, and tend to be less satisfied with the process

(Levine & Moreland, 1990); this negativity can be further compounded by cultural diversity. A larger group carries with it a greater likelihood that members will form subgroups or cliques (Schultz, 1989). This negativity is particularly severe for heterogeneous groups, in which people feel uneasy about communicating with others of different cultural backgrounds (Stephan & Stephan, 2001). Hence, learners in large heterogeneous groups tend to be obviously less satisfied with the process than those in large homogeneous groups.

Hypothesis 2b: The effect of increased group size on learners' satisfaction with process will be less negative if learners perceive they are in homogeneous groups than the condition when learners perceive they are in heterogeneous groups.

As mentioned, group members tend to have lower satisfaction with the process in groups with a leader compared to those without a leader. It is because as the leader exercises greater influence than other members, other members may have a feeling that they gain less access to participation (Napier & Gershenfeld, 1985). But member's demand for leader's direction and tolerance for leadership increases with group size (Hellriegel et al., 2001). As a group becomes larger, the emotional identification and sense of deeply shared commitment becomes more difficult to establish and maintain; therefore, members in larger groups are less satisfied (Levine & Moreland, 1990). Yet leaders are able to resolve conflicts and prevent subgroup formation. Hence, leader's guidance and facilitation in the collaboration process receives more appreciation from members in large groups than those in small ones. Quite the opposite, tension and subgroup formation are less likely to occur in small groups, so the potential benefits of leadership remains unappreciated and therefore, can give rise to a significant negative effect.

Hypothesis 2c: The effect of leadership on learners' satisfaction with process will be less negative in large groups than that in small groups.

RESEARCH METHOD

Experimental Design

A laboratory experiment with a 2×2×2 factorial design was conducted (see Figure 2). The following three independent variables were studied: group size (small vs. large); perceived cultural diversity (heterogeneous vs. homogeneous); and leadership (yes vs. no). Small and large groups were operationalized using three-member and seven-member groups respectively (Strijbos et al., 2003). Eighty-two subjects, undergraduates from a large university in a country with English as the working language, participated in this experiment, yielding 80 usable data. Two data points were discarded due to detection of confederate usage in the experiment (this will be elaborated in the later section). Subjects were firstly stratified to achieve the gender balance in each treatment condition.

Next, they were randomly and evenly assigned to the 8 treatments with 10 in each experimental condition. The subjects, aged between 20 and 23, were all "foreign" students from mainland China, with Chinese as working language. All subjects attended the university under a scholarship program to study in science, computing, or engineering. No significant group difference was reported in terms of age (see Table 1).

Only one student in each learning group was a real subject in this experiment, all other members were confederates (a person pretending to be subject); the use of confederates is not unfamiliar in social research and studies investigating computer mediated groups (Connolly, Jessup, & Valacich, 1990). The subjects were asked to collaborate using preassigned nicknames in a group formed with zero history.

In the culturally heterogeneous groups, all confederates acted as local students. While in the homogeneous groups, they acted as foreign students under the same scholarship program as the subjects. All sessions were conducted in English. Because the role of language transits information about an individual's social origin, the
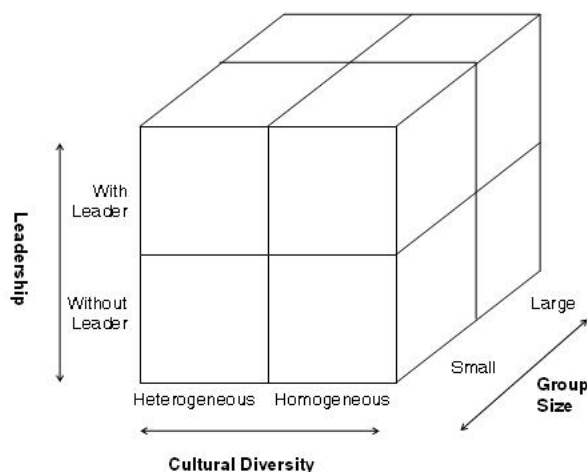
Figure 2. Experimental design

Table 1. Pre-experimental group differences

Source	Age		Computer Experience in relation to CSCL						Experience in group discussion on course material or assignment	
			Taking online quiz		exploring sites and links		using chat room			
	Mean Square	F (Sig.)	Mean Square	F (Sig.)	Mean Square	F (Sig.)	Mean Square	F (Sig.)	Mean Square	F (Sig.)
Cultural Diversity	0.05	0.07 (0.78)	0.13	2.09 (0.65)	0.80	3.27 (0.08)	0.20	0.80 (0.37)	0.61	2.78 (0.10)
Leadership	0.20	0.27 (0.60)	0.13	0.21 (0.65)	0.50	0.21 (0.65)	0.50	0.20 (0.65)	0.31	1.42 (0.24)
Group Size	0.20	0.27 (0.60)	0.13	0.21 (0.65)	0.00	0.00 (1.00)	0.80	3.20 (0.08)	0.61	2.77 (1.00)

different roles (local or foreigner) were manifested by designing into the scripts distinguishable use of the English language (Ji et al., 2004). By doing so, the effect of perceived cultural diversity could be reflected in this experiment; for instance, subjects in heterogeneous groups may perceive themselves being in a heterogeneous group *and* majorities of the groups are from a different cultural background.

In treatment groups with a leader, one confederate acted as the leader and the others ordinary group members. The leader made sure that all members had an opportunity to participate during each round of the discussion by inviting comments from each member. On the other hand, all confederates in treatment groups without leader acted as ordinary group members. The leadership assignment is not explicit because the functional approach of leaders is of interest in the current study. Based on the team literature that roles in groups could be worked out through communication with other members (Knippenberg & Hogg, 2004;), when the leader participated more actively, he/she was very likely to exercise the leader impacts on the subjects even without an explicit leadership assignment.

The use of confederate in this study not only afforded greater control and the associated internal validity, it also allowed dependent variables to be measured at the individual, rather than group, level. For each treatment, confederates participation strictly followed a designed script instrumental to change the perceptions of the subjects about the heterogeneity in group. Moreover, through this script, the effect of increase in group size was limited to perceptual, as intended.

Manipulation of the three independent variables was checked in the postexperimental interview. Subjects were asked to recall the group size, whether there was a leader, and their perception about the cultural diversity in their groups. The interview showed highly matched perceptions in relation to the manipulation for the different conditions; the manipulation of these variables was thus deemed effective. Moreover, the manipulation on the leadership treatment was checked through observation of the discussions, to ensure that the leaders had carried out his/her role in ensuring participation.

Task and Experimental Procedure

A collaborative learning system was developed to provide a science lesson about identifying poisonous mushrooms (Cooper & Stone, 1996). The system consisted of three components, reading materials, online quiz, and chat room. Instructions were integrated into the system to guide subjects

to complete the experiment according to the designed procedures. The experimental task required each learning group to hold discussions toward answering a quiz closely related to the reading materials. Subjects were asked to submit their individual answers after the group discussion. The text-based chat room facilitated collaboration among group members. To encourage the subject to participate actively in the collaboration, he/she was reminded that the group performance would be measured.

Prior to the experimental session, the subject completed a questionnaire aimed at ensuring no pre-experimental differences in computer experience in terms of taking online quizzes, exploring sites and links, and using chat room (Hilmer & Dennis, 2000; Leuthold, 1999). In this pre-experimental questionnaire, the subject was also assessed for his/her experience in collaborative learning, particularly in the form of group discussion on course materials or assignments (Ross, 1996). These measures made use of a 3-point scale (Never=1; Sometimes=2; Often=3). No significant differences were reported in terms of these measures across all experimental treatments (see Table 1). No subject reported that they had never participated in any of these activities mentioned in the measures.

Next, the subject studied the materials provided by the system in an individual capacity and took the quiz. This individual test was instituted to ensure that the subject had undergone learning of the topic before the group discussion. The subject then discussed with the other members (confederates) on the quiz in the chat room. Exam performance is a well-adopted measure of learning performance (Susman, 1998). In this experiment, the quiz consisted of both close-end questions and open-end questions with a full score of 10 points. Embedded in the design of the confederate scripts, confederates proposed conflicting ideas for each question in the quiz during the discussion; a subject would get clarifications from others only if he/she contributed his/her own views. In this

way, the subject's explanation and contribution in the collaborative learning activities could be reflected in the performance. In order to prevent the influence of social pressure and conformity from setting in, the subject was allowed to modify her/his answers on the individual basis after the discussion. These answers were then used to measure the performance variable. Finally, the subject completed a questionnaire on satisfaction with process (adapted from Tyran, 1997).

Data Analysis

The factor analysis result reflects that four of the items loaded highly on the same factor and they produced a Cronbach's alpha of 0.85 (see appendix). Therefore, the construct satisfaction with process is measured using these items. Table 2 summarizes the descriptive statistics on the two dependent variables. Table 3 reports the results of the 3-way ANOVA tests. A further analysis through simple effects of each factor is used to understand the interactions on performance and satisfaction (see Table 4), in accordance with the earlier formulation of hypotheses.

A significant joint effect of perceived cultural diversity and leadership on performance is found ($F=4.58$, $P<0.05$). Further analysis reveals that the effects of perceived cultural diversity are significant only in groups with leadership ($F=7.88$, $P<0.05$), but not in those without leadership; for groups with leadership, heterogeneous groups exhibit better performance than homogeneous groups. This seems to violate the negative relationship between perceived cultural diversity and performance that underlies Hypothesis 1a; Hypothesis 1a is not supported. Because no significant joint effect is reported on performance due to perceived cultural diversity and group size or leadership and group size, Hypotheses 1b and 1c are not supported.

For satisfaction with process, leadership is found to have significant joint effect with perceived cultural diversity ($F=9.08$, $P<0.01$), and with group

Table 2. Results: Mean (standard deviation)

Group Size	Cultural Diversity	Performance			Satisfaction with Process		
		Leadership			Leadership		
		With	Without	Total	With	Without	Total
Small	Heterogeneous	6.40 (1.43)	4.60 (1.35)	5.50 (1.38)	3.05 (0.65)	4.05 (0.71)	3.55 (0.84)
	Homogeneous	6.10 (1.10)	4.50 (1.35)	5.30 (1.45)	3.08 (0.88)	4.00 (0.37)	3.54 (0.81)
	Total	6.25 (1.25)	4.55 (1.32)	5.40 (1.53)	3.06 (0.76)	4.03 (0.56)	3.54 (0.82)
Large	Heterogeneous	7.05 (1.23)	4.40 (1.45)	5.73 (1.89)	4.25 (0.33)	3.50 (0.82)	3.88 (0.72)
	Homogeneous	5.10 (1.10)	4.90 (1.90)	5.00 (1.51)	2.88 (0.79)	4.00 (0.54)	3.44 (0.88)
	Total	6.08 (1.52)	4.65 (1.66)	5.36 (1.73)	3.56 (0.92)	3.75 (0.73)	3.66 (0.82)
Total	Heterogeneous	6.73 (1.34)	4.50 (1.37)	5.61 (1.75)	3.65 (0.80)	3.78 (0.80)	3.71 (0.79)
	Homogeneous	5.60 (1.19)	4.70 (1.62)	5.15 (1.47)	2.98 (0.82)	4.00 (0.45)	3.49 (0.84)
	Total	6.16 (1.37)	4.60 (1.48)	5.38 (1.62)	3.31 (0.87)	3.89 (0.65)	3.60 (0.82)

Table 3. Results of ANOVA tests

Source	Performance		Satisfaction with process	
	Mean Square	F	Mean Square	F
Cultural Diversity	4.28	2.23	1.01	2.27
Leadership	48.83	25.45**	6.61	14.83**
Group Size	0.03	0.02	0.25	0.57
Cultural Diversity*Leadership	8.78	4.58*	4.05	9.08**
Cultural Diversity *Group Size	1.39	0.72	0.90	2.03
Leadership*Group Size	0.38	0.20	3.00	6.73**
Cultural Diversity*Leadership*Group Size	6.33	3.30	4.75	10.66**
** $p<0.01$ * $p<0.05$				

Table 4. Exploration of interaction effects

Source	Performance		Satisfaction with process	
	Mean Square	F	Mean Square	F
Cultural Diversity (with Leader)	12.66	7.88*	4.56	6.95**
Cultural Diversity (without Leader)	0.40	0.18	0.51	1.19
Leadership (Heterogeneity)	49.51	26.98**	0.16	0.24
Leadership (Homogeneity)	8.10	4.02*	10.51	23.85**
Leadership (Large Group)			0.35	0.51
Leadership (Small Group)			9.26	21.05**
Group Size (with Leader)			2.50	3.52
Group Size (without Leader)			0.76	1.81
** $p<0.01$ * $p<0.05$				

size (F=6.73, P<0.01). The negativity of leadership is significant in homogeneous groups (F=23.85, P<0.01) but not heterogeneous groups; thus, Hypothesis 2a is supported. Similarly, Hypothesis 2c is supported since leadership's negative effect is significant on small groups (F=21.05, P<0.01) but not on large groups. However, no joint effect of perceived cultural diversity and group size is detected; hence, Hypothesis 2b is not supported.

DISCUSSION

Performance

In this study, the relationship between perceived cultural diversity and performance seems to have its direction reversed from negative to positive as a result of leadership. Learners in perceived heterogeneous groups tend to avoid expressing their opinions. Yet a leader, as explained previously, is able to encourage contributions from all learners. Interestingly, in the presence of leadership, learners may achieve better performance if they perceive themselves to be in a heterogeneous group than those who perceive themselves to be in homogeneous groups. Very likely when the participants become aware of the differences among group members (e.g., different culture backgrounds), comments would be written with greater care to ensure they would be construed as intended; this may in fact motivate the participants to explain their points with more deliberation (McFadzean & McKenzie, 2001). This argues strongly for the presence of leader in heterogeneous groups.

Leaders can help group members to achieve better performance through enhancing participation (Alavi & Leidner, 2001). Nonetheless, the tradeoff is that leader's facilitation may limit the openness of group discussion. The leader exercises greater influence than other members; he/she becomes the dominant member of the group and has higher participation at the expense of other members. Information exchange gets limited as

the discussion becomes less open. Consequently, in the condition with leadership, learners in larger groups tend not to outperform those in smaller groups.

However, the results report no supportive findings to the joint effect of perceived cultural diversity and group size on performance. This remains a problem to be resolved. Arguably, the missing joint effect may be caused by the overriding negative effect of perceived cultural diversity; learners intend to participate less if they perceive themselves to be in a heterogeneous group. Future research should look into this phenomenon and bridge the gap in the current team literature.

Satisfaction with Process

Generally, in the presence of a leader, members tend to perceive that they can only express their opinions when they are asked to do so. Thus, they are less motivated to participate and have lower satisfaction with process. Whereas this phenomenon holds in the culturally homogeneous groups, it does not in the heterogeneous groups. In the latter condition, it is likely that the leader's contribution in ensuring participation has been able to reduce the learners' anxiety associated with being in heterogeneous groups; members are therefore more tolerant of possible dominant behaviors exhibited by the leader. In perceived homogeneous groups, the "detrimental" effects caused by leadership remain, since members do not appreciate the facilitation provided by leaders.

Leaders facilitate group discussion in terms of resolving conflicts and preventing subgroups from forming. This role is arguably more appreciated in large groups, which more commonly suffer from tension and subgroups formation, as compared to smaller groups. Such appreciation may be sufficient to negate the otherwise undesirable impact of leadership on satisfaction. On the other hand, because subgroup formation and cliques are not major problems in small groups, the leadership role is less valued.

In face-to-face setting without collaborative learning technology support, learners in heterogeneous groups may suffer from communication distortions that make the discourse more difficult and less efficient, thus bringing detrimental effects to one's satisfaction with the process. However, as in the context of this study, the collaborative learning system has the capability of making "visible" the communication pattern and enabling learners a better understanding of others' ideas. In this way, the negative effects of cultural differences are reduced if not altogether eliminated, by the collaborative learning system, as learners of different cultures gain more accurate understanding of one another (Young, 2003). Learners in perceived heterogeneous groups believe that they could learn through interpreting others' comments, and they find the system supports this interpreting activity well in both larger and smaller groups. This may account for the missing joint effect of perceived cultural diversity and group size on learner's satisfaction with the process.

Limitations

This study has several limitations. It has addressed only users working on a task in which they had no vested interest and only for a short time period. Although the effect of perceived cultural diversity is most salient during the initial contact among group members, the influence may change in the long run. Continued collaboration generally reduces individual's anxiety of being in a culturally heterogeneous group, although bad experiences can increase it. This study has not been designed to reflect the effect of perceived cultural diversity across time. It should also be noted that whereas the tight control gained through the "scripting" of confederates has enabled a focus on perpetual impact, this approach may have, to some extent, restricted us from studying the full effect of group size. The current study has examined the chat room setting; future research should also analyze nontext-based contexts (e.g., videoconferencing and teleconferencing).

Implications

This study implies that a key to getting heterogeneous groups to achieve better performance is to make individual members feel involved and committed. Moreover, the collaborative learning system facilitates learning in heterogeneous groups by smoothing the communication process. As well, the findings highlight the role of leaders in collaborative learning for increasing members' performance, particularly when they perceive themselves in culturally heterogeneous groups. Leadership has been appreciated to a greater extent in perceived heterogeneous (vs. homogeneous) or larger (vs. smaller) groups; future research should look into ways to mitigate the negative influence of leadership on satisfaction, particularly in homogeneous and small groups.

This study is contributing to the understanding of cultural diversity it terms of it effects on group members' perception. Other related aspects are needed to be addressed in future work. Whereas the current research has examined the phenomenon in a single session setting, longitudinal studies are warranted to gain greater insights. The current research has viewed cultural diversity as being *either* heterogeneous *or* homogeneous; none the less, the *degree* of perceived heterogeneity can be defined and should be studied in future efforts. Moreover, the roles of important contextual factors, including learning task and system characteristics, are needed to be further explored in CSCL.

CONCLUSION

A laboratory experiment with a 2×2×2 factorial design was conducted in the current study to examine the interaction of perceived cultural diversity, group size, and leadership on learners' performance and satisfaction with the process. Instead of an expected negative relationship between perceived cultural diversity and performance,

a reverse observation was obtained, indicating a positive relationship as a result of leadership. Leadership lowered learners' satisfaction with the process in perceived homogeneous groups (as compared to perceived heterogeneous groups) and smaller groups (as compared to larger groups).

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APPENDIX: MEASUREMENT OF SATISFACTION WITH PROCESS

(Strong Disagree = 1, Disagree = 2, Neutral = 3, Agree, = 4, Strongly Agree = 5):

1	I believe the group learning has helped to increase my understanding of the material in this mushroom course (factor loading = 0.88).
2	I am satisfied with my contributions during the electronic discussion (factor loading = 0.53).[1]
3	This course has been a great deal of fun (factor loading = 0.86).
4	This course has NOT been fun at all (factor loading = 0.79).[2]
5	The group learning process has met my expectation (factor loading = 0.75).

Notes: [1] This item was excluded for the later analyses. [2] This item was measuring the corresponding construct in a reverse direction.

Chapter XII
Breaking the Knowledge Acquisition Bottleneck Through Conversational Knowledge Management

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ABSTRACT

Much of today's organizational knowledge still exists outside of formal information repositories and often only in people's heads. While organizations are eager to capture this knowledge, existing acquisition methods are not up to the task. Neither traditional artificial intelligence-based approaches nor more recent, less-structured knowledge management techniques have overcome the knowledge acquisition challenges. This article investigates knowledge acquisition bottlenecks and proposes the use of collaborative, conversational knowledge management to remove them. The article demonstrates the opportunity for more effective knowledge acquisition through the application of the principles of Bazaar style, open-source development. The article introduces wikis as software that enables this type of knowledge acquisition. It empirically analyzes the Wikipedia to produce evidence for the feasibility and effectiveness of the proposed approach.

INTRODUCTION

Ever since the development of artificial intelligence (AI) and expert systems, there has been the promise of capturing an organization's knowledge on a large scale and making it available to the entire organization. Unfortunately, these promises did not materialize (Buchanan & Smith, 1988; Ullman, 1989). While there have been several early success stories, such as

American Express' Credit Advisor or Digital's Expert Configurer (XCON), attempts to acquire the broad knowledge of organizations have been less fruitful. More than a decade later, a decidedly optimistic survey by Frappaolo and Wilson (2003) found that no more than 32% of the knowledge was available in computerized form. Obviously, knowledge acquisition is a challenge. How can we extract more of the existing knowledge from organizational sources, especially from people? And how can we manage the maintenance so as to assure that the stored knowledge is accurate and up-to-date? Discovering answers to these questions is important for organizations as information work becomes knowledge work, thus requiring knowledge to support non-routine decision making (Drucker, 1993, 1999). It is similarly important for organizations whose corporate portals that were set up years ago increasingly are becoming dated and stale (Newcombe, 2000). Furthermore, it is important for organizations in the business of creating knowledge assets who are faced with increased costs of knowledge creation, shorter knowledge life cycles, and increased knowledge obsolescence.

Seeking a solution to the problems of organizational knowledge acquisition, the chapter makes the following argument. First, it introduces previous approaches to knowledge acquisition, identifies four limitations, and offers evidence for these limitations. The chapter then refers to Bazaar style (software) development (Raymond, 2001) as a potential direction for knowledge asset creation. It then explains the concept of conversational knowledge management and advocates wiki technology and the "wiki way" (Leuf & Cunningham, 2001) as a possible approach to using Bazaar-style methods in conversational knowledge management. An empirical analysis of the viability and effectiveness of the approach follows. The chapter ends with implications and conclusions about the future of conversational knowledge management.

KNOWLEDGE ACQUISITION

Approaches to Knowledge Acquisition

Organizations that try to acquire organizational knowledge formally (based on artificial intelligence methods) have relatively few available alternatives. For application areas with large amounts of transaction data, data mining can induce rules from that data. Data mining solutions work well for high-volume applications such as credit approval. Even then, the knowledge creation effort is highly resource-intensive (Lee, 2001). When insufficient data volumes thwart data mining efforts, the acquisition activity has to elicit knowledge directly from experts as rules and facts or similar formal representations. This should be done under the guidance of knowledge engineers trained in knowledge elicitation, formalization, and representation. Yet a knowledge engineer's productivity is limited to hundreds of rules per year for development and maintenance (Sviokla, 1990; Turban & Aronson, 2000). This productivity level may be acceptable for high value-added projects but limits the broad applicability of the approach. Smaller projects have attempted to rely on capturing knowledge without knowledge engineers, relying on end-user development. The latter has not been very successful (Wagner, 2000, 2003). Wagner found end-user expert systems often to be poorly structured, incomplete, highly coupled, and thus, difficult to maintain. Artificial intelligence-based methods thus are facing considerable applicability constraints. Consequently, organizational knowledge management efforts have sought to capture knowledge in less formal ways; for instance, by extending document management and groupware systems into knowledge management systems (Davenport & Prusak, 1998; Holsapple & Joshi, 2002) in part through better indexing, search engines, and linking.

Yet challenges remain. When organizations try to make sense out of large volumes of docu-

ments in their document management systems, they usually need search engines, text mining, and automatic indexing tools, resulting in an expensive solution with limited success (Bygstad, 2003). Furthermore, this approach is well suited only for relatively stable and centralized knowledge bases. Users of such knowledge bases often encounter information overload, irrelevant responses, or no response to queries. Alternatively, organizations might use expert reports and harvest expert knowledge to capture the methods used by domain experts (Snyder & Wilson, 1998). Again, this method often is limited to niche applications, requires considerable effort, and still faces knowledge maintenance difficulties (Malhotra, 2000). Other solutions, such as corporate controlled portals, can quickly suffer from outdated knowledge and lack of maintainability (Newcombe, 2000).

Knowledge Acquisition Bottleneck

In summary, we can describe the knowledge acquisition bottleneck as follows (Wagner, 2000; Waterman, 1986):

- **Narrow bandwidth.** The channels that exist to convert organizational knowledge from its source (either experts, documents, or transactions) are relatively narrow.
- **Acquisition latency.** The slow speed of acquisition frequently is accompanied by a delay between the time when knowledge (or the underlying data) is created and when the acquired knowledge becomes available to be shared.
- **Knowledge inaccuracy.** Experts make mistakes and so do data mining technologies (finding spurious relationships). Furthermore, maintenance can introduce inaccuracies or inconsistencies into previously correct knowledge bases.
- **Maintenance trap.** As the knowledge in the knowledge base grows, so does the require-

ment for maintenance. Furthermore, previous updates that were made with insufficient care and foresight ("hacks") will accumulate and render future maintenance increasingly more difficult (Land, 2002).

Given these challenges, it appears that there are few opportunities for breaking the knowledge acquisition bottleneck. The next section will propose one possible remedy.

LEARNING FROM SOFTWARE DEVELOPMENT

One area that has offered lessons for the successful creation of knowledge assets is software development, and specifically open source software development by distributed teams of volunteers. Open source projects engage software developers, wherever they may reside, and have them collaboratively develop the knowledge asset (the software). Surprisingly, this activity takes place with little centralized management. Raymond (2001) characterized this approach to software development as the *Bazaar* style in contrast to the traditional *cathedral* style of development. Cathedral is a metaphor for the development of a large monolithic artifact through a structured and lengthy development process. Fundamental to the cathedral style approach is that source code is only widely available at release dates with access restricted to a few developers between release dates. Bazaar style development, however, occurs over the Internet in constant public view. Raymond identified principles of this development style that challenge the assumption that large and complex software assets need to be built via an *a priori*, centralized approach. Overall, four themes guide this development approach, which can be characterized as follows: (1) design simplicity of the artifact, (2) team work, (3) frequent creation of a visible work product, and (4) development as an ongoing conversation. This section introduces

Figure 1. Framework for open source software development
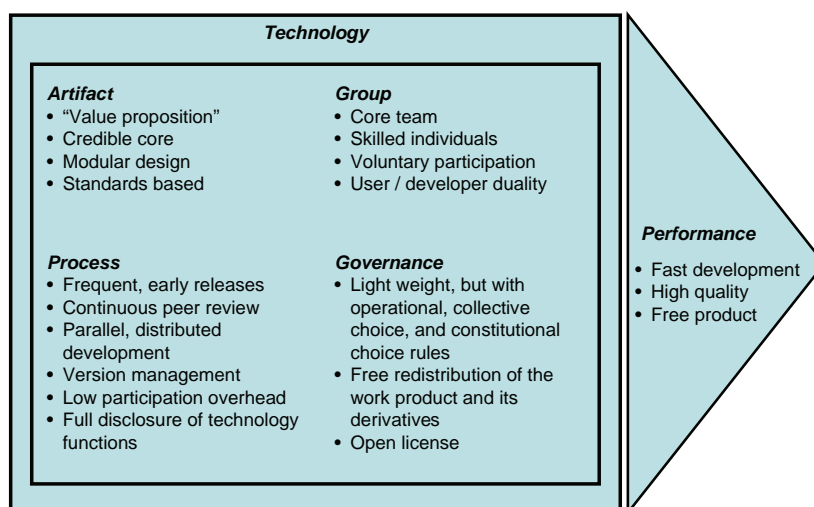
a framework of open source (software) development, identifies its benefits, and derives lessons about the applicability for knowledge assets other than software.

Open Source Software Development

Open source software development, as described, for instance, by Raymond (2001), Benkler (2002), and Markus, et al. (2000), relies on several factors to achieve success (and thus, performance of the knowledge creation effort). Key success factors (see Figure 1) consist of a suitable artifact, a skilled and motivated team of volunteer users and developers, a lean and transparent development process, and lightweight but effective governance. Added to this is an enabling factor; namely, an appropriate technology infrastructure, which, for instance, permits frequent releases, accommodates voting mechanisms to govern the community, or enables fast and reliable version management, all with little overhead and few transaction costs. With these factors in place, open source software development promises faster development speed than proprietary approaches

(including higher developer productivity) and a better quality product, which is also free.

Open source software development has had remarkable successes, creating software that appears to break long-standing rules of software evolution (Scacchi, 2004). For example, open source software size has been shown to grow super-linear (exponential) rather than linear or inverse-square (Mockus et al., 2002).

Bazaar-Style Knowledge Management

Can Bazaar-style development be applied successfully to the creation of knowledge assets other than software? Several leaders of the open source community have hypothesized this, including Torvalds (Hamm, 2004). Yet Torvalds also acknowledged that not all knowledge assets are equally suitable, as the creation process may be too personal or too linear. Hence, in order to extend the lessons and benefits of Bazaar-style development, we should target applications where the core themes can be applied: (1) simplicity of design and frequent redesign (refactoring) to maintain simplicity, (2)

teamwork (3) frequent creation of a small work product available for review and testing, and (4) development as conversation to facilitate back-up, clarity, and shared understanding. Applications of this kind exist within organizations, and among organizations and people. For example, companies could conceivably turn their traditional help desks into open help desks, where customers would openly share their problems with others, help each other, and free up company experts to tackle only the most difficult problems. Unfortunately, companies frequently do not want to relinquish control of their (closed) help desk. Open help desks exist on the Web, typically as discussion forums of questions and answers. While they embody teamwork and conversation, the resulting work product often is not simple and well-structured but lacks organization and is filled with repetition and inconsistencies.

Consequently, one necessary condition for this research was to find a knowledge asset that was highly amenable to the Bazaar-style development approach and that used a technology that facilitated this type of development. The selected asset was an online encyclopedia—Wikipedia (wikipedia.org)—that employs wiki technology and the "wiki way" of knowledge asset creation (Leuf & Cunningham, 2001). The chapter will provide more detail on the Wikipedia application, following a briefing on knowledge management with wiki technology and the wiki way.

CONVERSATIONAL KNOWLEDGE MANAGEMENT WITH WIKIS

Knowledge management with wikis has recently drawn media attention (Brown, 2004; Hof, 2004; Ripley, 2003) as a new, end user developed approach founded on collaboration and conversation. Collaborative knowledge management means that many people work together to create or acquire knowledge instead of a few individual experts. In other words, a community (of practice) will jointly create and maintain the knowledge. Research elsewhere (Cheung et al., 2005) suggests that conversational knowledge management is well suited for this challenge, whereby conversations (i.e., questions and answers) become the source of relevant knowledge.

Conversational knowledge management has become popular in communities that form around discussion boards. Leading solutions such as ez-board or Yahoo groups are now used by millions of communities[1]. Yet while discussion forums have been a simple and practical solution to share knowledge through conversation, they lack several useful knowledge representation and maintenance features. For example, discussion forum postings, even within a single thread, often do not build upon each other. As a result, the latest post may not be an incremental improvement of earlier ones. An alternative technology, which combines the most desirable features of other conversational technologies, is the wiki. This section discusses wiki technology and its suitability for knowledge management.

Wiki Structure and Principles

A wiki is a set of linked Web pages created through the incremental development by a group of collaborating users (Leuf & Cunningham, 2001) as well as the software used to manage the set of Web pages. Ward Cunningham developed the first wiki in 1995 as the PortlandPatternRepository in order to communicate specifications for software design within a large, heterogeneous community. The term *wiki* (from the Hawaiian *wikiwiki*, meaning *fast*) references the speed with which content can be created with a wiki. Wiki key characteristics are as follows:

- It enables Web documents to be authored collectively;
- It uses a simple markup scheme (usually a simplified version of HTML, although HTML frequently is permitted);

- Wiki content is not reviewed by any editor or coordinating body prior to its publication; and
- New Web pages are created when users navigate a hyperlink that points nowhere.

Underlying these characteristics are specific principles that have shaped wiki software as well as its use. They are intended to produce a development environment where multiple people easily can create and modify a set of jointly owned Web pages. Wiki pages are expected to be open, incrementally developed, and organic; require little markup; have consistent edit functions and clear naming, be heavily hyperlinked and easily observable (found). As a result, wiki pages are expected to change and improve incrementally.

Wikis in Use

Creating Wiki Pages

Creating and editing wiki pages is a simple activity. A wiki author will use a Web-enabled *formfield* to enter a comment he or she wishes to publish. Authors can use plain text or a simplified markup language. The system then automatically generates and publishes a Web page with a unique URL that can be indexed and linked to. Hence, users with virtually no Web publishing knowledge can create Web content about as quickly as they can write a text document.

Linking Wiki Pages

A fundamental aspect of knowledge management with wikis is the use of simple hyperlinks. Hyperlinks link topics and create context. Wikis drastically simplify hyperlinking. To link pages within a wiki, users do not have to create and use URLs (although they can). Instead, they normally use CamelCase (multiple words capitalized and

concatenated) or double parentheses around a term ([[term]]) in order to create a link. Links whose destination (page) does not exist are depicted as question marks (or similar) as if the author were asking a question. Another author (or the original creator) then can respond by clicking on the question mark, thus navigating the hyperlink to a new page and invoking an editor to write that page. Upon completion of the edit, the question mark automatically will be rendered as a regular hyperlink (now underlined text) pointing to the new page.

Versioning

As multi-user systems, wikis enable every user to modify any other user's Web pages (unless explicitly forbidden by access right settings). This creates challenges in version management. Wikis solve them by keeping prior versions of any Web page in memory, and enabling rollback, comparison, difference identification, and similar capabilities, if so desired. Wikis also track the history of prior changes with author, date, and related information.

Wikis and Open Source Principles

Knowledge management using wikis and the wiki way (see, for instance, "WhyWikiWorks" at http://c2.com/cgi/wiki?WhyWikiWorks) appear to bear considerable resemblance to open source software development, described in part by the following traits:

- Sense of responsibility in contributing to a common good;
- Openness to change and modification by anyone;
- Meritocracy (anyone can play, but only good players last);
- Self-governance of the developer team;
- Task decomposition and incremental development;

- Use of technology for communication and coordination, as well as norms for their use, including objectivity (neutral point of view); and

- Ease of use for knowledge creation and maintenance.

Thus, as an enabling technology, wikis establish an environment to develop the right artifact, to use a Bazaar-style process, to engage teams in voluntary collaboration, and to govern the effort with a lightweight structure (Figure 1), thus offering the potential for open source knowledge management. In open source software development, the corresponding results are ultimately lower error rates (compared to closed source); fast(er) development speed; and the ability to develop large(r) applications, accelerated development, and high(er) maintainability of the source code (Mockus et al., 2002). Whether these same benefits accrue in wiki-enabled open source knowledge management must be determined empirically.

ASSESSING CONVERSATIONAL KNOWLEDGE MANAGEMENT

Can principles of Bazaar-style development be applied to knowledge management, and if so, will they improve knowledge acquisition effectiveness? To begin to answer these questions, the research analyzed a single case of wiki-enabled knowledge asset creation—Wikipedia.

Knowledge Asset: Wiki-Based Encyclopedia

Encyclopedias reasonably can be characterized as knowledge assets. While one may debate how much of their content is information instead of knowledge, encyclopedias contain insights (factual), rules (inferential), principles (inferential), and so forth. They also fit the definition of *information in context* (Davenport &Prusak,

1998), since they frequently link concepts to other concepts (cross-referencing). By design, encyclopedias also are relatively loosely coupled knowledge assets, whose components (articles) can exist independently. Encyclopedias frequently are compiled from the work of a group of authors who know little about each other or each other's work. Encyclopedia articles have common structural elements, since all articles are definitions. They typically also follow some standards for articles of a similar type (e.g., all biographies are structured similarly and different from city descriptions).

The majority of digital encyclopedias, such as Britannica, Encarta, Compton, or Grolier, is closed source. They are compiled by a relatively small group of commissioned writers and editors. The result of their work only becomes available to the readership once the entire edit process has been completed and the new encyclopedia version is released. Yet, because of their loosely structured nature, encyclopedias (and other, similar knowledge assets) also can be created in Bazaar style, given certain conditions. The work product cannot be an off-line product such as a book or a CD; the technology in general has to be amenable to Bazaar-style knowledge acquisition and representation, and the organization creating the encyclopedia has to formulate procedures and methods that enable this type of knowledge acquisition. Bazaar-style knowledge acquisition, therefore, becomes a possibility when the asset is created following the wiki way. Hence, Wikipedia, the online encyclopedia developed as a wiki, was used as the knowledge asset to be analyzed for this research. Wikipedia is one of several knowledge products developed over the last few years with wiki technology and the wiki way of development. Other applications include Wikitravel and Wikibooks. Development of Wikipedia began in 2001. As of May 2004, less than three and a half years later, the (English) Wikipedia contains about 280,000 articles.

Table 2. Wikipedia fit with Bazaar-style development criteria

Dimension	Bazaar Style Development	Wikipedia Adaptation
Artifact	"Value Proposition"	Yes – create free and open encyclopedia
	Credible Core	Yes/No – not a content core, but a developer group core
	Modular Design	Yes – loosely coupled articles
	Standards Based	Yes – article structures
Group	Core Team	? - Is Wikipedia development a team effort?
	Skilled Individuals	Yes/No – participants from the Nupedia initiative were all PhDs, but no control over new participants
	Voluntary Participation	Yes – only one paid "chief editor", Larry Sanger (until 2002)
	User / Developer Duality	Yes – author and users
Process	Frequent, early releases	? – Are Wikipedia articles developed through an incremental approach with continuous releases?
	Continuous peer review	
	Parallel, distributed development	Yes – 7,000 authors worldwide
	Version management	Yes – through wiki technology
	Low participation overhead	Yes – through wiki technology
	Full disclosure of (technology) functions	Yes – through wiki technology
Governance	Light weight, operational, collective choice	Yes – Wikimedia organization with meritocracy as governing structure
	Free re-distribution of the work product	Yes – GPL license
	Open License	
Performance	Fast Development	? – Does conversational knowledge management result in linear or better growth of knowledge assets
	High quality	? – Does conversational knowledge management result in improved knowledge asset quality?
	Free product	Yes – GPL license

Wikipedia, applying wiki principles, appears to enable its developers to use a Bazaar-style approach. Specifically, writers can make incremental changes and then commit and publish them immediately. Also, articles can be written by numerous writers as joint authors, thus building on the work of others or correcting mistakes. Furthermore, Wikipedia rules stress an authoring etiquette that incorporates rules of article design and redesign targeted toward simple and clear articles. In other words, it is possible for Wikipedia authors to follow the main themes of Bazaar-style development. Whether authors do so and whether the outcome of their efforts is consistent in its effectiveness with Bazaar-style software development needs to be determined empirically.

Research Questions

The research sought to address two questions through empirical analysis.

1.   Is conversational knowledge management, as demonstrated in Wikipedia, consistent with Bazaar-style knowledge asset creation?
2.   Is conversational knowledge management, as illustrated by Wikipedia, able to achieve the benefits of Bazaar-style development?

The research thus needed to determine whether "Wikipedians" would follow Bazaar-style knowledge acquisition and whether the effect would be improved knowledge acquisition. Based on the criteria in Figure 1, numerous questions would have to be addressed. Yet, as Table 2 illustrates, compliance with the majority of criteria was confirmed from Wikipedia information (Wikipedia Web site and Wikimedia Meta-Wiki), leaving four core questions to be answered.

Thus, the research questions focused on the incremental nature of the knowledge acquisition effort, the multi-person effort, and the effect on the growth and quality of the work product, as described in the following subsections.

Incremental Development with Frequent Releases

Incremental development and frequent releases are fundamental to Bazaar-style development. Would Wikipedians follow this approach, or instead would they prefer to write an authoritative article in an effort burst with few revisions in the process and even fewer thereafter?

To answer this question, the research explored (1) the frequency of article edits and (2) the change in article size. If the effort were non-incremental, one would expect a relatively short development period of high activity (since an article is typically a few hundred to a few thousand words long) followed by little editing activity thereafter, possibly with some maintenance and some extensions. An incremental effort, in contrast, would result in a high level of activity with many edits during an extended development period followed by a much-extended maintenance period with lower yet still considerable update efforts. To operationalize the assumption, the research adopted the Pareto rule, thus hypothesizing that if Wikipedia articles were written in a non-incremental effort, then 80% of their size growth and 80% of the edit efforts should occur during the first 20% of their existence:

H1: Wikipedia articles are the outcome of an incremental development, and therefore, their growth and edit pattern does not follow the 80-20 Pareto rule.

Multi-Person Effort

There is little doubt that Wikipedia is a multi-person effort with presently more than 7,000 people contributing to it and more than 500 people making more than 100 contributions each per month (see Wikistats at http://www.wikipedia.org/wikistats/EN/TablesWikipediaEN.htm). However, according to the principles of Bazaar-style development, one would expect Wikipedia development to be a team effort at a more detailed level with multiple authors working on each article in order to extend it and possibly to correct mistakes. This would reflect one of the key themes of open source, also called *Linus' [Torvalds] Law*; namely, that "given enough eyeballs, all bugs become shallow." Hence, the research sought to determine whether enough eyeballs were scrutinizing each article, at least more than two. Hence, the analysis focused on whether article publication and maintenance was a multi-person effort.

H2: Knowledge acquisition and maintenance in individual Wikipedia articles is a multi-person effort.

Effectiveness

The research sought to determine whether encyclopedia development adopting the wiki way would be effective. In this exploratory study, effectiveness was measured through two variables; namely, (1) growth of the knowledge asset and (2) quality improvement efforts. Growth of the knowledge asset was determined, based on the increase in the number of articles in the Wikipedia over time. In line with other open source successes (Mockus et al., 2002), the expectation was that growth would be linear or better (super-linear).

Table 3. Wiki development activity

	20% Avg. Actual	Avg. Expected (80-20 Rule)	t (df = 39)	Significance p
2001 Articles, Size (Words)	793	1,855	6.468	.0000
2001 Articles, Edits	17	230	8.841	.0000
2002 Articles, Size (Words)	811	1,795	4.212	.0000

Table 4. Wikipedia article author statistics

	Min. No. Authors	Max. No. Authors	Avg. No. Authors	t-Statistic	Significance p
2001 Articles	33	285	121.4	10.33	.0000
2002 Articles	18	268	70.8	7.870	.0000
All Articles	18	285	96.1	12.21	.0000

H3: Wikipedia growth in terms of number of articles will be linear or super-linear.

Unable to assess the overall quality of the Wikipedia objectively vis-à-vis other encyclopedias, the research focused on process quality and specifically quality improvement efforts. These efforts were operationalized by the ratio of edit efforts vs. the growth of Wikipedia articles. In other words, the research tested whether editing efforts were devoted to increasing the size of articles or to refining existing articles. The assumption was that refinements (without significant increase in size) would improve overall quality, for instance, through an increase in presentation quality, content quality, or the inclusion of more viewpoints (diversity).

Hence, we computed a words-per-edit ratio based on the number of words (per article) written and the number of edits it took to create the article version. This ratio was calculated for articles in their early stages (20% of development effort) and at their present state. Decreasing ratios would indicate more effort being spent over time on article refinement. To exclude insignificant edits, the research only considered non-minor changes (counted separately in Wikipedia). The expectation was that, over time, more effort would be devoted to increased article quality. It is a stated Wikipedia goal to increase quality as articles mature (see, for instance, the reply to objections concerning Wikipedia, which discusses quality and growth issues, at http://en.wikipedia.org/wiki/Wikipedia:Replies_to_common_objections).

The corresponding hypothesis concerning quality improvement was as follows:

H4: Edit effort targeted at quality improvements for individual Wikipedia articles will increase over time, demonstrated by reduced article growth per edit.

Data Source

Wikipedia is an open encyclopedia in many ways. In addition to articles being freely accessible, so is the history of their creation, including dates, content of each version, and author information. Hence, it was possible to trace changes, change frequencies, and author contributions. To address the first two questions, 80 articles were randomly selected with the one qualification that 40 of them had to be created originally in 2001 and 2002. More recent articles were ignored because of their short history. To determine knowledge asset growth, Wikipedia summary statistics were accessed,

which logged the number of articles written each month from the start of Wikipedia.

Results

Incremental Development (Release Early and Often)

This analysis focused on two samples of 40 articles from 2001 and 2002. For both of these samples, the edit efforts for the first 20% of each article's existence (up to the measurement point in March 2004) were compared against the entire development effort. The results do not support the notion of a short effort burst but one of incremental development, as shown in Table 3.

For articles started in 2001, the first 20% of an average article's existence accounted for about 34% of the article's size (793 words out of 2,319) and less than 6% of its edits (17 out of 288). For the 2002 articles, the first 20% accounted for about 36% of article size and 15% of article edits. Overall, this was considerably less than expected according to the Pareto rule. All results are highly significant (p < 0.0001). Hence, size grew relatively incrementally with a somewhat larger upfront effort (about 35% of size produced in 20% of the time). Wikipedia edits were even more incremental with a disproportionately small number during the early existence of an article (15% or less of the edits in 20% of the time).

Multi-Person Effort

Each of the 80 articles in the two samples also was evaluated according to the number of authors. None of the articles in the sample was co-authored by fewer than 18 people, and the maximum number of authors for any article was 285. On average, more than 96 authors worked on an article (Table 4).

Given these results, what is the likelihood that articles overall were predominantly single-authored? Virtually none. A t-test showed very significant differences between the actual author numbers and the possibility of single authorship. This is a strong result, yet the reader is reminded that the sample articles were old articles. More than half of the Wikipedia articles were less than 12 months old (as of June 2004) and will have been edited by fewer people. An additional sample of 40 randomly selected articles started in 2003, though, still corroborated the results (average of 48 authors, t = 7.164, p = 0.0000). In other words, as time progresses, Wikipedia articles are scrutinized by "many eyeballs".

Wikipedia Growth

Data points concerning the growth of Wikipedia illustrate dramatic growth. Although Wikipedia has existed since 2001, more than half of its approximately 280,000 articles (English articles as of May 2004) were written since June 2003. (See http://www.wikipedia.org/wikistats/EN/TablesWikipediaEN.htm).

To explore the growth pattern further, the analysis targeted the numbers of new articles created each month. Three different time series were compared: number of articles, log of number of articles, and square root of number of articles. For each series, the fit was computed to determine which one best predicted Wikipedia growth. As Table 5 illustrates, Wikipedia growth is best explained by a quadratic function (R^2 = 0.988, highest). In other words, Wikipedia article growth is most likely quadratic and, thus, super-linear, which is an aggressive growth pattern. Quadratic growth also best explained the increase in the number of Wikipedians and in the number of edits (changes) made to Wikipedia.

Quality Improvement

The second effectiveness measure, the allocation of effort to quality improvement, suggested a shift toward more quality as Wikipedia articles aged. Table 6 illustrates that during the first 20% of

Table 5. Growth in Wikipedia articles (articles official count, March 2004)

Relationship	R^2	p
Linear	.932	.0000
Exponential (log)	.819	.0000
Quadratic (square root)	.988	.0000

Table 6. Words per edit by article age

	20% - Avg. – Words / Edit	80% - Avg. – Words / Edit	t (df = 39)	Significance p
2001 Articles	57.8	6.7	5.848	.0000
2002 Articles	64.4	10.7	4.239	.0001

an article's existence, each edit resulted in about 60 additional words vs. 11 or fewer words for the remaining 80% of the article's life (up to the measurement date in March 2004).

The differences in the means of these ratios were highly significant, confirming that later effort is an investment in article quality rather than article length.

Discussion

Results of the exploratory study confirm what has been expected. Hypotheses H1, H2, H3, and H4 were all confirmed. Knowledge acquisition efforts apparently can successfully adopt Bazaar-style development with multi-user involvement, incremental changes, and quick releases in an environment that enables conversational knowledge acquisition. In the case of Wikipedia, this was possible for several reasons. First, Wikipedia was able to draw a large and quadratically growing developer group (approximately 7,000 as of May 2004).

Second, Wikipedia pages are highly decoupled from each other so that new authors can write with little concern for the current content of other pages. When an author breaks a hyperlink or negatively affects content, it becomes quickly apparent, and other Wikipedians will fix the problem. Third, when authors make a contribution, whether writing a new page or changing an

existing article, the result is immediately visible to the entire community, thus enabling quick releases with minimal latency and multi-user quality assurance. Therefore, the transaction cost of making a contribution is low, much lower than in any peer-reviewed or closed source authoring environment (Ciffolilli, 2003). Fourth, there is no individual ownership of Wikipedia pages, which are developed by volunteers; thus, everyone works to improve everyone's contributions. Quality is everyone's responsibility. Fifth, Wikipedia has strong editing guidelines that are motivated by the refactoring rules of software development and principles of objectivity. This ensures that articles, which might have suffered in readability from the disjointed work of multiple contributors and commentator, ultimately become very readable again.

As a result, in three and a half years of existence, Wikipedia has challenged the otherwise largest but closed authorship *Encyclopedia Britannica* (Britannica Online) for leadership in content (*Britannica* has self-reportedly about 100,000 entries, although with a larger word count per article). Other wiki-supported knowledge assets, such as Wikitravel, for instance, may be able to achieve similar leadership roles in their knowledge domain. The open, multi-user model also appears to scale well by interesting an increasingly larger user population to contribute their efforts, thus keeping the article latency at

about 10 days for old articles (initially created in 2001) and less than two days for newer articles (i.e., 2003). However, since wiki technology is relatively new and contrary to many organizations' cultures, we should not expect this approach to become predominant soon. In fact, the successes are few at present. However, one should expect an increasing number of wiki software products to emerge in the future and an increasing number of communities to replace their inferior conversational technologies with wikis.

CONCLUSION

The challenge of capturing and maintaining exponentially growing volumes of knowledge requires new ways of knowledge acquisition; namely, on approaches that rely on the contributions of many rather than the expertise of a few. Wiki technology and the wiki way of collaboration show a feasible model for knowledge acquisition and maintenance. Wikipedia offers an illustration of the effectiveness of this approach. The research demonstrates that users of a wiki-based knowledge asset (i.e., Wikipedia) apply Bazaar-style methods and techniques in their conversational knowledge asset creation. The research also suggests that knowledge acquisition through collaboration and conversation can lead to super-linear knowledge asset growth and continuous quality improvement.

Not surprisingly, there are several caveats. For instance, knowledge quality cannot be measured or managed easily. The quality of Wikipedia articles, for instance, remains a source of arguments. Therefore, future research will need to investigate the quality of the resulting knowledge based on content. In addition, knowledge creation with wikis relies on a strong and positive social contract among its contributors and on subject matters that are not controversial. These conditions are not always present. Wikipedia does have guidelines in place to handle disorderly participants and to

maintain a neutral point of view (NPOV) in articles. But Wikipedia clearly relies on the social capital within its community. Studies of less strong communities will have to be part of the future research in order to determine knowledge losses due to lack of social capital. Furthermore, Bazaar-style knowledge management relies on volunteers who are genuinely interested in the cause. This may not be a paradigm for organizations where knowledge assets are not free. Future research will need to explore the applicability of open source knowledge management when the intellectual property is at least partially proprietary. Finally, the discussed approach to knowledge management appears to work, partly because it can engage increasing numbers of participants to deal with a growing task domain. One has to wonder about the limits of growth of this scenario. Considering both the positive findings and the challenging questions, it appears that Bazaar-style knowledge acquisition using wikis will be a promising application for the practice of knowledge management as well as a rich source of interesting research questions.

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ENDNOTE

[1] ezboard.com announced that it had hosted more than 1 million communities on March 1, 2002, and claims 14 million registered users as of June 2004.

Chapter XIII

Effects of Managerial Drivers and Climate Maturity on Knowledge–Management Performance:
Empirical Validation

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ABSTRACT

This study examined the effects of the organizational climate maturity on knowledge-management performance, measured in terms of knowledge quality and knowledge-sharing level. Reward, top management support, and IT service quality were investigated as the managerial drivers to positively influence such climate maturity. The hypothesized relationships were tested by the partial least square analysis, with data from 42 organizations in Korea. Findings of the study indicate that a more mature (knowledge friendly) organizational climate is linked to higher knowledge-management performance; reward, top management support, and IT service quality are critical managerial drivers influencing such climate maturity.

INTRODUCTION

As knowledge emerges as the primary strategic resource for firms, researchers and practitioners strive for clues about how to accumulate knowledge resources effectively and manage them for competitive advantages. On the practice side, building a knowledge-management system or creating a knowledge-repository system with database or data warehouse technology has been the most common example. However, as firms in more advanced knowledge-management stages came to realize, successful knowledge-management initiatives seem to require systematic managerial efforts as well beyond building repositories, networks, and search engines (Wasko & Faraj, 2005; Yu, Kim, & Kim, 2004).

Researchers have warned that using information technologies is not a panacea (Alavi & Leidner, 2001; Ruggles, 1998). They focused more on the knowledge itself and its creation and sharing within an organization, emphasizing the role of organizational culture and motivation of individual knowledge workers (Bock, Zmud, Kim, & Lee, 2005; Brown & Duguid, 1998; Holsapple & Joshi, 2001;). In this study, we verify whether a knowledge friendly organizational climate (learning orientation, trust, employee commitment), as claimed in the literature, is indeed linked to superior knowledge-management performance (in terms of knowledge quality and level of knowledge sharing), and if it is, what managerial drivers are closely related to fostering such an organizational climate. The following sections will review the relevant conceptual background, introduce the research model and hypotheses, describe the research method, and discuss the research results and implications for future studies.

CONCEPTUAL BACKGROUND

Organization as a Knowledge System

Organizations increasingly compete on the basis of their intellectual assets (Klein, 1998). To lead in the market, organizations should continuously create and accumulate organizational intellectual assets such as knowledge, experience, expertise, and associated soft assets from internal and external sources, and use them effectively to introduce superior products and services. What their intellectual assets are and how they are created and accumulated crucially depend on a particular inquiring system that is in place in an organization (Mitroff, 1990). That is, organizations usually scan their environment and interpret possible problems or opportunities through the lens of their own inquiry system.

Based on the interpretation, organizations plan and carry out actions, and finally learn through the system. Similarly, Argyris and Schon (1978) saw the firm as a system of knowing activity, and defined organizational learning as a process of putting cognitive theories into actions through the single- and double-loop learning. Here, single-loop learning takes place when errors are detected and corrected and firms carry on with their present policies. Double-loop learning occurs when, in addition to detecting and correcting errors, the organization is involved in questioning and modifying the existing norms, procedures, policies, and objectives. Thus, double-loop learning involves changing the organization's knowledge base or firm-specific competencies or routines (Dodgson, 1993). In this study, we adopt a perspective that an organization's competitiveness is reinforced through its learning, and such learning takes place when critical and relevant knowledge is created, shared, and utilized effectively among its members.

Table 1. Drivers for successful knowledge management

| Author(s)	Management drivers	Type of Study
Wasko & Faraj (2005)	• Individual Motivations(Reputation, Enjoy) • Structural Capital(Centrality) • Cognitive Capital(Experitse, Tenure) • Relational Capital(Commitment, Reciprocity)	Individual level survey + Secondary data analysis
Kankanhalli et al. (2005)	• Contextual factors (trust, norm, identification, reciprocity) • Extrinsic benefit (reward) • Intrinsic benefit (enjoyment from helping)	Individual level survey
Yu et al. (2004)	• KMS quality • Reward • Learning orientation • KM team activity	Organizational level survey
Massey, et al. (2002)	• Leadership, coordination, control, measurement • Financial, human resource, expertise • Technological opportunity, external environment	Literature & Case study
Alavi & Leidner (2001)	• Organizational culture • Information technology • Incentives • Organizational context	Literature review
Holsapple & Joshi (2001)	• Managerial, resource, environmental influences	Literature review
Klein (1998)	• Autonomous decision making, Visible top management support, Employee's participation, Infrastructure, Management	Literature review
Brown & Duguid (1998)	• Physical & social environments, Relations, Trust, Belief	Literature review
Nonaka (1994)	• Intention, Autonomy, environmental fluctuation	Literature & Cases

Critical Managerial Drivers for Knowledge Management

To make the knowledge system of an organization more effective, diverse managerial drivers have been suggested in the literature. Table 1 shows the summary of such drivers from the recent knowledge-management and organizational-learning literature. However, knowledge management is not simply a matter of assembling several management drivers or installing an electronic document management system. Rather, it is a management paradigm shift involving people and other resources such as organizational structure, culture, and so forth. Based on that, some research had also emphasized the importance of making organizational structure more flexible, changing the organizational culture into a knowledge oriented one, characterized by active communi-cation, mutual trust, and collaborations, and so forth (Day & Glazer, 1994; Nonaka, 1994; Quinn, Anderson, & Finkelstein, 1996).

Since the process of implementing a knowledge system starts with the active sharing of individual knowledge, current knowledge-management initiatives in most organizations focus their efforts on the enterprise-wide sharing of individual knowledge. However, as was true in the enterprise-wide data resource management, more knowledge does not necessarily mean better knowledge (Schultze & Leidner, 2002), suggesting the need to focus on the quality as well as quantity of the shared organizational knowledge. Therefore, this study posits that a knowledge friendly organizational climate must be essential to successful knowledge-management initiatives, and aims to identify a set of management drivers conducive to forming such an organizational cli-

Figure 1. Research model
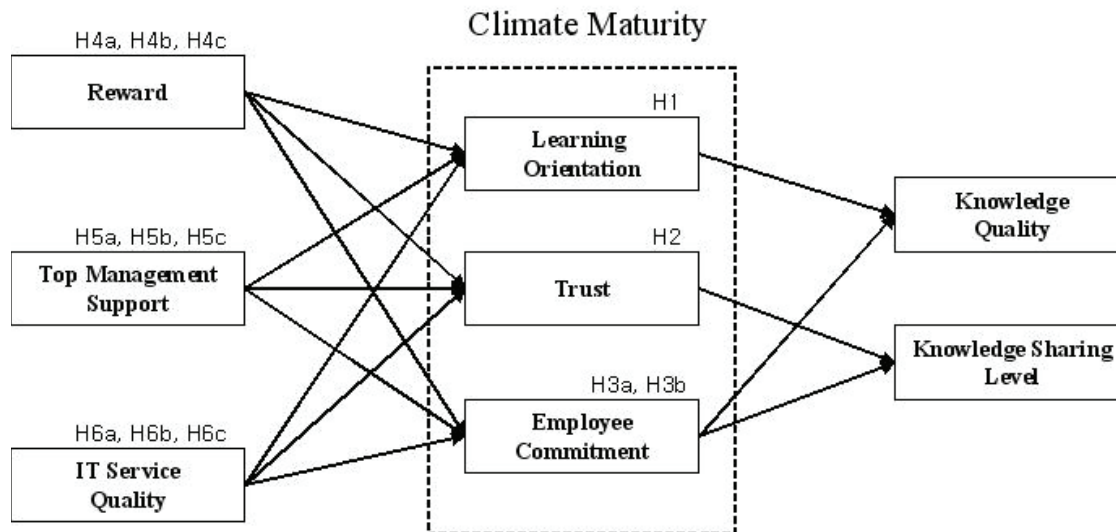
mate for the successful knowledge-management initiatives in terms of knowledge-sharing level and knowledge quality.

RESEARCH MODEL AND HYPOTHESES

Since knowledge management is as much a social activity as a managerial or technical activity, cultural change is believed to be the prerequisite for successful implementation of knowledge management. At the same time, since the knowledge friendly organizational climate (consisting of dimensions such as trust, learning orientation, and employee commitment) conducive to knowledge creation and sharing activities would not transpire without elaborate nurturing (Nonaka & Takeuchi, 1995), this study examines the effects of the three managerial drivers (reward, top management support, IT service quality) that cover 7 of the 10 most critical knowledge management issues identified by King et al. (King, Marks, & McCoy, 2001) on the knowledge friendly organizational climate.

Focusing on the two indicators of knowledge-management performance (knowledge quality and knowledge-sharing level), we developed a research model, as shown in Figure 1. That is, quality of organizational knowledge and knowledge sharing level are hypothesized to be significantly related to the climate maturity for knowledge management, which in turn is expected to be significantly related to the managerial drivers such as reward, top management support, and IT service quality.

The following sections introduce the theoretical background of each of the research constructs, and the expected relationships among them in the form of research hypotheses.

Performance Indicators for Knowledge Management: Knowledge Quality and Knowledge Sharing Level

Knowledge sharing and utilization are expected to induce new knowledge creation through individual interactions among organizational

members, and finally lead organizations to innovation opportunities and improved organizational performance. Therefore, the primary focus of the knowledge-management initiatives, to date, seems to have been on the acquisition of critical organizational knowledge from internal or external sources, and active sharing of this knowledge among the organizational members.

At the same time, the quality of the acquired and/or shared knowledge is also a critical factor for successful knowledge management. The ultimate goal of knowledge management should be to help end users in each functional department to become more productive and capable so that they can introduce innovative products and services faster, and optimize organizational processes in terms of quality and cost. If the quality of such knowledge is in doubt, the impact of actively sharing it will only result in marginal improvement (Schultze & Leidner, 2002). Neither the accumulation of incorrect knowledge nor the absorption of invalidated knowledge will lead to strategic innovations. Therefore, this study adopts knowledge quality and knowledge sharing level as the two indicators of knowledge-management performance.

Organizational Climate for Knowledge Management

Nonaka and Takeuchi (1995) emphasized the importance of the organizational cultural background by arguing that tacit knowledge is deeply rooted in an individual's actions and experiences, as well as in his or her ideas, values, schemata, and mental models. Despite the importance of organizational culture in knowledge management, changing an organizational culture is a challenge for most knowledge-management teams. Ruggles (1998) found out from his survey study of 431 U.S. and European firms that organizational culture is one of the biggest impediments to enterprise-wide knowledge sharing. Moreover, creation of an organizational culture usually takes a long time

and is context or climate dependent (Schein, 1985). Since climate may be directly manipulated by organizational members with power and influence, this study focuses on the dimensions of organizational climate, and proposes climate maturity for knowledge management as an emotional and behavioral determinant of knowledge-management performance. Schein (1985) suggested that culture could be assessed at three levels: artifacts and creations such as technology and behavioral patterns; values; and basic assumptions about human nature, activity, and relationship. Based on his suggestion, this study operationalized the climate maturity for knowledge management in terms of learning orientation, trust among organizational members, and employees' commitment to knowledge management.

Learning orientation is a behavioral characteristic of learning organizations. Garvin (1993) argued that the common activities of an innovative and learning organization are systematic problem solving, experimentation, learning from past experience, learning from others, and transferring knowledge. The behavioral patterns of learning orientation naturally increase the level of knowledge creation and sharing activities. Since knowledge is generally created from individual experiences and shared through social interactions such as communications and collaborations, its creation and sharing are directly related with the behavioral patterns of an organizational learning orientation. As the behavioral patterns of the learning orientation become mature, the quality of the created knowledge will also improve. Accordingly, in order for knowledge-management strategies to be successful in an organization, a continuous learning orientation of an organization, as part of its organizational climate, needs to be built and maintained.

Trust is one of the most frequently mentioned factors known to affect knowledge creation and sharing. Heumer et al. (Heumer, Krogh, & Roos, 1998) argue that trust facilitates learning between partners, and that decisions to exchange

knowledge under certain conditions are based on trust. Accordingly, trust and knowledge sharing mutually reinforce each other. Knowledge management is by nature a social activity, requiring active participation from organizational members. Accordingly, in the state of high commitment, employees at all levels of an organization are more likely to share critical knowledge so that they can influence and be rewarded for organizational performance.

We expect that if a supportive organizational climate for knowledge management does not exist, there will be little motivation for organizational members to share their critical know-how and experience, since such sharing may work against their own job security and competitive performance evaluation. Consequently, quality knowledge may not be actively generated and shared. Therefore, the following four hypotheses will be tested in this study.

H1: The level of learning orientation will have a positive effect on the knowledge quality.

H2: The level of trust among employees will have a positive effect on the level of knowledge sharing.

H3a: The level of employees' commitment will have a positive effect on the knowledge quality.

H3b: The level of employees' commitment will have a positive effect on the level of knowledge sharing.

Managerial Drivers for Building a Knowledge-Management Climate

Reward

Marshall et al. (Marshall, Prusak, & Shpilberg, 1996) argue that using a qualitative compensation scheme enables back- and front-office expertise to be better aligned. Hence, they maintain that

reward and incentives signal what behaviors and outcomes are most valued by the management. More recently, Kankanhalli et al. (Kankanhalli, Tan, & Wei, 2005) also concluded that knowledge contributors tend to be more motivated by organizational rewards. Therefore, we expect that the level of financial and nonfinancial reward offered by organizations will have a positive effect on knowledge quality and sharing within an organization:

H4a: The level of reward will have a positive effect on the level of learning orientation.

H4b: The level of reward will have a positive effect on the level of trust.

H4c: The level of reward will have a positive effect on the level of employees' commitment.

Top Management Support

Top managers usually exert influence over the members of an organization through a shared perspective on environmental events and organizational capabilities (Lyles & Schwenk, 1992). Through what they say and how they behave, senior executives establish norms that filter down through the organization, influencing attitudes about whether risk taking is desirable; how much freedom managers should give their subordinates; the actions that will pay off in terms of pay raises, promotions, and other rewards; and the like. Klein (1998) emphasizes the role of the visible top management support for organizational culture for knowledge management. Ruggles (1998) identified the top management's failure to signal the importance of knowledge as one of the biggest impediments to knowledge transfer in his survey of 431 U.S. and European firms. Therefore, we expect that top management support will be positively related to the climate maturity for knowledge management:

Table 2. Profiles of the respondent organizations and individual respondents

Industry types	Freq.	Percent	Number of Employees	Freq.	Percent	Period of KM implementation	Freq.	Percent
Manufacturing	13	31.0	Less than 100	10	10	Less than 6 months	19	45.2
Banking/ Insurance	6	14.3	100 – 200	5	5			
Construction	5	11.8	200 – 500	7	7	6 - 12 months	9	21.5
Distribution	2	4.8	500 - 1,000	5	5	12 - 24 months	8	19.0
Communication	4	9.5	1,000 - 3,000	8	8	24 - 36 months	6	14.3
Research	6	14.3	3,000 - 5,000	2	2			
Others	6	14.3	5,000 – 10,000	3	3			
			10,000 and above	2	2			
Total	**42**	**100**	**Total**	**42**	**100**	**Total**	**42**	**100**

(a) Respondent organizations

Functional area	Freq.	Percent	# of work years	Freq.	Percent	Job title	Freq.	Percent
Human resource	64	18.0	Over 15 years	58	16.3	CEO or CKO	42	11.8
Marketing	45	12.6	10 ~ 15 years	84	23.6			
Sales	51	14.3	5 ~ 9 years	110	30.9	General manager	68	19.1
Production	58	16.3	Less than 5 years	104	29.2	Manager	97	27.2
R&D	27	7.6				Operating level employee	149	41.9
KM	65	18.3						
Etc.	46	12.9						
Total	356	100	Total	356	100	Total	356	100

(b) Demographic information of individual respondents

H5a: The level of top management support will have a positive effect on the level of learning orientation.

H5b: The level of top management support will have a positive effect on the level of trust.

H5c: The level of top management support will have a positive effect on the level of employees' commitment.

IT Service Quality

Alavi and Leidner (2001) argue that IT has roles in transferring knowledge, increasing accessibility to existing knowledge, embedding knowledge into controls and processes, testing organizational knowledge, and generating new knowledge. Huber (1990) also argued that the use of IT leads to accessibility of information, and finally to improvement in the effectiveness of intelligence development and decision making. Therefore, we

posit that a high level of IT service quality will be crucial for building a supportive climate for knowledge management:

H6a: The level of IT services quality will have a positive effect on the level of learning orientation.

H6b: The level of IT services quality will have a positive effect on the level of trust.

H6c: The level of IT services quality will have a positive effect on the level of employees' commitment

RESEARCH METHODOLOGY

Sample and Data Collection

The unit of analysis in this study is an organization that is implementing or that has already implemented enterprise-wide knowledge-management initiatives. A total of 920 survey questionnaires were mailed to 92 organizations which were identified through relevant conferences and news media coverage, with 10 questionnaires assigned to each organization. The data for analysis was collected from 356 (38.6%) survey participants of the 42 (45.7%) organizations. Table 2 shows the respondent characteristics at the organization level and individual level.

Instrument Development

The knowledge-sharing level construct was intended to measure the level of activities for sharing individual knowledge with other organizational members. For control and internal validity purposes, this study limits the scope of knowledge sharing to activities of registering individual knowledge into the organizational knowledge-management system and utilizing the registered knowledge. Accordingly, knowledge-sharing

level was measured by the degree of registering knowledge and the extent of the utilization of this knowledge for work. The measurements of knowledge quality were adapted from the results of the MIT's TDQM research (Huang, Lee, & Wang, 1999; Wang & Strong, 1996). From the information-quality dimensions developed by Wang and Strong (1996), relevancy (4 items), completeness (4 items), accuracy (4 items), and reliability (4 items) were adapted in this study to measure the knowledge quality in the knowledge-management system.

The level of reward was operationalized by the level of organizational support in four types: monetary reward, promotion opportunity, education opportunity, and recognition. Top management support was measured by the presentation of a clear vision of knowledge management, understanding of knowledge management, frequency of mentoring on the importance of knowledge management by top management, and the level of manager-presence in knowledge-management activities. The level of IT service quality was adapted from the information-system literature (Delone & McLean, 1992; Melone, 1990). Since a knowledge-management system is also a type of information system used in an organization, the measurement reflects the same service-quality dimensions such as level of availability, accessibility, speed, ease of use, and stability provided by the knowledge-management system.

The climate maturity for knowledge management was operationalized by the three subdimensions: learning orientation, trust, and employees' commitment. Learning orientation was measured by the degree of active scanning to find internal and external information, the extent to which experimentation and the willingness to try new approaches was encouraged by top management, the learning intention of organization members, and a systematic approach in problem solving by organizational members. Trust among organizational members was measured by the beliefs and willingness in truthfulness, reliability, and

Table 3. Results of confirmatory factor analysis

Measures	Items	Composite Reliability	Cronbach's Alpha	Average Variance Extracted
Reward	4	0.92	0.87	0.73
Top Management Support	4	0.97	0.92	0.90
IT Service Quality	5	0.96	0.91	0.83
Learning Orientation	4	0.94	0.87	0.81
Trust	3	0.97	0.91	0.91
Employee Commitment	4	0.95	0.91	0.83
Knowledge Quality	16	0.98	0.97	0.77
Knowledge Sharing Level	7	0.93	0.95	0.78

consideration among organizational members. Employees' commitment was measured by the degree of employees' interest in, recognition of, participation in, and willingness to sacrifice for knowledge management.

Measurement Model

To validate our measurement model, we assessed internal consistency and three types of validity of the instruments: content validity, convergent validity, and discriminate validity. Since Cronbach's alpha does not estimate reliability within the context of the causal model, we used another measure of internal consistency suggested by Fornell and Larcker (1981). In PLS, composite reliability is the measurement for internal consistency. All constructs in Table 3 show composite reliability ranging from 0.92 to 0.98. While many studies using PLS had used 0.5 as the threshold reliability, 0.7 is a recommended value for a reliable construct (Chin, 1998). Cronbach's alpha values were also computed for a comparison purpose. They ranged from 0.87 to 0.97, which exceeded the generally accepted level of 0.7, indicating the adequate internal consistency level.

Content validity refers to the comprehensiveness and representativeness of an instrument used to create a scale. This was established by adopting the constructs and measurement items validated

in relevant research, conducting iterative experts' reviews of the instruments, and interviewing the senior knowledge-management team managers. Next, convergent validity was assessed by an examination of the composite validity and the average variance extracted from the measures (Hair, Anderson, Tatham, & Black, 1998). The average variance extracted by our measures in Table 3 ranged from 0.73 to 0.91, which exceed the acceptance level of 0.5. In addition, all loadings for each construct were significant ($p < 0.01$).

Finally, discriminant validity was tested by verifying that each indicator loaded higher with its associated construct than with other constructs, and that each construct shared more variance with its indicators than with other indicators. The former was tested by the principal components analysis with VARIMAX rotation. All items were loaded on each distinct construct and explained 73.0% of the total variance. The latter was tested by computing the square root of the average variance extracted for the constructs. Table 4 shows that the square root of the average variance extracted for each construct is greater than any off-diagonal correlations in the same row or column (Fornell & Bookstein, 1982).

Overall, these statistics indicate that the measurement model is adequate and sufficient to assess the structural model.

Table 4. Correlations between constructs

	1	2	3	4	5	6	7	8
Reward	0.85							
Top Management Support	0.54**	0.95						
IT Service Quality	0.31*	0.14	0.91					
Learning Orientation	0.56**	0.43**	0.55**	0.90				
Trust	0.51**	0.40**	0.56**	0.67**	0.95			
Employee Commitment	0.65**	0.56**	0.59**	0.65**	0.60**	0.91		
Knowledge Quality	0.53**	0.12	0.61**	0.56	0.54**	0.62**	0.88	
Knowledge Sharing Level	0.63**	0.18	0.63**	0.62**	0.56**	0.65**	0.78**	0.88

- *The diagonal elements are square roots of the average variance extracted; off-diagonal elements are inter-construct correlations.*

* p < 0.05, ** p < 0.01

Table 5. Summary of the hypotheses testing

Hypotheses	Path coefficient	t-value	Result
H1: The level of learning orientation will have a positive effect on the knowledge quality.	0.28	1.350	Not Supported
H2: The level of trust among employees will have a positive effect on the level of knowledge sharing.	0.23	1.70	Not supported
H3a: The level of employees' commitment will have a positive effect on the knowledge quality.	0.42	2.55	Supported
H3b: The level of employees' commitment will have a positive effect on the level of knowledge sharing.	0.48	3.70	Supported
H4a: The level of reward will have a positive effect on the level of learning orientation.	0.35	2.00	Supported
H4b: The level of reward will have a positive effect on the level of trust.	0.27	1.33	Not Supported
H4c: The level of reward will have a positive effect on the level of employees' commitment.	0.36	2.54	Supported
H5a: The level of top management support will have a positive effect on the level of learning orientation.	0.19	1.20	Not Supported
H5b: The level of top management support will have a positive effect on the level of trust.	0.20	1.22	Not supported
H5c: The level of top management support will have a positive effect on the level of employees' commitment.	0.30	2.75	Supported
H6a: The level of IT services quality will have a positive effect on the level of learning orientation	0.41	2.84	Supported
H6b: The level of IT services quality will have a positive effect on the level of trust.	0.45	3.32	Supported
H6c: The level of IT services quality will have a positive effect on the level of employees' commitment	0.43	5.03	Supported

Figure 2. Results of PLS analysis
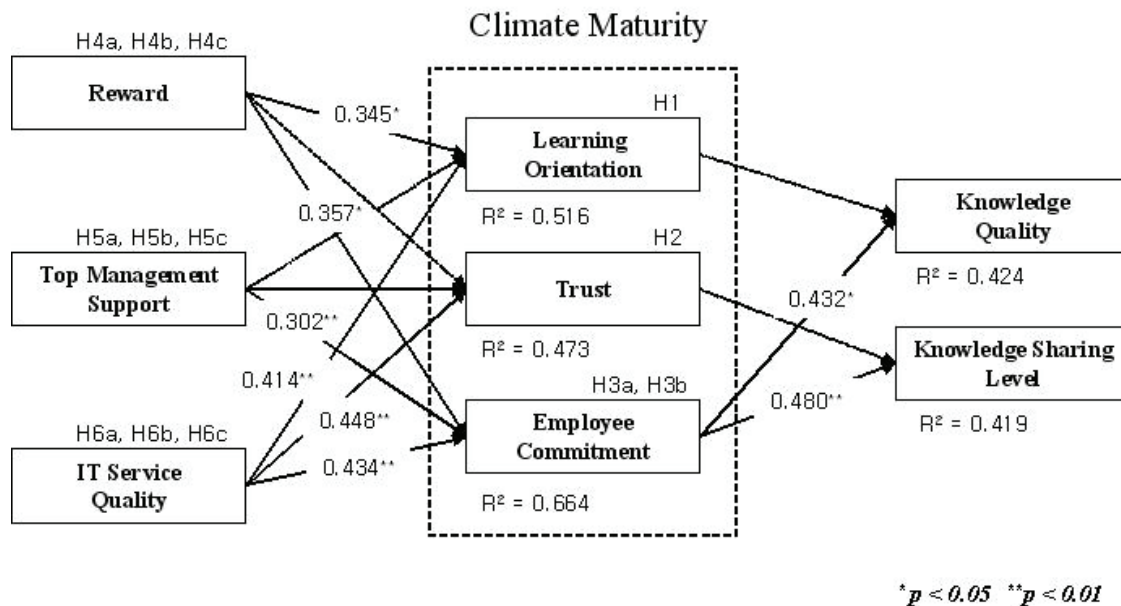
Structural Model

The proposed research hypotheses were tested by assessing the structural model with PLS. The results of the analysis are depicted in Figure 2 and summarized in Table 5. The path coefficients estimates and the links between constructs and their indicators can be interpreted as standardized regression estimates and factor loadings, respectively (Jarvenpaa & Staples, 2000). For estimating path coefficients, t-statistics are assessed with a nonparametric test of significance known as bootstrapping (Chin, 1998; Hair et al., 1998).

The employee commitment variable was found to be the most influential climate component for both knowledge quality and knowledge sharing level. These results support the common expectation that employee commitment will be deeply related with both knowledge quality and sharing level, supporting H3a and H3b. However, despite the literature emphasizing the importance of trust among organizational members and the learning

orientation in organizational behaviors, it is difficult to find any relationship between learning orientation and knowledge quality (H1), and between trust and knowledge sharing level (H2).

In hypotheses H4a, H5a, and H6a, we examined the effects of managerial drivers on learning orientation. We found that both reward ($\beta = 0.35$, p < 0.05) and IT service quality ($\beta = 0.41$, p < 0.01) were effective for building learning orientation of the organizational climate, but top management support was not. For trust, the results indicate that IT service quality ($\beta = 0.45$, p < 0.01) is significant. We also found that all managerial drivers, reward ($\beta = 0.36$, p < 0.05), top management support ($\beta = 0.30$, p < 0.01), and IT service quality ($\beta = 0.43$, p < 0.01), had significant and positive effects on employee commitment, supporting H4c, H5c, and H6c. Especially, IT service quality was found to be a more crucial management driver than reward or top management support in influencing climate maturity.

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FINDINGS AND DISCUSSION

Assuming that knowledge quality and knowledge-sharing level are critical indicators of a successful knowledge-management initiative, we can infer several implications from the results of this study on how to understand and implement the enterprise-wide knowledge management initiatives.

First, the organizational climate maturity for knowledge management was found to be significant in assuring high-quality organizational knowledge and active knowledge sharing. The climate maturity variables explained 42% of the knowledge-quality variance and the knowledge sharing variance, respectively. Among the three climate maturity subdimensions, with beta coefficients of 0.43 for knowledge quality and 0.48 for knowledge sharing, the employee commitment construct seems to reflect the knowledge management ready culture, and have predictive validity over organizational knowledge quality and knowledge sharing level. Therefore, as suggested in the literature, we conclude from this study that a mature supportive organizational climate is conducive to a successful knowledge management initiative.

Second, we found that all managerial drivers-reward, top management support, and IT service-significantly affect the organizational climate maturity for knowledge management, as shown in Figure 2. Together they explain 52% of learning orientation, 47% of trust, and 66% of employee commitment. It is noteworthy that, compared with reward or top management support, IT service quality turns out to be the more crucial management driver affecting the climate maturity for knowledge management, since it was the only construct among the three that had a significant relationship with all three climate maturity variables. This finding leads us to believe that IT serves the role of a critical and necessary tool for knowledge management, so that every organizational member can access and share core organizational knowledge any time, from any place, in a secure and user-friendly way.

LIMITATIONS AND FUTURE DIRECTIONS

This study had several limitations in its methodology and interpretation of the results. First, while employee commitment was found to have a significant effect on both knowledge quality and knowledge-sharing level, the other two climate maturity variables (learning orientation, trust) were not significantly linked to the two dependent variables, leaving room for further refinement and validation of the current research model. Second, since this study studied individuals' perceptions of organization-level variables, it does not take into consideration the role of groups in knowledge management, particularly group cognition. Third, despite the natural lead time between implementation of management drivers and realization of knowledge-management performance, this study only analyzed the cross-sectional view of the respondent organization's knowledge-management environment, thus limiting the interpretation of its findings to a correlational rather than a causal link between independent and dependent variables.

These limitations suggest the directions for future research to address a similar theme. First, a larger and more heterogeneous set of organizations needs to be analyzed. Second, deeper and more theoretical understanding of the climate maturity construct is necessary, along with enhancing its measurement validity. Third, it might be desirable to conduct a longitudinal study on their migration from earlier stages, and identify the critical success factors for successful knowledge-management evolution over time.

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Chapter XIV

Development and Validation of an Instrument to Measure Maturity of IT Business Strategic Alignment Mechanisms

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ABSTRACT

Achieving IT-business alignment has been a long-standing, critical, information management issue. A theoretical framework of the maturity levels of management practices and strategic IT choices that facilitate alignment was empirically tested and validated. Confirmatory factor analysis (CFA) validated 6 factors and identified 22 indices to measure strategic alignment maturity. A mixed model repeated measure analysis of variance (ANOVA) obtained significant results for both the main effect and interaction effect of differences for the 6 maturity factors across the 11 business units. Regression analysis found a positive association between overall strategic alignment maturity and respondents' self-rated maturity. These exploratory findings show promise for the assessment instrument to be used as a diagnostic tool for organizations to improve their IT-business alignment maturity levels.

INTRODUCTION

IT and business leaders are continually looking to align their IT and business strategies. In their seventh annual survey, Computer Sciences Corporation (2005) reported that IT-business strategic alignment has persisted among the top-ranked issues of chief financial officers. In another study, over 300 Society for Information Management (SIM) executives ranked IT-business alignment as their number one management concern (Luftman & McLean, 2004). Research has shown that IT-business strategic alignment contributes to higher levels of organizational performance (Chan, Huff, Barclay, & Copeland, 1997) and perceived business value from IT (Tallon, Kraemer, & Gurbaxani, 2000). Lee and Pai (2003) found that the maturity of the information systems function has a strong effect on strategic information systems planning and that IT-business alignment improves with the effectiveness of a firm's planning process. Clearly, there is a need and benefit in determining mechanisms to facilitate the alignment of the IT and business functions.

We propose that IT-business strategic alignment can be facilitated by the management practices and strategic IT choices that an organization makes. There are different levels of implementation for these mechanisms, referred to as maturity. Luftman (2000) proposed a framework called strategic alignment maturity (SAM) that exhibits these organizational mechanisms. We used this framework as a model to develop and validate an instrument to measure SAM. Luftman's SAM framework includes five conceptual levels of strategic alignment maturity modeled after the capability maturity model (CMM) of software quality developed by the Software Engineering Institute at Carnegie Mellon (Humphrey, 1988). The SAM framework models the CMM in that the SAM describes key management practices and strategic IT choices at each of five levels. In the SAM framework, maturity levels are composed of six key areas: communication, competency and value measurement, governance, partnership, scope and architecture, and skills. Each key area identifies a grouping of related mechanisms that, when performed collectively, are considered important for enhancing IT-business alignment capability. These areas form not only mechanisms, but also criteria that measure achievement of a maturity level. These areas are cumulative, meaning that an organization at level three, for example, will meet the criteria of both levels two *and* three.

The five levels of strategic alignment maturity are as follows:

1. **Initial/ad hoc process:** This is the lowest level of maturity; management practices and strategic IT choices to facilitate alignment do not exist or are ad hoc in nature.
2. **Committed process:** Management practices and strategic IT choices to facilitate alignment exist at a low level in the organization.
3. **Established focused process:** Management practices and strategic IT choices to facilitate alignment exist at a moderate level in the organization.
4. **Improved/managed process:** Management practices and strategic IT choices to facilitate alignment exist at a strong level in the organization.
5. **Optimized process:** Management practices and strategic IT choices to facilitate alignment are fully integrated and coadaptive between the business and IT function.

LITERATURE REVIEW

Several multistage or multilevel models have been proposed to describe various concepts related to IT-business alignment. King and Teo's (1997) model consists of four stages or levels of growth for the evolution of information systems planning.

The premise behind their model is that organizations have increasing levels of integration between business planning and information systems planning. King and Teo (1997) proposed that 10 benchmark variables were indicative of each of the four different stages of planning integration, and the degree to which each benchmark variable was present in an organization was associated with the perceived level of integration the organization placed themselves. More recently, Jeffery and Leliveld (2004) proposed the IT portfolio management maturity model as a tool for assessing best practices as defined by four stages, and van der Raad, Soetendal, Perdeck, and van Vliet (2005) proposed that IT architecture is comprised of multiple aspects that represent three different maturity levels, depending on the number of aspects being used and the scope of their use within an organization.

An underlying motivation of our research is how and why organizations change from being less strategically aligned to being more strategically aligned. One possible impetus of change is explained by the punctuated equilibrium perspective (Gersick, 1991). In this view, organizations shift from one maturity level to another through "purposeful enactment" (Van de ven & Poole, 1995) of top management in the form of competitive selection of organizational routines. Another possible impetus of change, explained by evolutionary and teleological perspectives, is that deliberate and planned implementation of management practices and strategic IT choices enable an organization to adapt to its internal and external environment so that it remains competitive.

Additionally, institutional and diffusion theory suggest that the diffusion of management practices evolves from an ad-hoc adoption to becoming interorganizationally ingrained based on an organization's need to conform to the requirements or expectations of its institutional partners, alliances, and competitors (Zeitz, McAulay, & Mittal, 1999).

We propose that SAM can be influenced by identifiable organizational initiatives (for example by conducting an assessment of maturity mechanisms and making deliberate efforts to implement specific management practices and strategic IT choices) that encourage (or perhaps discourage) implementation and ongoing use of the processes and mechanisms associated with strategic alignment, resulting in organization-led increased SAM.

The primary goal of our research was to validate a model for assessment of strategic alignment mechanism maturity. To that end, our primary research question was "Can a survey be developed to assess different levels of strategic alignment maturity with acceptable reliability and validity using the SAM theoretical framework"? In addition to identifying and validating an instrument to measure strategic alignment maturity, an obvious validation of this research is to determine whether companies have different levels of maturity. Therefore, an additional research question was "Do companies differ in their level of the strategic alignment maturity factors"?

The following is a brief description of each of the components of the SAM framework.

Communication maturity refers to the effectiveness of leveraging information for mutual understanding and knowledge sharing. Communication has long been associated with IT-business alignment. Calhoun and Lederer (1990) found that a lack of communication of top management's objectives could account for the business function's dissatisfaction with strategic information systems planning. Reich and Benbasat (2000) found that shared domain knowledge and communication between IT and business managers positively influence alignment. Rockart, Earl, and Ross (1996) suggested that communication ensures that business and IT capabilities are integrated into the business effectively. Luftman, Papp, and Brier (1999) reported that IT understanding of the business was one of the top three enablers of alignment.

Competency/value measurement maturity refers to the management decisions and strategic choices an organization makes when determining the value and contribution of IT to the firm. Henderson, Venkatraman, and Oldach (1996) suggested that value management is a valuable mechanism for ensuring that maximum benefits are achieved from IT investments and as such, are a means to facilitate IT-business alignment. Research suggests that measures of business contribution should be multidimensional (Maltz, Shenhar, & Reilly, 2003) and IT and business measures should be integrated (Luftman, Bullen, Liao, Nash, & Neumann, 2004, p. 382; Van Der Zee & De Jong, 1999).

Governance maturity refers to the choices organizations make when allocating decision rights for IT activities such as prioritizing projects and controlling budgets and IT investments (Henderson et al., 1996). Henderson et al. (1996) suggested that governance is a valuable mechanism to facilitate IT-business alignment. They saw governance as a mechanism for specifying IT decision-making capabilities within the organization and with strategic alliances and partners.

Partnership maturity pertains to how IT and the business perceive the contribution of each other. Sharing risk and responsibility of IT initiatives requires trust and mutual respect between IT and business partners (Ross, Beath, & Goodhue, 1996). Effective long-term partnerships are sustained when IT and business partners exhibit trust and positive attitudes toward the potential contributions of each other (Henderson, 1990).

Scope and architecture maturity refers to the management decisions and strategic choices an organization makes when allocating resources toward its information technology infrastructure, including its reach and range. Keen (1996, p. 152) suggested that IT architecture, integration, infrastructure, and standards should be defined from the organization's goals, and that IT infrastructure should be an early consideration when defining business goals.

Skills maturity refers to the organization's cultural climate toward change and innovation. Strategic alignment is a process of continuous adaptation and change (Henderson & Venkatraman, 1993). The adoption and diffusion of IT throughout an organization is better enabled when an organization anticipates change. Being ready for change may increase the potential for change efforts to be more effective (Armenakis, Harris, & Mossholder, 1993).

METHOD

To provide a representation of each organization's strategic alignment maturity level at the time of the study, a cross-sectional design was employed utilizing the survey assessment instrument.

The SAM framework (Luftman, 2000) suggests management practices and strategic choices that may act as measurement items for the different components of strategic alignment maturity. Since our study was the first to empirically test a measure of strategic alignment maturity and there was no existing validated measurement instrument, it was necessary to develop one. Measurement items were developed from the SAM framework and from existing literature (see Sledgianowski, 2004 for the operationalization of the scale items of the strategic alignment maturity measurement instrument).

The strategic alignment maturity instrument consisted of 39 items. Each survey item consisted of a statement and a five-choice answer scale, with each answer choice representing a different level of maturity, similar to the concept of benchmark variables employed by King and Teo (1997). A choice of one indicated the lowest level of maturity, and a choice of five indicated the highest level of maturity (see Appendix A for a sample of scale items).

The survey also contained a single item to measure a respondent's perceived overall strategic alignment maturity level. This indicator was used

in our analysis to ascertain how well the mechanisms to measure strategic alignment maturity from the assessment instrument correlated with self-rated maturity levels. Even though this is a single-item scale, we believe that it provides an accurate assessment, given the high level of authority and responsibilities of the individuals who completed the questionnaire. Other research has used executive-level respondent's perceptions to measure the existence of alignment within his or her firm (i.e. Reich & Benbasat, 1996; Tallon et al., 2000)

Instrument Development

Because we used nominal anchors for our scales, we tested the assumption that our nominal categories reflected an underlying continuum consistent with our a priori rankings of each category. We used a technique similar to classic item analysis. For each item in a particular scale consisting of k items, we used the a priori scale values to create a score based on k-1 items. The five options for the kth item were then used as the levels of a one-way ANOVA. We assessed the significance of the resulting F-value, and also examined the means to determine whether the rank order of means for the five categories corresponded to the a priori order. For all items examined the F-test was significant, indicating that the a priori categories were differentiating a total score based on the a priori scoring system for k-1 items. We found that, in general, the a priori categories corresponded to the empirical values of the means for the same categories.

Pilot Test of the Questionnaire

A pilot test was administered to 23 IT and business executives within one organization, revealing that all items were interpreted as intended, resulting in no changes to the final questionnaire. An independent samples t-test was performed to determine whether there was a significant differ-

ence in overall maturity level (calculated as the overall mean of the six factors) and self-rated maturity level (a single item indicator of respondents' perception of their firm's maturity level) between the pilot data set and the final data set. There were no significant differences in scores between the two groups. Because no additional changes to the questionnaire were necessary, and because the pilot data was collected in a manner consistent with the other organizations in the study with no significant differences between the two groups, the data from this pilot test was included in the final data set.

Data Collection

A survey was conducted of 153 IT and business executives from 11 business units across eight organizations. The respondents completed the assessment instrument as part of a strategic alignment assessment. The assessment program was offered to all organizations which were current members of The Conference Board or SIM. According to the Web sites of these two organizations, SIM membership consists of over 3,000 IT leaders and The Conference Board membership consists of executives from over 2,000 companies.

Membership in the two organizations may overlap, as some executives may belong to both.

The eight organizations participating in this study included one government agency, two chemical manufacturers and five firms in the financial and insurance industry. Each organization was located in the United States. The number of employees ranged from approximately 1,000 employees to over 50,000 employees. For the five publicly held companies, total revenue ranged from $300 million to $5.5 billion.

Of the 153 completed questionnaires received, 150 were usable. Of these, 83 self-identified as belonging to a business function, and 67 self-identified as belonging to an IT function. The title of responding executives ranged from "Staff" to

Table 1. Goodness-of-fit indices for the five factor(1) and six factor (2) models

#	x^2	Df	p	RMSEA	SRMR	GFI	AGFI	CFI	NNFI	PGFI	PNFI
1	1004.77	687	.00	.055	.07	.74	.71	.84	.83	.65	.62
2	189.76	194	.57*	.000	.05	.90	.87	.99	.99	.69	.72

Table 2. Reliabilities and average variance extracted for all factors

Factor	Alpha reliability	Composite factor reliability	Average variance extracted
COMM	0.71	0.72	0.40
COMP	0.83	0.83	0.50
GOV	0.73	0.75	0.50
PART	0.74	0.75	0.50
SCOPE	0.73	0.75	0.50
SKILLS	0.79	0.79	0.49

"CEO," with the majority being either "VP" or "Director."

Data Screening

Prior to analysis, the data were screened for missing values, outliers, and normal distribution of the variables. Missing values and do not know responses were replaced with the mean value of the other items within the same category.

The means for the 39 survey questions ranged from 2.01 to 3.73, and the standard deviations ranged from 0.74 to 1.31. In general, items were positively and significantly intercorrelated with no indication of univariate multicollinearity.

The test for multivariate skewness was significant ($z = 2.269$, $p = 0.023$), indicating the existence of multivariate skewness. Jaccard and Wan (1996, p. 76) found that statistical estimation methods used to analyze data, such as the maximum likelihood method used in confirmatory factor analysis, may be sensitive to multivariate skewness.
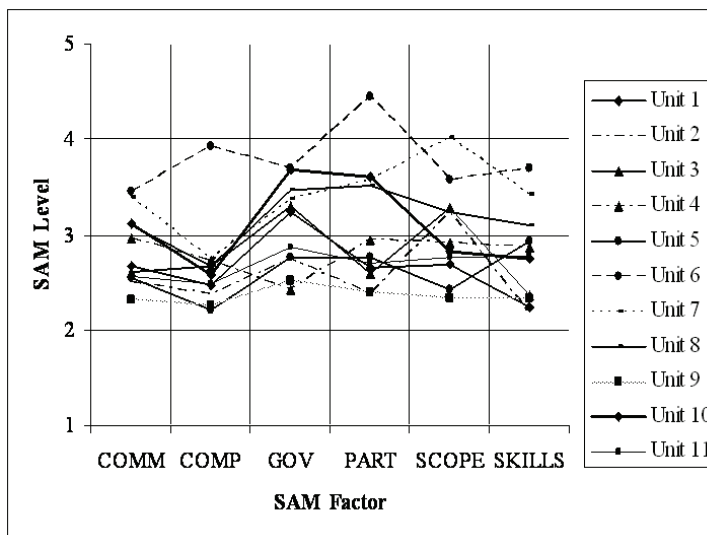
RESULTS

To determine whether our survey instrument demonstrated acceptable reliability and validity, and whether our instrument was able to differentiate maturity levels among organizations, CFA and ANOVA were used to analyze the collected data. To determine whether our instrument demonstrated concurrent validity, bivariate correlations and multiple regression analyses were evaluated.

Confirmatory Factor Analysis of Maturity Constructs

Due to the existence of multivariate skewness, the robust maximum likelihood estimation feature of LISREL 8.51 CFA was used. The robust ML uses the ML estimates obtained under the normality assumption, but the chi-square is corrected for nonnormality using the Santorra-Bentler scaled chi-square statistic and standard errors are ad-

Figure 1. Interaction effect of the SAM factors with business units

justed, with the end result being a more appropriate test (Ferrando & Lorenzo, 2000).

The first model, Model 1, comprised of the a priori 39 indicators within the 6 components resulted in a poor fit to the data (see Table 1). The second model, Model 2, was derived from Model 1 by recursively dropping items that shared a high degree of residual variance with other items (Gefen, Straub, & Boudreau, 2000). Before dropping each item, a decision was made as to whether it made theoretical sense to drop the item. Dropping the items resulted in a good fit for the collected data (see Table 1).

The overall degree of fit is acceptable as evidenced by all of the fit indices being at or better than their minimum threshold value except AGFI (see Table 1).

Convergent validity and unidimensionality demonstrate the degree to which the factor is represented by the items that comprise it. Model 2 showed acceptable convergent validity and unidimensionality, as measured by assessing factor loadings, t-values, and modification indices.

The standardized parameter estimates for Model 2 are listed as loadings in Appendix B. The loadings ranged from 0.519 to 0.847. The model

parameters were significant ($p < .001$) for all variables. All standardized residuals were within the threshold of |2.58| except for two (-3.88 and 2.73). Four modification indices for Lambda-X were above the upper limit of 5.0 (Segars, 1997): COMM_1 on PART (9.00), SKILLS_1 on COMM (7.70), SKILLS_2 on PART (7.42), and COMM_3 on PART (5.75).

Next, further convergent validity was assessed using Cronbach's coefficient alpha, composite factor reliability, and average variance extracted (AVE). For Model 2, all results exceeded the recommended value of 0.70 for the coefficient alpha and composite reliability measures (Segars, 1997). Model 2 had AVE values meeting the 0.50 lower threshold except SKILLS at 0.49 and COMM at 0.40, indicating that for these two factors, the total variance for each factor due to error is larger than total variance due to the measurement (see Table 2).

Discriminant validity was assessed using two techniques. The first used the chi-square difference test to compare each individual factor to another by constraining the estimated correlation parameter between the two factors to 1.0 so that all the items appear to measure the same construct,

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and then comparing the results to those with the two factors unconstrained. If the difference in the change in chi-square between the constrained and unconstrained model is significantly lower ($p < .05$), this indicates that the individual factors are not perfectly correlated, and that discriminant validity is achieved (Bagozzi & Phillips, 1991). All chi-square differences were significant at the the $p < .01$, indicating strong support for discriminant validity. The second method of discriminant validity used analysis of variance, and is described in the next subsection.

Interaction of SAM Factors with Business Units

To answer our second research question, "Do companies differ in their levels of the strategic alignment maturity factors?", it was necessary to determine whether the six SAM factors significantly differed across the 11 business units. A necessary, but not sufficient condition, for construct validity is discriminant validity. In this case, the question was whether business units had reliably different patterns of SAM. If they did not, the results would cast doubt on the validity of the six factors to provide diagnostic information. To answer this question, a mixed-model repeated measures ANOVA was run to compare means across the 11 business units for the six SAM factors. The model assessed differences among business units (a between factor), differences among the six factors (a within-factor), and the interaction between the two factors. Differences between business units reflect the difference in the average score across the six factors. Differences between the six factors reflect differences among the SAM means across business units. However, the primary interest in this analysis was the interaction between business units and SAM factor scores. The purpose of the analysis was not

to determine which factors differed for which organizations, but merely to determine whether the patterns of SAM scores varied by business unit. This method is similar to that proposed by Stanley (1961) and additional methods discussed by Saal, Downey, and Lahey (1980), in which a mixed model ANOVA is used for the assessment of the quality of ratings.

The mixed-model repeated measures ANOVA resulted in significant results for the main effect ($F(1, 139) = 11.038$, $p < .001$), revealing a reliable difference for business units in the means across the six SAM factors. More importantly, there was a significant result for the interaction effect of maturity factors with business units ($F(10, 139) = 2.580$, $p < .01$). Figure 1 shows the pattern of means on the six maturity factors for the 11 business units. (Unit 1 through Unit 11).

Assessing goodness-of-fit, convergent validity, unidimensionality, factor reliability, and discriminant validity, as a whole, the six factors comprising

Model 2 appear to serve as moderately valid indicators of the concepts they represent, except some of the COMM items failed to significantly converge on the COMM factor. Discriminant validity tests for Model 2 provided mixed results, with the AVE-relative-to-factor-correlations test unable to discern the COMM factor from four of the other five factors, but with the chi-square difference test significant across all factors.

Relationship between Measured Maturity and Self-Rated Maturity

The evaluation of the mechanisms to facilitate IT-business strategic alignment can be further enriched by answering the question "Is there a relationship between the measured strategic alignment maturity level and the self-rated level of strategic alignment maturity?" In order to examine the concurrent validity of the maturity measurement

Table 3. Bivariate correlations of factors and calculated overall maturity

	COMM	COMP	GOV	PART	SCOPE	SKILLS	OVERALL
SELF-RATING	.649*	.509*	.353*	.474*	.471*	.348*	.604*

Table 4. Results of regression analysis for self-rated maturity and six factors

Factor	β	t	Significance		
Commuications Maturity	0.461	5.429	0.000		
Competency Maturity	0.169	2.065	0.041		
Governance Maturity	-0.073	-0.899	0.370		
Partnership Maturity	0.079	0.914	0.362		
Scope Maturity	0.162	2.013	0.046		
Skills Maturity	-0.019	-0.240	0.811		
Model Summary	**R**	**R²**	**Adjusted R²**	**Std. Error of the Estimate**	
	0.683	0.467	0.445	0.666	
Analysis of Variance					
	Sum of Squares	**df**	**Mean Square**	**F**	**Significance**
Regression	56.673	6.000	9.445	21.292	0.000
Residual	64.767	146.000	0.444		
Total	121.440	152.000			

Dependent Variable: Self-rated maturity level

instrument, we examined this relationship using bivariate correlations and simple and multiple linear regression with SPSS v. 10.0.

Two-tailed bivariate correlations between self-rated maturity level, the six factors from Model 2, and the overall computed maturity level were analyzed. The overall computed maturity level was a single value for each of the 150 cases, computed by taking the mean of each of the 22 indicators. Each of the bivariate relationships was significant (see Table 3).

Simple linear regression was run between self-rated maturity level as the dependent variable, and overall computed maturity level as the independent variable. The simple linear regression model $R^2 = .36$, $F(1, 149) = 85.16$ was significant ($p < .01$). This result provides further evidence that, overall, the levels used to measure the maturity of mechanisms that facilitate IT-business alignment are associated with IT and business executives perceptions of IT-business alignment maturity levels within

their organization.

Standard multiple linear regression was run between self-rated maturity level as the dependent variable and each of the six factors from Model 2 as the independent variables (IV) (see Table 4). Only three (COMM ($sr^2 = .168$), COMP ($sr^2 = .028$), and SCOPE ($sr^2 = .026$)) of the six IVs contributed significantly to prediction of self-rated maturity level. The six IVs in combination contributed another .24 in shared variability. Altogether, 47% (45% adjusted) of the variability in self-rated maturity level was predicted by knowing scores on the six IVs.

Although the correlations between self-rated maturity level and the GOV, PART, and SKILLS factors were significant (see Table 4), these three IVs did not contribute significantly to regression. Apparently, the relationships between self-rated maturity level and GOV, PART, and SKILLS are mediated by the relationships between COMM, COMP, SCOPE and self-rated maturity.

DISCUSSION

The first research question, "Can a survey be developed to assess strategic alignment maturity acceptable reliability and validity using the SAM theoretical framework?" was addressed by conducting an extensive literature review, and developing and validating an assessment instrument to measure SAM. The instrument was evaluated using confirmatory factor analysis that reduced the SAM model variable set from 39 items to 22 items for a more parsimonious representation of SAM. Statistical evidence was provided to support the goodness-of-fit of the six factors of the SAM framework.

The second research question, "Do companies differ in their level of the strategic alignment maturity factors?" was addressed by performing a mixed-model repeated measures ANOVA for each of the SAM factors across the 11 business units. Support for this research question was found, with significant results being obtained for both the main effect of differences between factors, and the interaction effect of differences for the factors across the 11 business units. This analysis indicates that there are significant differences between companies over all factors, there are significant differences across companies between factors, and that there is an interaction between companies and factors. This finding is important because it suggests that the SAM assessment instrument can be used to develop a maturity profile of an organization that can be used to identify the organization's maturity level for each SAM factor, and that the maturity levels for each SAM factor can be improved upon by the organization.

The research instrument developed, validated, and tested in this study provides a tool that appears to be useful for practitioners and managers to assess the current maturity level of the management practices and strategic IT choices currently in place in their organization. Further testing of this instrument may show that firms can imple-ment the mature alignment management practices to further facilitate IT-business alignment. For example, most firms were identified as having SAM between level one and level three. Firms at this level may want to implement the more mature items from the instrument as best practices to facilitate greater alignment.

Luftman (2000) offers a six-step SAM assessment process that practitioners and managers can apply. The SAM assessment instrument can be used as a tool in this process to help a firm understand its IT-business linkage, and to determine the gaps. The results of a firm's initial assessment can be used as a starting point for communications between IT and business executives to develop a plan to achieve more mature alignment.

Our research shows that different firms have different levels of alignment maturity. This implies that the SAM instrument may provide some specific best practices to be considered by practitioners and managers. For example, an indicator of more mature architectural integration is an infrastructure that is integrated across functional units and with business partners. Weill and Broadbent (1998, pp. 60-61) suggest that firms with an IT infrastructure that links their business units and integrates their different business processes have stronger revenue growth than those firms that have a less extensive IT infrastructure. As another example of a potential best practice, we found that a more mature mechanism to facilitate strategic alignment is frequent and formal IT assessments and reviews. Evaluation of IT investments, including formal and regular reviews, is positively related to IT-business alignment (Tallon et al., 2000).

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

Like any research, this study has several limitations, which should be mentioned, that can provide opportunity for future research. The primary

limitation of this research study is the restriction in range of companies (*n* =8) and industries (*n*=3), precluding generalizability of the results to the general population.

Additionally, due to sample size limitations, this study did not benefit from the opportunity to modify some of the items excluded from the factor analysis to try to improve them. With the limited sample size, it did not make sense to control for organizational factors that have the potential to influence IT practices such as IT budget (Reich & Benbasat, 2000), and information intensity of the value chain (Kearns & Lederer, 1997), and other contingency variables, including company size, structure, strategy, and the environment (Daft, 1997, p. 359), that should be considered with a sample containing a greater number of organizations.

A major limitation with this research design is that the SAM measurement instrument has not been cross-validated with a sample separate from the one used to initially validate it. Kelloway (1998) recommended that models that are modified from their original sample should be considered as exploratory until they can be cross-validated on an independent sample.

Also, this study was unable to examine any firms with extreme levels of maturity, either low or high, and was therefore unable to provide any information about the effect of low or high maturity. For example, are specific mechanisms from the SAM components more common in predominantly high-maturity firms or lacking in predominantly low-maturity firms? Several of the items comprising the competency component were not able to distinguish between levels four and five; while not an issue in this study, the answer choices for these two levels should be revised to ensure a difference.

Although this study makes a contribution to the strategic alignment research by showing concurrent validity between the measured overall maturity rating and the respondents' self-rated maturity, additional work should be done to

examine why the governance, partnership, and skills factors did not contribute significantly to respondents self-rated maturity level.

Additionally, work should be carried out to examine the communications component, to improve its properties, and ensure that it adequately measures the relevant construct.

Calling on previous stages of growth research to provide ideas for future research, the strategic alignment literature would benefit from applying to the SAM model some of the research questions addressed by Teo and King (1997) in their study of IT-business planning integration. For example:

1. Over time, does strategic alignment maturity follow an evolutionary pattern, with a firm moving from lower levels of maturity to higher levels?
2. Do firms move from one level of maturity to another due to a competitive selection of organizational routines initiated by "purposeful enactment" of top management, as proposed by punctuated equilibrium theory?
3. Do organizations go through each of the five levels of strategic alignment maturity or can the levels be bypassed?
4. What are the relative times spent at each SAM level, and the reason for movement to the next level of maturity?

Another area for future research includes examining managerial practices that facilitate IT-business alignment at the operational level. The literature suggests that all levels of the organization need to be concerned with how IT can enable and drive the objectives of the firm. For example, Middleton & Harper (2004) suggest that the degree to which the employees' goals support their organization's goals may influence the success of information system implementations within the company. They suggest that when the goals of employees are aligned with those of their organization, employees are more likely

to act in a way to improve their organization. Future research could investigate management mechanisms at the operational level that facilitate alignment of employees' goals with those of their organization.

CONCLUSION

IT-business strategic alignment literature encompasses different aspects of management practices and strategic IT choices made by organizations to facilitate alignment. What distinguishes this study from other studies is that it is the first research of its kind to incorporate these different aspects into an assessment instrument based on a model using multiple criteria and multiple levels to represent different degrees of alignment, from less mature to more mature.

This study contributes to the existing strategic alignment literature by investigating management practices and strategic IT choices that facilitate IT-business alignment, and by developing and validating an instrument to measure the degree to which those mechanisms are in place in an organization

This exploratory research suggests that the maturity assessment instrument may be a useful tool to help organizations assess their strategic alignment maturity and to improve it by implementing best practices from more mature levels provided in the instrument, and as such, warrants further testing of the instrument. Knowing the maturity of their management practices and strategic IT choices in place to facilitate IT-business alignment may help organizations determine whether these practices and choices are appropriate and whether they want to improve them.

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APPENDIX A

Example of Questionnaire Item

The following statements pertain to IT investment decisions. Our IT investment decisions are primarily based on IT's ability to:

1) Reduce costs.
2) Increase productivity and efficiency as the focus.
3) Traditional financial reviews. IT is seen as a process enabler.
4) Business effectiveness is the focus. IT is seen as a process driver or business strategy enabler.
5) Create competitive advantage and increase profit. Our business partners see value.
6) N/A or do not know.

The following statements pertain to the use of integrated IT and business metrics to measure IT's contribution to the business.

1) We do not measure the value of our IT business investments, or do so on an ad-hoc basis.
2) The value measurements for IT and business are not linked. We have limited or no formal feedback processes in place to review and take action based on the results of our measures.
3) The value measurements for IT and business are starting to be linked and formalized. We are also starting to have formal feedback processes in place to review and take action based on the results of our measures.
4) We formally link the value measurements of IT and business. We have formal feedback processes in place to review and take action based on the results of our measures, and to assess contributions across functional organizations.
5) We use a multidimensional approach, with appropriate weight given to IT and business measures. We have formal feedback processes in place to review and take action based on the results of our measures. These measures are extended to our external partners (e.g., vendors, outsourcers, customers).
6) N/A or do not know.

(Note: Contact jluftman@stevens-tech.edu regarding full access to survey)

APPENDIX B

CFA Factor Loadings

Indicator	Description	Loading
Communications Maturity		
COMM_1	Degree of understanding of the business by the IT function	0.67
COMM_2	Degree of understanding of IT by the business	0.67
COMM_3	Degree of richness of methods used for organizational learning	0.52
COMM_4	Communication style used within the organization	Dropped
COMM_5	Degree of knowledge sharing throughout the organization	0.64
COMM_6	Use of IT-business liaisons	Dropped
Competency and Value Maturity		
COMP_1	Focus of the metrics and processes to measure IT's contribution	0.69
COMP_2	Focus of the metrics and processes to measure business contribution	0.67
COMP_3	Degree of and orientation of integrated IT and business measures	0.81
COMP_4	Degree of service level agreements	Dropped
COMP_5	Frequency and formality of benchmarking practices	Dropped
COMP_6	Frequency and formality of IT assessments and reviews	0.69
COMP_7	Degree of continuous improvement practices	0.66
COMP_8	Contribution of IT to strategic goals	Dropped
Governance Maturity		
GOV_1	Degree of business strategic planning with IT involvement	Dropped
GOV_2	Degree of IT strategic planning with business involvement	Dropped
GOV_3	Basis of budgeting IT resources	0.64
GOV_4	Basis of IT investment decisions	0.76
GOV_5	Frequency formality, and effectiveness of IT steering committees	Dropped
GOV_6	Integration of IT project prioritization	0.72
GOV_7	IT function's responsiveness to changing business needs	Dropped
Partnership Maturity		
PART_1	Business' perception of the role of IT	0.63
PART_2	Role of IT in strategic business planning	Dropped
PART_3	Integrated sharing of risks and rewards	0.63
PART_4	Formality and effectiveness of partnership programs	Dropped
PART_5	Perception of trust and value	0.85
PART_6	Reporting level of business sponsor/champion	Dropped

Appendix B continued.

Scope and Architecture Maturity		
SCOPE_1	Technological and strategic sophistication of primary systems/applications	Dropped
SCOPE_2	IT standards articulation and compliance	0.71
SCOPE_3	Degree of architectural integration	0.82
SCOPE_4	Degree of infrastructure transparency	0.58
SCOPE_5	Degree of infrastructure flexibility	Dropped
Skills Maturity		
SKILLS_1	Degree of an innovation culture	0.74
SKILLS_2	Degree of integrated locus of power in IT-based decisions	0.66
SKILLS_3	Degree of a change readiness culture	0.71
SKILLS_4	Degree of opportunity for skills enrichment through job transfer	Dropped
SKILLS_5	Degree of opportunity for skills enrichment through cross-training or job rotation	Dropped
SKILLS_6	Degree of interpersonal interactions across IT and business	Dropped
SKILLS_7	Ability to attract and retain IT staff with technical and business skills	0.68

Chapter XV
A Lag Effect of IT Investment on Firm Performance

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ABSTRACT

This chapter discusses the positive effects of IT investment on firm financial performance when a distinct range of characteristics is examined. The relationship between IT investment and firm performance considering the information intensity of the industry is explored using a distributed lag model. Findings indicate both a positive effect and a positive lag effect of IT investment. The effects of IT investment in the high information-intensive industry are significantly larger than in the low information-intensive industry. Furthermore, a lagged effect of IT investment is larger than an immediate effect, regardless of the information intensity of the industry. We conclude that firms in the high information-intensive industry need to be more cognizant of performance factors when investing in IT investment than in the low information-intensive industry. Moreover, it is necessary to consider the time lag between IT investment and firm performance.

INTRODUCTION

Improved application of information technology (IT) may be the key factor in an organization gaining competitive advantage (Kohli & Devaraj, 2004; Porter & Millar, 1985). The greater attention executives give to the tangible benefits of IT investment, the more researchers become interested in the benefits of IT investment. However, while a number of studies have focused on the effects of IT investment, there has been a long-running debate on the relationship between IT investment and firm performance. Research about the relationship between IT investment and firm

performance can be classified into three categories. First, several researchers have asserted that there is no relationship between IT investment and organizational performance (Brynjolfsson, 1993; Gordon, 2000; Quinn & Baily, 1994; Roach, 1991; Strassmann, 1997). Rather, they argue that IT investment could have a negative impact (Menon & Lee, 2000) on the productivity of an organization because of inefficient allocation of management resources. The elasticities of other management activities (e.g., marketing, research and development, advertising) and similar capital targeting on improving firm performance are greater then the elasticity of IT capital (Brynjolfsson & Hitt, 1996; Lee & Menon, 2000). In the worst case, as firms invest more in IT, there is a greater need for coordination between different activities and information systems across all functional areas of the organization (Dasgupta, Sarkis, & Talluri, 1999).

The second research group has asserted that there is a significant positive relationship between IT investment and organizational performance. If firms invest more in IT, their performances correspondingly increase (Bharadwaj, 2000; Bharadwaj, Bharadwaj, & Konsynski, 1999; Brynjolfsson & Hitt, 2003; Li & Ye, 1999; McGuckin & Stiroh, 1998; Rai, Patnayakuni, & Patnayakuni, 1996). Suggesting that further discussions are needed on the limitations of the studies, they have used various techniques and data to explain a positive relationship between IT investment and organizational performance.

The third research group has reported partial or mixed results, and explained possible reasons for the results (Chircu & Kauffman, 2000; Devaraj & Kohli, 2000; Francalanci & Galal, 1998; Hu & Plant, 2001; Lee & Menon, 2000; Mahmood & Mann, 1993; Prattipati & Mensah, 1997; Stiroh, 1998; Tam, 1998; Zhu & Kraemer, 2002). They report that there is a positive relationship between IT investment and a range of firm performance variables; while in some performance variables, there is a negative relationship or effect.

More in-depth discussion is needed on the three viewpoints to explain the resultant effects of IT investment on firm performance. The reasons may be variances in the sample period, the industry investigated, the level of analyses (e.g., firm, sector, country), and the methodology used (see Appendix, which describes the summary of previous firm-level studies that used IT investment as one of the IT measures). It is also likely that no consideration was given to the critical factors in the research framework regarding IT amortization (Brynjolfsson, 1993; Quinn & Baily, 1994). In addition, the issue of the time lag has been identified as an important factor in the relationship between IT investment and firm performance (David, 1990; Devaraj & Kohli, 2000, 2002; Jurison, 1996b). The investigation of the time lag has been acknowledged by researchers as being one of the limitations to their studies and an aspect for future research (Peffers & Dos Santos, 1996; Pinsonneault & Rivard, 1998; Rai et al., 1996). Implementing IT projects is invariably a lengthy process, and employees need sufficient time to learn new information systems and to become reskilled. Furthermore, sensitivity to customers' needs and responsiveness to market dynamics are considerations that also need recognition when ultimately determining firm performance (Hu & Plant, 2001). Therefore, consideration of the time lag is paramount if a comprehensive exploration of the effects of IT investment is to be conducted with an appropriate level of rigor.

Another cause of empirically inconsistent results may be a lack of consideration for the characteristics of the industry sector. Melville, Kraemer, and Gurbaxani (2004) proposed an IT business value model that included industry characteristics, such as competitiveness, regulation, technical changes, clock-speed, and other aspects that shape the way in which the focal firm generated business value. In an organizational context, the role of IT should be a decisive factor for influencing performance. Consequently, while recognizing that the role of IT in each

industry is different, one also should be aware that the relationship between IT investment and the final size of the effect from IT investment might differ in and between sectors (McGuckin & Stiroh, 1998). Simultaneously, the size of the time lag for IT investment and its payoffs can vary according to the information intensity of the particular industry.

Identifying explicit empirical evidence regarding the benefits derived from IT investment is a key area of the study. To support direction and give greater exploratory focus, our research questions are as follows: (1) What is a relationship, either positive or no relationship, between IT investment and firm performance? (2) What is a relationship when consideration is given to a time lag and the information intensity of the industry? (3) Does the magnitude of any IT effect vary according to the information intensity of the industry? Moreover, do the characteristics of the time lag have a connection with the information intensity of the industry? (4) Which effect of IT investment on firm performance is larger: an immediate effect or a lagged effect?

The structure of this chapter is as follows: The following section presents the review of literature. Next, in the methods section, we suggest a research model and framework for considering the time lag between IT investment and firm performance, and present several hypotheses. In the results section, we present the results of the research. In the discussion section, we discuss the implications of the findings and contributions to an academic knowledge stock. Finally, we summarize the results, identify limitations of our research, and draw upon concluding remarks.

LITERATURE REVIEW

The Information Intensity of the Industry

Information intensity is the degree to which firms' products or services and their operations are dependent on the information collected and processed as part of internal transformational processes and exchanges along the value-added chain (Bhatt & Stump, 2001). Although the importance of information is increasing in firms and products, the role and the degree of importance of IT varies, depending on the industry (Porter & Millar, 1985). Because the size of information intensity differs among industries, the effects of IT may vary among industries. Both financial services and insurance industries are traditional information-intensive industries, but the cement manufacturing or chemical industry might use physical processes in addition to information-processing technology. Zhu (1999) suggested that banks, stock exchanges, airlines, e-commerce retailers, and high-tech companies that develop IT products are examples of information-intensive organizations.

The lack of appreciation for the information intensity of the industry is a possible reason for the range of explanations and inconsistent results in existing literature. In data used in previous research, the information intensity was not always considered. Richardson and Zmud (2002) found statistically significant positive effects of IT investment in the financial industry but insignificant results in non-financial industries. Even though they did not state this explicitly as information

Table 1. Research result of IT investment and the information intensity of the industry

		The information intensity of the industry		
		Low	High	No classification
Research result	Positive	•Li, Irani, & Love (2000)	•Menon, Lee, & Eldenburg (2000) •Sriram & Krishnan (2003)	•Bharadwaj (2000) •Bharadwaj, Bharadwaj, & Konsynski (1999) •Brynjolfsson & Hitt (1996, 2003) •Kudyba & Vitaliano (2003) •Lehr & Lichtenberg (1999) •Li & Ye (1999) •McGuckin & Stiroh (1998) •Rai, Patnayakuni, & Patnayakuni (1996)
	No effect or negative		•Menon & Lee (2000)	•Dasgupta, Sarkis, & Talluri (1999) •Gordon (2000) •Loveman (1994) Quinn & Baily (1994) •Roach (1991) •Strassmann (1997)
	Mixed result	•Weill (1992)	•Devaraj & Kohli (2000) •Francalanci & Galal (1998) •Lee & Menon (2000)	•Barua, Kriebel, & Mukhopadhyay (1995) •Hitt & Brynjolfsson (1996) •Hu & Plant (2001) •Mahmood & Mann (1993) •Prattipati & Mensah (1997) •Stiroh (1998) •Tam (1998) •Zhu & Kraemer (2002)

Note: The construction (SIC Division C), the valve manufacturing industry (SIC major group 34), which are used by Li, Irani, and Love (2000) and Weill (1992), respectively, are a low information-intensive industry, while financial services, insurance, retail, and health industries are a high information-intensive industry.

intensity, their results may be associated with the information intensity of the industry. Furthermore, Chatterjee, Pacini, and Sambamurthy (2002) used as control variables the industry type (standard industry classification (SIC) ≥ 5000 vs. SIC < 5000), the financial service institutions, and IT-producing firms, which can be related to the information intensity of the industry, but they did not mention explicitly the information intensity of the industry.

The majority of existing studies, which revealed negative or zero effects of IT investment, used aggregated data that did not consider the information intensity of the industry as a critical factor (see Table 1). On the contrary, using the sample of the high information-intensive industry, researchers found positive effects, or at least partial or mixed results, with a few exceptions, such as Menon and Lee (2000). Moreover, there

are few studies with a data set of the low information-intensive industry (Li, Irani, & Love, 2000; Weill, 1992).

Stiroh (1998) classified computer-using sectors for those where the nominal value of office, computing, and accounting machinery (OCAM) capital services exceeded 4% of total capital services.[1] Computer-using sectors include printing and publishing (major group of SIC: 27), stone, clay, and glass (32), non-electrical machinery (35), electrical machinery (36), instruments (38), trade (Division F and G of SIC), financial services, insurance, real state (FIRE) (Division H), and other services sectors (Division I). Approximately 88% of IT investment in the United States was invested in the computer-using sectors. In particular, 77% of IT investment was invested in trade, FIRE, and other services (Stiroh, 1998). Firms in computer-using sectors used the greater IT resources. In an

empirical study such as ours, where the exploration focuses on the relationship between IT investment and firm performance, it is necessary to make a distinction between information-intensive industries where most IT resources were used and low information-intensive industries where little IT resources were used.

## The Time Lag Between IT Investment and Firm Performance

Many studies have put forward various reasons for inconsistent findings regarding the effects of IT investment. Brynjolfsson (1993) stated that various explanations for the IT productivity paradox, which does not show the increase of productivity in spite of the increased IT investment, could be grouped into four categories: measurement error, lags, redistribution, and mismanagement. Furthermore, some studies (Devaraj & Kohli, 2002; Jurison, 1996b; Quinn & Baily, 1994) have commonly pointed out a time lag as one of the causes for the IT productivity paradox. The true benefits that will be observed after an initial period might range anywhere from several days to several months, and in some cases even years, depending on the size and complexity of IT implementation (Devaraj & Kohli, 2002). Therefore, any evaluation of benefits from IT investment must be cognizant of this aspect of the time lag and assess benefits over time.

Zhu and Kraemer (2002) found empirically a meaningful result; namely, that there is a positive relationship between e-commerce capability and some performance measures, such as cost and inventory turnover, but no significant relationship between e-commerce capability and profit-related performance measures. They suggested that the time lag between the use of an e-commerce initiative and its outcome could be a possible explanation of their partial result. For gaining a competitive advantage from IT, the learning curve of IT users is an indispensable element. There is a need to wait for a certain time so that IT users

can learn sufficient aspects of the new systems and adequately adapt their working methods to them (David, 1990). If workers in firms do not use new information systems or use them inefficiently, it is not possible to expect an improvement in individual or organizational performance from the introduction of IT into the organization.

Some studies, which recognized the time lag between IT investment and firm performance as a critical factor, have tried to include the time lag in their research models. The first group of studies considered the effect of IT investment after a specific lag (e.g., two years). Shafer and Byrd (2000) used an average information systems budget as a percent of revenues, average processor value as a percent of revenues, and an average percent of IS budget allocated to training as operational definitions of IT investment. They made use of performance variables, such as sales growth (compound annual increase or decrease over a five-year period) and profitability growth (compound annual increase or decrease in net income over a five-year period) as dependent variables. Their study analyzed the relationship between IT investment and the past five years' performance with only a three-year lag. Devaraj and Kohli (2000) included a time concept in their research model. Capital investments in hardware and software have influence on the reports program, data analysis, changes in patient care, and financial and quality outcomes sequentially with two or three months lag at each step in the hospital industry. In summary, Devaraj and Kohli (2000) included lags for each of the four stages for IT capital and considered eight or 12 months lag, while Shafer and Byrd (2000) used the three-year lag. In another study by Devaraj and Kohli (2003), they studied the two-month lag effect of IT use on organizational performance in the hospital industry. Brynjolfsson and Hitt (2003) used only the lagged effect of IT investment with various specific different lengths of a time lag (one to seven years).

Figure 1. Research model
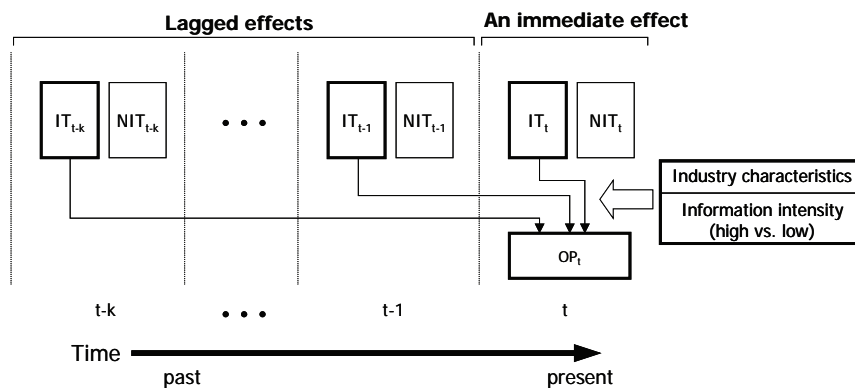
Note: The k is lag, ITt is IT factor at time t, NITt is other factors except IT at time t, and OPt is firm performance at time t

Second, it is possible to consider the time lag approach with the computation of weighted IT expense. Francalanci and Galal (1998) have assumed predefined sizes of lagged effects in each year. Weighted IT expense for a firm in a given year *t* is calculated from the amortization quotas of IT investments over a five-year period. The weights are 0.1 for the current year and four years ago, 0.2 at a year ago and three years ago, and 0.4 at two years ago. This means that the effect of IT investment at last year is double the effect of IT investment at year *t*.

Third, Hu, and Plant (2001) performed the granger causality test with the two-year lagged effect and concluded that IT investment not only has mixed influence on firm performance (sales growth: negative effect; Return on Asset (ROA), Return on Equity (ROE): positive effect) but also is affected by organizational performance. Similarly, they identified the lag effect of IT investment, but they could not find any immediate effect of the IT investment. Finally, other researchers (Kudyba & Vitaliano, 2003) have tried to consider the lag effect of IT investment with IT stock concept. IT investments have transformed IT stock at the constant rate and the IT stock effects on firm performance.

A few studies tried to consider the time lag between IT investment and performance using a range of research methods. Some studies did not measure both the immediate effect and lagged effects simultaneously but tended to consider only the lagged effect. Generally, IT investment has an influence on business processes; and changed business processes affect business process performances; consequently, the achieved business performance has an effect on organizational performance (Melville et al., 2004). However, there may be such longer lag effects (e.g., over one year) but also virtually immediate effects (e.g., less than one month) of IT investment, such as an introduction of state-of-the-art servers. If either an immediate effect or lagged effect of IT investment is considered on its own, the true value of IT investment may be missed. Furthermore, some studies did not free the lag length and assumed a notional period (e.g., two years). Clearly, there is a lack of a robust theory to decide the length of the time lag between IT investment and firm performance. This quest is still being undertaken by researchers. Finally, some studies have presumed the predefined size of lag effects using a rationale. Some authors assumed that the one-year lagged effect of IT investment is larger than the immediate effect. They have some concerns about

the sizes of lag effects, but existing studies reveal very little supportive evidence.

With an understanding of the significance of the issue and the limitations of previous studies, we explored the effect of IT investment on firm performance with varying time lags. Furthermore, we did not predefine the length of a lag and the size of lag effects but allowed them to be varied. The next section presents the research model and hypotheses.

METHODS

Research Model

The research model with the time lag and the information intensity of the industry is depicted in Figure 1. The firm performance at specific period t (OP_t) is affected by the sum of the IT factor at period t, t-1, t-2, …, t-k (IT_t, IT_{t-1}, …, IT_{t-k}) and also non-IT factors at period t, t-1, t-2, …, t-k (NIT_t, NIT_{t-1}, …, NIT_{t-k}). Non-IT factors are similar to complementary organizational resources, which include non-IT physical resources, non-IT human resources, and organizational resources in IT business value model by Melville, et al. (2004). However, we are concerned specifically with issues shown by bold-lined rectangles in Figure 1. We find both immediate and lagged effects of IT investment on firm performance at the same time, because our focus relates to IT investment. Furthermore, we use the information intensity of the industry as a moderating variable, because the effect of IT investment may not be equivalent in all industries. We consider that the effect of IT investment differs according to the information intensity of the industry. With the classification of Stiroh (1998), we classify the computer-using sectors and the computer-producing sector as the high information-intensive industry, while remaining sectors are classified into industries of low information intensity.

The equation to consider the cumulative effects of IT investment follows (1).

$$OP_t = \alpha + \sum_{i=0}^{k} \beta_i IT_{t-i} + \varepsilon_t \qquad (1)$$

where the k is lag, OP_t is firm performance at year t, IT_{t-i} is IT investment at year t-i, α is the intercept, β_i is the partial coefficient of IT investment at year t-i that influences firm performance at year t, and ε_t is the error term at year t.

In equation (1), we include successively the lag effect of IT investment in the research model to examine the incremental variance explained by IT lag effects. Specifically, we increase gradually the size of k by the integer within the maximal lag length. We estimate separately the model with weighted least squares (WLS) regression approach, which has the error-components pooling procedure (Pindyck & Rubinfeld, 1998) for the total sample, a high information-intensive industry sample, and a low information-intensive industry sample, because sample data are panel data.

When the adjusted R^2 does not increase even by adding another independent variable in the model or the direction of any IT investment coefficients changes,[2] then in order to decide the best fitting model, we stop adding the longer lagged effect variable in the model; that is, the increasing of k stops. First, when a new independent variable (e.g., a longer lagged effect) that is expected to affect theoretically or rationally the dependent variable is added in the regression model, the increase of the adjusted R^2 is general. On the contrary, if the adjusted R^2 does not increase in spite of adding a new variable in the model, a newly added independent variable is unnecessary to the regression model, and the model, which does not include the newly added variable, can be the best fitting model (Hair, Anderson, Tatham, & Black, 2003; Pindyck & Rubinfeld, 1998). Second, while IT investment affects positively (negatively) firm performance on the first occasion, after a specific period it is not general that IT investment affects negatively (positively) firm performance. When

the direction of the effect of IT investment changes due to an addition of longer lagged effects, this chapter decides that the model, which did not include the additional longer lagged effect, is the best-fitting model.

To compare two regressions in the high information-intensive industry and the low information-intensive industry, we use the dummy variable approach as follows (2):

$$OP_t = a_1 + a_2 D + \sum_{i=0}^{k} \{b_i IT_{t-i} + c_i (D \cdot IT_{t-i})\} + u_t$$

(2)

where k is the lag, OP_t is firm performance at year t, IT_{t-i} is IT investment at year t-i, a_1 is the intercept, a_2 is the differential intercept, b_i is the partial coefficient of IT investment at year t-i that influences firm performance at year t, c_i is the differential slope coefficient at year t-i, D=1 for observations in the high information-intensive industry and zero for observations in the low information-intensive industry, and u_t is the error term at year t.

To investigate the dissimilarity of the effects of IT investment according to the information intensity of the industry, we will examine the significance of a_2 in equation (2) in order to compare two intercepts in the high information-intensive industry and the low information-intensive industry. Moreover, to compare the slopes of IT investment, we will analyze the significance of c_0 for the immediate effect of IT investment and c_i for i-year lag effect of IT investment.

Independent and Dependent Variables

Following previous studies regarding the relationship between IT investment and organizational performance (Bharadwaj et al., 1999; Francalanci & Galal, 1998; Mahmood & Mann, 1993; Prattipati & Mensah, 1997), we use IT budget as the operational definitions of an IT investment vari-

able. IT budget is the estimated annual information systems budget in year *t* as a percentage of revenue in year *t* to normalize for differences in each firm size. This ratio shows how much a firm is spending on IT compared to its competitors.

We use financial performance indicators, which would be analyzed separately, as a reflection of firm performance, since most organizations and stakeholders may measure a firm's value through these measurements. In particular, exploring the effect of IT investment on firm financial performance is very important issue (Dedrick, Gurbaxani, & Kraemer, 2003). Following numerous existing research (Bharadwaj, 2000; Brynjolfsson & Hitt, 2003; Hitt & Brynjolfsson, 1996; Kudyba & Vitaliano, 2003; Rai et al., 1996; Tam, 1998; Zhu & Kraemer, 2002), we select return on equity (ROE), return on capital (ROC), and profit margin as measures of profitability. Moreover, we use the rate of sales growth and the rate of earnings per share (EPS) growth as the indicator of a firm's growth.

Data

Our sample comprises data from *InformationWeek* magazine. *InformationWeek* data are gathered from an annual survey and published in its annual special issue, *InformationWeek 500*. Many researchers (Bharadwaj, 2000; Bharadwaj et al., 1999; Dasgupta et al., 1999; Kudyba & Vitaliano, 2003; Li & Ye, 1999; Rai et al., 1996), who were concerned about the impact of IT investment, also have used secondary data from *InformationWeek*. We use the annual IT budget data for the seven-year period from 1991 to 1997, because in 1998, *InformationWeek* changed to rankings rather than publishing numeric values.

We use *Forbes* as data sources of firm performance measures for ease of access to financial information. Various financial measures are analyzed and provided in the "Annual Report on American Industry" section of *Forbes* magazine (*Forbes*, 1996, 1997, 1998).

We use the pooled data that have elements of both time-series data and cross-sectional data, because we cannot get a longer time series of IT investment for a longitudinal study. The final sample is comprised of 81 firms with consecutive five-year IT investment terms on the cross-sectional side. Furthermore, on the time-series side, our sample is for the three years from 1995 to 1997 on firm performance, and the seven years from 1991 to 1997 on IT investment.

Hypotheses

The focus of this study is not the effects of non-IT factors, such as salespersons, advertising, and R&D, but only the effects of IT investment (Figure 1). Therefore, the most important question, which many researchers (see Appendix) have tried to answer, is being tested again in the first hypothesis. As identified in the introduction section, previous studies have failed to identify consistent empirical evidence regarding the effects of IT investment on firm performance. While this issue has been widely studied, this hypothesis with financial performance is one of the opportunities for future research until recently (Dedrick et al., 2003).

Hypothesis 1: *There is a positive relationship between IT investment and firm performance.*

Many researchers have suggested that one of the limitations in their studies was not considering the time lag between IT investment and firm performance (Peffers & Dos Santos, 1996; Pinsonneault & Rivard, 1998; Rai et al., 1996). If the time lag is included in their research model, research results may be more concrete, consistent, and significant. In addition, David (1990) argues that computers may require substantial changes in complementary infrastructure before the gains to them may be realized.

IT projects that implement corporate information systems generally take a long time, but it also takes longer to see their effect on firm

performance. Such a situation appears in Figure 1. The firm performance at year *t* is influenced by each IT investment at year t, t-1, t-2, …, t-k simultaneously. Longitudinally, considering IT investment and firm performance with a time lag, we can find a significant positive effect of IT investment. While firms invest in IT for short-term payoffs, they also invest in IT for long-term payoffs. This issue is one of the opportunities for future research (Dedrick et al., 2003) and is related to the second hypothesis.

Hypothesis 2: *Both an immediate effect and lagged effects between IT investment and firm performance are positive.*

Melville, et al. (2004) emphasized that it is necessary to consider industry characteristics, such as competitiveness, the degree of unionization, and time sensitivity, in measuring IT investment payoffs. In addition, Dedrick, et al. (2003) also pointed out that it is not well understood why firms in different industries accrue different payoffs. Some industry-level studies (Stiroh, 1998) have considered industry characteristics (e.g., computer-using sector, computer-producing sector), while a few firm-level studies have not considered the information intensity of the industry until recently. Some classifications, such as financial industry vs. non-financial industry (Richardson & Zmud, 2002), an industry type (SIC $\geq$ 5000 vs. SIC < 5000) (Chatterjee et al., 2002), have been used, but such classifications are not based on the information intensity of the industry.

IT will not influence all industries to the same degree (Porter & Millar, 1985). If the core process of a firm is not related to information, the effect of IT on firm performance may be low. Industries using a physical processing technology (e.g., the cement manufacturing industry) can be the low information-intensive industry, despite increased information processing in such a business. In such industries, firm performance is not closely connected with IT but may be closely related

Table 2. Descriptive statistics and results of Pearson correlation analysis

	Number of Observation	Mean	ROC	ROE	Profit margin	Sales growth	EPS growth	IT_t	IT_{t-1}	IT_{t-2}	IT_{t-3}
ROC	166	11.74									
ROE	114	15.58	.847***								
Profit margin	158	7.32	.415***	.420***							
Sales growth	167	8.53	.230***	.288***	.009						
EPS growth	138	9.92	.513***	.624***	.335***	.271***					
ITt	174	2.49	.123	-.014	.381***	-.017	.049				
ITt-1	174	2.39	.088	-.013	.407***	-.028	.060	.784***			
ITt-2	174	2.39	.076	.019	.279***	-.034	.058	.711***	.883***		
ITt-3	174	2.44	.159**	.064	.221***	.023	.076	.738***	.775***	.877***	
ITt-4	174	2.49	.214***	.082	.243***	-.031	.077	.710***	.760***	.818***	.883***

*Note: *** means correlation is significant at the 1% level (two tailed), ** means correlation is significant at the 5% level (two tailed), and * means correlation is significant at the 10% level (two tailed). In addition, ROC, ROE, and EPS are Return on Capital, Return on Equity, and Earnings per Share, respectively.*

to processing equipment or an automated line of production. If IT is not associated with firm performance in the low information-intensive industry, firms in the industry may not need to invest heavily in IT.

In a competitive environment of e-commerce or online trading through the Internet, IT investment will require shorter time frames for capturing and analyzing payoffs or stronger associations with firm performance than in traditional businesses or the cement manufacturing. IT is a powerful resource and can differentiate a firm's products or services from others, and IT may provide a competitive advantage to a firm.

After due consideration of the time lag, it is quite likely that IT investment does not have an influence on firm performance to the same degree due to differences in the information intensity of different industries. Because researchers have not considered the information intensity of different industries, they may fail to find consistent empirical results. To analyze accurately the payoff for IT investment, two concepts need to be considered simultaneously: the information intensity of the

industry and the time lag. In the group comprised of high information-intensive industries, there may be a larger effect of IT investment than the effect of IT investment in the low information-intensive industry. That is, the total effect from IT investment in the high information-intensive industry may be larger than the total effect in the low information-intensive industry. This is the third hypothesis of our study and a concept that researchers have analyzed to determine the effects of IT investment.

Hypothesis 3: *The greater the degree of information intensity in an industry, the greater the extent to which firms achieve efficiency gains and profitability gains via IT, regardless of a lag.*

To measure the real payoff from IT investment, we hypothesized previously that consideration is required for an immediate effect and a lag effect simultaneously. Because of workers' time and effort in absorbing IT, there may be a lag between IT investment and firm performance. As the worker's learning accumulates, firm performance

Table 3. Preconditions of regression analysis and their standard detection methods used

Preconditions	Standard methods used
1) The number of observation / The number of explanatory variables > 10	
2) The regression data do not have outliers	•Histogram •Normal P-P plot of regression standard residual •Scatter diagram •Casewise diagnostics •Cook's distance statistics
3) The data should satisfy normality	•Scatter diagram
4) The data should satisfy linearity	•Scatter diagram
5) The conditional variance of the disturbance term has homoscedasticity	•Goldfeld-Quandt test •White test
6) There is no autocorrelation (serial correlation) in the disturbances	•The runs test •Durbin-Watson d test
7) There is no multicollinearity among explanatory variables	•Pair-wise or zero-order correlation coefficient between two regressors •Tolerance •Variance Inflation Factor (VIF) •Condition Index (CI)

Table 4. Results of multiple regressions with IT investment for sales growth, EPS growth, ROC, and ROE

Variable	Dependent variable: Sales growth		Dependent variable: EPS growth		Dependent variable: ROC		Dependent variable: ROE	
	k=0	k=1	k=0	k=1	k=0	k=1	k=0	k=1
Intercept	9.016***	9.248***	4.644***	5.060***	10.608***	10.676***	15.777***	15.789***
IT_t	-.302***	-.027	1.654***	.501***	.453***	.511*	-.065	.026
IT_{t-1}		-.375***		1.146***		-.089***		-.090
N	166	166	137	137	166	166	114	114
Adjusted R^2	.508	.352	.403	.380	.834	.816	-.003	-.006
F-value	171.192***	45.844***	92.669***	42.661***	830.541***	366.176***	.608	.688
Δ adjusted R^2		-.156		-.023		-.018		
Note	Best fitting		Best fitting		Best fitting			

*Note: Each column represents a separate regression. The k is lag. *** denotes significant at the 1% level, ** denotes significant at the 5% level, and * denotes significant at the 10% level. D indicates the change by adding a longer lag.*

may increase. Jurison (1996a) identified that the perceived timing of maximal organizational productivity improvement was the second year. Moreover, Francalanci and Galal (1998) assumed that the lagged effects of IT investment on firm performance are larger than the immediate effect of IT investment. This issue will be investigated through Hypothesis 4.

Hypothesis 4: *The lagged effect of IT investment on firm performance is larger than the immediate effect of IT investment on firm performance.*

Table 5. Results of multiple regressions with IT investment for profit margin

Variable	Total industry			High information-intensive industry sample			Low information-intensive industry sample	
	k=0	k=1	k=2	k=0	k=1	k=2	k=0	k=1
Intercept	4.938***	4.502***	4.511***	3.987***	3.111***	3.175***	5.788***	5.606***
IT_t	.917***	.390***	.409***	1.329***	.585***	.511***	.396***	.115
IT_{t-1}		.746***	1.661***		1.008***	1.355***		.387***
IT_{t-2}			-.979***			-.294***		
N	158	158	158	65	65	65	93	93
Adjusted R^2	.912	.949	.713	.839	.975	.960	.641	.566
F-value	1627.567***	1476.501***	130.833***	333.384***	1243.132***	515.773***	165.388***	60.997***
Δ adjusted R^2		.037	-.236		.136	-.015		-.075
Note		Best fitting			Best fitting		Best fitting	

Note: Each column represents a separate regression. The k is lag. *** denotes significant at the 1% level, ** denotes significant at the 5% level, and * denotes significant at the 10% level. D indicates the change by adding a longer lag.

RESULTS

The observation number of IT investment variables is 174, and the observation number of firm performance variables ranges from 114 to 166 (due to some missing values) (Table 2). The mean of IT budget per revenues is approximately 2.49%, while the mean of profit margin is 7.32%, and EPS growth is 9.92%.

The result of the Pearson correlation analysis identifies that there are positive relationships among firm performance variables. This reveals that the performance variables used are consistent among firm performance variables. In addition, as we expected, there are positive relationships between current IT investment and past IT investment. Interestingly, and contrary to our expectation, there is a significant positive relationship between IT investment and *only* profit margin; but in IT investment and other firm performance variables, we cannot find any positive relationship. Therefore, we can only partially accept Hypothesis 1.

Prior to conducting further analyses, an examination of the validity of the basic assumptions for the regression analysis is needed (Gujarati, 1995; Hair et al., 2003; Pindyck & Rubinfeld, 1998). Table 3 presents preconditions of regression analysis and standard methods used for deciding whether they are satisfied or not. Because there were no problems after the detailed examination, we could continue the regression analysis.

Table 4 shows the results of the multiple regression analysis for sales growth, EPS growth, ROC, and ROE. Especially, in sales growth, there is a negative effect of IT investment. The coefficient of IT investment is -0.302 and significant at the 1% level. The F-value that reveals the fitness of model is 171.192 and significant at the 1% level. Furthermore, the adjusted R^2 is 0.508. On the other hand, there are positive effects of IT investment in EPS growth and ROC. If IT investment increases by one, EPS growth and ROC will increase by 1.654 and 0.453, respectively; both are significant at the 1% level. In ROE, we cannot find any evidence of a positive effect. Because

Table 6. Testing the equality of two regressions in the high information-intensive industry and the low information-intensive industry for profit margin

Parameter in equation(2)	k=0		k=1	
	Unstandardized Coefficients	Standard Deviation	Unstandardized Coefficients	Standard Deviation
a_1	5.788	(0.024)***	5.606	(0.100)***
a_2	-1.801	(0.249)***	-2.495	(0.214)***
b_0	0.396	(0.031)***	0.115	(0.084)
b_1			0.387	(0.093)***
c_0	0.933	(0.079)***	0.471	(0.134)***
c_1			0.621	(0.138)***
N	158		158	

Note: The k is lag. *** means significant at the 1% level (two-tailed test).

the F-value is not significant (0.608), we cannot accept the regression model for ROE. Moreover, there is the significant increase of profit margin affected by IT investment (the second column in the Table 5). Therefore, we are able to conclude that there is partial support for Hypothesis 1 from the result of the regression analysis.

We found an immediate impact of IT investment on sales growth, EPS growth, ROC, and profit margin. Even though we introduced the one-year lag effect of IT investment to the regression model with sales growth, EPS growth, and ROC as a dependent variable, and contrary to our expectation, the adjusted R^2 decreased by 0.156, 0.023, 0.018, respectively (the third, fifth, and seventh column in the Table 4). It is difficult to accept that the regression model with an additional lagged effect is the best fitting due to decreasing of the adjusted R^2, so the basic model without a time lag can be the best fitting for sales growth, EPS growth, and ROC. However, we identified the time lag effect between IT investment and profit margin (the third column in the Table 5). In the relationship between IT investment and profit margin, the adjusted R^2 of the regression model with the one-year lag effect increased by 0.037. The coefficient of the immediate effect is 0.390 and significant at the 1% level, and the coefficient

of the one-year lag effect is 0.746 and significant at the 1% level. However, in spite of adding a longer lag effect than one year to the regression model, the adjusted R^2 decreased by 0.236 (the fourth column in the Table 5). Hence, we were compelled to refrain from going to a longer lag. The one-year lag model is the best fitting in the total industry sample for the profit margin. As a result, we could find both an immediate effect and a lag effect of IT investment on profit margin simultaneously, and therefore, this could partially support Hypothesis 2.

Because we could not discover any significant result in sales growth, EPS growth, ROC, and ROE in the subsample, we present only the result for profit margin. Table 5 represents the result of the regression analysis on profit margin in the high information-intensive industry and the low information-intensive industry. We obtained the statistically significant regression model in the high information-intensive industry (F value = 333.384***) with the adjusted R^2 of the model of 0.839. When we added the one-year lag effect of IT investment to the basic model, both an immediate effect and the lag effect of IT investment are positive and statistically significant at the 1% level. In addition, F value of the one-year distributed lag model is significant at the 1% level

Table 7. Testing the equality of two regression coefficients for profit margin

Parameter in equation (2)	k=0		k=1	
	Unstandardized Coefficients	Standard Deviation	Unstandardized Coefficients	Standard Deviation
a_1	5.788	(0.024)***	5.606	(0.100)***
a_2	-1.801	(0.249)***	-2.495	(0.214)***
b_0	0.396	(0.031)***	0.115	(0.084)
b_1			0.387	(0.093)***
c_0	0.933	(0.079)***	0.471	(0.134)***
c_1			0.621	(0.138)***
N	158		158	

Note: *** means that t-value is significant at the 1% level (one-tailed test); ** means that t-value is significant at the 5% level (one-tailed test); * means that t-value is significant at the 10% level (one-tailed test). The parenthesis is a standard deviation.

(1243.132***), and the adjusted R^2 increased from 0.839 to 0.975. We continued to introduce a longer lag effect (i.e., a two-year lag) to the regression model, but without suitable results. The adjusted R^2 of the model included a two-year lag effect decreased by 0.015. Furthermore, the coefficient of the two-year lag effect changed from a positive sign into a negative. Therefore, we can accept that the model with a one-year lag is the best-fitting model. While we could not find a longer lag than one year, we could identify the lag effect of IT investment on firm performance in the high information-intensive industry.

Conversely, in the low information-intensive industry, we can find a positive immediate effect of IT investment at the 1% significance level (0.396***). However, when we introduced the one-year lag effect of IT investment to the model, the immediate effect of IT investment was no longer statistically significant, and the adjusted R^2 decreased by 0.075. Therefore, according to our stopping rule, in the low information-intensive industry, the best fitting model can be a basic model without any lag effect.

To compare the difference of regression models between the high information-intensive industry and the low information-intensive industry, we analyzed equation (2). The differential slope coefficient of the immediate effect in the basic model without a time lag is 0.933 and significant at the 1% level (Table 6). This means that the immediate effect of IT investment in the high information-intensive industry is significantly larger than in the low information-intensive industry. Furthermore, the differential slope coefficients of the immediate effect and the lagged effect in the one-year distributed lag model are 0.471 and 0.621, both at the 1% significance level in the two-tailed test. Therefore, we can conclude that sizes of both an immediate effect and a lag effect from IT investment in the high information-intensive industry are significantly larger than in the low information-intensive industry whether the distributed lag model is used or not. Because of this, we cannot reject Hypothesis 3. We found empirical evidence to support the view that not all industry is influenced by IT to the same degree.

It can be seen that in the total industry, the lag effect of IT investment is significantly larger than the immediate effect (Table 7), because the t-value for testing the equality of two regression coefficients is significant at the 1% level in one tail

(t-value = 4.919, 0.746*** > 0.390***). In addition, in the high information-intensive industry, we find a similar result at the 5% significance level in one tail (t-value = 2.099, 1.008*** > 0.585***). In the low information-intensive industry, although the coefficient of the immediate effect is not statistically significant, the lag effect is larger than the immediate effect at the 10% significance level in one tail (t-value = 1.578, 0.387** > 0.115). Thus, we find that the lag effect of IT investment is larger than the immediate effect for all types of sample after the t-test. Therefore, we can accept Hypothesis 4. This means that the one-year lagged effect of IT investment is significantly larger than the immediate effect of IT investment, regardless of the information intensity of the industry.

DISCUSSION

This chapter investigated a relationship that is suggested by Dedrick, et al. (2003) as one of the opportunities for future research between IT investment and firm financial performance, and found a significant positive relationship and effects on performance. However, this study also uncovered a negative impact of IT investment on sales growth. These results should conclude that hypothesis 1 is partially supported due to mixed results. We found a negative impact of IT investment on sales growth, while we found positive effects of IT investment on profit-related performance variables. If IT investment is not in the interest of a firm's expansion but primarily for a firm's efficiency, such as cost saving, then one may fail to find a positive effect of IT investment on firm performance related to the expansion, such as sales growth. Some firm-level studies (Bharadwaj, 2000; Bharadwaj et al., 1999; Kudyba & Vitaliano, 2003; Li & Ye, 1999) that used profit-related performance variables have found a significant positive relationship or effects between IT investment and firm performance. Furthermore, Hu and Plant (2001) also have shown mixed results,

which simultaneously have a positive impact on profitability performance and a negative impact on sales growth, as illustrated in this chapter. As a result, because both those studies and this chapter have used a similar time period, we can cautiously conclude that IT investment in the early/mid-1990s was used in the interest of firms' efficiencies.

Second, this chapter measured a lagged effect, the lack of which some researchers identified as one of the limitations on their work (Peffers & Dos Santos, 1996; Pinsonneault & Rivard, 1998; Rai et al., 1996) and one of opportunities for future research (Dedrick et al., 2003) of IT investment on firm performance. Some studies (Devaraj & Kohli, 2000; Hu & Plant, 2001) have stressed the need to observe benefits from IT investment or use over longer time. Dedrick, et al. (2003) described that some (IT investments) will have short-term impacts and others (IT investments) will have longer-term impacts. This chapter thus tried to consider simultaneously both an immediate effect and lagged effects, and uncovered significant results. Moreover, the lag in this study was not predefined but allowed various lengths of a lag to be tested to identify the size of a lagged effect. To decide a best-fitting model, this study used the most common standard (the selection of the highest adjusted R^2 among regression models) of multivariate analysis. Although there is a lack of a robust theory to decide the length of a lag between IT investment and firm performance, this exploratory statistical method can contribute to deciding the length of a lag.

Third, this chapter found empirical evidence confirming an argument (Porter & Millar, 1985) that the effects of IT investment on performance vary, depending on the information intensity of the industry. In the relationship between IT investment and firm performance, industry characteristics play an important role (Melville et al., 2004). However, mechanisms of the role are still not understood at present (Dedrick et al., 2003). The varying payoffs of IT investment due to the information intensity of the industry is an important

issue, because a few studies have considered such characteristics. One possible explanation for this phenomenon (more information intensity, more payoffs from IT investment) may be that because in information-intensive industries IT has a closer relationship with and is invested in core business processes of firms, the effect of IT investment can be larger. As IT may be one of the leverages in the information-intensive industries, firms in the industries need to show more sensitivity with regard to the strategic application of IT investment than in the low information-intensive industry. By contrast, firms in the low information-intensive industry (e.g., the cement manufacturing or mining industries) might be concerned about other critical factors (i.e., process technology) rather than IT investment.

Fourth, the empirical finding from hypothesis 4 shows that the lagged effects of IT investment are larger than the immediate effects, regardless of the information intensity of the industry. This result, which concurs with other studies (Francalanci & Galal, 1998; Jurison, 1996a) can be explained by a learning curve. IT users may require some learning before becoming proficient due to unusual complexity and novelty in IT (Brynjolfsson, 1993). According to models of learning-by-using, growing experience allows the firm to ride the learning curve and to get benefits similar to economies of scale. When IT users learn sufficient aspects of the new systems and adequately adapt their work (business processes) to them, the effect of IT investment on performance can increase (David, 1990). Furthermore, IT investment affects business processes, and changed business processes are capable of significantly affecting firm performance (Melville et al., 2004). It can be easily accepted that this IT value generation process needs specific time. The benefits from business process reengineering or redesign (BPR) enabled by IT, which may take a long time to realize, are greater than the benefits from replacing outdated computers with new ones, in which the effect of

investment can be realized immediately (Devaraj & Kohli, 2000; Hu & Plant, 2001).

Meanwhile, Table 5 also prompts a new question about why the length of a lag in information-intensive industries is different from the length of a lag in low information-intensive industries. One possible explanation for this is mentioned in the following. Devaraj and Kohli (2000) state, "Specific lags vary based on the nature of the industry…" (p. 55). The nature of the industry can be the information intensity of the industry. Information-intensive industries are more dependent on information, while low information-intensive industries are comparatively less dependent on information (Porter & Millar, 1985). Firms in information-intensive industries may naturally invest in more IT to manage and process information, and IT is more heavily invested in domains that are related to the firms' core processes. Because the change of the core processes is needed over a comparatively long time in spite of severe competition, the lag in information-intensive industries can be longer than the lag in low information-intensive industries.

Why is the length of a lag at the firm level shorter (zero or one year) against expectation? The competition can be one of the reasons for such a short lag. When some firms are getting payoffs from IT investment under severe competition, other firms that analyzed the competitor's IT strategy and its payoffs also will invest in IT to expect similar payoffs from IT investment. The first movers (firms) that invested in IT before others can gain until other firms are successful in imitating competitive IT. If other firms succeed in copying the IT, most firms cannot gain additional benefits from IT investment. Though the firms can no longer gain benefits from IT investment, the benefits associated with IT use do not disappear but may be passed on to consumers by making it easier for consumers to compare prices (Hitt & Brynjolfsson, 1996).

CONCLUDING REMARKS

Our study is an empirical analysis at the firm level. The relationship between IT investment and firm performance was studied with a time lag and the information intensity of the industry. We obtained several findings from this study. First, there is a positive relationship between IT investment and firm financial performance, and IT investment has an influence on performance (H1). Second, IT investment has an instantaneous effect and a lag effect on performance (H2). That is, the effect of IT investment is not a simple one-time event but a continuous phenomenon. Third, when we considered the information intensity of the industry, we found that the effect of IT investment on firm performance in the high information-intensive industry is larger than the effect of IT investment in the low information-intensive industry (H3). Finally, after performing an equality test on the immediate effect and the lag effect from IT investment, we found that the lag effect from IT investment is larger than the immediate effect (H4).

These empirical results suggest clues to the inconsistent results of some firm-level studies, which were described in the introduction section. First, when one tries to find the effect of IT investment on performance, both growth indicators and profit-related indicators of the firm financial performance should be considered. Second, if a sample from the low information-intensive industry is used, then the studies can fail to find a positive effect from IT investment. Finally, if only the immediate effect from IT investment is measured, then the real effects of IT investment may be missed.

There are some limitations in this chapter. One limitation is that the study considers the linear relationship between IT investment and firm performance. If IT investment is increasingly unlimited, firm performance also can be increasingly unlimited. It is difficult for this to happen in the real business world. There may be a

boundary line or a saturation point beyond which the performance cannot increase, despite more IT investment. Second, this chapter uses the annual IT investment data for seven years; hence, the period of an analysis may be too short in order to consider the complete lag effects of IT investment (Gujarati, 1995). Third, the firms in the sample are comparatively heavier IT investing firms, so it may not be a random sampling method and could produce a skewed distribution. Finally, the sample period is outdated. The early 1990s may not be in keeping with the new millennium, because current IT investments are related to e-business on the Internet.

While the first limitation is related to an equation type, the remainders originate from data sources. Justification for the first limitation is that the linear relationship is the first step of the study regarding both the immediate effect and the lag effect of IT investment on firm performance. The study has to evolve from a simple concept (linear relationship) into a complex concept (non-linear relationship) (e.g., an S-shape curved model).

Some justifications related to data sources are as follows: First, it is difficult to acquire IT investment data (which have a longer time series) from lighter IT investing firms. The budget or information about IT investment is not an obligatory report but the results of internal management activities and strategies. We can collect information related to IT investments, such as IT budgets, computer capital from *InformationWeek* and *Computerworld* (Bharadwaj, 2000; Bharadwaj et al., 1999). Many firm-level studies (Bharadwaj, 2000; Bharadwaj et al., 1999; Dasgupta et al., 1999; Li & Ye, 1999) have used the same data sources as we use (see Appendix). Various studies (Barua, Kriebel, & Mukhopadhyay, 1995; Lee & Barua, 1999; Loveman, 1994) with the same sources (e.g., management productivity and information technology database for 1978-1984) can solidify the empirical results of the studies about the effectiveness of IT investment. Moreover, it is accepted that there might have been a so-called IT

productivity paradox in the early/mid-1990s. This chapter investigates the causes of the paradox with the data of the sample period (1991-1997).

Second, whether the Internet introduced them or not, firms generally invest in the most suitable capitals and labors for them. Likewise, IT budgets of the firms are justly invested in the most suitable IT items for the firms. In this study, we did not focus on the payoffs from any specific information systems but on the performance from IT investment at the firm level. We were not concerned with information systems designs (e.g., host-based, client-server-based, and Web-based architecture, etc.) in the firms.

Third, the time period studied may not really be so outdated after all. Secondary data that some firm-level studies (Barua et al., 1995; Brynjolfsson & Hitt, 2003; Francalanci & Galal, 1998; Kudyba & Vitaliano, 2003; Menon & Lee, 2000; Shao & Lin, 2002; Tam, 1998) used are just as outdated as the time period studied in this chapter. Furthermore, some firm-level studies (Lee & Barua, 1999; Lehr & Lichtenberg, 1999) and some industry-level studies (Gordon, 2000; Stiroh, 1998) have used very much older data than the sample period of this chapter.

In spite of these limitations, this study revealed empirically the benefits from IT investment. It may be necessary to increase IT investment for increasing a firm's performance. Moreover, there is a time lag effect between IT investment and firm performance, so managers have to wait for a specific time to get the long-term payoffs from IT investment. They also need to know the industry characteristics, such as the information intensity of the industry, at the outset. It is necessary to establish the appropriate competitive strategy with IT, depending on the industry characteristics.

When firms overcome the resource barriers, knowledge barriers, and usage barriers that may be hindering conversion from potential payoffs to realized payoffs, and when firms overcome industry barriers and organizational barriers such as those identified in the study of Chircu and

Kauffman (2000), firms that invest in IT can get realized performances. Our results show that IT investment has a positive impact simultaneously on firm performance for immediacy and a time lag. However, when practitioners and firm managers who accept our results decide to invest in IT as a strategic weapon, they should pay attention to the interpretation of our results. If they just wait for implicit payback after IT investment, they cannot gain the full range of benefits. Because IT investment is not a sufficient condition but a necessary condition, when firms have superior capability (e.g., faster learning capability) to convert from IT investment to realized performance and increase their IT investment, their performances can be *really* increased.

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ENDNOTES

[1] Bureau of Economic Analysis (BEA) includes computer investment in its asset class "Office, Computing and Accounting Machinery (OCAM)." Each computer component of OCAM (e.g., personal computers, mainframes, displays, and printers) is separately deflated with a constant-quality price index to account for the large quality improvements (Stiroh, 1998).

[2] We have to use not R^2 but the adjusted R^2. As the number of independent variables increases, R^2 almost invariably increases

APPENDIX

Summary of Previous Firm-Level Studies Using IT Investment as One of the IT Measures

Researchers	IT Measures	Performance Measures	Data / Sources	Methods	Main Results	Note
Barua, Kriebel, & Mukhopadhyay (1995) M, F	Economic input variables •IT capital for Strategic Business Unit (SBU) •Production IT purchases •Marketing IT purchases •Innovation (R&D) IT purchases	Intermediate level variables •Capacity utilization for SBU •Inventory turnover •Relative (inferior) quality •Relative price •New products •Aggregate firm performance •Return on Assets (ROA) •Market share	•60 SBUs of 20 corporations for 1978-84. From Management Productivity and Information Technology (MPIT) data Same as Loveman (1994)	Regression analysis	Positive effects: others. Negative effects: between Production IT purchases and Inventory turnover	2 stage model
Bharadwaj (2000) P, F	IT resources IT infrastructure Human IT resources IT-enabled intangibles	*Profits* Return on Assets (ROA) Return on Sales (ROS) Operating income to assets Operating income to sales Operating income to employees *Costs* Cost of goods sold to sales Selling and general administration expense Operating expense to sales	56 firms in all industries vs. 56 control firms for 1991-94 From InformationWeek, Compustat database	Group comparison analysis between IT leader group & control group	Positive relationship: There is a better performance in IT leader group than in control group.	
Bharadwaj, Bharadwaj, & Konsynski (1999) P, F	Ratio of IT expenditure to sales Industry-level controls Industry concentration Industry capital intensity Industry average Tobin's q Regulation Firm-level controls Market share of firm Ratio of firm's advertising expenditure to sales Ratio of firm's Research and Development (R&D) expenditure to sales Entropy measure of firm diversification Firm size: Number of employees (log)	Tobin's q	631 firms (81~159 firms at each year) in all industries for 1989-93. From InformationWeek, Compustat database	Regression analysis: Ordinary Least Squares (OLS) Hierarchical regression analysis	The relationship between IT expenditure ratio and performance is positive, but other variables are not significant. IT expenditure has a positive effect on firm performance (increasing from 0.27 to 0.70).	

Note: In the first column of an appendix table, N, M, and P mean that studies show no relationship or negative results, mixed results, and positive relationships or effects, respectively. Furthermore, F means that the unit of analysis is a firm.

APPENDIX *continued.*

Researchers	IT Measures	Performance Measures	Data/Sources	Methods	Main Results
Brynjolfsson & Hitt (1996) P, F	•Computer capital •Non-computer capital •IS staff •Non-IS labor and expense	Total sales	367 firms in all industries for 1987-91 From International Data Group (IDG) survey, Compustat database	Cobb-Douglas function Regression analysis: OLS (Ordinary Least Squares), 2SLS (Stage Least Squares)	Marginal product (elasticity) of computer capital is higher than others.
Brynjolfsson & Hitt (2003) P, F	•Computer capital •Non-computer capital •IS staff •Non-IS labor and expense *Control variables* •Year •Industry	•Total sales •Value added	527 firms in all industries for 1987-94 From Computer Intelligence InfoCorp (CII), Compustat database	Cobb-Douglas function Regression analysis	*Positive effects* The productivity and output contributions associated with computerization are up to 5 times greater over long periods (using 5- to 7-year differences).
Dasgupta, Sarkis, & Talluri (1999) N, F	•IT budget •IT employees	Net income	85 manufacturing + 77 service companies for 1997 From InformationWeek	Basic Data Envelopment Analysis (DEA) ratio model Kruskall-Wallis (KW) test	Negative effects
Devaraj & Kohli (2000) M, F	•IT labor: total salary and wage expenses •IT support: includes consulting fees expense, Decision Support Systems (DSS) computer programming, software support, DSS maintenance expense •IT capital: cost of the DSS software product and its associated modules	*Financial index* •Net patient revenue per day (NPR-DAY): the ratio of the total revenue realized by the hospital to the total number of days •Net patient revenue per admission (NPRADM): the ratio of the total revenue realized by the hospital to the total number of patient admissions *Quality index* •Mortality rates (MORT): the % of mortalities within 30 days of an operative procedure divided by the total number of operative procedures •Customer satisfaction (SATIS): the % of "top-box" scores	8 hospitals (members of a health system) in health-care industry for 36 monthly periods From above hospitals	Regression analysis	*Positive effects* •Net patient revenue per day (NPRDAY), Net patient revenue per admission (NPRADM): IT labor, IT capital Customer satisfaction (SATIS): IT capital *Negative effects* Mortality rates (MORT): IT labor

Note: In the first column of an appendix table, N, M, and P mean that studies show no relationship or negative results, mixed results, and positive relationships or effects, respectively. Furthermore, F means that the unit of analysis is a firm.

APPENDIX *continued.*

Researchers	IT Measures	Performance Measures	Data/Sources	Methods	Main Results	Note
Francalanci & Galal (1998) M, F	•IT expense (introduction of amortization) •Work composition: clerical, managerial, professional intensity •Combined effects: interaction between IT expense and work composition	Premium income per employee Total operating expenses to premium income	52 U.S. life insurance companies for 1982-95 From Life Office Management Association (LOMA) database, Annual and 10k reports, A. M. Best insurance reports, Compustat database	Generalized estimating extension (GEE) of the Generalized Linear Models (GLM) random estimator	•Positive effects: managerial intensity, combined effects of IT & managerial •Negative effects: IT expense, clerical and professional intensity, combined effects of IT & clerical, professional	Use of predefined time lag effects
Hitt & Brynjolfsson (1996) M, F	Total IT stock Non-computer Capital LaborIndustry (dummy variables) Year (dummy variables) Sector (dummy variables)	Value added	370 firms in all industries for 1987-91 From International Data Group (IDG) survey, Compustat database, Bureau of Economic Analysis (BEA)	•Regression analysis: •Ordinary Least Squares (OLS) •Iterated Seemingly Unrelated Regression (ISUR) •Two Stage Least Squares (2SLS) •Cobb-Douglas production function	Positive effects	
	IT stock per employee Capital intensity Debt / Equity ratio Market share Sales growth Industry (dummy variables) Year (dummy variables)	Return on Assets (ROA) Return on Equity (ROE) Total return	370 firms in all industries for 1987-91 From International Data Group (IDG) survey, Compustat database, BEA	Regression analysis	Negative effects	
	Ratio of IT Stock to Value added- Price of IT StockValue Added	Consumer surplus	370 firms in all industries for 1987-91 From International Data Group (IDG) survey, Compustat database, BEA	Index number method	Positive relationship	

Note: In the first column of an appendix table, N, M, and P mean that studies show no relationship or negative results, mixed results, and positive relationships or effects, respectively. Furthermore, F means that the unit of analysis is a firm.

APPENDIX *continued.*

Researchers	IT Measures	Performance Measures	Data/Sources	Methods	Main Results	Note
Kudyba & Vitaliano (2003) P, F	•IT rate = IT stock / Sales where IT stock = IT capital + 3 x IT labor, IT capital at period t = (0.75 x IT capital at period t-1) + (% H/W portion of IS budget at period t) Control variables •Rate of sales change = (Sales at period t – Sales at period t-1) / (Sales at period t-1)	•Gross operating margin = [Sales – Cost of Goods Sold (CGS) – Selling and General Expenses (SG&A)] / Sales	345, 355, 183 firms in all industry for 1995, 1996, 1997 From InformationWeek, Computerworld, corporate disclosure reports	Regression analysis	Positive effects	
Lee & Menon (2000) M, F	•IT capital •IT labor •Non-IT capital •Non-IT labor	•Adjusted patient days= inpatient days + outpatient days (= dividing outpatient revenue by inpatient revenue per day)	Hospitals in healthcare industry for 1976-94 From Washington State Department of Health (WADOH) hospital database	Stochastic production function	Positive: The coefficients of Non-IT variables are higher than IT capital variables.Negative: IT labor	Industry -specific results
Lehr & Lichtenberg (1999) P, F	•IT capital •Computer investment •Capital •Labor Control variables •Industry •Firm	•Sales •Inventory / Sales	3,000+ firms, 400+ firms in all industries From U.S. Bureau of Census data for 1977-87, Computer Intelligence (CI), Compustat database for 1986-93	Regression analysis using Cobb-Douglas production functions	Positive effects	
Li, Irani, & Love (2000) P, F	*IT investment index (Average of following variables)* •Number of PCs as the percentage of total employees •Value of IT as a percentage of total value of assets •Budget for IT as a percentage of total budget	Annual net profit per employee	20 engineering firms, 20 architectural firms, 20 quantity surveying firms in construction industry (Hong Kong) From Telephone survey	Correlation analysisRegression analysis	Not significant: in engineering firms, architectural firmsPositive effects: in quantity surveying firms	

Note: In the first column of an appendix table, N, M, and P mean that studies show no relationship or negative results, mixed results, and positive relationships or effects, respectively. Furthermore, F means that the unit of analysis is a firm.

APPENDIX *continued.*

Researchers	IT Measures	Performance Measures	Data/Sources	Methods	Main Results	Notes
Li & Ye (1999) P, F	IT investment (= IT budget / total assets) *Mediation variables* •Environmental dynamism •Strategy orientation •IT-strategy integration	Return on Assets (ROA)Return on Sales (ROS)	216 firms in all industries for 1992-94 From Information-Week, Compustat database, U.S. International Outlook	Regression analysis	• Positive effect with mediation variable • However, too low the adjusted R² (each 0.05, 0.10)	
Loveman (1994) N, F	*IT factor* •Real IT capital *Non-IT factor* •Real materials expenditure •Real non-IT purchased services expenditures •Real total labor compensation •Real non-IT capital	Sales less inventory changes (deflated by a price index)	60 business units in manufacturing sector for 1978-84 From Management Productivity and Information Technology (MPIT) database (= Profit Impact of Market strategy (PIMS) database)	Regression analysis using Cobb-Douglas function: •Static model •Dynamic model •Producing management model	•No effect •Partially negative effect •Not positive effect	
Mahmood & Mann (1993) M, F	•IT value •IT budget •Training budget •Staff budget •PCs and terminals per employee	Return on Sales (ROS) Growth in revenue Sales by total assets (SBYTA) Return on Investment (ROI) Market value to book value (MVTOBV) Sales by employee (SBYE)	100 firms in all industries for 1989 From Computerworld premier 100, Compact Disclosure database	•Pearson correlation analysis •Canonical correlation analysis	•Pearson: weak, negative • Canonical: more significant relationship (mixed)	
Menon & Lee (2000) N, F	•IT capital •IT labor *Non-IT factors* •Medical equipment capital •Medical labor	Adjusted patient days= in-patient days + out-patient days (= multiplying out-patient revenue by the ratio of the in-patient days to the in-patient revenues)	50 + hospital observations per year for 1976-94From Washington State Department of Health (WADOH) hospital database	Estimated conditional demand function	Negative relationship: IT factors	
Menon, Lee, & Eldenburg (2000) P, F	•Medical IT capital •IT capital •IT labor *Non-IT factors* •Medical capital •Medical labor •Teaching control •Time control	A hospital's annual changes for services deflated by the consumer price index for health care services	55 hospital observations per year for 1976-94From Washington State Department of Health (WADOH) hospital database	Stochastic frontier approach	Positive relationship: IT factors	

Note: In the first column of an appendix table, N, M, and P mean that studies show no relationship or negative results, mixed results, and positive relationships or effects, respectively. Furthermore, F means that the unit of analysis is a firm.

APPENDIX *continued.*

Researchers	IT Measures	Performance Measures	Data/Sources	Methods	Main Results	Notes
Prattipati & Mensah (1997) M, F	ISBUDGET: IS budget 1993 / sales 1993 LEVEL: level of Chief Information Officer (CIO) ISEMP: percentage of IS employees CIOYR: CIO's years in position in the same company CBUD: percent change in IS budget from 1992 OUT: percentage of IS budget spent outside the IS department NEWD: percent of software budget spent on new development CSAP: percent of software development spent on client/server applications PCS: number of desktop servers NETWK: percent of desktop devices networked	Information Productivity Index (IPI) = (net income after taxes – cost of equity capital) / sales, general, and administrative expenses (SG & A)High IPI group vs. LOW IPI group	100 firms in all industries From Computerworld premier 100 in 1994	•Discriminant analysis •Correlation analysis	•Positive relationship: ISEMP, CSAP •Negative relationship: CIOYR, NEWD	
Rai, Patnayakuni, & Patnayakuni (1996) P, F	IS budget Efficiency of IS department •Sales per IS employee •Income per IS employee	•Financial firm performance •Return on Assets (ROA) •Return on Equity (ROE) •Sales performance •Total sales •Market share •Intermediate performance •Asset turnover •Labor productivity	210 firms in all industries for 1992-1993 From InformationWeek, Compustat database	•Regression analysis •F-test	•No effect: financial index, asset turnover •Positive effect: sales performance, labor productivity •No difference: efficiency of IS department	
Sriram & Krishnan (2003) P, F	IT-related costs *Control variables* Income before extraordinary deposits minus time deposits Core deposit intangibles (= domestic deposits minus time deposits in excess of $100,000 Year effect (dummy variable)	Market value of equity / Book value of equity	171 firms in financial services industry for 1997 and 1998 From Compustat PC plus database, firms' annual reports	Correlation analysisRegression analysis	Positive relationship	

Note: In the first column of an appendix table, N, M, and P mean that studies show no relationship or negative results, mixed results, and positive relationships or effects, respectively. Furthermore, F means that the unit of analysis is a firm.

APPENDIX *continued.*

Researchers	IT Measures	Performance Measures	Data/Sources	Methods	Main Results	Notes
Strassmann (1997) N, F	IT spending per employee	Profitability: Return on Equity (ROE)	468 firms in manufacturing, retailing, banking, utility industries for 1994	Scatter diagram	No relationship between IT investment and returns	
Tam (1998) M, F	Computer capital *Control variables* Size (book asset value) Year (dummy variable) Industry (dummy variable)	Total shareholder return (TSR) Return on Equity (ROE) Return on Assets (ROA) Return on Sales (ROS)	38, 26, 24, 18 firms in all industries from Hong Kong, Singapore, Malaysia, Taiwan for 1983-91 From Asian Computer Directory (ACD), Sandra Am Morsilli Pacific–Basin Capital Markets (PACAP) database, Global Vantage (GV)	Regression analysis: Ordinary Least Squares (OLS)	•Positive effects: ROE, ROA in SingaporeROE in Malaysia •Negative effects: ROS in Hong Kong ROE, ROA in Taiwan	Cross-national setting
Weill (1992) M, F	IT investment (= ratio of IT expenditure to total annual sales) was categorized into strategic, informational, and transactional.	Sales growth rate Return on Assets (ROA) Nonproduction labor per million dollars sales (LABOR) Percent change in LABOR	33 valve manufacturing firms for 1982-87From survey, interview	Regression analysis	•Positive effects: in transactional •Negative effects: in strategic and short-term IT	Conversion effectiveness
Zhu & Kraemer (2002) M, F	•E-commerce (EC) capability indicators: ①information, ②transaction, ③interaction and customization, ④supplier connection •IT infrastructure: ①personal computer (PC), ②local area network (LAN), ③total installed millions of instructions per second (MIPS), ④IT stock, ⑤IT intensity •Interaction effects (EC*IT)	•Revenue per employee •Profit margin •Cost of goods sold (COGS) •Inventory turnover	64 high-tech manufacturing firms + 196 traditional manufacturing firms from Fortune 1000 list From Harte-Hanks database (formerly the Computer Intelligence database), Compustat database, Internet (Web site)	•Validity tests for EC capability indicators •Regression analysis	•Positive effects: Between COGS and EC capability, interaction effect (EC*IT) in high-tech firms Between Inventory turnover and EC capability, interaction effect (EC*IT) •Negative effects: Between COGS and IT intensity Between Inventory turnover and IT intensity in high-tech firms Between COGS and EC capability, interaction effect (EC*IT) in traditional firms	

Note: In the first column of an appendix table, N, M, and P mean that studies show no relationship or negative results, mixed results, and positive relationships or effects, respectively. Furthermore, F means that the unit of analysis is a firm

Chapter XVI
The Institutionalization of IT Budgeting in Firms:
Investigating Sources of Influence

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ABSTRACT

Organizations around the world invest billions of dollars each year in information technology (IT) related products and services. What are the factors influencing each individual firm's investment budget decisions? Limited empirical results derived from firm-level data suggest that internal affordability, such as previous IT budget levels, sales, profitability, and size, are significant sources of influence. In this study, we introduce the perspective of "external institutional influence" for examining corporate IT budgeting processes, in addition to the internal affordability perspective. Using firm-level IT and financial data of publicly traded companies in the financial sector, we show that the two most significant sources of influence on corporate IT budgets are the firm's IT spending level of the previous year (internal) and the IT spending level of the perceived industry leaders (external). We posit that as IT becomes pervasive in all aspects of business operations and all sectors of the economy, IT budgeting processes have been, at least partially, institutionalized. The implications of this institutionalization are discussed and future research directions are suggested.

INTRODUCTION

Studies show that more than two trillion dollars were spent on IT related products and services by organizations worldwide in 2001, of which more than $800 billion were in US alone (Carr, 2003; Steinert-Threlkeld, 2002; WITSA, 2002). Not surprisingly, over the last three decades, there

have been strong interests, from both academicians and practitioners, in understanding why organizations invest in IT and what impact IT has on organizations (e.g., Applegate, Austin, & McFarlan, 2003; Bharadwaj, 2000; Brynjolfsson & Hitt, 2000; Clemons & Row, 1991; Gordon, 2002; Melville, Kraemer, & Gurbaxani, 2004; Porter & Millar, 1985; Strassmann, 1996; Wade & Hulland, 2004; Wilson, 1993). Managing IT budgets and creating business value from IT investments have been some of the top challenges facing firms in the global economy (Curley, 2006; Luftman Kempaiah, & Nash, 2005).

A stream of academic research on the business value of IT and IT investments provides many justifications for investing in IT. The process-based view states that IT investments create competitive advantages by improving operational efficiency of business processes (Barua, Krieble, Mukhopadhyay, 1995; Mooney, Gurbaxani, & Kraemer, 1996; Soh & Markus, 1995). The resource-based view proposes that IT investments improve organizational performance by creating and leveraging resources and capabilities (Bharadwaj, 2000; Clemons & Row, 1991; Mata, Fuerst, & Barney, 1995; Powell & Dent-Micallef, 1997; Wade & Hulland, 2004). The economics-based view suggests that IT investments create higher marginal return than other types of capital investments in economic production processes of organizations (Brynjolfsson & Hitt, 1996; Hitt & Brynjolfsson, 1996; Lehr & Lichtenberg, 1999; Lichtenberg, 1995; Siegel, 1997). More recently, a significant development in theories of IT business value is the digital options view that applies real options thinking and analytical models to IT investment analysis (Benaroch & Kauffman, 2000; Tallon, Kauffman, Lucas, Whinston, & Zhu, 2002; Taudes, Feurstein, & Mild, 2000). This view holds that the value of IT to businesses is not limited to short-term, direct, and tangible benefits, as identified in the economic and process views, but can be extended to long-term capabilities and flexibilities created or enabled by IT investments. Sambamurthy et al. (Sambamurthy, Bharadwaj, & Grover, 2003) further theorize that the digital options created by IT provide a platform for organizational agility that, in conjunction with entrepreneurial alertness and competitive action, has a significant impact on firm performance.

In this study, we offer an alternative perspective on the justification of investing in IT based on the internal affordability stemming from the strategic necessity argument (Carr, 2003; Clemons & Row, 1991) and the external influence according to the institutional theory (DiMaggio & Powell, 1983; Meyer & Rowan, 1977; Scott, 1995). We argue that as IT permeates all aspects of business processes, managers and stakeholders of firms become increasingly more acceptive to the notion of strategic necessity of IT. Over time, their IT budgeting processes become institutionalized. As a result, IT investment becomes less about creating competitive advantages for firms, but more about following organizational routine and creating legitimacy for management as well as organizations. This argument is based on two recognizable patterns of the firm-level IT budget data used in this study: (1) firm-level IT budgets as a percentage of revenue hover around a narrow range of 3%-5% with small variances across all firms; and (2) the two most significant determinants of an individual firm's IT budget are IT spending level of the perceived successful firms in the same industry as well as the individual firm's previous IT spending level. These patterns suggest the presence of institutional forces in the IT budgeting processes of these firms.

The rest of the chapter is organized as follows. In the next section, we develop the theoretical foundation and research hypotheses from the perspectives of strategy necessity and institutional theory. It is followed by descriptions of our research model and data set. Then we present the results of empirical tests of these research hypotheses using firm-level IT budget data. Finally, managerial implications and directions for future research are discussed.

Theoretical Foundations

Although the questions of how and why IT investments impact firm performance have been the subject of numerous studies (Melville et al., 2004; Wade & Hulland, 2003), only a relatively small number of studies have addressed the question of how a firm decides its annual IT budget (e.g., Hu & Plant, 2001; Kobelsky, Richardson, & Zmud, 2002; Weill, 1992). In this section, we establish a theoretical foundation for our IT budgeting model based on two complementary perspectives: internal affordability and external institutional influence. We argue that they jointly determine how much a firm invests in IT and related products and services.

The Internal Affordability Perspective

Most of the literature on the value of IT suggests that firms invest in IT for gaining competitive advantage by making better decisions and improving operational efficiencies. It is also argued that IT can alter the competitive landscape by introducing new products or services or entering completely unexplored markets, and by creating new strategic resources or leveraging existing ones (Applegate et al., 2003; Bharadwaj, 2000; Brynjolfsson & Hitt, 2000; Clemons & Row, 1991; Porter & Millar, 1985). However, there is a notable dissent from the mainstream IT value propositions in recent publications. The fundamental conjecture of this new school of thought is that IT has become such a readily available and ubiquitous commodity to all firms that it no longer creates any sustainable competitive advantage for firms (Carr, 2003). On the other hand, it is argued that inadequate IT, just like electricity or telephone services, could significantly undermine the very survival of firms in the information age and the highly competitive global economy. "When a resource becomes essential to competition but inconsequential to strategy, the risk it creates

becomes more important than the advantage it provides." (Carr, 2003, p. 42)

In essence, IT has evolved from a strategic resource in the dawn of the information age to a strategic necessity, a notion first suggested more than a decade ago by Clemons and Kimbrough (1986) and further elaborated by Clemons and Row (1991). They argue that since many IT systems supposedly providing competitive advantages to its adopters can be readily copied by competitors, IT itself seldom delivers the benefits it is designed for. Rather, it is the complementary strategic resources needed to exploit IT innovations that are important in explaining and predicting the sustained competitive advantages of the adopters.

Thus, the notion of "strategic necessity" of IT is less about "competitive advantage" but more about "fear of being left behind." It lends validity to the argument that firms invest in IT out of reactive response to competitive necessity rather than proactive pursuit of competitive advantage. The pressure to invest in IT in order to survive, coupled with ambiguous consequences of IT investments, often makes a firm's IT budgeting decision a difficult one. What factors does a firm consider when determining how much to spend each year on IT products and related services? In a study of corporate IT budgeting, Kobelsky et al. (2002) find that previous year IT spending level, affordability factors, and industry concentration were identified as the main determinants. This is consistent with the prediction of "strategic necessity" argument. We label this set of determinants as "internal affordability."

In fact, the essence of the "internal affordability" proposition has been discussed in prior studies to various degrees. For instance, Weill (1992) suggests a circular IT investments model in which he postulates a positive association between incremental IT investments of the current year and firm financial performance measures of the prior years. Subsequent empirical tests show that neither "strategic" nor "informational" IT investments are associated with previous year

financial measures, but "transactional" IT investments are (Weill, 1992). This lends partial support for the "internal affordability" proposition. When studying the impact of IT investments on firm performance, some researchers (e.g., Brynjolfsson & Hitt, 1996; Shin, 2001; Siegel, 1997; Sircar, Turnbow, & Bordoloi, 2000; Stratopoulos & Dehning, 2000) have noted the possibility of "reverse causality." That is, better firm performance could lead to higher IT investments. Using firm-level IT investment and performance data published in *InformationWeek* and explicit causal modelling, Hu and Plant (2001) show it is more likely that better firm performance leads to higher level of IT investments than the reverse. In an analysis of the same *InformationWeek* data set, Kobelsky et al. (2002) show that previous year IT spending and profitability have more significant impacts on the current year's IT budget than other financial measures and industry characteristics, when taking into consideration of "affordability" with other financial factors. This line of discussion leads to our first two hypotheses:

H₁: A firm's IT budget of the previous year has a positive and significant effect on its IT budget of the current year;

H₂: A firm's financial performance of the previous year has a positive and significant effect on its IT budget of the current year.

The External Influence Perspective

The internal affordability argument offers a compelling explanation for why firms make perpetual IT investments without being able to determine the exact benefits of such investments. But it is incapable of explaining a widely observed phenomenon in corporate IT spending, that is, most firms budget their IT spending each year at about 3%-5% of their revenues. If internal affordability were the only determining factor, one would expect a greater variation in IT budgets measured

as a percentage of revenue (ITR) across all firms. We believe that the narrow range of ITR manifests the existence of institutional isomorphism among firms within and across industries in their IT budgeting processes. Hence, as a complement to the internal affordability perspective, which focuses on the internal forces affecting firms' IT budgeting processes, the institutional theory, outlined in Meyers and Rowan (1977) and DiMaggio and Powell (1983), is well suited to explain the external influences. Based on this theory, we argue that as IT investments become a strategic necessity and their direct effects are increasingly uncertain, IT budgeting is institutionalized and becomes an organizational routine. As a consequence, IT investments are less about creating sustainable competitive advantages, but more a ritual to gain legitimacy and resources needed to survive by the management.

The institutional theory posits that organizations are structured by phenomena in their environment and tend to become isomorphic with each other in the organizational filed. This, in turn, promotes the success and survival of these organizations. It is argued that by incorporating externally legitimated formal structures, an organization can increase the commitment of internal participants and external constituents. Therefore, by designing a formal structure that adheres to the prescriptions of myths in the institutional environment, an organization can demonstrate that it is acting on the collectively valued purposes in a proper and adequate manner, thus protecting the organization from having its conducts questioned (Meyer & Rowan, 1977).

Two of the most important components of the institutional theory are the institutionalization process and the isomorphism process. Tolbert and Zucker (1983) define "institutionalization" as the process through which components of formal structure become widely accepted, as both appropriate and necessary, and serve to legitimate organizations. They argue that the initial decision to adopt an innovation in a formal structure

depends on, to a large degree, how the adoption will improve its internal process. In contrast, once historical continuity establishes the importance of the innovation adoption, changes in the formal structure are adopted by other members of the community because of their societal legitimacy, regardless of their value to the internal functioning of their organizations. When some organizational elements become institutionalized, that is, when they are widely understood to be appropriate and necessary components of efficient, rational organizations, an organization is under considerable pressure to incorporate these elements into its formal structures in order to maintain its legitimacy (Tolbert & Zucker, 1983).

Applying this institutional argument to firm IT budgeting processes, the following thesis can be proposed. For early IT innovators and adopters, spending a certain percentage of their revenues to implement certain IT projects, perceived to have great strategic or operational significance, could well be a carefully thought-out decision. The well-known cases of the integrated POS and distribution systems of Wal-Mart, the EDI system of American Hospital Supply, and the SABRE system of American Airlines substantiate this point. Once these innovations showed their successes, what those companies did with their information systems was perceived as "best practices" by peers and competition alike. The effectiveness of these best practices was taken for granted on improving internal operational efficiency and external competitive advantage. The perceived effectiveness and legitimacy of these practices are particularly important since the actual effects of these innovations are often difficult to determine. As a result, firms' IT budgeting processes are institutionalized as appropriate and necessary, regardless of their actual effect on firm performance.

Then, how does this institutionalized IT budgeting process propagate among the firms within and across industries? DiMaggio and Powell (1983) identify three mechanisms through which institutional isomorphism can occur:

- **Coercive isomorphism:** The coercive isomorphism occurs as a result of the formal and informal pressures exerted on organizations and decision makers to follow or adopt certain institutionalized rules and practices. These pressures often come from other organizations upon which the focal organizations are dependent for resources, and from cultural expectations from the society within which the focal organizations function.

- **Mimetic isomorphism:** The mimetic isomorphism occurs as a result of organizations imitating other organizations in uncertain environments in order to minimize the risk of taking innovative actions. Mimetic behaviour has considerable economic benefit because it reduces the cost of finding a viable solution when organizations are faced with problems with ambiguous causes or unclear solutions.

- **Normative isomorphism:** The normative isomorphism is described as the result of professionalization of organizational actors, such as managers and administrators. When the organizational actors are professionalized (i.e., they have similar formal education and training and participate in the same professional networks), it is argued that a pool of almost interchangeable individuals is formed. These individuals occupy similar positions across a range of organizations, and possess a similarity of orientation and dispositions.

We argue that some or all of these forces have shaped firm IT spending and contributed to the isomorphic pattern of IT budgeting. The professionalization of IT managers and workforce has been well recognized. Most firms in both private and public sectors have created a "Chief Information Officer" (CIO) position. Profes-

sional certification programs, such as Microsoft Certified Systems Engineer (MCSE) and Oracle Certified Professional (OCP), are well established. And MIS/CIS academic programs in universities worldwide are fast growing. In addition, numerous IT trade magazines and online information sites, such as *CIO*, *Computerworld*, and *InformationWeek*, have been promoting "best practices" and "success stories" to decision makers with full force over the last few decades. Each of the three named publications publish annual surveys with headlines such as "100 Premier IT Leaders," and on special topics such as IT spending and management practices. Given the readiness and widespread of idea exchange and information sharing, managers are hard pressed not to pay attention to what is going on in their industry or market segment. Thus, we posit that:

H_3: The average IT budget as a percentage of revenue (ITR) of firms in the same market segment has a positive and significant effect on the IT budget of individual firms of that segment.

The isomorphic IT budget pattern, measured as a percentage of revenue (ITR) across firms, is likely enhanced by another unique characteristic of IT investments: uncertain outcomes. Since Morgan Stanley analyst Steven Roach questioned the impact of IT investments on firm performance and productivity (Roach, 1987), there has been an ongoing debate about the "IT Productivity Paradox" and the value of IT (see Brynjolfsson, 1993; Brynjolfsson & Hitt, 1996; Carr, 2003; Gordon, 2002; Lehr & Lichtenberg, 1999; Loveman, 1994; Strassmann, 1996). This causal ambiguity creates a highly uncertain environment for decision makers when it comes down to the question of how much a firm should spend on IT each year. The institutional theory predicts that "the more uncertain in the relationship between means and ends the greater the extent to which an organization will model itself after organizations

it perceives as successful" (DiMaggio & Power, 1983; p.154). Thus, we propose:

H_4: The average IT budget as a percentage of revenue (ITR) of perceived "industry leaders" has a positive and significant effect on the IT budget of individual firms of that industry.

The coercive force seems to have played a marginal role in the isomorphic ITR pattern across firms. DiMaggio and Powell (1983) suggest that the coercive isomorphism is a result of resource dependency in the organizational field, and mandates from governmental or environmental policies and regulations. Since IT spending is basically a "voluntary" act by firms, barring the perceived "strategic necessity," we argue that based on the stricter interpretation of DiMaggio and Powell's definition, the coercive isomorphic mechanism may not be as significant as the other institutional forces in explaining firm IT budgeting behavior.

In summary, we posit that as IT increasingly becomes commoditized in the digital economy, IT investments are more about institutional legitimacy than about competitive advantage. As a result, IT budgets, measured as a percentage of revenue, have become increasingly isomorphic across firms within and even across industries, mostly due to the institutional forces. These research hypotheses are summarized in Figure 1. In the next sections, we test these hypotheses using firm-level IT budget data gathered from financial sectors of the U.S. economy.

DATA AND EMPIRICAL EVIDENCE

Data

To fully investigate the extent of institutionalization of IT budgeting in the corporate environment, it is necessary to obtain detailed firm-level IT

Figure 1. Research model
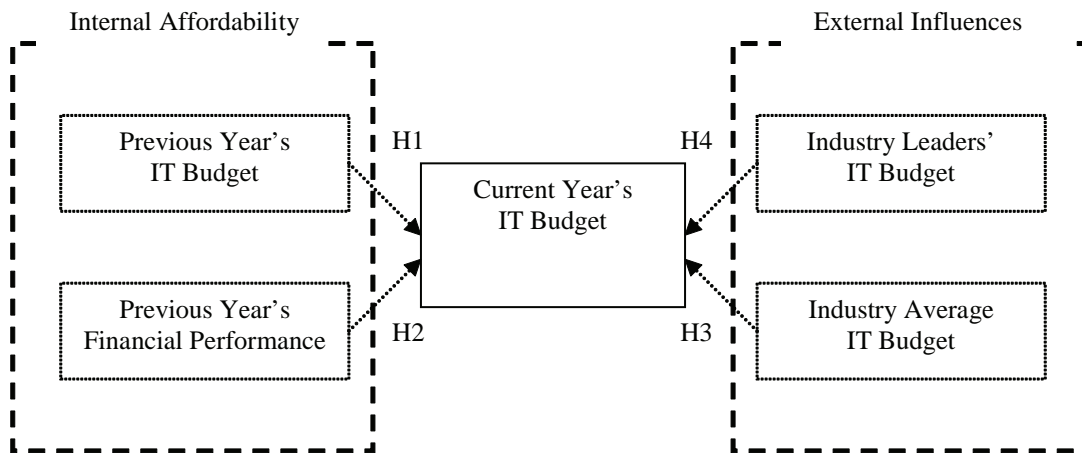
budgeting data and identify the "IT Leaders." We limited our sample to firms in the financial sector because of data availability. Firm-level IT budget data was collected from two leading IT industry trade publications: *InformationWeek* and *Computerworld*. Since 1989, *InformationWeek* has published their special annual issue listing various data items including IT budget, size of IT staff, and sales for 500 firms in the US. From 1988 to 1996, *Computerworld* published a list of IT leaders, in various industries, based on peer review and a 3-year moving average of Information Productivity Index (IPI) developed by Strassmann (1994). We grouped these companies by their four-digit primary Standard Industry Classification (SIC) code, and matched the firms in *InformationWeek* data set with a leader identified in the *Computerworld* list. Using only the overlapping years between the two publications, we compiled the IT budget data from 1990 to 1996. Previous studies that used data from the same sources include Bharadwaj (2000), Brynjolfsson and Hitt (1996), Hitt and Brynjolfsson (1996) and Lichtenberg (1995).

Financial data, such as revenue, total assets, return-on-asset (ROA) of the sample firms, were then gathered from the Compustat database published by Standard & Poor. The market share of

each firm was calculated using the ratio of its revenue to the total revenue of all firms in the same industry defined by the SIC. In order to test causality between the independent variables and the dependent variable (ITR), we decided to introduce a 1-year time lag in the model by grouping the overlapping companies that appear in any 2 consecutive years from 1990 to 1996. This yielded a sample size of 57 firms. Table 1 shows some statistical characteristics of our sample.

The isomorphic IT budget among the firms in the financial sector is graphed in Figures 2 and 3. The average IT budget, as a percentage of firm revenue, stayed in the narrow range of 3%-5% over the 6-year period from 1990 to 1996, while the IT leaders, as identified by *Computerworld,* had consistently outspent the rest of the firms by about 1% of their respective revenues. The overall IT budget trends of the leaders and the rest of the firms were fairly consistent and in locked steps. Figure 3 shows that the standard deviation of the ITR ratio among all the firms in the financial sector had been steadily declining until 1994. The jump in 1995 seems to coincide with the Internet dot com boom, when many firms drastically increased their IT spending in e-commerce and related initiatives. This temporary shock to the steady spending pattern started to level off

Table 1. Market segments and characteristics of sample firms

Period	SIC	# of Firms	ITR (%)		Means		
			Industry	Leader	Assets ($1000)	ROA (%)	Sales ($1000)
1990-91	60xx	9	4.33	5.40	47062.43	0.64	5635.44
	62xx	2	5.60	6.85	17881.24	0.38	1506.00
	63xx	3	1.66	2.52	38081.16	0.91	8731.67
1991-92	60xx	11	3.18	5.27	35576.24	0.38	3852.82
	62xx	2	5.36	4.17	22155.42	0.67	1587.50
	63xx	2	2.56	1.58	53387.28	0.67	11021.00
1992-93	60xx	10	3.31	5.04	43843.86	0.82	4285.60
1993-94	60xx	8	4.66	5.90	63627.51	0.96	4813.38
	61xx	1	3.85	4.00	12916.90	1.40	1958.00
	63xx	2	2.34	4.40	58464.45	-0.58	10028.00
1994-95	60xx	3	4.87	7.08	65844.86	0.87	5970.67
1995-96	60xx	2	5.87	2.01	53946.28	1.21	4867.00
	63xx	2	1.39	1.00	115019.70	1.05	16392.50

Figure 2. IT budget of financial sector (ITR_L: Leaders, ITR_I: All Firms)
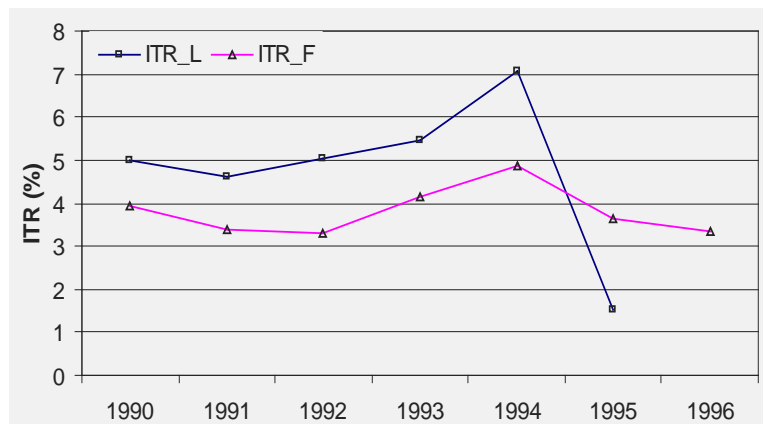
Figure 3. Standard deviation of the IT budget among all firms
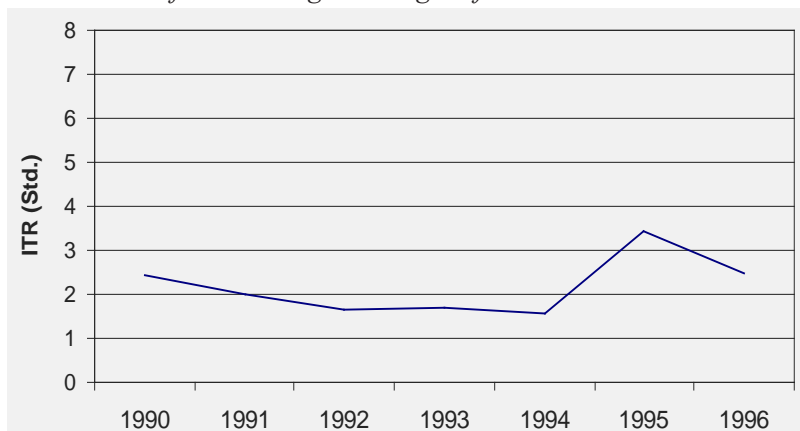
after 1995. This is consistent with the IT budget pattern in Figure 2.

Empirical Model

The following linear regression model is used to test our hypotheses. We chose the linear function form to model the effects of various independent variables not only for its simplicity, but also due to the lack of a compelling theoretical basis for alternative functional forms.

$$ITR_t = a_0 + a_1 ITR_{t-1} + a_2 SHA_{t-1} + a_3 AST_{t-1} +$$
$$a_4 ROA_{t-1} + a_5 ITG_{t-1} + a_6 ITL_{t-1} + a_7 D + e$$

(1) where:

ITR_t = IT budget as a percentage of revenue in year t;

ITR_{t-1} = IT budget as a percentage of revenue in year t-1;

SHA_{t-1} = Market share of the firm in year t-1, calculated as percentage of the sales of the firm to the total sales of all firms with the same two-digit SIC code;

AST_{t-1} = Total asset of the firm in year t-1;

ROA_{t-1} = Return-on-asset of the firm in year t-1;

ITG_{t-1} = Market segment IT budget influence, in terms of the mean ITR of all firms with the same two-digit SIC code in year t-1;

ITL_{t-1} = Market leader IT budget influence, in terms of the mean ITR of all firms with the same two-digit SIC code identified as IT leaders year t-1;

D = Dummy variables, representing the effect of time over the period of 1991-1996.

Table 2 shows the relationships between the variables in the regression model and the hypotheses to be tested. Market share (SHA) and total assets (AST) were included in the regression model as control variables to control the effect of firm size. Dummy variables for time periods were used to control the effect of time trend. A 1-year time lag was introduced to strengthen the causal implications of the research hypotheses.

Results and Analyses

Three separate statistical analyses were performed, using the data sets described previously, based on the number of institutional factors considered. The first test included only the market segment influence (ITG), along with ITR and all the financial factors. The second test included only the market leader influence (ITL), along with ITR and all the financial factors. And the last test was conducted using the full model specification as defined in equation (1). The results of these tests are presented in Tables 3 to 5.

First, the F values of all three tests are highly significant. Each of the models explains more than 75% of the total variance in ITR, indicating a good fit. Second, hypothesis H_1 is strongly supported in all three models, indicating that to a large degree, firms in our sample determine their future IT budgeting based on the cue of prior budget figures. This finding is consistent with that of Kobelsky et al. (2002). However, hypothesis H_2 is not supported in any of the models due to the insignificance of the coefficients of ROA_{t-1}.

Table 2. Relationships between regression variables and hypotheses

Regression Variable	Associated Hypothesis	Expected Result
ITR_{t-1}	H_1	Positive and significant
ROA_{t-1}	H_2	Positive and significant
ITG_{t-1}	H_3	Positive and significant
ITL_{t-1}	H_4	Positive and significant
SHA_{t-1}, AST_{t-1}, D	Control variables	N/A

This shows that firm financial performance, in terms of ROA of the previous year, has little or no effect on the current year IT budget, at least for our sample. This result seemingly contradicts the findings of Hu and Plant (2001) and Kobelsky et al. (2002), using the same data source, that is, better performance in prior years leads to higher IT spending in the subsequent years. A closer examination reveals there are some major differences between these studies. For instance, both Hu and Plant (2001) and Kobelsky et al. (2002) used multi-industry cross-section data, while the current study focuses on the financial sector. Furthermore, different financial measures were used in these two studies: ROA in the current study, the change of ROA in Hu and Plant (2001), and earning/sales ratio in Kobelsky et al. (2002).

The relatively small sample size of the current study makes it difficult to argue strongly against the findings of previous studies.

Third, the test results for institutional influences are mixed. Tables 3 through 5 show that hypothesis H_3 is not supported (ITG_{t-1} is insignificant) but H_4 is supported (ITL_{t-1} is significant). This indicates that successful companies have a much stronger influence than rival peers on the IT budgeting behavior of individual firms. Thus, mimetic influence is a much stronger institutional force than normative influence in the formation of the isomorphic ITR pattern of firm IT budgeting behavior. The strong "leader influence" has been found in other institutional studies. For instance, when studying the diversification patterns of the savings and loans industry, Haveman (1993)

Table 3. Regression with only market segment influence

Variable	Coefficient Est.	t-value	Pr > |t|
Intercept	1.2467 *	1.68	0.0997
ITR_{t-1}	0.7170***	10.18	<.0001
SHA_{t-1}	0.1257 **	2.39	0.0212
AST_{t-1}	-0.0681	-1.17	0.2478
ROA_{t-1}	-0.0324	-0.89	0.3787
ITG_{t-1}	0.2030	1.42	0.1613
D9192	0.1976*	1.83	0.0737
D9293	0.4665***	3.83	0.0004
D9394	0.2238*	1.85	0.0707
D9495	0.1591	0.83	0.4129
D9596	0.1413	0.81	0.4242
F = 18.82 ***	Pr > F <.0001	$R^2 = 0.8036$	Adj. $R^2 = 0.7609$

Table 4. Regression with only leader influence

Variable	Coefficient Est.	t-value	Pr > |t|
Intercept	1.4115**	2.02	0.0491
ITR_{t-1}	0.7236***	11.95	<.0001
SHA_{t-1}	0.1715**	3.13	0.0031
AST_{t-1}	-0.0981*	-1.74	0.0890
ROA_{t-1}	-0.0220	-0.63	0.5314
ITL_{t-1}	0.3749**	2.54	0.0147
D9192	0.2230***	2.14	0.0373
D9293	0.4414	3.79	0.0004
D9394	0.2177	1.88	0.6620
D9495	0.1064	0.57	0.5699
D9596	0.5608**	2.33	0.0243
F = 20.97***	Pr > F <.0001	$R^2 = 0.8201$	Adj. $R^2 = 0.7810$

Table 5. Regression with both group and leader influences

Variable	Coefficient Est.	t-value	Pr > |t|
Intercept	1.4417*	1.99	0.0526
ITR_{t-1}	0.7293***	10.66	<.0001
SHA_{t-1}	0.1729**	30.9	0.0034
AST_{t-1}	-0.1005*	-1.72	0.0926
ROA_{t-1}	-0.0210	-0.59	0.5601
ITG_{t-1}	-0.0337	-0.19	0.8524
ITL_{t-1}	0.3984**	2.04	0.0472
D9192	0.2226**	2.12	0.0398
D9293	0.4384***	3.69	0.0006
D9394	0.2185*	1.87	0.0683
D9495	0.1068	0.57	0.5726
D9596	0.5850**	2.12	0.0394
F = 18.67 ***	Pr > F <.0001	R^2 = 0.8202	Adj. R^2 = 0.7763

Table 6. Summary of hypothesis testing

Hypothesis	Test Result	Remarks
H_1	Supported	Previous IT budget has a strong effect on the current IT budget of a firm.
H_2	Not Supported	Previous financial performance has no significant effect on the current IT budget of a firm.
H_3	Not Supported	Previous IT budgets of peer firms have no significant effect on the current IT budget of a firm.
H_4	Supported	Previous IT budgets of perceived industry leaders has a strong effect on the current IT budget of a firm

finds evidence of firms imitating the decisions of profitable firms and no evidence of firms imitating the decision of other firms similar in size. Table 6 summarizes the result of the empirical tests of the hypotheses.

CONCLUSION

In this study, we attempt to answer the question of what influences the IT budgeting process of firms and the levels of IT investments. We examine the issue of IT budgeting from two different, yet complementary, perspectives: internal affordability and external institutional influences. This approach departs significantly from the conventional IT value propositions. Using firm-level IT and financial data of the financial sector (SIC 60xx – 63xx) from 1990 to 1996, we found that both

internal affordability and institutional influences are significant determinants in firm IT budgeting processes. Internal affordability dictates that a firm determines its current IT budget based on its financial performance and previous year's IT investment experience. Institutional influences imply that a firms' current IT budget level follows that of perceived successful firms, a typical behavior predicated by institutional theory when the outcome of the IT spending is often ambiguous at best. Under such circumstances, annual IT budgeting becomes an organizational routine and structured into the institutional myths.

This study offers some significant implications for both practicing managers and academic researchers. To managers, this study suggests that they should consciously avoid being carried away by institutional pressures to "follow the leaders," and professional norms to "do the right thing"

when deciding their own IT budget. Furthermore, by no means do the findings of this study imply that IT investments no longer contribute to the competitive advantage of firms in any circumstances. On the contrary, we believe this study challenges managers to make a concerted effort to identify areas that might have better payoffs from IT investments in their unique competitive environment. Managers should determine their IT investment needs based on the vision and the strategies of the entire organization (Curley, 2006; Hu & Huang 2006).

For academic research, we believe the finding of institutionalization of IT budgeting processes has two important implications. First, it reiterates the call by Orlikowski and Barley (2001) for more studies applying the institutional theory to IT-related research in order to gain more insight into the social and political aspects of technology use in firms. Second, since the causal ambiguity of IT investments is likely the main source of the institutionalization of IT budgeting, more robust theories are needed for evaluating the impact of IT on firm performance in general. The usefulness and validity of such evaluation systems, however, hinge on the better understanding of the value of IT to organizations and businesses. Unfortunately this is far from clear and still the subject of considerable debate in both academic literature and management practices (Brynjolfsson & Hitt, 2000; Carr, 2003; *Economist*, 2003; Melville et al., 2004; Wade & Hulland, 2004).

Finally, the following caveats should be considered. Since our research is limited to the financial sector (banks, financial services, and insurance firms), the impact of institutional influence identified by this study may or may not be as evident or significant in other sectors. Another consideration is that the institutional environment where financial firms operate might be different from those of other sectors. One may argue that the financial sector is more institutionalized than other sectors because of regulations and traditions. However, if it is true, the institutional environment in the

financial sector tends to have a more significant effect on the coercive mechanism than the mimetic or normative mechanism. Since this study focuses on the mimetic and normative institutional effects, we argue that the findings should not be materially impacted by this limitation. Nonetheless, the role of coercive forces in the IT budgeting process is certainly an interesting topic for future research. Finally, the relatively small sample size might limit the generalizability of the results. In the future, we plan to address these limitations by expanding the number of industry segments to include more competitive and innovative industries such as IT, automobile, retail, and consumer products.

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Chapter XVII
A Metadata Model and Related Framework for Unstructured Document Management in Organizations

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ABSTRACT

Effectively managing documents is a strategic requirement for every organization. Available Document Management Systems (DMS) often lack effective functions for automatic document management. One reason is that relevant information frequently is conveyed by unstructured documents, whose content cannot be easily accessed and processed by applications.
This article proposes a metadata model, the DMSML (Document Management and Sharing Markup Language), to enable and to ease unstructured document management by supporting the design of DMSs. We argue that the extensive use of this metadata language will render organizational information explicit, promoting information reuse and interoperability, in a more profitable way than what is guaranteed by proprietary DMSs. We also describe the DMSML Framework, a set of tools that we have developed in order to ease DMS design and deployment. Finally, we briefly depict the design and deployment phases of a Web-based DMS prototype based on the DMSML Framework.

INTRODUCTION

document management (DM) is the scientific domain dealing with the use of ICTs for the effective "storage, organization, transmission, retrieval, manipulation, update and eventual disposition of documents to fulfill an organizational purpose" (Sprague, 1995, p. 32). Existing ICT-based DM solutions, hereafter called document management systems (DMS), do not completely fulfill the expectations of providing enough effective tools for information creation, sharing and retrieval inside an organization, often causing user frustration, dissatisfaction and inefficiencies (Ginsburg, 2001).

A typical situation that creates problems in many organizations is the management of unstructured documents, that often convey an important amount of information and knowledge (Chakravarthy, 2006a; Blumberg, 2003; Andric, 2005); due to their lack of structure, these documents cannot be easily and effectively accessed and processed by applications, thus limiting effective document management. As a consequence, members of organizations have difficulty retrieving the information contained in these by documents. Moreover, existing DMSs seldom are designed according to a general and/or standard methodological approach and are built around open data and process models. Thus, related disadvantages are vendor dependence, difficult maintenance and poor interoperability with other information systems (Stickler, 2001; Schandl, 2006).

In order to deal with these issues, we propose in this article a metadata model, enabling the design of DMSs and aiming at combining the benefits of metadata for document description with the use of Web standards. The metadata language described in this work has been named DMSML (document management and sharing markup language). DMSML offers a solution to representing a set of document properties that are relevant to document management and to rendering business and organizational information explicit in a way that promotes reuse, user-driven extensibility, and interoperability with heterogeneous systems. A Web-based prototype developed according to DMSML specifications will help make the theoretical arguments presented throughout this article concrete.

This article is organized as follows: initially, some considerations on the management of unstructured documents are made in order to point out which relevant characteristics of an unstructured document are worth being described in order to improve its efficient management (its *content* and *context of use*). Then, an example of a typical document frequently managed in many types of organizations, the *project proposal*, will sustain what is said from a general perspective. The following paragraphs will be devoted to the analytical description of the requirements for high-quality DMSs. The fulfillment of these requirements will be taken as the basis for the design of the metadata language (DMSML) as well as for the development of the Web-based DMS prototype presented in this work. Examples and comparative evaluation of available products—both commercial and open source—will show that meeting all of the aforementioned requirements is a characteristic satisfied by none of the presented products, to the best of our knowledge.

The central part of this article is aimed at describing (from a general point of view) the use of metadata for document management, illustrating the benefits of their usage in this domain. Existing metadata languages related to document management at the state of the art also will be recalled in this part of the article.

In the sequel, the DMSML metadata specification will be described, highlighting its fulfillment of high-level requirements. DMSML will be proposed as a declarative language for the specification of DMSs, based on existing standards and on a rigorous modeling approach. Metadata modeling, using proper formal representation techniques, then will be illustrated. The advantage of using DMSML for DMS design and development will be described in the related paragraph.

Finally, the DMSML framework prototype for DMS design and deployment will be described in its functional components and implementative details. Using these arguments, we demonstrate that the extensive use of this metadata language in document management systems will help to exploit business and organizational information in a more profitable way than what is guaranteed by proprietary document management applications, because the knowledge (properly codified through a metadata language) will allow both human and machine readability and, consequently, more effective reusability.

MANAGEMENT OF UNSTRUCTURED DOCUMENTS

Unstructured documents are text and multimedia documents such as e-mails, reports, and so forth, stored in various formats that do not provide an explicit, formal, and separate representation of either content structure (also called logical structure) or presentation structure (physical structure). Often, these are encoded in proprietary and binary formats. For instance, a project proposal has a logical structure, because it is organized in a specific set of fields: project title, objectives, activity plan, business plan, and so forth. It also has a physical structure related to presentation instructions; for instance, a project title should be rendered in bold, centered, font size 14.

In unstructured formats, this information usually is blended and cannot be easily and/or automatically extracted and processed by applications. As a consequence, applications do not have explicit references to specific elements of the content, thus preventing automatic document processing and leading to poor interoperability among applications. Currently, effective indexing, retrieval, and processing would require the system to access document content with a degree of granularity, which cannot be provided by unstructured document formats.

As a matter of fact, collaboration among colleagues can be slowed down dramatically by factors such as the use of different word processing applications and graphical and CAD tools. This dramatically compromises the quality of information reuse and sharing in organizations. It is important to highlight that organizational information not only refers to document content but also to its context of use. With the term *context of use* of a document, we hence refer to by whom, where, how, under which constraints, and for which purpose a document is being accessed, transmitted, and modified (Gilliland-Swetland, 2000; Päivärinta, 2001). For instance, a project proposal document contains a set of information that is strategic in the accomplishment of organizational goals (e.g., objectives and planned activities for innovation in terms of products, processes, and/or services), but it also refers to a set of organizational information that describes its context of use. This kind of information is related strictly to organizational processes, roles, and responsibilities. Usually, business information, such as access right policies and document lifecycle descriptions, is encoded in the application logic of a DMS. In most commercial products, this information is specified in proprietary formats and cannot be reused by other systems. On the other hand, many open source solutions are based on open standards, but the organizational information is encoded in a technology-dependent way. As a consequence, the reuse or extension of this business information and the migration to new technologies can be a difficult process requiring high technical expertise, time, and resources.

EXAMPLE OF A TYPICAL DOCUMENT TO BE MANAGED: A "PROJECT PROPOSAL"

To clarify the benefits of metadata usage for document management, we describe through this example the characteristics of a common type of

document, which is relevant in private as well as academic domains—the project proposal.

In a generic organization, a typical process of project proposal editing can envisage different steps toward the completion of the document. A heterogeneous group of persons can participate in this process, including administrative staff, technical experts, marketing staff, external consultants, and so forth. Different responsibilities then will be assigned to each person according to his or her skills and organizational role.

Possible steps in project proposal editing are:

- Editing an abstract, describing the main objectives of the future project.
- Edition of the project proposal, usually according to a pre-defined document template; in this phase actors can collaboratively edit the document.

While undergoing these phases, the project proposal passes through different "states" such as: draft document, document under review, document under revision, final proposal and submitted document. The transition between states is regulated by actions operated by persons with specified roles; for instance the transition among *document under review* and *final* is conditioned by the approval of the person in charge of the project (e.g., a project manager).

According to what is illustrated in this example, it becomes evident that a lot of strategic information needs to be codified and shared among the actors in order to execute the overall process. The organizational information related to the documents' context of use usually refers to the definition of roles in the organizational schema, access control policies and lifecycle of documents. In order to speed up the process of project proposal editing, this information should be conveniently formalized and made available to the involved actors. Moreover, it should be available after the process completion, in order to formalize the

practice and make this experience available to other colleagues for future activities, such as the editing of another project proposal.

REQUIREMENTS FOR DOCUMENT MANAGEMENT SYSTEMS

The main critical issues concerning unstructured document management can thus be summarized in terms of poor reuse of content and context of use business information. These considerations provide hints for the definition of the general requirements that DMS should fulfill in order to enable effective document management:

- **Standard compliance:** The adoption of international widely accepted standards promotes interoperability among heterogeneous information systems and data sources. Standard compliance includes technological as well as business standards. Examples of technological standards are the extensible markup language (XML) (Sall, K. B., 2002) and J2EE (Java 2 Enterprise Edition) (Sun Microsystems, 2003). With the term *business standard* we refer to the specifications related to business information describing documents' context of use. Examples of business standards are: business process definition languages, such as the XML process definition language (XPDL) (Workflow Management Coalition, 2005), the petri net markup language (PNML) (Weber & Kindler, 2002; Billington, 2003), and access right policy languages, such as the extensible access control markup language (XACML) (OASIS, 2006).
- **Multi-platform compatibility and support** (Stickler, 2001). A DMS solution should be deployable on different platforms, in order to avoid monolithic and vendor-dependent solutions. Moreover, support of several platforms enables interoperability among heterogeneous information systems and fa-

cilitates the integration with existing legacy systems in the organization (e.g. http server, mail server, etc.).

• **Metadata-based approach for the representation of document properties** (Karjalainen et al., 2000; Murphy, 1998; Päivärinta, 2001; Salminen et al., 2000): Metadata are data about data. They provide an explicit representation in a human- and machine-understandable format of document properties. Traditionally, metadata are used in order to represent descriptive properties (i.e. title, author, keywords, etc.) of information resources, in order to support document classification, search and retrieval (Gilliland-Swetland, 2000). An example of descriptive metadata is the Dublin Core (DC) specification (Dublin Core Metadata Initiative, 2006). Moreover, metadata could be conveniently used to describe the document's context of use. In this way, business information, such as document lifecycle (Krishna, 2004) and access policies, can be specified by abstracting it from implementation details. For instance, the above-mentioned business standards (e.g., XPDL, PNML and XACML) provide a meta-language making it possible to describe organizational processes by means of standardized labels (e.g., activity, task, actor).

• **A standard methodological approach:** It should be followed for the design and development of a DMS, rather than a tool-oriented approach (Stickler, 2001). In fact, a methodological approach based on standard models and methods for DMS design and development can facilitate the formalization of user requirements, fast prototyping, and deployment of a high-quality product, accomplishing the formalized requirements. Moreover, a standard methodological approach for the design of an effective DMS should conveniently promote the accomplishment of the previous requirements (i.e., standard compliance, multi-platform compatibility

and support, metadata-based approach), by including proper design and development methods and techniques.

The fulfillment of these requirements can lead to an effective, easily maintainable, flexible and cost effective solution for document management.

Existing document management Systems

At present, several commercial and open source DMSs are available. Among the commercial products, the most important solutions in terms of market diffusion in the domain of document management are: Documentum, FatWire, IBM, Interwoven, Microsoft[1] (Moore & Markham, 2002). Among the open source products, Zope Content Management Framework, OpenCMS, Apache Lenya, and open source solutions for Digital Libraries, such as DSpace, and Marian[2], deserve to be mentioned. A comparison of some of these products, with respect to their provided features, is provided by Moore and Markham (2002).

For the purpose of this article, we will evaluate some of these products according to their compliance with the previously mentioned requirements for DMS: standard compliance, multi-platform compatibility and support, metadata-based approach and use of a standard methodological approach. The analysis synthesized in Table 1 refers to two commercial products, FatWire Content Server and Documentum, and three open source products: Apache Lenya, DSpace and Marian.

The analysis of these products highlights that the compliance with technical standards and multiplatform compatibility are requirements commonly understood and addressed by means of wide adoption of industrial standards, such as XML and related standards (Sall, K. B., 2002), LDAP (lightweight directory access protocol) (Yeong et al., 1993), SOAP (simple object access

Table 1. DMSs evaluation results (***= good ** = sufficient * = insufficient compliance level with requirements for document management systems, - = No publicly available information)

Requirements	Open Standards Compliance		Multi-platform support	Metadata-based approach		Open and standard methodological approach	
Products	**Technical standards**	**Business standards**		**Content**	**Context of use**	**Data model**	**Method**
FatWire	*** LDAP, XML, SOAP and Internet protocols	-	*** J2EE compliant	-	-	* Object model	-
Documentum	*** LDAP, XML, SOAP and Internet protocols	-	*** J2EE compliant	-	-	* Object - relational model.	-
Lenya	*** LDAP, XML and Internet protocols	* No standards for lifecycle and access policy.	*** J2EE compliant	*** Dublin Core compliant	* Dublin Core compliant	** Open data model	-
DSpace	** Internet protocols	* No standards for lifecycle and access policy	** It runs only on UNIX and Linux OSs	*** Dublin Core compliant	* Partial compliance with Dublin Core	** Open relational data model	-
MARIAN	*** Internet protocols and XML	* No standards for lifecycle and access policy	*** Thanks to java code portability	*** It is compliant to USMARC and DC	* It is compliant to USMARC and Dublin Core	** Open data model	*** The study of a standard method is in progress·

protocol) (Mitra, 2003), J2EE and Internet protocols, such as HTTP (hypertext transfer protocol) and FTP (file transfer protocol). On the other hand, compliance with business standards is partially accomplished. As a matter of fact, while descriptive metadata standards are often used in open source solutions (e.g., Dublin Core), metadata standards for lifecycle and access policy descriptions rarely are used. Moreover, only MARIAN is associated to an open and standard methodological approach for the design and development of the product tailored to the requirements of a specific organization (Gonçalves et al., 2004). The discussion on commercial products is limited by the lack of

documentation about some requirements (business standard compliance and metadata-based approach). The overall remark of this analysis is that these products do not completely address the above-mentioned high-level requirements for DMSs.

Research Directions in document management

The research in document management, as a discipline which encompasses social and organizational issues, user needs and potentially utilizes several technologies in an organizational context, is still in its infancy. The work of Sprague (1995) paves the way towards a systemic view of electronic document management, which should integrate three perspectives of analysis of document management: *technologies* for document management, *benefits* for the application areas for which documents are mission-critical, and *roles and responsibilities* of the organization's departments and functions for which EDM will be strategic. Based on this seminal contribution, Päivärinta (2001) proposes a method for the requirements analysis for DMS design, based on the use of metadata and the genre theory of organizational communication (Yates & Orlikowski, 1992).

The use of metadata, together with markup languages and formal information models is widely recognized as a basic mechanism for DMS design (Murphy, 1998; Murray, 1996; Salminen et al., 2000). A more implementation-oriented approach is discussed in (Ginsburg, 2000; Ginsburg, 2001), providing practical guidelines for the design of DMS, such as the use of metadata, mechanisms of coordination between authors and readers and ontology building. However, this contribution does not aim to define a methodological approach for design, development and deployment of DMSs supported by standard modeling methods and techniques.

METADATA FOR DOCUMENT MANAGEMENT

Benefits of Metadata for document management

As mentioned in previous sections, metadata allow the representation of information resource relevant properties in a human and machine-understandable way. Especially in case of unstructured document management, metadata are the mechanisms enabling the representation of document content and context of use properties in an explicit and formal way. Metadata can provide a solution to the opacity of unstructured documents (Ginsburg, 2001), allowing a machine-processable representation of document-relevant information.

At present, metadata are used in organizations to describe unstructured documents, beyond those used for highly structured information (e.g. databases): for instance, the properties for word-processed documents, the metadata contained in the header records of e-mail messages and directories of reusable software objects, and used in the indexes of digital image management and manual record retention systems (Murphy, 1998). Murphy (1998) states that metadata in organizations generally lack the centralized or controlled aspect that metadata have in application domains such as digital libraries or Web communities, and consequently, they are not exploitable enough in information sharing, organizational learning, or knowledge management. As far as we know, this situation has not changed for many years. Moreover, while several standardization efforts exist for digital libraries, Web communities and other application domains, standard metadata models in document management are still lacking.

State of the Art

Several metadata sets have been proposed by research communities and/or industrial consortia in order to provide a standard way to describe and

manage information resources. Most metadata standards belong to the following categories:

- **Description of information resources:** These standards provide metadata for the description and identification of information resources. Examples are Dublin Core (Dublin Core Metadata Initiative, 2003), which is a standard for library information items, and also suitable for application to generic information objects; and MPEG-7 (Manjunathn et al., 2002) for multimedia content.
- **Specific functions of information management:** Some of the following metadata standards cover specific issues related to the management of information resources: XPDL and PNML standards for business process description, extensible access control markup language (XACML) for the description of access right policies, Common Warehouse MetaModel, CWM (Object Management Group, 2001) for Data warehouses, ISO 15489 (International Organization for Standardization, 2001) for record management, just to mention a few.
- **Specific application domains:** There are several standard propositions for specific application domains, such as USMARC for Digital libraries (Crawford, 1989), IMS (IMS Global Learning Consortium, 2003) for e-learning and IEC 82045 (International Electrotechnical Commission, 2001) for management of technical documents.

From this classification, no existing metadata specifications are focused purposely on document management. The single exception is represented by the IEC 82045 specification, which, however, is focused on technical document management.

Some existing standard specifications could be conveniently adapted and integrated in order to represent document properties in organizations (Päivärinta et al., 2002). For instance, Dublin Core (DC), one of the most widely adopted metadata

standards for information item description, offers generic descriptive labels, which could be used to describe content-related properties of documents in organizations. The DC element set provides 15 labels: *Coverage, Creator, Date, Description, Format, Language, Other Contributors, Publisher, Relation, Resource Identifier, Resource Type, Rights Management, Source, Subject, Title*. Most of them are meaningful in an organizational context. An exception is certainly provided by the label *Publisher*, which is tied to the author-title-publisher model, traditionally applicable to documentation that is made publicly available (e.g. books, journals, etc.). This model is not always applicable to organizational documents, as the volume of internal use documents largely exceeds documents from external sources (Murphy, 1998). Obviously, a special case is provided by those kinds of organizations (e.g. publishing companies) that produce material that should be made available for public distribution. In general, a document is described more usefully through its states, such as *draft*, *authorized*, *signed*, declaring the evolution of the document during its lifecycle, but not necessarily by condition of public distribution of the resource. The example of the document *project proposal*, illustrated in a previous paragraph, clearly highlights what was stated before. As already mentioned, a metadata model that is useful for document management should include the description of the organizational context (i.e., the lifecycle model of the documents) and its relation with organizational processes, roles and responsibilities (Salminen et al., 2000).

Many standardization efforts exist in the domain of record management, such as the ISO 15849 international standard (International Organization for Standardization, 2001). A Record "is evidence of an activity or decision and demonstrates accountability" (Public Record Office, 2001, p.7). Records are documents (both structured and unstructured), whose management requires a rigorous process (Emery, 2003). While a document management system is focused on knowledge

sharing and collaboration capabilities which can be promoted by using a document repository, a record management system is focused more on maintaining a repository of evidence that can be used to document events related to statutory, regulatory, fiscal, or historical activities within an organization (Emery, 2003).

DOCUMENT MANAGEMENT AND SHARING MARKUP LANGUAGE

This article aims to propose a metadata model, named document management and sharing markup language (DMSML). DMSML represents document properties that are relevant for document management and enable the design of Web-based DMSs in a way that promotes the reuse of content and context of use information conveyed by unstructured documents for organizational purposes. In the following section we describe the high-level requirements for DMSML metadata specification and the modeling approach that we have adopted.

DMSML Metadata Specification

Specification of metadata elements should guarantee that metadata are representative and relevant properties of documents. In order to decide which properties are representative and relevant for our needs, some high-level requirements are defined. Although these guidelines drove the specification process of DMSML, they are generally applicable to metadata specification in other application domains.

High-Level Requirements for DMSML Specification

The high-level requirements that we identified for the specification of DMSML are: generality, extensibility and interoperability.

- **Generality:** The metadata model should be applicable to document management for organizations in any application domain (e.g., public administration, construction, software and services businesses, etc.). General commonly sharable and widely adopted labels should be selected. An example of fulfillment of generality is the choice to label as *creator* the person who created a document, instead of *journalist* or *writer*, which carries the significance of a specific application domain.
- **Extensibility:** Since DMSML cannot contain specific labels tailored to any application domain, it will allow the extension of its element set. Refinement of existing elements (e.g. substitution of the element "creator" with the element "journalist"), or the introduction of new elements should be allowed in order to deal with the requirements of specific application domains. Moreover, the extension of the metadata set should be driven by business requirements rather than technological choices.
- **Interoperability:** Interoperability is defined as "the ability of two or more systems or components to exchange information and to use the information that has been exchanged" (Institute of Electrical and Electronics Engineers, 1990). Two applications that are both DMSML-aware can exchange just the metadata or the metadata with the related document and be able to access and meaningfully process them.

DMSML is not a standard proposition, and interoperability based on DMSML-awareness may be limited, as long as the metadata set is not widely adopted. Furthermore, as mentioned above, some specific issues which are encompassed in the discipline of document management (e.g., information resource description, access management and business process) are addressed by existing standards. The adoption of some of these standards in the DMSML specification is an

effective way to promote interoperability and to create a comprehensive framework of document management metadata, by taking advantages of existing contributions.

Metadata Modeling

The use of proper formal representation techniques enables the unambiguous understanding of the concepts conveyed by the metadata elements in heterogeneous communities and promotes the metadata exchange across heterogeneous systems (Duval et al, 2002; Murray, 1996). Most metadata standards lack an accounting for underlying data modeling principles, thus not providing clear exposition of entities and relationships represented in metadata specification (Lagoze & Hunter, 2001). As suggested by several sources (Duval et al., 2002; Melnik & Decker, 2000), it is important to express in a formal and abstract way concepts and relationships embedded in the specification (i.e., the meaning or semantics), and to share strategies and rules for metadata encoding and implementation (syntax) for computer-supported serialization, exchange, access and manipulation of the metadata set.

Meaning and syntax should be kept as separate as possible, in order to allow agreement and adoption of the metadata set, independently from technological and implementation choices, which can vary over time.

In order to provide a rigorous formalization of the DMSML metadata model, we refer to two layers of data modeling, usually adopted in the traditional database design approach (Elmasri & Navathe, 2003).

1. **Conceptual layer:** This layer provides an abstract representation of concepts and relations among concepts, independent from implementation details and often by means of standard graphical notations. Conceptual models enable people with low technical expertise to understand meaning of data and

manipulate the data model and participate to the extension of DMSML for the specific purposes of their own organization; it thus encourages the transfer of business knowledge detained by the organization members to the DMSML metadata set. Conceptual UML class diagrams (Booch et al., 1998) are used in order to represent concepts and relationships underlying the DMSML metadata model.

2. **Logical layer:** The logical layer translates domain-related concepts and relationships in data constructs, which are expressed in a rigorous and standard logical data modeling paradigm. Logical models are used by database designers to translate concepts into database constructs. The traditional paradigms for logical data modeling are the relational and object-oriented models (Elmasri & Navathe, 2003). Our approach aims to benefit from the use of XML, which is at present the standard for data serialization and exchange. XML defines a generic syntax used to markup data in a text document, using simple and flexible tags. The grammar of XML documents can be defined by means of the XML Schema language, as proposed by the W3C in its March 2001 XML Schema Recommendation (Sall, 2002). An XML document which respects the grammar rules of its XML Schema is called a valid instance of that XML Schema. In our case, DMSML is an XML Schema which defines rules in order to represent document metadata and their values in an XML document.

DMSML BUILDING BLOCKS

After analyzing the role of documents in organizations, the content as well as the context of use are relevant properties of documents. DMSML is made of three building blocks: content-related properties are included in the Descriptive Infor-

mation Model, while context of use properties are expressed in the Collaboration and Lifecycle Models:

1. **Descriptive information model:** Contains the set of metadata that describes and identifies the document, such as title, author and subject.
2. **Collaboration model:** Formalizes how the human resources are structured (the organizational model) and how access to information resources is regulated (the access right policy) on the basis of organizational roles or responsibilities of individuals.
3. **Lifecycle model:** Specifies the lifecycle of the document. The document lifecycle usually consists of the following stages: creation, review, publication, access, archive and deletion. A specific lifecycle may not implement all these stages, or implement others. This depends on the characteristics of the document types in use in the organizations. For instance, a project proposal lifecycle is different from the lifecycle of an official communication, which should be conveyed to the personnel of the organization at the final stage of its life cycle (the document passes through the states draft, revised, final, and published).

DMSML also includes other concepts which represent the entities relevant for document management, such as the *Document*, which is the atomic unit of information that we consider; the *Folder*, which is a collection of documents; and the *Workspace*, which models the working environment and contains documents and folders. Each entity type may be described by specific labels of the DMSML model. In the following paragraphs we will show the conceptual views of the Descriptive Information, Collaboration and Lifecycle Model (Figures 1, 2 and 3), together with an example of metadata specification for our case study (a Project Proposal). Due to limitation of space, we provide an extract of the logical layer for the Descriptive Information Model (Figure 2). For more details, the DMSML model is fully presented in (Paganelli, 2004).

Descriptive Information Model

The Descriptive Information Model includes labels which provide description of information resources. It mostly includes static properties, which generally are used for search and indexing purposes (e.g., Title, Creator, Date, Description, Document Type, Subject, Contact, Affiliation), as described in Figure 1. These labels are general

Figure 1. DMSML – Descriptive information model, conceptual layer
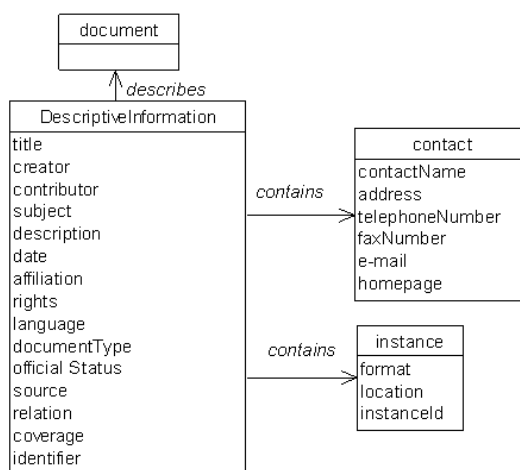
enough to be applied to any document type and any organization. A subset of these labels can be used to describe also the workspace and folder entities (e.g., Title, Creator and Description). DMSML can be extended in order to address the requirements of a specific organization by including descriptive elements which are tailored according to the specificities of a document type, organization or organizational unit. For instance, a scientific paper can be characterized by further elements, such as Abstract, Journal and Publisher, while a document of type *Contract* should be associated to descriptive elements such as Contract Type, Customer and Product. We chose to integrate the Dublin Core (DC) (Dublin Core Metadata Initiative, 2003) metadata set in the Descriptive Information Model, as it provides generic description labels and it is a widely adopted standard. In addition to the DC elements, DMSML provides labels which are specific to the organizational environment, for instance, *Contact* (e.g. mail, telephone number, etc.) and *Affiliation* (e.g. project, department, organizational unit, etc.).

This conceptual view is mapped into the XML Schema modeling primitives (see Figure 2) to provide the logical view of the model. Recalling the example of the project proposal mentioned above, Figure 3 shows an instance of descriptive DMSML metadata for a specific project proposal document.

Collaboration Model

Document sharing can be considered a specific instance of collaborative activities. During the stages of document lifecycle, the participants collaborate for the accomplishment of organizational purposes. In this context, the DMSML Collaboration Model is defined in terms of access policies assigned to the members of the organizational model, as shown in Figure 4. Access policies define the access rights to resources (Figure 4a). There are two dimensions related to permission assignment: a permission can be assigned to a specific employee or user (e.g., by means of a specific attribute, such as *name* or *identifier*), or

Figure 2. DMSML – Part of descriptive information model, logical layer

```xml
<?xml version="1.0" encoding="UTF-8"?>
   ...
   <xs:element name="document" type="DocumentType"/>
     <xs:complexType name="DocumentType">
       <xs:sequence>
         <xs:element name="description" type="DescriptionType"/>
       </xs:sequence>
     </xs:complexType>
     <xs:complexType name="DocumentDescriptionType">
       <xs:sequence>
         <xs:element ref="dc:title"/>
         <xs:element ref="dc:creator"/>
         <xs:element ref="dc:contributor"/>
         <xs:element ref="dc:subject"/>
         <xs:element ref="dc:description"/>
         <xs:element ref="dc:date"/>
         <xs:element ref="dc:rights"/>
         <xs:element ref="dc:language"/>
         <xs:element name="documentType" type="xs:string"/>
         <xs:element name="affiliation" type="xs:string"/>
         <xs:element name="contact" type="contactType"/>
         <xs:element name="identifier" type="xs:string"/>
                      .....
       </xs:sequence>
     </xs:complexType>
</xs:schema>
```

Compliance with *the Dublin Core (DC) metadata standard*

Figure 3. DMSML specification for a project proposal: Descriptive information model

```
<document>
        <title> Mobile Commerce Project Proposal </title>
        <creator> John Smith </creator>
        <contributor> Mark Johnson </contributor>
        <subject> wireless technologies, e-commerce </subject>
        <description> Proposal for Mobile Commerce services
                                            architecture</description>
        <date> 10/07/2004 </date>
        <rights> confidential</rights>
        <language> english</language>
        <documentType> Project Proposal</documentType>
        <affiliation> R&D Department </affiliation>
        <identifier> 0012223456</identifier>
        <contact>
        <contactName>John Smith</contactName>
        <address> my address  </address>
        <telephoneNumber> my telephone number </telephoneNumber>
        <faxNumber> my fax number </faxNumber>
        <e-mail> john.smith@mycompany.com </e-mail>
        <homepage> www.mycompany.com/johnsmith/ <homepage>
        </contact>

        .....
</document>
```

the policy can be specified in terms of organizational entities and roles, rather than to specific participants (e.g., by means of the *organizational role* attribute), according to the role-based access control (RBAC) strategy (Sandhu et al., 1996). We adopted the extensible access control markup language (XACML) (OASIS, 2006), allowing the description of access policies to information resources in an extensible and standard way.

Organizational models then map roles and organizational functions and units to individuals or groups (Figure 4b). DMSML includes an organization model that specifies the *organizational units*, *individuals* and related *organizational roles*. In order to satisfy changing requirements (e.g., the setup of a short-term project) it also may be extended to *groups* or *external entities* that are not institutional members of the organizational model but may be defined ad-hoc for specific purposes and have a short life. The DMSML organizational model can also be connected with already existing Directory Services, such as LDAP (Yeong et al., 1993), in order to synchronize common information.

For instance, an access policy can state that a project proposal can be accepted by a project manager of a specific organizational unit (Figure 5a). The organizational model makes it possible to associate these parameters (project manager, organizational unit name) to individuals' names or identifiers (Figure 5b). On the basis of this information a software application can decide if an end user has the permission to accept the project proposal.

Lifecycle Model

The document lifecycle is a *process* specified in terms of a sequence of *tasks*, performed by some *actors*, as shown in Figure 6. The execution of a *task* is usually triggered by a *transition* condition, which can be *automatic*, *time-dependent* (e.g., a deadline) or caused by a *user* action or by an *external event*, and it is associated to an evolution of the document state (e.g., from draft to under_review, to final, or under_revision). The DMSML model easily can be mapped to the Petri Net Markup

Figure 4. DMSML – Collaboration model, Conceptual Layer

a. Access Policy   b. Organizational Model
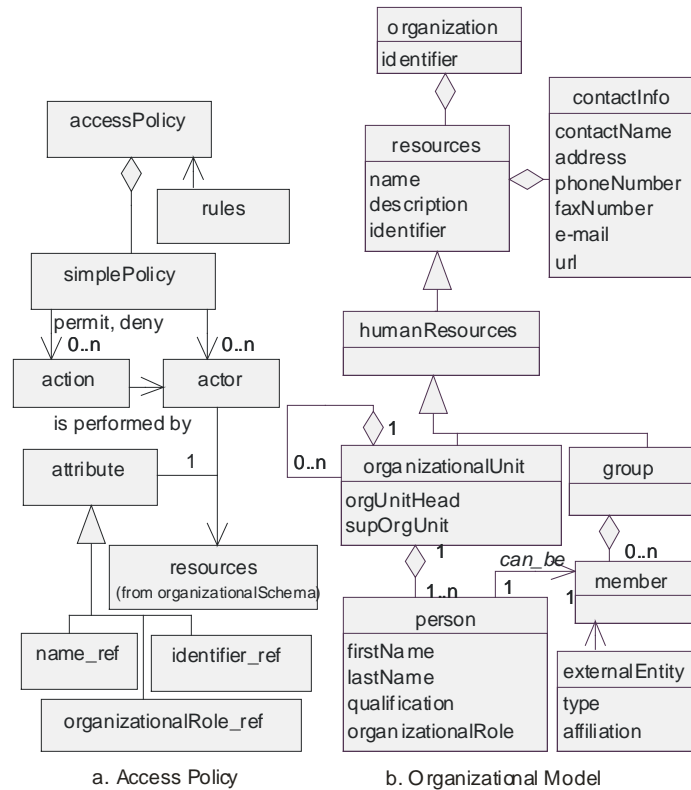
Language (Weber & Kindler, 2002), which is a standard proposition for an XML-based format of Petri Nets, by means of XSL Transformations (Sall, 2002). DMSML can thus benefit from the use of the Petri Net process model, which has been proposed as a conceptual standard for the modeling and analysis of processes, thanks to its formal semantics, graphic notation, expressiveness and abundance of analysis techniques.

For the sake of clarity, Figure 7a shows the lifecycle description for a project proposal document in the graphical Petri Net notation. Circles represent the states of documents (or places in the Petri Net language) and rectangles represent the transitions from one state to another. The lifecycle of the document is built upon the concatenation of these states and transitions. Figure 7b shows a part of the XML document, describing the project proposal lifecycle in the DMSML language.

DMSML BENEFITS FOR DMS DESIGN AND DEVELOPMENT

DMSML represents a comprehensive metadata model that encompasses content- and context of use document properties. DMSML has been designed with the traditional metadata-design principles of generality, extensibility, and interoperability in mind and aims to address document management requirements with which, to the state of our knowledge, existing metadata standards do not deal. As a matter of fact, DMSML contains labels that are applicable to any document type. Thanks to the standard extension mechanisms provided by XML and XML Schema, the DMSML specification can be extended in order to deal with specific requirements. Interoperability is promoted by compliance with existing standards: Dublin Core, XACML and PNML.

Figure 5. DMSML specification for a project proposal: Collaboration model

a.Access Policy   b.Organizational Model
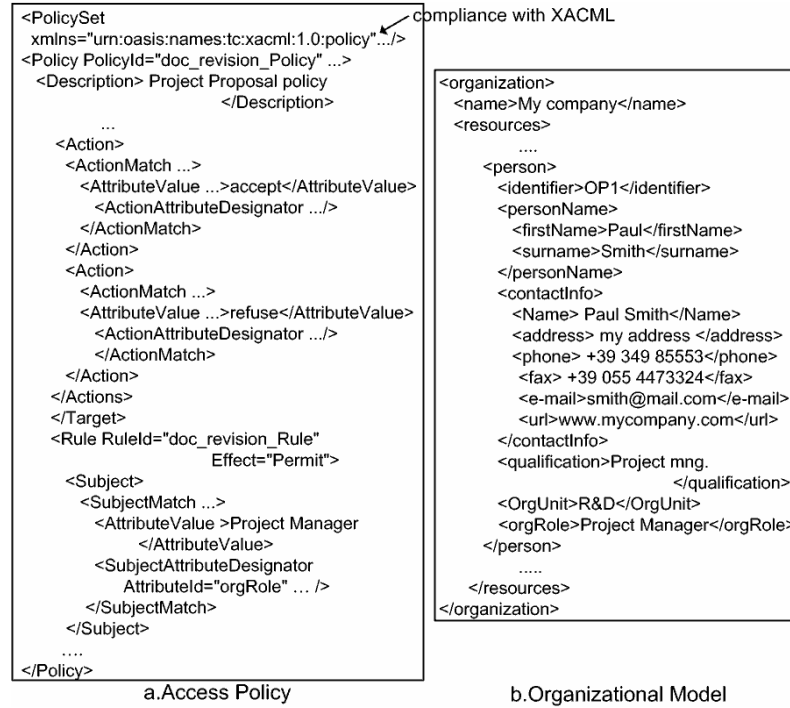
Figure 6. DMSML – Lifecycle model, Conceptual Layer.
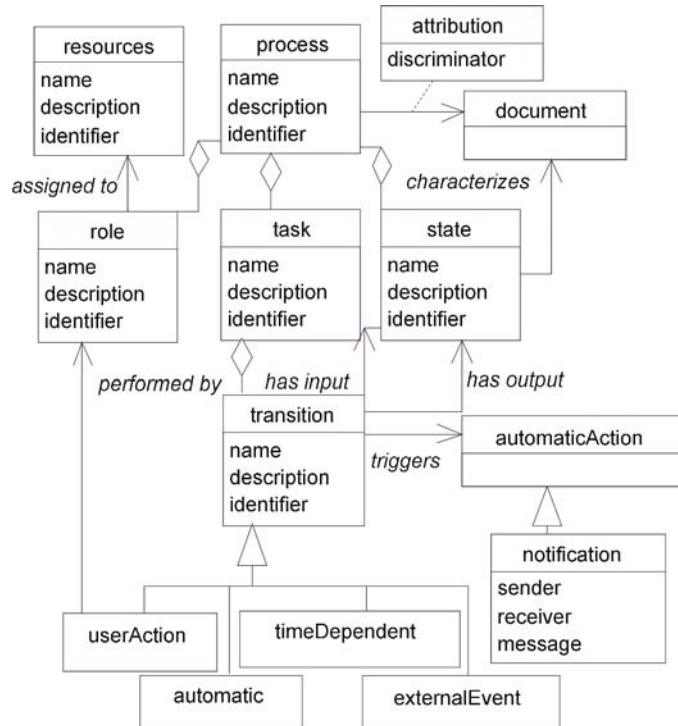
Figure 7. DMSML specification for a project proposal: Lifecycle model
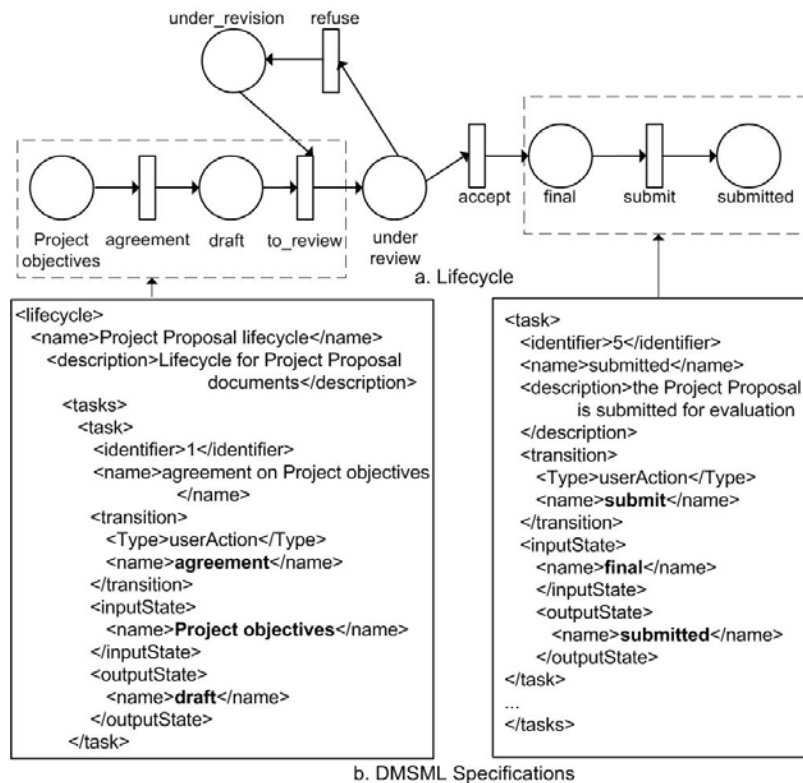
DMSML is a language that enables one to define open data and process models for the design, development and operation of a DMS, by means of a metadata based-approach. More specifically, DMSML enables the specification of functional requirements and their representation in an XML document, for the design and deployment of a document management system. The DMSML provides XML elements to describe the configuration of the workspace, the folder structure, to create or import a document resource classification schema, and to specify the lifecycle and the access policies assigned to single documents or on a document type basis. While generally most of these specifications are embedded in proprietary workflow engines or collaborative applications, DMSML provides a comprehensive framework which enables one to configure a DMS based on a declarative approach, minimizing the need

for new code when the configuration needs to be modified. Thanks to its modeling principles, DMSML facilitates the understanding of the metadata meaning and enables communication among heterogeneous communities. In such a way, business knowledge can be effectively exploited for the extension of DMSML metadata in a specific case. In order to validate the DMSML-driven method for DMS design and deployment and provide some tools to support the DMSML methodological approach, we are developing a DMSML Framework prototype.

DMSML FRAMEWORK PROTOTYPE

The DMSML Framework prototype provides the user with automated support for adaptation and use of the metadata set, and the design, deployment and

maintenance of a document management system. The DMSML framework consists of three parts: a DMS Configurator, a DMS Engine and a DMS Web Application, as shown in Figure 8.

DMS Configurator

The DMS Configurator will be used by a sort of super-user (e.g., a system administrator), because its usage corresponds to the DMS specification and installation phase. This installation process is crucial for the definition of an instantiation of DMSML-based document containing all information relevant to the proper document management of the specific organization. To this extent, the DMS Configurator acts through a wizard which will guide the user through the configuration of a DMS Web Application according to organization requirements. The Configurator application provides a sequence of interfaces that progressively guides the user through the definition of the workspace, the organizational schema and the structure of folders. The end user can specify a set of lifecycle templates and access policies, to be assigned to documents or document types.

The DMSML instance thus created (DMSML specifications, containing business and organizational information, such as organizational schemas and access policies) then will be processed by the DMS Engine.

DMS Engine

The DMS Engine is a Web-based application that enables the user accessing a standard Web browser to deploy a DMS that is customized according to the specifications encoded in the DMSML instance document. Again, the end-user of this component of the prototype is a technical person or a system administrator.

Based on the features of the DMSML model, the DMS Engine enables a completely declarative approach for the design and deployment of an ad-hoc document management system based on the specifications expressed in the DMSML instance. As shown in Figure 8, the declarative specifications in DMSML then are fed into the DMS Engine to produce tailored document management systems. These are built upon a collection

Figure 8. DMSML framework prototype architecture
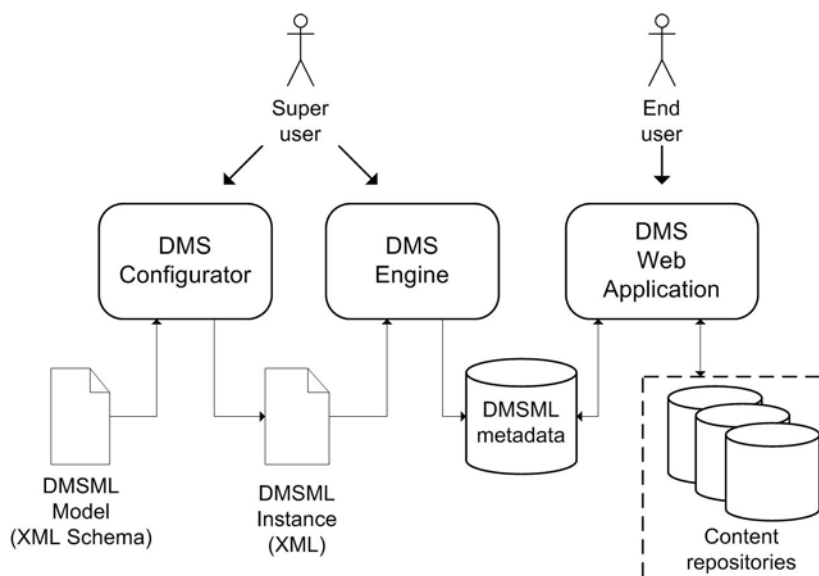
of configurable components (Java classes) that provide the infrastructure for the new DMS. This infrastructure includes core libraries providing document management features.

DMS Web Application

The DMS Web application provides basic document management features, which can be accessed by a generic end user (a member of the organization) through a standard Web browser. The DMS Web application can be automatically configured and deployed, thanks to the facilities offered by the DMS Configurator and the DMS Engine applications.

The functions provided by the DMS Web application include:

- Facilities for navigation, document upload, version control, and so forth. The Interface provides end users with some information about the documents organized in the workspace folders, not only in terms of descriptive properties (e.g., title, creator, etc.) but also of lifecycle and sharing constraints.
- Document lifecycle management
- Access control (ruling the execution of permitted actions, according to the organizational access policies).
- Search functions enabling a metadata-based and a full-text document search
- Log files recording

Based on the formal foundations of DMSML, the DMS Web application aims to provide a solution for document management that is capable of addressing the above-mentioned high level requirements:

- **Open standards compliance:** The application is based on technical standards (e.g. J2EE and XML), and on business metadata standards as well (i.e. Dublin Core, XACML and PNML).

- **Multiplatform compatibility:** As it is based on J2EE standard specifications.
- **Metadata-based approach:** Thanks to its extensive use of DMSML metadata
- **Open and standard methodological approach:** For DMS design and development, thanks to the instrumental support provided by the DMSML Framework prototype.

PROTOTYPE IMPLEMENTATION DETAILS

The DMS Configurator is a Java application. Its architecture consists of an *Interface*, which uses the JavaSwing Graphic Toolkit and other Graphic Utilities (e.g., images, etc.) and the *DMS Configurator Core*, built on top of the *Java Virtual Machine,* as shown in Figure 9a. The DMS Configurator Core is composed of five main components:

- An XML Schema Parser, which verifies the validity of the XML document against the DMSML model. The XML Schema Parser contains also an XML parser.
- JDOM API, used to create, access and manipulate XML Documents.
- An XPath Engine, enabling to validate XPath expressions.
- A Rule Manager, which interprets and enforces the rules associated to the user actions.
- A set of Basic Services, such as logging and data storage facilities.

DMS Engine and DMS Web application are both Web applications, designed according to the standard J2EE specifications. They are characterized by a multi-tier architecture, consisting of a Client, an application logic (composed of an Interaction and a Business Logic side), and a data tier, as shown in Figures 9b and 9c, respectively. The Client side is a standard Web browser, and the Interaction side is realized by means of JSPs (Java Server Pages).

Figure 9. DMSML framework prototype: (a) DMS Configurator, (b) DMS Engine, (c) DMS Web Application
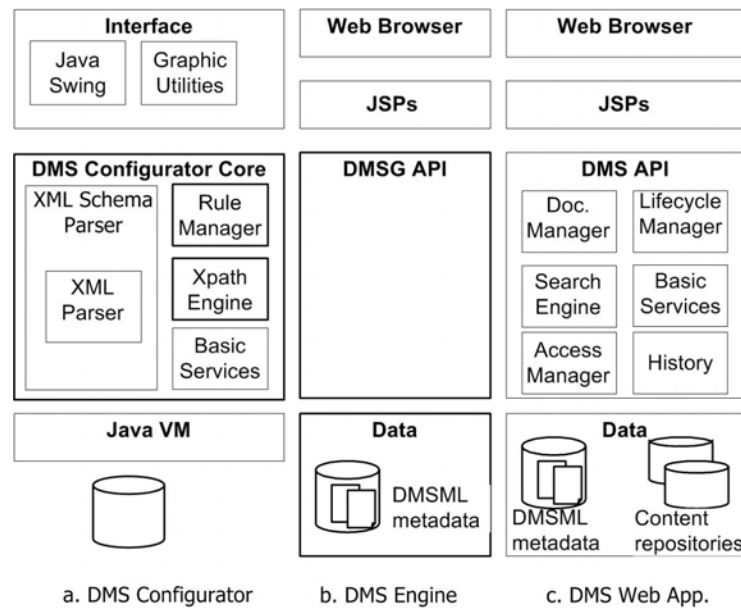
Regarding the DMS Engine, the Business Logic contains a template of a DMS Web Application and a set of APIs (DMSEngine API). The DMSEngine APIs are a set of Java classes which customize the template according to the DMSML specifications. The Business Logic of the DMS Web application is composed of a set of DMS APIs, implemented by Java classes, which provide basic functions for the management of workspaces, folders and documents. The DMS APIs consists of several components:

- A document management component providing facilities for navigation, document upload, version control, and so forth.
- A lifecycle management component that enforces the evolution of the document across the lifecycle steps.
- An access manager, which should guarantee that users execute permitted actions, according to the organizational access policies.
- A search engine, enabling a metadata-based and a full-text document search.

- An history component that records log files.
- Basic services, such as monitoring, connection to database services.

USING THE DMSML FRAMEWORK FOR DMS DESIGN AND DEPLOYMENT

The DMSML Framework Prototype offers support to the DMS designer for DMS design, development and deployment inside an organization. A methodology based on the use of DMSML has been defined in order to ease these activities. The methodology, fully described in (Paganelli & Pettenati, 2005), consists of the following steps:

- **Preliminary meeting:** This first step envisages a meeting with some organization representatives. The aim is to delineate the profile of the organization and the organization's strategy for information management, in order

to highlight existing inefficiencies, problems and critical factors.

- **Critical factors analysis:** The critical factors discovered during the first stage should then be analyzed in order to find the causes of possible inefficiencies in DM strategies and/or the factors that should be improved (e.g. bad practices, deficiencies of IT tools, lack of formalized procedures).

- **DMSML-based specification:** This stage aims to design a system for unstructured document management, dealing with the requirements of the target organization. It includes two main activities: firstly, classification of documents in use in the organization, in collaboration with some organization employees; secondly, analysis of each document class in terms of descriptive information and collaboration and process-related properties, relevant for document management, according to the DMSML model.

- **DMS design, development and deployment:** The DMSML specifications provide the formal foundation for DMS design and development. The DMSML Specifications can be interpreted by a CASE tool for the automatic generation of DMS code.

- **Testing and evaluation:** A selected group of organization employees (a group of users) should then test the DMS, during their working activities. This step aims to evaluate the capability of a DMSML-based solution of document management to address the critical factors discovered and analysed in the first two steps of the method, as well as the level of usability of the DMSML Framework Prototype.

The following sub-sections describe the use of the DMSML Framework for DMS Design, Development and Deployment.

DMSML-Based Specification

The DMS Configurator provides the DMS designer with a sequential set of graphical windows, which progressively guide the user in the DMS configuration, throughout the definition of the workspace, the organizational schema and the folder structure. The DMS Configurator permits to specify the workspace entity, characterizing the information items in terms of Descriptive Information Model, Collaboration Model and Process Model. First, the interface enables the user to specify the workspace organization in folders and sub-folders. For instance, in case of project documentation management, the designer can distinguish the following folders, each related to a project execution phase: Analysis, Specification, Development, Accounting. The graphical window, depicted in Figure 10.a, helps the user in specifying the organization folder, according to the DMSML Information Descriptive Model. Figure 10.b is an excerpt of a DMSML instance document representing the folders' organization (e.g. folder *ProjectA* and subfolders *Analysis*, *Specification*, *Development*, *Accounting*), automatically encoded by the DMS Configurator in the DMSML syntax.

The user can specify some properties for each folder: for instance *title*, *creator*, *affiliation*, and *document types*. The system provides some default document types (e.g., technical report, brochure, etc.), but it also enables the user to insert ad-hoc labels.

The system provides graphical support for the definition of lifecycle models. Figure 11.a shows the graphical representation of a lifecycle template for documents subjected to review. The document lifecycle is a process specified in terms of a sequence of tasks. The execution of a task is usually triggered by a transition condition, which can be automatic, time-dependent (e.g., a deadline) or caused by a user action or by an external

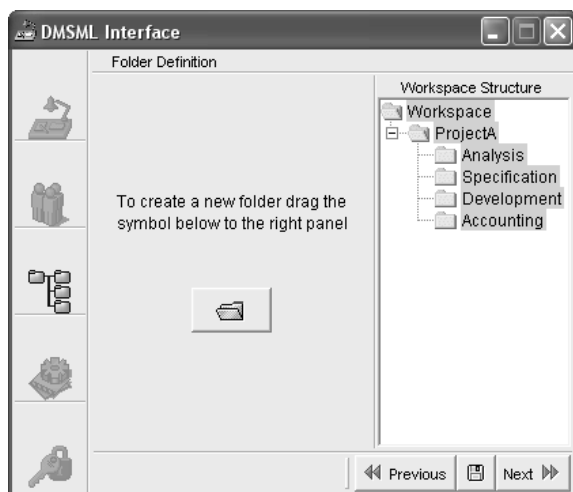*Figure 10a. DMS Configurator interface for folders' organization specification*

Figure 10b. DMSML instance document excerpt for folders' organization specification (DMSML Descriptive Information Model)

```
<workspace xmlns="http://det.unifi.it/dmsml">
    <folder>
        <itemDescription>
            <dc:title>ProjectA</dc:title>
            ...
        </itemDescription>
        <folder>
            <itemDescription>
                <dc:title>Analysis</dc:title>
            </itemDescription>
        </folder>
        <folder>
            <itemDescription>
                <dc:title>Specification</dc:title>
            </itemDescription>
        </folder>
        .....(other folders)
    </folder>
</workspace>
```

event, and it is associated to an evolution of the document state (e.g. from *draft* to *in_review*, to *accepted*, or *refused*). In Figure 11.a circles represent the states of documents (or places in the Petri Net language) and rectangles represent the transitions from one state to another. The lifecycle of the document is build upon the concatenation of these states and transitions. Figure 11.b shows an excerpt of the DMSML representation of this lifecycle template.

These lifecycle models serve as a collection of templates which can then be assigned to documents in order to accordingly enforce their evolution during their life. At design time, the user can assign a lifecycle template to the document types previously defined. In order to accommodate a certain level of flexibility, this pre-assignment can be modified by document creators by means of a proper interface offered by the DMS.

Finally, the designer can specify the access control policies which regulate the access to the information items on the basis of roles and responsibilities defined in the organization. The DMS Configurator automatically generate the DMSML instance document and check the validity of the specification according to the DMSML rules.

Design, Development and Deployment of the Document Management System

The DMSML specification is processed by the DMS Generator in order to properly customize the DMS template according to the organization's specific requirements. The DMS Generator Web interface enables the user to upload the DMSML specification, called Business Configuration Document, together with the technical parameters (e.g. connection to databases, ip addresses, etc.) encoded in a XML document, named Technical Configuration Document.

The DMS Web Application offers an intuitive interface with basic document management functionalities. The browsing and metadata-based search interfaces are shown in Figure 12 and Figure 13, respectively.

CONCLUSION AND FUTURE WORK

This article has highlighted some critical issues concerning unstructured document management in organizations, giving sound arguments to in-

Figure 11a. DMS Configurator interface for lifecycle templates specification
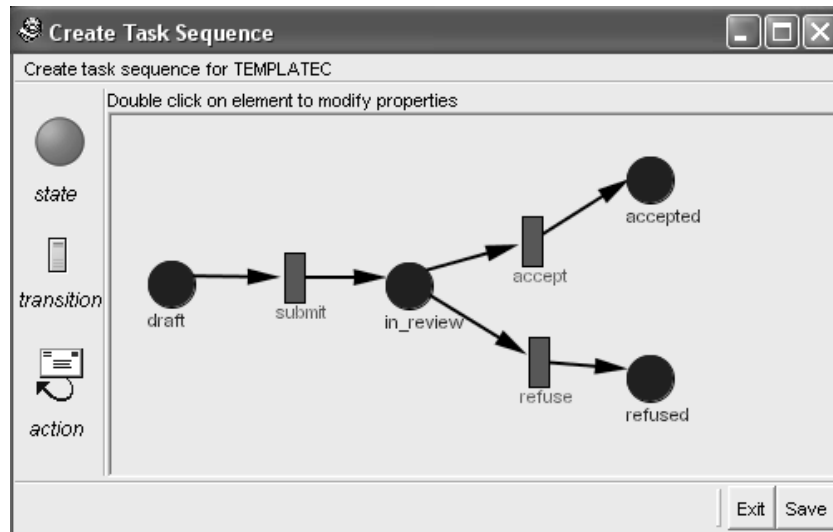
Figure 11b. DMSML instance document excerpt for lifecycle templates specification (DMSML Lifecycle Model)

```
<lifecycle><name>lifecycleTemplate</name>
  <description>lifecycle of document subjected to
  review</description>
  <tasks>
    <task><name>submission</name>
      <description>document submission</description>
      <transition type = "userAction">
        <name>submit</name>
      </transition>
      <inputState>
        <inputStateName>draft</inputStateName>
      </inputState>
      <outputState>
        <outputStateName>in_review</outputStateName>
      </outputState>
      <automaticActions>
       <notification>
          <description>reviewers are notified that a
          new document has been submitted</description>
          <receivers>
            <receiverID>reviewer1</receiver>
            <receiverID>reviewer2</receiver>
          </receivers>
          <message>"A new document has been submitted
          for review"</message>
        </notification>
      </automaticActions>
    </task>
      (other tasks)
  </tasks>
</lifecycle>
```

crease the awareness of what managers should account for when considering the possibility to adopt a document management system to fulfill their organizational needs. In particular we defended the idea that metadata are the basis for novel strategies and solutions for effective document management. However, since existing metadata specifications are too generic or focused on application domains other than document management, we have proposed in this article a metadata model for the management of unstructured documents in organizations, enabling the design and deployment of DMSs.

The DMSML metadata includes descriptive, collaboration- and process-related properties of unstructured documents. The DMSML modeling approach here presented enables the representation of the metadata set in a way which promotes human and machine-understanding, by separating and properly representing metadata semantics and syntax.

We also described the DMSML Framework Prototype. The prototype includes a Web-based DMS (based on the DMSML Descriptive Information, Collaboration and Lifecycle models), a DMS Configurator and a DMS Engine enabling the end users to specify business requirements to properly configure and customize the DMS for the needs of the specific organization by exploiting the features of the DMSML model.

At the moment, testing activities of the prototype in real application scenarios are undergoing. The evaluation activity aims to verify the capability of the DMSML-based solution, based on the DMSML Model and the DMSML Framework Prototype, to address critical factors related to the management of unstructured documents in an organization. We expect that the results of the evaluation provide a measure of the impact of a DMSML-based approach in an application scenario and suggestions for the refinement of the

Figure 12. DMS Web Application: Browsing interface
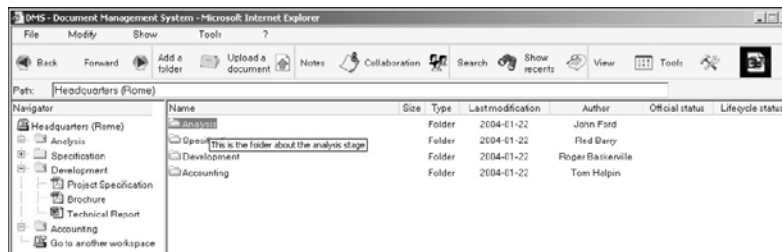
Figure 13. DMS Web Application: Search interface
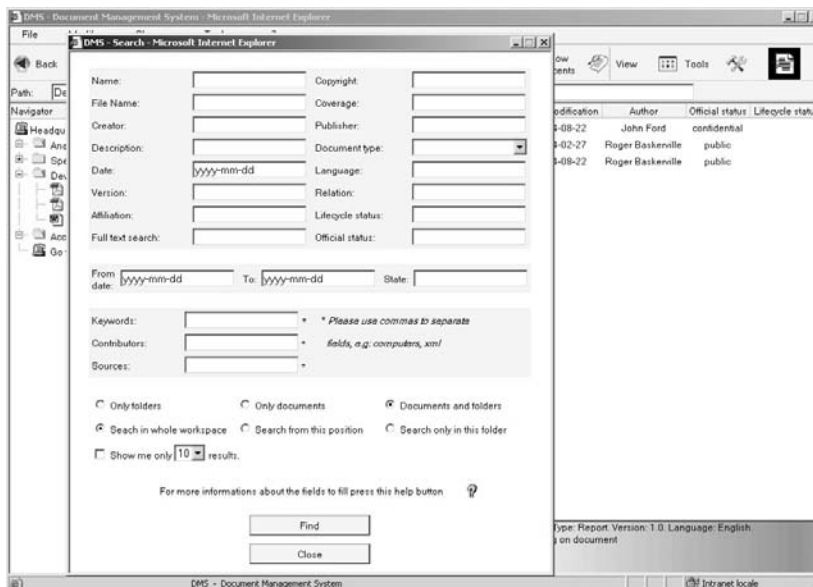
DMSML labels. The testing phase aims also at evaluating the degree of usability and user-satisfaction provided by the DMSML Framework Prototype. The evaluation should focus conveniently on those organizations which have already adopted process optimization and reengineering strategies (i.e., organizations with quality certifications). In this case, the DMSML-based DMS configuration could support pre-defined organizational processes and document lifecycles. At present, first stages of evaluation are being carried out in an Italian SME (Small Medium Enterprise).

During the evaluation phase, the cost of using metadata will also be analyzed. As illustrated throughout this work, the use of metadata has several benefits, but its cost has to be evaluated, in terms of resources needed for metadata creation and management (Duval et al., 2002; Gilliland-Swetland, 2000). Metadata creation and insertion in the system can require a manual or automatic procedure, or a hybrid approach, according to the type of metadata (for instance *creator* and *date* values can be automatically inserted by the system). The optimal strategy should be found in order to obtain the best compromise of accuracy and efficiency.

At the current stage of the prototypal development of the DMS Web Application, the end user should manually insert most descriptive metadata. Further work is needed in order to investigate strategies and mechanisms in order to automate this stage as much as possible (for instance using content analysis tools for the automatic extraction of metadata from texts (UIMA, 2006)).

In this direction, future research will also deal with semantic annotation and document enrichment as a way to make information available in documents for their effective and efficient use (Chakravarthy, 2006b; Whiting, 2005); collaborative tagging techniques and folksonomies (Golder & Huberman, 2006; Wu , 2006) in order to improve information management, retrieval and search inside an organization will also be accounted for. Even if the application context

addressed in this paper is related to organizational document management, we also envisage the possibility to integrate the document model with metadata accounting for personal information management as proposed in (Dittrich, 2006), Another relevant research challenge would be to integrate structured and unstructured information management by means of automatic association of relevant unstructured content with structured query results as presented in (Roy, 2005).

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Chapter XVIII
Relevance and Usefulness of Corporate Web Site Disclosure Practices

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ABSTRACT

We investigate whether corporations are following the "best disclosure practices" when presenting business reports on their Web sites. As a benchmark, we use the recommendations made by the Jenkins Committee (1994) to evaluate disclosures on corporate Web sites for value, relevance, and quality of information. We compute a disclosure score using 26 items recommended by the Jenkins Committee and Meek, Roberts, and Gray (1995) as indicators of best reporting practices. Our findings reveal that most corporations do not follow "best disclosure practices" when reporting information on their Web sites. Only about half of the 26 disclosure items recommended by the Jenkins Committee are reported, and less than 50% of the sample firms in our study make such disclosure. Some of the items that the Jenkins Committee recommends as essential for improving quality and relevance of reporting, such as forward-looking information (e.g., plans, opportunities and risks, forecasts, critical success factors), nonfinancial items (e.g., changes in operating performance, research and development activities), or offbalance-sheet financing, are least often reported. The findings suggest that corporations must improve their Web site disclosures for investors to find them valuable, relevant, and useful.

INTRODUCTION

The World Wide Web or Internet is becoming an important medium to communicate information about an organization and its activities. A survey of the members of National Institute of Investor Relations finds that investment relations departments are striving to fulfill investors' demand for online information (Editorial Staff, *Investor Relations Business*, 1999, 2001). Corporations recognize that providing information online is operationally and strategically advantageous (Berk, 2001; Clarksworthy, 2000; Ettredge, Richardson, & Scholz, 2001; Stewart, 1998). Studies indicate that corporations disclosing information derive benefits in the forms of increased market liquidity (Welker, 1995), lower cost of capital (Botosan, 1997), and enhanced institutional and analyst interest in the firms' stock (Healy, Hutton, & Palepu, 1999; Lang & Lundholm, 1996). Corporations also reduce costs by distributing information through their Web sites, widen the geographical coverage, and provide access to investors all over the world. The greater and quicker access to important information about corporate activities, available through interactive and connected reports, provides investors with rich and useful information for their decision making.[1]

In the past, several studies examined the content of Web site reports and the characteristics of corporations that provided financial reports on their Web sites (Ashbaugh, Johnstone, & Warfield, 1999; Debreceny, Gray, & Rahman, 2002; Ettredge, Richardson, & Scholz, 2002; Petravick, 1999; Petravick & Gillet, 1996). A few studies also examined the content of Web site disclosure along several dimensions, including timeliness (Petravick & Gillet, 1998), completeness (Ettredge, Richardson, & Scholz, 2000), and types of information and presentation (Beck, 2003; Caballero, Gomez, & Piattini, 2004; Debreceny et al., 2002; Ettredge et al., 2002; Matheus, 2004; Moustakis, Litos, Dalivigas, & Tsironis, 2004). However, these studies did not examine whether the disclosure items and presentation were relevant to investors or conformed to standards of quality reporting.

The issues of relevance and usefulness of information presented at corporate Web sites have become very important in today's corporate environment. Concerned by scandals and failure of some major corporations (e.g., Enron), the Sarbanes-Oxley Act (SOX) was passed in 2002. The SOX demands that corporations improve their reporting practices. Similarly, Regulation Fair Disclosure (FD), issued by the SEC in October 2002, also requires that publicly traded companies simultaneously supply information to professional security analysts and retail investors. The SEC specifically encourages the use of Internet to ease the distribution of information to small investors and to make such information available without the intervention of intermediaries (SEC Release No. 33-7881). Section 409 of the SOX also emphasizes the importance of real-time reporting. The Act requires that corporations immediately disclose any changes in financial condition and operating results to the public.

Highlighting the need to improve disclosure practices and the use of online and real-time media for such proposes, SOX and Regulation FD give considerable attention to corporate Web sites as prime sources of information for investors. However, corporate Web sites can fulfill expectations only if the sites provide relevant information on a timely basis, and conform to "Best Disclosure Practices." In the present study, we examine Web site disclosures, and ascertain to what extent they follow "Best Disclosure Practices." We define "Best Disclosure Practices" as disclosures that are relevant and useful to investors and that conform to recognized standards of disclosures. Studies examining information quality identified several dimensions of quality (Moustakis et al., 2004; Pipino, Lee, & Wang, 2002; Zhang, Keeling, & Pavur, 2000). Moustakis et al. (2004) use the following criteria to assess Web site quality: content, navigation, design and structure, appearance and

multimedia, and uniqueness.[2] Since the focus of the current study is online business reporting, we focus only on the relevance and usefulness of content or disclosures made online.

At present, there are no commonly accepted standards to indicate what constitutes "Best Disclosure Practices." Therefore, we use the Jenkins Committee's (1994) recommendations on improving business reporting as a benchmark to evaluate Web site disclosures and reports. We chose the Jenkins Committee recommendations as the standard because they were developed after obtaining direct input from various information users, and after the committee identified the types of information that are useful and relevant for investor decision making.

We evaluated "Best Disclosure Practices" by noting the types of items disclosed on corporate Web sites, and then compared them to the 26 disclosure items grouped in five broad categories of financial and nonfinancial disclosure items that the Jenkins Committee recommends as relevant and useful for investor decision making.[3] We find that, on average, corporate Web sites disclose about half of the items recommended by Jenkins Committee. Some of the items that the Jenkins Committee considers important and essential for investor decision making, such as forward-looking information, nonfinancial performance reports, off-balance sheet financing, and information on acquisition and disposals are reported by very few firms. Collectively, our findings leads us to the conclusion that corporate Web site reports are not making adequate disclosures to make them relevant and useful for investors, and they fall far short of adhering to "Best Disclosure Practices."

We also did a secondary analysis to examine whether the disclosure practices are influenced by firm characteristics, such as firm size, industry membership, investor profile, and financial performance. For this purpose, we grouped our sample firms into two major groups: traditional firms and technology firms. Technology firms, on average,

have fewer physical assets than their traditional manufacturing counterparts. They derive strength from their intangible assets: human resources, application development, patents, and innovation. These intangible assets are difficult to measure and are seldom reported in published financial statements. Thus, we expected that technology firms disclose more information about their activities to facilitate better investor decisions than do the traditional firms. We find some evidence supporting this expectation. We also expected that technology firms would be more cautious about reporting information that could undermine their competitive positions, such as forward-looking items (e.g., new product introduction, research and development). However, we did not find any evidence that traditional firms are more forthcoming than technology firms. In addition to industry membership (technology vs. nontechnology), we extended our evaluation of best disclosure practices to include corporate characteristics such as firm size, investor profile, and financial performance, and found these characteristics do influence disclosure practices.

The chapter is organized as follows. First, we address the benefits and limitations of Web site disclosure. Second, we discuss the Jenkins Committee reporting model, and why this model was chosen as the benchmark for "best disclosure practices." Third, we report why firm-specific characteristics could influence Web site disclosure. We follow these discussions by describing our sample selection process, disclosure scores, and the results. In the last section, we provide summary and conclusions.

BENEFITS AND LIMITATIONS OF WEB SITE DISCLOSURE

The disclosure literature suggests that corporations benefit from disclosing information about their activities (Botosan, 1997; Chow & Wong-Boren, 1987; Frankel, Johnson, & Skimmer, 1999;

Gelb, 1999; King, Pownall, & Waymire, 1990). Information asymmetry is always an issue in corporate environments where management is separate from ownership (Berle & Means, 1932). One way a corporation can reduce information asymmetry is by providing investors with more access to information about their activities. The reduced information asymmetry would, in turn, help a corporation in raising capital and debt (Botosan, 1997; Gelb 1999; Miller, 2002; Sengupta, 1998) and eventually, in increasing its firm value (Frankel et al., 1999; King et al., 1990; Yeo & Ziebart, 1995). Other benefits of disclosure include higher market liquidity (Welker, 1995) and increased interest shown by institutions and analysts in the firm's stocks (Healy et al., 1999; Lang & Lundholm, 1996).

While there are incentives for making voluntary disclosures about corporate activities, there are also disincentives that discourage a corporation from disclosing too much information. For example, certain disclosures (e.g., future plans or new product introductions or plans and forecasts) have the potential to tip its competitors and undermine its competitiveness (Lewis, 1997). With advanced notice of a corporation's plans and product introductions, competitors can prepare themselves to meet the challenges. A corporation must also be careful not to present information that could hype the expectations of their investors and lead to increased liability risk (Ettredge et al., 2002). In summary, a corporation must follow "best disclosure practices" without compromising its competitiveness or exposing itself to legal liabilities.

The Securities Exchange Act of 1934 requires that all securities sold by publicly traded companies, with assets in excess of $5 million and 500 or more stockholders, come under the continuous disclosure provisions of the act. These firms are required to periodically file forms 10-K, 10-Q, and 8-K to the Securities Exchange Commission (SEC). The 1934 Act is intended to provide investors with full and fair disclosure of the financial position and earnings of all publicly traded corporations. While disclosures under the 1934 Act are mandatory, public corporations voluntarily supply their investors with more information beyond the SEC mandatory filings. Because there are both incentives and disincentives, the types of voluntary information disclosed would vary among corporations and what is disclosed and through what means such disclosures are made, are left to the management's discretion.

Best Practice Disclosures

What constitutes "best disclosure practices" has not been defined in the literature. Regulatory agencies only point out that greater and quicker disclosure of information to investors would, in the long run, benefit the capital markets. As stated earlier, the SEC's Regulation FD and SOX of 2002 require that corporations improve their reporting practices. But neither Regulation FD nor SOX defines "best practices" or the items that would point to best disclosure practices. The only source for what constitutes best reporting is provided by the Jenkins Committee recommendations. Although the Jenkins Committee recommendations were not specifically directed at Web site reporting, they provide a reliable benchmark for assessing "best disclosure practices."

Concerned by reporting deficiencies and wanting to improve corporate reporting, the American Institute of Certified Public Accountants (AICPA) formed a Special Committee on Financial Reporting, known as the Jenkins Committee, to investigate financial reporting practices and to make recommendation on improving financial reporting. The Committee interviewed investors and creditors and asked users to list the information they considered relevant for their decision making. Relevant, for this purpose, was defined as information helpful in deciding whether to commit resources to a company, and whether to continue the investment already made in that company. Finally, the Jenkins Committee recommended a

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new reporting model that would be relevant and useful for investor decision making.

The Committee concluded that the new reporting model should not be limited to financial information. To ascertain whether business reports were meeting key information needs of users, the committee adopted the broader term "business reporting" to include the idea of reporting nonfinancial information. In today's economy, companies are creating value using new combinations of tangible and intangible assets. Intangibles, such as brands, people, systems, and innovation, cannot be measured in financial terms, yet are essential in creating a firm's long-term value (Elliott, 2001). Other nonfinancial information, such as goals and strategies, profiles of top executives and corporate directors, and research and development, are also valuable information for assessing a firm's future prospect and value.

The Committee issued its report in 1994 titled "Improving Business Reporting, A Customer Focus." The report recommended the following five categories of information, including nonfinancial information, to be integral for a business-reporting model. The committee considered these five categories essential for user decision making.

- Financial and nonfinancial data including financial statements and associated data, and operating and performance data that managers use in the business;
- Management analysis of the data;
- Forward-looking information on opportunities, risks, key trends, management plans, and critical success factors.
- Information about the company, directors, objectives, and strategies.
- Background information on company objectives, strategies, and impact of industry structures.

Web Site Disclosure-Influence of Firm Specific Characteristics

One focus of the present study is examining whether Web site disclosures are influenced by firm-level characteristics. Prior research has documented that the level of disclosures is influenced by firm attributes. Industry membership is an important firm-level attribute that influences disclosures. We expected that the incentives for disclosure would differ between traditional and high-technology firms. When compared to traditional firms, firms from the high-technology group are younger and own fewer physical assets. Most assets owned by a high-tech firm are in intangible form (e.g., intellectual capital, human resources, patents, and copyrights). Although the intangible assets owned by a high-tech firm are very valuable and contribute to the growth and stability of the firm, they are often difficult to measure in monetary value (Stewart, 1998). For example, while expert consultants and software programmers are the backbone of a high-tech firm, their value cannot be measured in quantifiable terms, or be included in accounting records along with physical assets such as machinery, land, or buildings. If a high-tech firm wants to convey the value of its intangibles, it can only do so by making greater disclosures about such assets voluntarily and through means other than published financial statements. One of the most useful media for making such disclosures is the corporate Web site.

Although a high tech firm might be interested in conveying the value of its intangibles and in disclosing information about its activities on its Web site, it is not always in its best interests to make additional disclosures. Certain types of information can be very sensitive, and both high-tech and traditional firms would be guarded when making certain disclosures. For example, disclosures about

research and development or new products introduction (Jenkins Committee refers to these items as forward-looking information), while creating a positive image about the firm, can also hurt its competitiveness. The disclosures might be used by competitors to prepare themselves to meet the challenges and to undermine the benefits that the firm would have otherwise obtained. In a volatile and rapidly changing industry such as high tech, premature disclosures of future plans or forecasts that later do not meet expectations can also lead to litigation by investors (Francis, Philbrick, & Schopper, 1994; Palmrose, 1988).

Firm size is another attribute that influences disclosure level (Foster, 1986). Large firms with distributed ownership generally have greater agency costs and information asymmetry (Ashbaugh et al., 1999; Clarkson, Kao, & Richardson, 1994; Cox, 1985; Debreceny et al., 2002; Ettredge et al., 2002; Lang & Lundholm, 1993). Such firms are also more sensitive to political costs (Jensen & Meckling, 1976; Leftwich, Watts, & Zimmerman, 1981; Watts & Zimmerman, 1986). Therefore, reducing the uncertainty surrounding their activities would not only lead to lower costs of capital for these firms, but would also reduce the chances of government regulation of their industry (Chow & Wong-Boren, 1987; Firth, 1979; Verrechia, 1983). In addition, large firms generally provide more disclosures because the costs of producing and disseminating information decrease with firm size (Lang & Lundholm, 1993).

Other attributes influencing disclosures are firm performance, investor profile, and security offering. The empirical evidence on the relationship between firm performance and disclosure levels is mixed. A few studies suggest that firms with positive earnings increase disclosures (Clarkson et al., 1994; Lang & Lundholm, 1993; Lev & Penman, 1990) while other studies suggest that managers expecting unfavorable earnings increase disclosures to soften the reaction of investors and to reduce legal liability (Baginski, Hassel, & Waymire, 1994; Kellogg, 1984; Lev & Penman, 1990; Skinner, 1994).

On the relationship between investor profile and extent of disclosures, Ashbaugh et al (1999) report that firms whose greater proportion of their stocks are held by individual investors engage in more Web site reporting than firms whose greater proportion of the stocks held by large investors such as mutual funds or other corporations. Ettredge et al. (2001) state that corporations consider the information needs of various users when designing their Web sites. They note that Web sites with greater numbers of sophisticated users (e.g., mutual funds, analysts) contain more detailed and objective financial data than those with greater number of individual or retail users. The latter are more likely to contain only summary information.

Plan to raise capital through stock offering is another factor influencing disclosure level (Clarkson et al., 1994; Frankel, McNichols, & Wilson, 1995; Gibbins, Richardson, & Waterhouse, 1990; Lang & Lundholm, 1993). Corporations intending to raise capital benefit from reduced information asymmetry and greater access to information about corporate plans and activities (Leland & Pyle, 1977; Myers & Majluf, 1984). The reduced information asymmetry would increase investor interest in the security offering and enhances the ability of the corporation to raise much needed capital (Fishman & Hagerty, 1989; Merton, 1987).

Sample Selection

Prior studies on Web site reporting chose the sample firms for their study either from the Fortune's 150 largest U.S. corporations (e.g., Petravick, 1999; Petravick & Gillet, 1996) or from the Association for Investment Management and Research (AIMR) publications (e.g., Ashbaugh et al., 1999; Ettredge et al., 2002). In this study, we did not use the AIMR samples because they are outdated; the most recent AIMR ratings were published in 1996. Instead, we extended our population to Fortune-1000 corporations. This gives us a larger population to choose our sample from

and a more recent list of firms; the Fortune-1000 list was published on April 15, 2002.

From the Fortune-1000 list, we first chose our sample of high-technology firms. Similar to the Francis and Schipper (1999) study, we identified high-technology firms using the following three-digit SIC codes: 283, 357, 360-368, 481, or 737. We identified 106 high-tech firms belonging to the computer, electronics, pharmaceuticals, and telecommunication industries.[4] After choosing the high-tech firms, we selected the traditional firms (using three-digit SIC codes other than the ones used to identify the high-tech firms) from the Fortune-1000 list by matching them against each high-tech firm, using asset size as a matching criterion. The final sample, therefore, consisted of 212 firms (106 high tech firms and a matched sample of 106 traditional firms).

Table 1 provides the industry distribution for our sample firms. Five high-tech industries accounted for 84% of the technology sample. These are Computer Programming, Software, and Data Processing (SIC 737), Electronic Components and Semiconductors (SIC 367), Computer and

Table 1. Sample distribution: High-technology and traditional industries

SIC	Descriptions	No. firms	Percent
High-technology industries			
283	Drugs	14	13%
357	Computer and office equipment	16	15%
360	Electrical machinery and equipment, excluding computers	1	1%
362	Electrical industrial apparatus	1	1%
363	Household appliances	2	2%
364	Electrical lighting and wiring equipment	3	3%
365	Household audio, video equipment, audio receiving	1	1%
366	Communication equipment	9	8%
367	Electronic components, semiconductors	20	19%
481	Telephone communications	13	12%
737	Computer programming, software, data processing	26	25%
Total high-technology firms		**106**	**100%**
Traditional industries			
160-170	Heavy construction and special trade contractors	4	4%
201-291	Manufacturing, excluding SIC 283	30	28%
324-399	Manufacturing, excluding SIC 357, 360, 362-367	35	33%
401-451	Transportation	22	21%
521-599	Retail and restaurant	15	14%
Total traditional firms		**106**	**100%**
Total sample firms		**212**	

Notes:
We selected our sample firms from the 2002 Fortune-1000 list. We identified all high-tech firms using Francis and Schipper's approach (1999). Firms are in a high-tech industries if their three-digit SIC code belonged to any one of the following: 283, 357, 360-368, 481, or 737. This process gave us a sample of 106 high-tech firms. Once the high-tech firms were identified, we selected traditional firms (using three-digit SIC codes other than the ones used to identify the high-tech firms) from the same Fortune-1000 list, and matched each traditional firm with a high-tech firm by asset size.

Office Equipment (SIC 357), Drugs (SIC 283), and Telephone Communications (SIC 481). In the traditional sector, manufacturing firms (SIC 200-291 and SIC 324-399) represented 61% of the total sample followed by transportation (21%) and retail and restaurant industry (14%).

Disclosure Scores

We composed a list of disclosure items as a standard for assessing Web site disclosure practices. We composed this disclosure list based on the disclosures items recommended by Jenkins Committee and by Meek et al. (Meek, Roberts, & Gray, 1995). Our benchmark list consisted of 26 disclosure items and they were classified into five categories: financial and nonfinancial data (DS_1), management analysis ((DS_2), forward-looking information (DS_3), information about employees, directors and management (DS4), and information on company background, objectives, strategies, and industry structure (DS_5).

Later, we visited the Web site of each sample firm and noted the presence (or absence) of each disclosure item from the benchmark list. Some of these items were disclosed by a corporation on their investor relation pages, and others as direct links from the corporate Web sites to the SEC's EDGAR database. We then computed a total disclosure score (DSCORE) for each firm by coding one if an item was disclosed at the Web site (during June-July 2002) or zero otherwise. For each firm, we also computed five additional disclosure scores: a score for each subcategory (DS_1 to DS_5). Each score is additive and not weighted, since investor preference for various disclosure items are not known. Previous studies also used unweighted scores (e.g., Cooke, 1989; Chow & Wong-Boren, 1987; Meek et al., 1995).

The dependent variable for our study is the total disclosure scores and the subscores for each of the five categories. The independent variables for the study are the characteristics of the reporting firms: asset size (ASSET) to distinguish between large and small firms, industry variable (TECH) representing technology firms and traditional firms, return on assets (ROA), INSTITU to denote whether the corporation has more institutional investors or individual (retail) investors, and ISSUE to identify whether a corporation has any plans to issue securities in the near future.[5]

RESULTS

Table 2 provides the complete list of the disclosure items and the percentage of firms reporting each item on their Web sites. Most corporate Web sites reported information on items such as dividend (#3), stock price (#5), and description of company business (#19) (90% of the firms reported such items). Information on these items is also available through published documents and as such, the marginal value of these items is limited. In contrast, less than 10% of the firms reported items such as critical success factors (#14), comparison of actual performance to plans (#15), and organizational structure (#21) that the Jenkins Committee recognized as relevant and useful for investors. Similarly, less than one in four firms (21.64%) reported forward-looking information (DS_3). These groups of items are very relevant and useful for an individual investor to make investment decisions. Unlike a mutual funds manager or an analyst, an individual investor has very few sources for such information. The Web site would be an easy-to-access and one-stop source for such information. However, the absence of such forward-looking information on most Web sites leads us to the conclusion that, even after the passage of the Private Securities Litigation Reform Act of 1995, which provides a safe harbor provision, corporations are not providing information that is relevant and useful for investors.

Panel A of Table 3 presents the descriptive statistics for the dependent and independent variables. It shows that firms disclose, on the average, less than 14 items (DSCORE) or 53.8%

Table 2. Disclosure checklist and frequency of disclosure items reported at Web sites

Item No.	Disclosure Item	% Firms Disclosing
Financial and nonfinancial Data (DS$_1$)		
1	Summary financial data and financial history	37.90
2	Financial ratios	53.88
3	Dividend information	95.43
4	Off-balance-sheet financing information	36.07
5	Stock price data	92.24
6	Segment data in quarterly reporting	53.88
7	Segment information: geographical capital expenditure, geographical production, line of business, competitor, and market share	89.95
8	High-level operating data and performance measures	32.42
Management's analysis of financial and nonfinancial data (DS$_2$)		
9	Changes in operating and performance (nonfinancial) data	19.63
10	Performance in each business segment	81.28
Forward-looking information (DS$_3$)		
11	Future prospects (qualitative or quantitative forecast of sales, profits, cash flows, or other forecasts)	21.92
12	Opportunities and risks from participations in additional industries, changes in industry structures, concentrations of assets, customers, and suppliers, illiquidity	
13	Management's plans to meet objectives and strategies	30.59
14	Critical success factors	44.29
15	Comparison of actual performance to previously disclosed opportunities, risks, and management plans	8.68
		2.74
Information about employees, directors, and management (DS$_4$)		
16	Employee information (number, training, accident, recruitment, categories)	84.02
17	Director information (age, qualifications, experience, other directorships)	63.93
18	Management information and compensation	89.95
Information on company background, objectives, strategies, and industry structures (DS$_5$)		
19	Scope and description of business	95.43
20	Company history	78.08
21	Organizational structure	5.48
22	Strategies and objectives	78.54
23	Acquisitions or disposals	32.88
24	Research and Development (R&D), including policies, locations, and number of people employed	30.59
25	Social policies (product safety, environmental policies and programs, charitable- or community-related programs)	59.82
26	Impact of industry structure on the company	73.52

of the total disclosure items. The results suggest that most corporations do not follow the best disclosure practices when disseminating information through their Web sites, and some of the disclosure items considered relevant and useful for investors' decision making (e.g., management's analysis of financial and nonfinancial data or forward-looking information) are absent from corporate Web

Table 3. Descriptive statistics and correlation between independent variables

Panel A: Descriptive statistics of dependent and independent variables

Variable	N	Mean	Median	Std. Dev.	Min.	Max.
DSCORE	212	13.99	14	3.01	6	22
DS_1	212	4.92	5	1.32	1	8
DS_2	212	1.01	1	0.55	0	2
DS_3	212	1.13	1	1.06	0	5
DS_4	212	2.38	3	0.84	0	3
DS_5	212	4.54	5	1.31	1	8
ASSET	212	14391.53	4143.69	35087.00	364.65	323969.00
TECH	212	0.50	0.50	0.50	0.00	1.00
ROA	212	5.70%	7.62%	14.16%	-71.41%	44.38%
INSTITU	212	62.80%	66.32%	20.04%	0.01%	98.50%
ISSUE	212	0.71	1	0.45	0	1

Panel B: Pearson and Spearman correlations between independent variables

Variable	LASSET	TECH	ROA	INSTITU	ISSUE
LASSET		0.0951	0.0252	**-0.1565**	**-0.2099**
		(0.1716)	(0.7184)	**(0.0240)**	**(0.0023)**
TECH	0.0904		-0.1041	-0.0620	-0.0441
	(0.1940)		(0.1345)	(0.3738)	(0.5270)
ROA	0.0443	**-0.1602**		0.0068	**-0.2918**
	(0.5253)	**(0.0208)**		(0.9228)	**(<.0001)**
INSTITU	**-0.1416**	-0.0321	0.0084		0.1072
	(0.0413)	(0.6454)	(0.9046)		(0.1233)
ISSUE	**-0.2049**	-0.0441	**-0.2678**	0.0508	
	(0.0030)	(0.5270)	**(<.0001)**	(0.4659)	

Notes:
DSCORE is the total disclosure score. DS1 to DS5 denote subtotal scores for the five disclosure categories. ASSET is the 2001 total assets (in millions of dollars). LNASSET is the natural logarithm of ASSET. TECH is equal to 1 for high-tech firms and 0 for traditional firms. ROA is the 2001 return of assets defined as earnings before extraordinary items, interests, and taxes deflated by the 2001 total assets.
INSTITU is the percentage of total shares outstanding that is owned by institutions at the beginning of fiscal year 2002. ISSUE equals 1 if the firm issued common equity in 2002, and 0 otherwise.
In Panel B, p-values are provided in parentheses. The p-values are for a two-tail test of statistical significance. Pearson (Spearman) correlations are reported in the lower (upper) diagonal. Correlations are significant at the 0.05 level or better are shown in bold.

sites. This definitely raises questions about the usefulness and relevance of Web site reports.

Panel B of Table 3 reports Pearson and Spearman correlations between the independent variables. Although a few correlations are significant at the 0.05 level or lower, none of the correlations are large. Multicollinerity diagnostics, using Variance Inflation Factor (VIF) and Condition Index (CI), indicate no severe multicollinearity.[6]

Univariate and Multivariate Analyses

Tables 4 and 5, respectively, present the univariate analysis and multivariate analysis of disclosure scores and firm-specific independent variables. The results on Table 5 are similar to the correlations on Table 4.

As predicted, reporting practices appeared to improve with firm size. Table 5 shows that larger firms, on the average, report more financial and nonfinancial data (DS_1), management's discussion on changes in financial and nonfinancial data (DS_2), and strategic and industry information (DS_5) than do smaller firms (p <0.01). We found no evidence that larger firms are more likely to disclose forward-looking information (DS_3) than smaller firms.[7] As discussed earlier, this low reporting of forward-looking information may be influenced by the fear of legal liability. However, with Regulation FD and SOX, we expected more corporations to report forward-looking information through their Web sites in the future.

Firms in the high-tech industries report more disclosure items (DSCORE) on their Web sites than do firms in the traditional industries (p-value<0.01). Since most high-tech firms are younger and have a greater need to reduce information asymmetry in investors' minds, they appear to disclose more information about their employees, managers, and directors (DS_4), and company's

Table 4. Univariate analysis: Correlations between disclosure scores and independent variables

Independent Variable	Predicted Sign	DSCORE	DS_1	DS_2	DS_3	DS_4	DS_5
LNASSET	+	**0.2995**	**0.2135**	**0.2578**	0.0404	0.1018	**0.2477**
		(<.0001)	**(0.0002)**	**(0.0002)**	0.5624	0.1435	**(0.0003)**
TECH	+/-	**0.2046**	0.0460	0.0432	-0.0431	**0.3710**	**0.2038**
		(0.0030)	0.5098	0.5358	0.5363	**(<.0001)**	**(0.0032)**
ROA	+/-	-0.0193	0.0100	0.0300	**-0.1291**	-0.0015	0.0385
		0.7817	0.8862	0.6674	**(0.0632)**	0.9824	0.5812
INSTITU	-	**-0.1866**	**-0.1436**	**-0.1186**	-0.0550	-0.0877	**-0.1230**
		(0.0070)	**(0.0386)**	**(0.0879)**	0.4303	0.2079	**(0.0768)**
ISSUE	+	-0.0851	-0.0727	0.0627	0.0864	-0.0858	**-0.1607**
		0.2217	0.2967	0.3686	0.2148	0.2181	**(0.0204)**

Notes: *The p-values are shown in parentheses. Except for the independent variables TECH and ROA, the p-value represent one-tail test of significance.*
Correlations significant at the 0.10 level are shown in bold.

Table 5. Multivariate analysis: Disclosure scores and determinants of disclosures

Independent Variable	Predicted Sign	DSCORE	DS_1	DS_2	DS_3	DS_4	DS_5
LNASSET	+	0.59	0.20	0.12	0.04	0.03	0.20
		(3.86)***	(2.69)***	(3.87)***	(0.70)	(0.71)	(2.88)***
TECH	+/-	1.02	0.06	0.04	-0.13	0.58	0.48
		(2.62)***	(0.34)	(0.47)	(-0.89)	(5.59)***	(2.72)***
ROA	+/-	-0.14	-0.01	0.24	-1.57	0.25	0.31
		(-0.10)	(-0.01)	(0.87)	(-2.35)**	(0.65)	(0.48)
INSTITU	-	-0.02	-0.01	-0.002	-0.002	-0.003	-0.01
		(-2.17)**	(-1.66)*	(-1.29)	(-0.63)	(-1.03)	(-1.26)
ISSUE	+	-0.12	-0.08	0.17	0.13	-0.08	-0.29
		(-0.27)	(-0.38)	(1.96)**	(0.72)	(-0.64)	(-1.41)
Intercept		9.92	3.76	-0.002	1.02	2.09	3.16
		(6.11)***	(4.83)***	(-0.01)	(1.63)	(4.81)***	(4.28)***
Adj. R^2		12.08%	3.67%	6.91%	1.77%	13.07%	9.20%
F		6.69***	2.58**	4.07***	1.73	7.22***	5.20***

Notes:T-values are given in parentheses. Except for TECH and ROA, the t-values are for a one-tail test of statistical significance.

*** (**, *) significant at the 0.01 (0.05, 0.1) level.

background, strategies, and industry structures (DS_5) than traditional firms do.

Once again, firms with poor performance (negative ROA) disclosed more forward-looking information, such as future prospects and management plans (DS_3), than more profitable firms (p-value<0.05). This result is consistent with prior studies documenting that bad news is associated with greater disclosures because firms want to avoid further decline in their stock prices.[8] This supports the view that firm disclosure decision is more influenced by the needs of the corporations than by what is relevant and useful for investors. We believe that Web site reporting should be guided by investors' needs, and firms must report items such as plans, forecasts, and forward-looking information, regardless of their industry membership or financial performance.

Such disclosures would definitely increase the value of these Web site reports.

One of the other measures of disclosure levels, INSTITU, a surrogate for investor profile, has a negative correlation with DSCORE and DS_1 (p-value<0.1 or better, one-tailed), indicating that corporations with more institutional investors disclosed fewer items on their Web sites than corporations with more retail investors. We interpret it as evidence that corporate Web sites are used more by retail investors than institutional investors as a source of information and accordingly, corporations disclose information about themselves to benefit these retail investors. This also supports the argument that corporate Web sites are more useful for smaller investors with limited access to corporate data than institutional

or large investors. By disclosing information relevant to these small investors, a corporation can significantly improve investor relations. Since small and retail investors depend more on Web sites than do institutional investors, the greater dissemination can only improve access to relevant information and in the long run, improve overall financial reporting quality.

CONCLUSION

We investigated whether corporations follow "best disclosure practices" when they present business reports on their Web sites. Since the SEC and other regulatory agencies do not provide any guidance on what "best reporting practices" are, we used the disclosure items recommended by the Jenkins Committee and the Meek et al. (1995) study as a benchmark to evaluate corporate Web sites. We computed a disclosure score for each sample firm using 26 disclosure items.

Our findings suggest that corporations must improve Web-site disclosures significantly because a typical corporation reports only about half the number of our reporting items that Jenkins Committee considered relevant and valuable for investor decision making. Scrutiny of the reported items revealed that less than one in two firms report 46% of the items in our disclosure list. Among the least reported items are those under the forward-looking category: management's plans (44.29%), opportunities and risks (30.59%), forecasts (21.92%), critical success factors (8.68%), and comparison between plans and actual performance (2.74%). We expected that after the passage of the Private Securities Litigation Reform Act of 1995, which gives them protection against spurious lawsuits, more corporations would be encouraged to present such information on their corporate Web sites. Surprisingly, our results show that less than a quarter of our sample firms disclose forward-looking items on their Web sites.

The Jenkins Committee's study revealed that nonfinancial information is essential input for users' decision making. However, our study shows that less than a third of our sample firms report nonfinancial or operating measures, changes in nonfinancial measures, and information about their research and development activities. We further noted that only one of every three corporations report items such as off-balance-sheet financing and information about acquisitions and disposals.

Overall, our results lend support to the view that Web site reporting is less than optimal and corporation must significantly improve their reporting practices. Forward-looking, nonfinancial, and off-balance-sheet financing are the most important areas that need improvement. Following the Jenkins Committee's approach, corporations should adopt a customer focus; that is, they should understand users' information needs, and serve such needs to reduce the information asymmetry between management and investors. Miller (2002) argued that firms compete in both capital market and product/service market, and that both competitions are equally important. If firms want to win the competition in the capital market, they will have to provide investors with their information needs "more quickly, thoroughly, and conveniently."

Our results also suggest that reporting practices are influenced by firm characteristics. We included technology firms in our sample to ascertain whether they disclose more information than traditional manufacturing firms. Technology firms differ in their asset composition from traditional firms because they own more intangible assets whose values are difficult to measure. Consequently, investors have limited information to evaluate the firms' future prospects and values. Our expectations were somewhat supported, since we observed that technology industries, on the average, provide more disclosure than their traditional counterparts.

Consistent with prior studies, we documented that large firms provide more disclosures on their Web sites. Similarly, firms that could benefit by reducing investor uncertainty were following better reporting practices than others. Poorly performing firms, for example, disclosed more forward-looking information than better performing firms. Firms planning to issue stocks provided more analysis on their activities and performance. For both poorly performing firms and firms with plans to raise equity, less uncertainty in the minds of the investors about their firm value will benefit them. One of the interesting findings of this study is that firms with more individual stock holding (as opposed to greater institutional holding of shares) made greater disclosures on their Web sites and followed better disclosure practices. Unlike institutional investors, individual investors are more likely to use a Web site as a source of information for their decision making.

Several research opportunities arise from the present study. Currently, we examine only the content of online business reports. A future study could examine other criteria of information quality, such as timeliness of business reports and reliability of information.[9] The Regulation Fair Disclosure and Sarbanes-Oxley Act of 2002 encourage the use of Internet for immediate disclosure of any changes in financial condition and operating results to all market participants. Future studies could also examine Web-design quality, ease of use of navigation, and clear information structure for locating online business reports.[10] Firms should not only supply the types of information that users need, but also provide convenient access to such information on corporate Web sites.

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ENDNOTES

[1] While the web is originally an information pull medium, there has been a growing movement toward its use as an information push medium. In the past, users of corporate information had to discover sources of information on the web using search engines. Today, most corporate Web sites allow interested parties to subscribe online newsletters that will prompt subscribers for any updates on firm activities. Investors need not wait to obtain updated information through intermediaries such as analysts or investment bankers.

[2] Matheus (2004) indicates that studies on Web site quality do not clearly distinguish between design qualities and information qualities of Web sites. Of the five criteria used by Moustakis et al. (2004), only "content" is related to Web site information qualities. The rest are criteria for assessing web design qualities.

[3] The Jenkins Committee proposed a reporting model containing five categories of disclosure items. The committee adopted the broader term "business reporting" to include the idea of reporting not only financial but also nonfinancial information.

[4] We initially identified 127 high-tech firms. We excluded 21 firms that had no financial and operating data on its site between June and July 2002 and/or lacked market and financial data from Compustat and CRSP.

[5] ASSET is measured as the 2001 total assets (in millions of dollars). TECH) is a dummy variable, 1 for high-tech firms and 0 for traditional firms; ROA is the 2001 return of assets or the 2001 earnings before extraordinary items, interests, and taxes (EBIT) deflated by the average of the 2000-2001 total assets. INSTITU represents the percentage of ownership by institutional investors. ISSUE

is a dummy variable, 1 if the firm issued common equity in 2002, and 0, otherwise.

[6] As a general rule, if the VIF of a variable exceeds 10 or the CI exceeds 30, that variable is said to be highly collinear. All independent variables have VIF and CI below the thresholds.

[7] In un-tabulated regressions, we substituted market value of outstanding equity for total assets as an alternative measure for size and found similar results.

[8] For sensitivity analysis, we used return on equity (ROE), market-adjusted return, and dummy variable for loss/profit firm as alternative measures of firm performance and obtained similar results. None of the conclusions change with the use of alternative performance measures. Return on equity (ROE) is defined as earnings before extraordinary items available to common stockholders deflated by common equity. Market-adjusted return is computed by subtracting the value-weighted market return from the return on the firm's stock. A firm is coded 1 if its earnings before extraordinary items are negative, otherwise zero.

[9] See Xiao, Jones, & Lymer (2002) for other internet-based reporting issues.

[10] A recent study by Hodge and Pronk (2006), for example, documents that professional and nonprofessional investors have different preference on the file format used to present reports on corporate web sites. Professional investors prefer to view PDF-formatted reports, while nonprofessional investors prefer to view HTML-formatted reports.

Chapter XIX
The Role of Impulsiveness on a TAM–Based Online Purchasing Behavior Model

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ABSTRACT

This chapter investigates consumer online purchasing behavior using an augmented technology acceptance model. Particularly, we posit that Web use leads to intention to purchase online. Impulsiveness, Web use, and subjective norm are included in the model to test several hypotheses concerning online consumer beliefs, intentions, and the effect of psychological traits. We developed a survey instrument to collect data and used structural equation modeling to validate the research model. All of our hypotheses were confirmed except the one that links subjective norm and online buying behavior. The positive relationship between consumer impulsiveness and online purchasing behavior suggests that online stores should design their Web sites to attract impulse purchases.

INTRODUCTION

The Internet has become an integral part of people's daily lives. Consumers use the Internet for various purposes, such as information seeking, online purchasing, and communicating with people around the world. The widespread use of computers and communications technologies

presents many behavioral and psychological questions with respect to the adoption and use of the technologies. In the context of technology adoption, the theory of reasoned action (TRA) is often used to explain diverse decision-making behaviors by relating an individual's attitudes and social norms to intentions to act (Lee & Park, 2001).

It is expected that 75% of US and Canadian firms will maintain or increase their e-commerce investment (Gatti, 2004). Jupiter estimates that B2C will grow 17% annually by 2008 (Gatti, 2004). This rapid increase in online sales shows that online shopping is becoming a mainstream channel for acquiring goods and services. Because the Internet is an important channel for communication with customers, e-marketers are motivated to convert casual Web viewers into paying customers for products and services.

Online vendors are eager to attract casual visitors to making impulsive purchases of merchandise. Impulse buying is a documented consumer behavior. Impulsiveness is a well-recognized social psychological trait that plays a significant role in consumer decision making (Bellman et al., 1999; Donthu, 1999; Joines et al., 2003). Consumers constantly are engaged in impulsive buying either in physical stores or online. User Interface Engineering (www.uie.com, 2001), a leading consulting firm in Web site usability, claims that impulse purchases represent almost 40% of the money spent on e-commerce sites. The development of the digital economy makes impulsive purchasing even more convenient and pervasive. Individual consumers exhibit different levels of susceptibility to impulse buying, and there are numerous factors that affect such behavior (Mendelson, 1964). Online vendors are convinced that a substantial portion of their sales is attributed to impulse purchases (Hedegaard, 2000). According to a survey of 1,001 consumers by a Web marketing company, FreeRide, in 1998, online shoppers are more receptive to known or trusted brands when making an impulse purchasing decision. Impulsive purchasing is bound to increase as the Internet makes it easier for consumers to access a wide range of brands and to compare different products without ever leaving home.

Despite the extensive literature devoted to consumer behavior in retail stores and direct marketing, cyber shopping is a new shopping mode that has not been explored fully. Little is known about how personal traits affect online shopping behavior. The purpose of this study is to identify the factors that affect online transactions as well as to evaluate how consumer impulsiveness affects online intention to purchase. We use the technology acceptance model (TAM) as the theoretical basis to frame our study.

BACKGROUND AND RESEARCH ISSUES

Our model expands TAM with additional behavioral and social constructs. TAM was studied extensively, and its effectiveness in predicting the use of a technology is validated by numerous studies (Adams et al., 1992; Agarwal & Karahanna, 2000; Korzaan, 2003). However, TAM focuses on the aspects of the technology as perceived by the user and overlooks behavioral and sociological issues that may affect the interaction between the technology and the user. In marketing, such behavioral and social factors as impulse and subjective norms have long been recognized as significant determinants of consumer purchase behavior (Fishbein & Ajzen, 1975; Rook & Fisher, 1995). Our model addresses two additional constructs—impulsiveness and subjective norms. Some studies expanded TAM to incorporate subjective norms, but none has addressed impulsiveness along with TAM (Karahana et al., 1999; Lohse & Spiller, 1998).

Technology Acceptance Model

The original TAM (Davis, 1986) has three constructs: (1) perceived ease of use, (2) perceived usefulness, and (3) usage. Its primary objective is to predict and explain the use of a technology. Later, the model was expanded to include the intention to use the technology as a mediator variable between the independent variables (perceived ease of use and perceived usefulness) and the dependent variable (usage of the technology). Perceived ease of use and usefulness were also replicated to substantiate the reliability and validity of the scales (Adams et al., 1992).

Numerous studies have utilized, extended, and validated TAM in various types of technology. Some employed TAM to investigate the system usage (Gefen & Straub, 1997; Klopping & McKinney, 2004; Szajna, 1994), while others explored the attitudinal aspect of TAM (Igbaria et al., 1995; Lee & Park, 2001). Davis' instrument was used to evaluate software packages, and the results support the predictive validity of the TAM instrument (Davis et al., 1989).

TAM also was used to explain individual differences in accepting information technology (Agarwal & Karahanna, 2000; McCloskey, 2003). Cross-cultural issues using TAM also were explored to understand cultural differences and the applicability of TAM (Taylor & Todd, 1995). Some additional variables, such as user characteristics, system characteristics, and organizational support, were added to TAM (Igbaria et al., 1995; Zhang & Prybutok, 2004; Zhang & Prybutok, 2005). Recently, TAM was expanded to study the adoption of e-commerce (Lee & Park, 2001; McCloskey, 2003; Venkatesh & Davis, 2000; Zhang & Prybutok, 2003a, 2003b).

Impulsive Purchase

Impulsive purchasing behavior is defined as a consumer's tendency to buy spontaneously, unreflectively, immediately, and kinetically (Rook & Fisher, 1995). This study claimed that two-fifths of consumers are impulse buyers. Impulsive buying is pervasive in the marketplace and has been researched extensively for many years (Bellenger et al., 1978; Gardner, 1983; Rook, 1987).

Consumers buy products and services for different reasons and with varying degrees of reasoning and planning. What constitutes a reasoned and planned purchase and what constitutes an impulsive purchase is a highly subjective matter. One study suggests that impulsive buyers account for between 1% and 8% of the population (Faber & O'Guinn, 1992), while others claim that 90% of all consumers make impulse purchases (Cobb & Hoyer, 1986).

Identifying impulse shoppers in the online market is even more difficult. A survey by the Angus Reid Group suggests that one-fourth of online shoppers are impulse buyers, while @dtech (1999) claims that more than four-fifths are impulse buyers. E-marketers recognize the importance of impulse buying behavior in an online market and design their Web sites to encourage such impulse purchases. For example, an online vendor may attempt to organize items in flexible and customized categories to stimulate unplanned purchases. The biggest driver of impulse purchases is ease of use of the Web site. Subtle differences in the design of the home page can significantly affect the level of impulse sales on the site (Nielsen, 1999). Businesses use numerous marketing strategies to encourage impulse purchases. For example, in physical stores, magazines, candies, and snacks are placed near the checkout counter in order to induce last-minute purchases. In an online environment, ease of use of a Web site is associated with ease of finding items and ease with the checkout process. This ease of finding items and checking out also serves to induce impulse purchases. In addition, Hoffman and Novak (1996) suggest that a well-designed shopping environment creates a positive mood that results in greater shopping satisfaction and a higher likelihood of impulse purchases. In the online

shopping context, Web design interface represents the online shopping environment. Furthermore, Web design and usability translate into increased impulse purchases and dollars spent (Wolfinbarger & Gilly, 2001). Despite ample anecdotal evidence of the role of impulse purchasing online, there is little systematic research on the topic. This study looks at the role of impulsive behavior in online purchasing.

Subjective Norms

A subjective norm is defined as a "person's perception that most people who are important to him think he should or should not perform the behavior in question" (Ajzen, 1991, p. 195). Researchers have employed subjective norms to investigate various behavioral issues (Venkatesh & Morris, 2000; Taylor & Todd, 1995) and the predictive power of subjective norms within the Theory of Reasoned Action and Planned Behavior (Ajzen, 1991; Fishbein & Ajzen, 1975; Szajna, 1994). The theory of reasoned action (TRA) addresses social influence via a construct called subjective norm. The construct of subjective norm was incorporated into an enhanced TAM model (Davis et al., 1989), in which subjective norm is hypothesized to lead to behavioral intention and subsequent actual behavior. Subjective norms capture the social pressure that a decision maker feels when making a purchasing decision. Subjective norm is a significant determinant of intention to adopt a technology (Karahana et al., 1999).

Some researchers call for research relevant to the social aspects of technology use (Mathieson, 1991). In response, researchers tested and validated the TAM model (Mathieson, 1991; Taylor & Todd, 1995). However, the effect of subjective norms has mixed findings in TAM studies. Some have found subjective norm to be significant in determining people's behavior (Taylor & Todd, 1995), whereas others have found no significant relationship (Mathieson, 1991; Davis et al., 1989). Furthermore, the role of subjective norms varies,

depending on other factors such as gender. It was found that subjective norm does not influence men's decisions at any stage, but it does affect women's decisions at the initial stage of technology introduction (Venkatesh & Morris, 2000).

The development of the Internet calls for new social traditions to enhance collaborations in electronic environments that are conducive to e-commerce, e-services, and online communities. Companies operating in an electronic environment must recognize and take advantage of such norms in order to enhance their businesses and communications. This study investigates whether such social norms play an important role in online purchasing decisions.

Web Use

Several studies have looked into factors that motivate Web users to surf and shop online. Gratification theory focuses on what people do with media in an attempt to understand what motivates consumers (Klein & Hirschheim, 1989). Gratifications are indicative of desired needs and expected benefits from the use of products and services (Stafford, 2003). Different types of gratifications are recognized, such as forming companionship, acquiring information, counteracting boredom, relaxation, and entertainment (Mendelson, 1964; Stafford, 2003).

To better understand Internet usage, studies relate the time spent online searching for product- and service-related information to different demographic backgrounds (Joines et al., 1999). Several factors are identified as gratification related: (1) information motivations; (2) interactive control motivations; and (3) socialization motivations (Korgaonkar & Wolin, 1999). Information motivation is related to how consumers use the Web to search for information; interactive control relates to how users choose a page to navigate and interact with chat rooms; socialization motivations refers to the Web's ability to facilitate interpersonal communications. To assess the level

Table 1. Summary of constructs

Constructs	Literature Support	Definition
Purchase	Bellman et al. 1999	The number of times a person shopped online during the past 12 months
Perceived Ease of Use	Davis, 1989; Adams et al. 1992	The degree to which a person believes that using a particular system would be free from effort
Perceived Usefulness	Davis, 1989; Taylor & Todd, 1995	The degree to which a person believes that using a particular system would enhance his or her job performance
Intention	Davis 1989; Bellman, Lohse & Johnson 1999	the likelihood to purchase in the future
Impulse Buying Subjective Norms	Lohse & Spiller, 1998; Rook and Fisher, 1995 Fishbein & Ajzen, 1975;	A consumer's tendency to buy spontaneously, unreflectively, immediately, and kinetically A person's perception of how people who are important to him think he should or should not perform the behavior in question
Web use	Joines et al. 2003; Korgaonkar & Wolin, 1999	The number of hours a person spends on the Internet

Figure 1. Research model
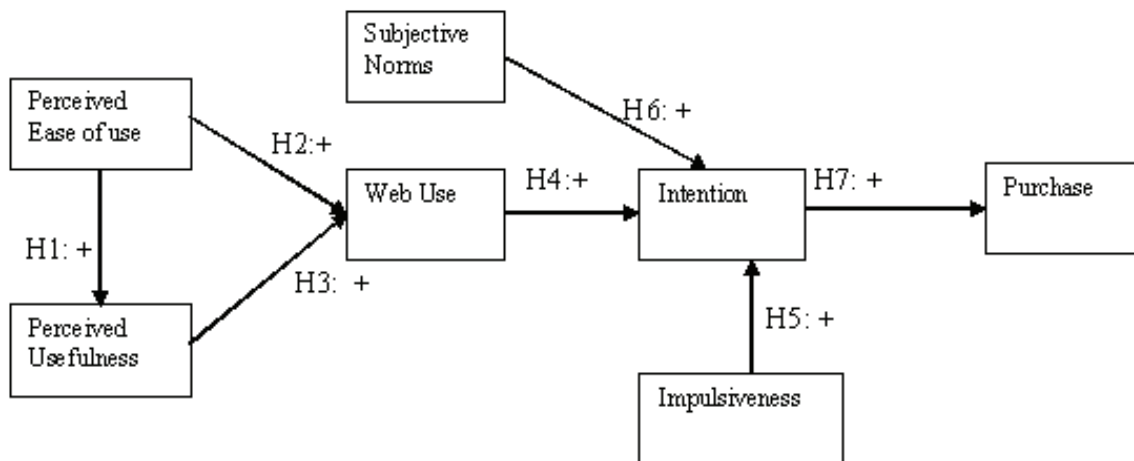
of motivation and gratification of an online user, studies often employ such Web usage measures as (1) the number of hours per day spent on the Web; (2) the percentage of time spent for business vs. personal purposes; and (3) the number of purchases made with an online business (Kraut et al., 1999).

Research Framework

Online shopping is a complex and relatively new phenomenon. To explore how consumers behave in an electronic market, we proposed an online shopping model based on TAM. We modified TAM for our study by incorporating consum-

ers' behavioral traits and social influences on purchasing behavior. Table 1 shows our research constructs and definitions.

As shown in Figure 1, our model postulates that ease of use and usefulness of a Web site influence how often a consumer uses the Web site. In turn, the frequency of Web site use affects the extent to which the consumer intends to make a purchase. The intention to purchase also is intervened by the degree of impulsiveness of the consumer and the subjective norms that influence the behavior of the consumer. Based on this research model, we set forth the following hypothesis:

Hypothesis 1: *There is a significant relationship between perceived ease of use and perceived usefulness.*

Hypothesis 2: *There is a significant relationship between perceived ease of use and Web use.*

Hypothesis 3: *There is a significant relationship between perceived usefulness and Web use.*

Hypothesis 4: *There is a significant relationship between Web use and intention to shop online.*

Hypothesis 5: *There a significant relationship between impulsiveness and intention to shop online.*

Hypothesis 6: *There is a significant relationship between subjective norms and intention to shop online.*

Hypothesis 7: *There is a significant relationship between intention to shop online and an online purchase.*

RESEARCH METHOD

To assess ease of use and perceived usefulness of a Web site, we adopted instruments previously used and validated by early TAM studies (Straub et al., 1997; Venkatesh & Morris, 2000). We modified them to fit an e-commerce context. To measure consumer impulsiveness, we used an established instrument in marketing developed by Rook (1987) and Rook and Fisher (1995). Finally, to measure subjective norms, we modified the instrument developed by Fishbein and Ajzen (1995).

Measures

We adopted Davis et al.'s (1989) measures to assess perceived ease of use and usefulness of a Web site. To assess perceived ease of use, we used six items designed to measure the level of effort required to find information. Furthermore, we used five items to measure perceived usefulness and four items to measure intention. To measure online purchase, we used the number of purchases made during the past 12 months. To measure Web use, we used the number of hours spent surfing the Internet per week.

Survey Instrument Development

Factors that are perceived as important to online shopping were identified from both marketing and information systems literature. All the items used to measure the constructs in the research model were selected from previous research and modified for this study's specific context. The use of previously validated instruments as the basis of our survey provided face validity. To ensure the content validity of the instrument, we pretested the instrument with a panel of e-commerce experts and online consumers. The panel consisted of three marketing professors and three IS professors with extensive research in e-commerce. The panel also included four academic staff members who had online purchasing experience. Based on the feedback from the panel, we revised the instrument so that the questions were clearer and easier to understand.

Table 2. Construct reliability

Constructs	Construct Reliability	Variance Extracted	Cronbach Alpha
Perceived Ease of Use	0.90	0.60	0.91
Perceived Usefulness	0.87	0.59	0.86
Subjective Norms	0.93	0.73	0.88
Impulsiveness	0.91	0.74	0.94
Intention	0.92	0.74	0.82

DATA ANALYSIS

Respondent's Profile

We conducted a survey with students to collect data for the study. We believe that students represent a reasonable population for this study for several reasons: (1) The students used in this study were not traditional students. The majority of the participating students were seniors majoring in business, and they worked an average of 35 hours per week in various industries. (2) Prior interactions and surveys with this group show that these students are active online shoppers. Eighty-three percent of the respondents in this study reported that they recently had made purchases online. (3) Students are consumers whose purchase behaviors and decision-making processes are consistent with other consumers (Hackbarth et al., 2003; McKnight & Chervany, 2002). (4) Previous studies on Web design and presentation support the contention that students are an appropriate proxy for regular Web users (Scharl & Bauer, 1999; Zhang & von Dran, 2001-2002). (5) Wolburg and Pokrywczynski (2001) state that the youth market is one of the most coveted of all segments due to the group's spending power, trend-setting traits, receptivity to new products, ability to influence parental choices of major purchases, and the potential for becoming lifetime customers. There is a reasonable body of work that suggests that college students resemble a large portion of the real Web users and are appropriate subjects for Web evaluation (Gefen et al., 2003; Hackbarth et al., 2003; McKnight et al., 2002).

A total of 32 questions were included in the survey. Two questions were open ended; 24 were based on a 7-point Likert scale; and six were related to demographic information, Web usage, and the Internet access method. We collected the survey data via both paper-based and online survey methodologies. Several instructors handed surveys in their classes, and respondents were asked to return the survey within three weeks. As an alternative, respondents were given the Web address for the online survey and were provided with a user ID and password to log on to the online survey.

In order to make the survey more readily accessible, we made the survey available online as well as in paper format. A total of 349 responses were collected with 120 coming from the Internet and 229 from the paper-based surveys. Among the 349 responses received, 55 were discarded as incomplete. Fifty-eight percent of the respondents were male, and 42% were female. Clothing, books, CDs, software, computer hardware, and travel tickets were among the top products purchased online. Sixty-two percent of the respondents reported using dial-up connection to access the Internet; 21% used DSL, 18% cable modem, and 9% T1. On average, the respondents spent 8.5 hours per week surfing the Internet.

Confirmatory Analysis

Because the constructs in this study are repeatedly tested in the literature, we used confirmatory analysis for testing the relationships shown in Figure 1. LISREL 8.51, one of the most popular software programs for testing structural equation modeling (Zhang et al., 2004), was used to analyze the paths showing the relationships between constructs.

Evaluation of Overall Model Fit

In order to assess the overall fit of the model, we measured various fit indices. In confirmatory factor analysis, fit indices are used to evaluate measurement model. The indices of GFI, AGFI, NFI, and NNFI are all above 0.9. This shows that the measurement model is appropriately specified.

Evaluation of Measurement Model

Reliability

Reliability refers to the consistency of measurement. There are different ways to evaluate reliability, and in this work, we examined reliability based on three methods: composite reliability, the variance extracted, and Cronbach alpha. The most widely used internal reliability measure is Cronbach's coefficient alpha. Some suggest the acceptance level for coefficient alpha should be at least 0.7 (Roberson et al., 1991). We calculated the reliability score using the method suggested by Hair, et al. (1998) as shown in the following:

Construct reliability =

$$\frac{(\sum \text{Standardized Loadings})^2}{\left(\sum \text{Standardized Loadings}\right)^2 + \sum \varepsilon_j}$$

(1)

Table 2 shows all the construct reliability scores ranging from 0.84 to 0.92, exceeding the recommended limit of 0.7. These results show that all our constructs demonstrated good reliability.

Variance extracted =

$$\frac{\sum (\text{Standardized Loadings}^2)}{\sum (\text{Standardized Loadings}^2) + \sum \varepsilon_j}$$

(2)

Furthermore, the variance extracted measures the amount of variance that is captured by an underlying factor in relation to the amount of variance due to measurement error. We used 0.5 as the minimum threshold for an extracted variance to be considered desirable for a construct (Fornel & Larcke, 1981).

Validity

To ensure the legitimacy of the study, we assessed the validity of the study in three different areas: content validity, discriminant validity, and convergent validity. Content validity refers to the extent to which items or questions adequately capture the concept to be measured in the study. Content validity was established by extensive literature review and the review of the instrument by a panel of experts (Churchill, 1979; Devillis, 1991).

Convergent validity refers to the degree to which two measures designed to measure the same construct are related. Convergence is found if the two measures are highly correlated. An early advocated rule of thumb for convergent validity is that the correlation between two measures designed to assess the same construct should be statistically significant and sufficiently large to encourage further examination of validity (Devillis, 1991). Larger loadings provide evidence that the measured variables represent the underlying constructs (Bollen, 1989; Mueller, 1994). Loadings also are used to evaluate the convergent validity

Table 3. Factor loadings

Ease of Use	Subjective Norms	Perceived Usefulness	Impulse	Intention
0.23	0.07	0.07	0.03	**0.92**
0.14	0.03	0.14	-0.03	**0.82**
0.06	0.06	0.05	-0.05	**0.85**
0.01	0.13	0.11	-0.04	**0.84**
0.76	0.15	0.06	0.17	0.09
0.76	0.08	0.04	0.04	0.07
0.82	0.13	0.10	0.05	0.00
0.66	0.19	0.05	0.07	0.02
0.84	0.19	0.13	0.02	0.00
0.78	0.11	0.13	-0.01	0.10
0.19	**0.69**	0.16	-0.12	0.05
0.29	**0.96**	0.05	0.02	0.00
0.25	**0.9**	0.15	-0.09	0.12
0.35	**0.74**	0.22	-0.02	0.11
0.29	**0.95**	0.21	-0.08	0.07
0.18	0.38	**0.68**	0.06	0.12
0.17	0.14	**0.86**	0.02	0.17
0.16	0.12	**0.83**	-0.01	0.06
0.27	0.48	**0.55**	0.09	0.14
0.21	0.16	**0.85**	-0.02	0.06
0.09	-0.11	-0.08	**0.79**	-0.06
0.04	-0.05	0.05	**0.95**	-0.02
0.03	0.00	0.04	**0.9**	-0.02
0.09	-0.03	0.04	**0.78**	0.00

Table 4. Correlation matrix of constructs

Constructs	PU	Intention	Web Use	PEU	Risk	Impulse	Subjective Norms
Perceived Usefulness (PU)	1						
Intention	0.58	1					
Web Use	0.64	0.46	1				
Perceived Ease of Use (PEU)	0.48	0.73	0.1	1			
Impulse	0.09	0.23	0.02	0.2	0.14	1	
Subjective Norms	0.05	0.14	0.01	0.11	0.09	0.23	1

of the constructs in the confirmatory analysis (Devillis, 1991). Table 3 shows the loadings of each item on its corresponding construct. All the standardized loadings are above 0.5, and the LISREL output shows that all these loadings are statistically significant. Table 3 provides evidence of convergent validity.

Discriminant validity assesses the degree to which two measures designed to measure similar but conceptually different constructs are related. A low to moderate correlation often is considered evidence of discriminant validity (Wang et al., 2001). Table 4 shows the correlation matrix for the constructs and provides evidence of discriminant validity.

Confirmatory Analysis of Structural Model

LISREL output produces the following four equations. All the coefficients are statistically significant at the 5% level except subjective norms. Table 5 shows the results of structural equations and R^2. The R-squared value is the fraction of the variance in the data that is explained by a regression. In this work, 24% of the variance in perceived usefulness is explained by perceived ease of use; 78% of the variance in intention is explained by Web use and impulse; 41% of variances in Web use is explained by perceived usefulness and perceived ease of use; and 18% of variances in purchase is explained by intention.

Table 5. Structural equations

Equations	R2
Perceived Usefulness =0.48 Perceived ease of use**	0.24
Intention = 0.54 Web use** + 0.11 impulse* + 0.036 subjective norms	0.78
Web use =0.72 perceived usefulness** + 0.19 perceived ease of use**	0.41
Purchase =0.19 Intention**	0.18
* significant at 5% ** significant at 1%	

Table 6. Coefficients

Paths	RQ Coefficients	Significance Level
Ease of use to Usefulness: H1	0.48	0.001
Ease of use to Web use frequency: H2	0.19	0.05
Usefulness to Web use frequency: H3	0.72	0.001
Web use frequency to Intention: H4	0.54	0.005
Impulsiveness to Intention: H5	0.11	0.01
Norms to Intention: H6	0.036	0.26
Intention to Purchase frequency: H7	0.19	0.001

Figure 2. Path model
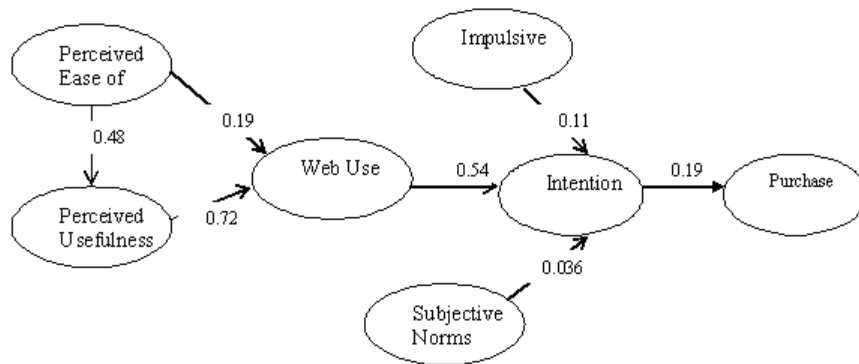
Table 6 shows the coefficients of each path described in Figure 2 and their associated significance level. The significance level tells us the results of hypotheses 1 through 7 testing. All these hypotheses were confirmed except hypothesis 7.

To investigate further the value of our research model, we performed a comparative analysis of the model with several alternatives. Specifically, we created three new models that are subsets of the full research model—one without ease of use (eou), another without usefulness, and the third without usefulness and eou—and compared them to the original model. Table 7 shows the fit indices for each of the models. The fit indices show that the current model, the model without ease of use, and the model without usefulness have fit indices that are above 0.9. However, the model without ease of use and usefulness had GFI and AGFI values that were less than 0.9. Therefore, by comparing the fit indices, we concluded that the model without eou and usefulness was less favorable. The slight improvement in model fit when only either eou or usefulness was removed suggests that these constructs have some overlap or redundancy in what they measure. However, the significance of the individual paths in conjunction with the R^2 values supports the full model.

Table 8 shows the R^2 and coefficients for each of the previous models. The full model produces the overall highest R^2, and all of the paths within the model are statistically significant. Although the model without ease of use and the model without usefulness have satisfactory fit indices, the R square for each of the paths is relatively low. Considering these results, we concluded that the full model has the higher predictive power than the more parsimonious competing models.

DISCUSSION AND CONCLUSION

The findings of our study confirmed the relevance of previously established constructs—perceived ease of use, impulsiveness, Web use, perceived usefulness, intention, and purchase—and the relationships among these constructs in an online shopping setting. The study also validated TAM as a relevant research model for online purchasing studies. The results of this study were consistent with other prior works in general (Davis et al., 1989; Mathieson, 1991), but the findings did not

Table 7. Fit indices

	NFI	NNFI	GFI	AGFI	RMSEA	ChiSquare/df
Current Model	0.94	0.95	0.92	0.9	0.061	3.12
Model without eou	0.97	0.97	0.95	0.93	0.053	2.68
Model without useful	0.96	0.96	0.93	0.91	0.061	3.22
Model without eou and useful	0.92	0.92	0.89	0.86	0.075	3.85

Table 8. Comparing models

Current Model	R^2
Perceived Usefulness =0.48 Perceived ease of use**	0.24
Intention = 0.54 Web use** + 0.11 impulse* + 0.036 subjective norms	0.78
Web use =0.72 perceived usefulness** + 0.19 perceived ease of use**	0.41
Purchase =0.19 Intention**	0.18
Model without PEOU	
Intention = 0.49Web use** + 0.013 impulse -0.11 0.036 subjective norms	0.25
Web use =0.27 perceived usefulness**	0.07
Purchase =0.24 Intention**	0.06
Model without PU	
Intention = 0.49Web use** + 0.072 impulse -0.041 subjective norms	0.45
Web use =0.47 eou**	0.22
Purchase =0.25 Intention**	0.07
Model without PU and PEOU	
Intention =0.62Web use** + 0.61 impulse** - 0.25 subjective norms**	0.38
Purchase =0.43 Intention**	0.19
* significant at 5%	
** significant at 1%	

show that subjective norm was a significant agent for online purchasing behavior.

The absence of significance of subjective norms in the online purchasing environment may indicate that online buyers are better informed and confident about purchasing decisions and less likely influenced by others or their environment. In addition, online shopping provides an environment with an increased level of privacy and comfort; thus, shoppers may feel less pressured to conform to social norms.

This study provided empirical evidence for the relationship between consumer impulsiveness and purchase behavior that are in line with the findings from previous studies on online purchasing behavior (Lee & Park, 2001; McCloskey, 2003). A

practical implication of this finding is that online firms should design Web sites to help consumers make prompt purchasing decisions. Some online savvy businesses like Amazon.com already are doing this by reminding online shoppers about similar products or by suggesting accessories associated with the product they have already bought. Amazon's Web site allows easier and faster access to information on products and services and facilitates consumers in making prompt decisions for convenient transactions and payments. In reality, however, many online businesses with poorly designed and administered Web sites do not fully take advantage of the potential of impulsive consumer behavior.

The most significant intellectual contribution of this study is that it has validated TAM in the context of online shopping. TAM has been validated as a useful framework to study how technologies are adopted and used. Our work establishes a foundation for other researchers to explore issues on online consumer shopping behavior in a systematic way.

Future Study

E-commerce or online commerce presents a significant potential for businesses to improve market share and visibility, expand customer reach, reduce cost, create new revenue streams, and improve operational efficiency. To maximize the benefits while reducing or controlling risks associated with online commerce, it is crucial to understand the dynamics of the market and its stakeholders. While our study has provided valuable insight into the behavior and perception of shoppers in an online shopping setting, there are many more questions that remain to be addressed, such as:

- If and how the design of online shopping Web sites affects online shopping;
- If and how demographic profiles affect online shopping; and

- If and how online vendors perceive online shopping differently from shoppers.

This study explored the validity of the research model and the relationship among the constructs based on self-reported perceptions of the participants. It may be interesting and useful to conduct similar studies using a method designed to assess objective measures. Examining Web design elements may be one way to assess such measures. Web design elements include images, links, colors, text, and animations. The presence of these Web design elements and quality of these design elements affect the Web user's perceptions of ease and usefulness. Additionally, studies with consumer groups that represent a broader cross-section of the general population are called for to substantiate or to dispute the ability to generalize the findings of the study. Other studies may explore the topic from the perspective of online vendors, as they may have different views and perceptions of online shopping. Cross validating vendors' and consumers' views can provide a more accurate picture of ease of use about online shopping Web sites and a better understanding of Web use and purchase frequency.

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Chapter XX
Home–Based Telecommuting:
Technology's Role

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ABSTRACT

This chapter examines the role of technology in home-based telecommuting (HBT), and the implications of this role for organizational IT departments and for managers of telecommuting employees. Specifically, it addresses the question: Does technology both facilitate and hinder home-based telecommuting? Although technology enables HBT, it has also been blamed for HBT's slow growth. To clarify the role that technology currently plays when employees telecommute, we describe a recent study that investigated the relationship between different forms of organizational support (classified as technology-related, somewhat technology-related and non-technological) and employees' reactions to HBT. Two technology-related support variables and manager's trust (a non-technological support) were found to have broad impact on employees' reactions to HBT; so, while technology plays a crucial role and thus could be a major factor in HBT's slow growth, we argue that HBT is better understood within a multi-factor rather than a single-factor framework. Other implications are that organizations should emphasize providing IT support and appropriate technology for telecommuters, as well as HBT-related training for non-telecommuting co-workers and managers of the telecommuters.

INTRODUCTION

Since the 1980s, there have been predictions that a high proportion of workers will work in their electronic cottage (Braus, 1993; Handy, 1995; Konradt, Schmook, & Mälecke, 2001; Potter, 2003; Toffler, 1980). Yet the reported proportion of remote workers remains far below the predictions, typically below 10% (European Teleworking Online, 2000; Flexibility Ltd, 2002; McClure, 2001; Scott & Timmeran, 1999). The reasons for this discrepancy are still unclear, although the figures do vary somewhat, as do the definitions used for gathering the data (Haddon & Brynin, 2005; Lindorff, 2000; Mokhtarian, Salomon, & Sangho Choo, 2005; Sullivan, 2003). A large body of literature has addressed the question of why the expected shift from working in the office to home-based telecommuting (HBT) has not occurred.

BACKGROUND

Early research drew attention to resistance to home-based work from supervisors, managers, and employer organizations (Olson, 1982; Zuboff, 1982). Attempts to respond to managerial concerns about losing control led to calls for more trust in HBT employees, more use of management-by-results for HBT (Konradt et al., 2001), and continuing research into effective HBT control strategies (Kurland & Cooper, 2002; Snell, 1992).

The focus then shifted from the managerial side to the prospective HBT employees. Studies established the importance of personal characteristics, such as autonomy or self-efficacy (Belanger, 1999; Katz, 1987; Raghuram, Wiesenfeld, & Garud, 2003), individual coping strategies (Konradt et al., 2001) and job factors (Raghuram, Garud, Wiesenfeld, & Gupta, 2001) for increasing the likelihood of employees adopting HBT. It is also now recognized that HBT is constrained by the availability of suitable space in the home (Green,

Strange, & Trache, 2000) as well as the characteristics of the person's household (Baruch, 2000).

Increasingly, the literature has reflected a recognition that a broader, multi-factor approach is more appropriate for understanding HBT than the study of single factors, because of the complexity of the HBT situation (Bailey & Kurland, 2002; Baruch, 2000; Depickere, 1999; Pearlson & Saunders, 2001; Raghuram et al., 2001; Siha & Monroe, 2006). This is also consistent with the recent emphasis on more complex approaches to the study of organizations (Eisenhardt, 2000; Lewis, 2000). Typical of this broader approach to HBT is the summary of research related to the slow growth of telecommuting by Baruch (2000). He concluded that the appropriate variants for each of four factors (the telecommuting interface, job, individual, and organization) need to be present *simultaneously* for telecommuting to be effective. The absence of the appropriate variants for any one of these components undermines effective telecommuting, thus slowing the spread of this innovation. Within Baruch's framework, technology is treated as part of the telecommuting interface and job factors, rather than as a separate factor.

The Role of Technology

In contrast to this broader approach, the possibility has recently been raised that the technology being used in the home when telecommuting is the major determinant of the slow growth in the numbers who work from home. That this is being argued now is somewhat surprising, as the technology available for HBT has improved, and there has also been an increase in the expertise related to information and communications technologies (ICTs) within working populations in developed countries. That technology is important in HBT was demonstrated by Hartman, Stoner, and Arora (1992), who reported that satisfaction with HBT was correlated with satisfaction with technological considerations such as long computer response

times and lack of helpdesk support out of office hours. However, even in 2005, a study at Lloyd's of London revealed that IT problems remain more important to satisfactory HBT than most managers realized (Collins, 2005).

The role of technology in HBT may in fact be equivocal. On the one hand, the availability of ICTs to connect the HBT employee with others gave rise to expectations of increased HBT. Much of the telecommuting literature assumes that technology facilitates telecommuting (although the role of technology is generally not addressed empirically), and many definitions of telecommuting specifically mention technology (e.g., Baruch, 2000; Belanger, 1999; Nilles, 1998). From this perspective, technology is seen as an enabler and facilitator of HBT.

On the other hand, technology may be detrimental to the development of HBT. In "The Social Life of Information", Brown and Duguid (2000) devote an entire chapter, entitled 'Home Alone,' to the slow growth of HBT. They argue that current technology is still so badly designed that users need to have other employees present in their vicinity so that a group of co-workers can share the load of learning and expertise required to get work done. Brown and Duguid (2000) point to the absence of both technical support and peer support within the home, and contrast this with the high level of technical and peer support that is necessary within office environments that have large amounts of IT (Strassmann, 1997). According to this view, it is the technology itself that is slowing the growth of HBT.

Technology could be both facilitating and hindering the development of HBT. Robey and Boudreau (1999) provide evidence that technology sometimes plays contradictory roles in organizational change. One pattern that they identify is when contradictory consequences result from the same technology in a single organization. An example appropriate to a home setting is when technology is used in a household and gives rise to both centripetal and centrifugal forces, resulting

in the technology holding the household together, but also tearing it apart (Avery & Baker, 2002).

Technology can also play a contradictory role when different organizational consequences result from the implementation of the same technology in comparable settings. An example is identical communication technologies being appropriated differently by different groups (DeSanctis & Poole, 1994). Robey and Boudreau (2000) suggest that "outcomes diverge because IT is implemented in different social contexts and through different social processes" (p. 56). With respect to technology used for HBT, the social contexts that could be relevant to its implementation are the HBT employee's household and workgroup(s), and the employer organization.

In this chapter, our aim is to report on a study into whether technology plays a crucial role in explaining the slow growth of telecommuting. Brown and Duguid (2000) provided no empirical data to support their proposition that technology is the major barrier to the growth of telecommuting. We describe a study that compares the impact of technology-related support with other, less-technological forms of employer support for HBT employees.

Regarding terminology, working from home using ICT has been studied under many names, and there are no generally accepted definitions of these phenomena (Duxbury, Higgins, & Neufeld, 1998; Sullivan, 2003). In the literature, terminology differs from study to study (Hill, Ferris, & Martinson, 2003) and the different terms are sometimes used interchangeably (Depickere, 1999; McCloskey & Igbaria, 1998). In this chapter, we use the terms "home-based telecommuting," "telecommuting," and "working from home" interchangeably.

Organizational Support for HBT

Although telecommuting has been studied extensively and practitioner reports on telecommuting suggest that employer support

can be facilitative, there is surprisingly little empirical research on attempts by organizations to facilitate HBT. A pioneering study by Hartman, Stoner, and Arora (1991) is the exception. Their study provides evidence that employer support increases the satisfaction of HBT employees. However, Hartman et al. (1991) did not examine the impact of different forms of support. They studied the "technical and emotional support" (reported as a single variable) provided by the "telecommuting supervisor" and found that it was significantly related to telecommuting satisfaction, but not to telecommuting productivity. Because technical and emotional support were not reported separately, it is not clear whether both technical and nontechnical support contributed to HBT satisfaction, although in a later paper both were related to satisfaction (Hartman, Stoner, & Arora, 1992). Also, only support provided by the "telecommuting supervisor" was assessed, leaving open the question of the effect of support provided by other sources, such as other managers, IT departments, and HR departments.

Here, we examine the impact of a range of employer support variables selected from three categories that differ in how closely related the support variables are to technology. We limit the scope of the study to variables for which evidence exists from practitioner reports or research studies of a relationship to employees' reactions to HBT.

The first category consists of variables that are directly related to the use of technology. One variable in this category is "IT support," that refers to assistance with technology-related problems and questions from the HBT employee. Lack of technical support has been mentioned as a contributor to the stress that some telecommuters report (Collins, 2005; Deeprose, 1999; Mann, Varey, & Button, 2000; Tan-Solano & Kleiner, 2001). A second variable is "appropriateness of the technology used at home," as this has also been mentioned in a number of studies (Fritz, Narasimhan, & Rhee, 1998; Hill, Miller, Weiner, &

Colihan, 1998). This variable measures the timely provision of suitable technological resources by the employer.

The second category consists of support variables that are somewhat related to technology use. "Training for HBT employees" is an example. Training generally involves instruction in technology use, but for the HBT employee, it may also include topics that are less technology centered, such as running a home office, occupational health and safety, and even organizational communication (Deeprose, 1999). Training that supports HBT can, however, be provided to people other than the HBT employee, rather than to the HBT employee. Some evidence suggests that the training of managers, coworkers, and household members for HBT can be facilitative (Davenport & Pearlson, 1998), although this is not a consistent finding (Felstead, Jewson, Phizacklea, & Walters, 2002); so, "training of others" provides a separate organizational support for HBT employees.

Another variable that is somewhat related to technology use is the provision of "financial support for HBT expenses." These expenses are commonly for purchasing HBT technology or for its running cost. It has been noted that HBT may just shift costs from the employer to the employee (Baruch, 2000). Costs incurred are frequently mentioned as a problem by employees who telecommute (Mann et al., 2000), and are a determinant of employee attitudes towards telecommuting (Iscan & Naktiyok, 2005). Robèrt and Börjesson (2006) propose that any savings from reduced office space and other operating costs occasioned by HBT should be passed on to those who HBT as compensation for the use of their homes. Not being able to ascertain reliably whether savings in office rent are actually achieved in a particular instance of HBT, we focused on the employer paying for any necessary modifications to the home to enable HBT.

The third category covers support variables that are unrelated to technology, that is, that

are nontechnological, but have been reported in the literature as being facilitative for HBT employees. A useful framework is provided by Depickere (1999), who argues that organizational structural changes should occur concurrently with the technological changes that support HBT. Examples are using empowerment as a management tool and developing more appropriate approaches to human resource management. One support variable in this category that has been found to be facilitative is employees feeling that they are "trusted by their manager" when they are working from home and not able to be observed directly by the manager (Davenport & Pearlson, 1998; Konradt et al., 2001). A second is "human resource department (HR) support" for the HBT employee (Alford, 1999; Deeprose, 1999). This would include anticipating the HR issues that could act as impediments, establishing policies and procedures for dealing with them, and assigning responsibility for HBT issues to a particular person within the HR department. A third variable in this category is "prior planning for HBT" on the part of the employer (Deeprose, 1999; Piskurich, 1998), which has been considered a success factor in introducing HBT in practical situations (e.g., Collins, 2005). In these cases, as part of decision making before commencement of HBT, the employer takes into account the individual needs of the employee and possibly those of other members of their household, the task, and the suitability of the employee's home for HBT.

Dependent Variables

We studied participant reactions to HBT from multiple perspectives, chosen to try to reflect some of HBT's different aspects and thus enhance our understanding of the relationship between organizational support and employees' reactions to HBT. The three measures were satisfaction, perceived productivity, and number of days per week spent telecommuting.

For this study, it is the HBT employees' satisfaction with their own work when they work from home that is of interest, rather than overall job satisfaction. Satisfaction is often used in research on remote and virtual work (e.g., Collins, 2005), and has obvious face validity as a measure of employees' reactions to HBT.

Perceived productivity when they work from home is the second measure used in this study. Studies of employees who work from home, on the whole, indicate that they perceive an increase in their own productivity (Belanger, 1999; Duxbury et al., 1998; Nilles, 2004), although this perceived productivity should not be interpreted as a measure of actual productivity because those who have volunteered for HBT may be biased in this judgment (Bailey & Kurland, 2002). That productivity increases under HBT was quantified empirically, showing a 23% increase in productivity for HBT staff over comparable office-based employees (Collins, 2005). Productivity is of particular interest for our research because the Hartman et al. (1991) study, mentioned previously, found no relationship between technical and emotional support and the telecommuters' perceived productivity.

In addition, a third measure, number of days per week spent telecommuting, is used in this study on an exploratory basis. This variable has been included in previous studies of HBT as a covariate, to assist with the understanding of observed relationships (McCloskey & Igbaria, 1998; Ramsover, 1985) or as a moderator (Raghuram et al., 2003), but in this study, we explore its use as a supplementary behavior-based variable to measure reaction to HBT. This is similar to the use of both objective and self-report measures when assessing the outcomes of technology implementations by Venkatesh and Johnson (2002), and the increased use of unobtrusive measures in other social-science research (Page, 2000).

We note that, since these three measures were included to reflect different aspects of HBT, the

relationships between a given support variable and the three measures might not be of equal strength.

Research Hypotheses

To summarize, in this study, we assess the impact of employer support that is classified as technology related, somewhat technology related or nontechnological on employees' reactions to HBT. Based on what the literature indicates as the most likely relationship, we postulated positive relationships between the organizational support variables and employees' reactions to HBT. More specifically, it is hypothesized that the three dependent variables described will be positively related to each of the following forms of support:

Technology related
H1a: Amount of IT support for HBT provided by the employer
H1b: Appropriateness of the technology used for HBT
Somewhat technology related
H2a: Amount of training related to HBT given to the HBT employee
H2b: Amount of training related to HBT given to others (the employee's manager, coworkers, household)
H2c: Extent of employer financial support provided for HBT costs
Nontechnological
H3a: Amount of prior planning for HBT in which the organization engaged
H3b: Amount of HR support provided for HBT by the employer
H3c: Amount of trust by the HBT employee's manager

Data Collection

A questionnaire-based approach was taken to testing the research hypotheses. The questionnaire was designed to obtain HBT employees' perceptions of organizational support provided to them and their reactions to HBT, as well as other relevant information including demographic characteristics and their use of HBT technology.

Sampling Procedure

To ensure the participants had a reasonable amount of experience with HBT, the first sampling requirement was that respondents must be full-time employees who work from home on a regular basis and have been working from home for at least 3 months. This "intensity" sampling entails selecting "participants who are experiential experts and who are authorities about a particular experience" (Morse, 1994, p.229).

Eligibility for participation was based on both location of the work and characteristics of the work. Home-based working is often differentiated from work performed in satellite offices, neighborhood work centers, and mobile working (Konradt et al., 2001; Kurland & Bailey, 1999). The European Teleworking Office (ETO), in addition, separates supplemental work (taking home extra work after hours), mobile working (e.g., from the car or clients' offices), and being self-employed from home-based working (European Teleworking Online, 2000). ETO also uses a relatively stringent criterion in terms of the regularity of home-based working, that employees work from home at least 1 day per week. Because we were interested in understanding the impact of organizational support on those who telecommute regularly, we adopted their more stringent criterion. We adopted the criterion of working from home for at least 3 months from Igbaria and Tan (1998), and used the official Australian definition for separating part-time from full-time employees (that they work 20 hours or more per week). The questionnaire defined "working from home" thus: "We use the term *working from home* to mean working at your home for your organization. It does NOT mean working at a client's site or at any location other than your home."

We also limited respondents to those in professional roles. There is evidence of differences between professionals and operative workers who work from home, which suggests that the two groups need to be studied separately (Felstead et al., 2002; Haddon & Brynin, 2005; McCloskey & Igbaria, 2003). Professionals were selected as being more typical of the employees referred to in Brown and Duguid (2000).

The requirements were set out on the front of the questionnaire:

1. Work for your employer for 20 or more hours per week
2. Work from home at least 1 day per week in general
3. Have been working from home for 3 months or more
4. Are in a professional role

If a potential respondent did not meet all these criteria, s/he was asked to pass the questionnaire on to a colleague who did.

A second sampling requirement was that employer organizations should be sufficiently varied that a range of HBT support variables could be included in the study. In any case, selection of organizations could not be random because so few people work from home, and because it is difficult to locate organizations that have many HBT employees (Lindorff, 2000). So that organizations with contrasting approaches to HBT support would be included, we contacted a wide range of organizations. These were organizations that had been rated as the "Best Employers to Work for in Australia" (Hewitt Associates, report released April 2002), organizations selected from *Business Review Weekly's* 25 largest employers in Australia, major public-sector organizations, and smaller organizations from both the private and public sector that were not on any of the previous lists.

To satisfy the sampling requirements, a three-step procedure was adopted: organizations were selected, each of their HR departments was asked to identify employees who work from home to the researchers, and then the researchers mailed questionnaires to those employees. By dealing with respondents directly, we protected their identities from their employers, as ethical guidelines required. Questionnaires were anonymous and were returned directly to the researchers.

In total, the HR departments of 101 organizations in Australia were approached, of which 20 organizations were able to identify HBT employees to us. These organizations were from a variety of industries and sectors and were of varying sizes. Within them, 130 questionnaires were distributed over a 6-month period, which provided 50 usable questionnaires.

Measures

The measures were all obtained from items on the questionnaire. Demographic and HBT information included age, gender, tenure with this organization, who initiated the decision to work from home, how long respondents had been working from home for this organization, and whether they wished to continue to spend about the same amount of time working from home. Regarding technology use when working from home, we asked which technologies respondents use, whether they access their organization's computer system, and, if so, how easy that is to do.

For the satisfaction and perceived productivity measures, we drew upon measures used by Staples, Hulland, and Higgins (1999) for employees working remotely from their managers. Satisfaction and Perceived Productivity were measured using 5-point scales, coded so that higher scores represented more satisfaction and productivity. On the HBT Satisfaction scale, two items dealt with employees' satisfaction with how they were managed, one with satisfaction with hours of work, and one with variety in the job. A fifth item was added to the Staples et al. (1999) scales that asked directly how satisfied

the respondent was with working from home. The Perceived Productivity scale consisted of four items that dealt with effectiveness, efficiency, productiveness, and quality. For the third dependent variable, respondents reported on whether they spent one, two, three, four, or "five or more" days per week working from home, these options being coded with the corresponding values, 1 to 5.

The eight organizational support scales were developed specifically for this study, as suitable measures were not available from the literature. Items for the following five were presented in a single section: *IT-Support*, *Appropriateness-of-Technology*, *Planning-for-HBT*, *HR-Support*, and *Trust-by-Manager*. Each scale initially consisted of three items, but one of the *Planning-for-HBT* items was removed from the calculation of this scale to increase the Cronbach reliability

coefficient. Items for these five scales are shown in Appendix A. Responses to the 5-point rating scale, ranging from Strongly Agree to Strongly Disagree, were coded for each item on a scale of 1 to 5, with a higher score representing a greater amount or quality of that type of support.

Questions about HBT-related training provided by the employer were grouped within the questionnaire. Respondents reported on training for using the technology, other HBT training they had received, and on whether their manager, coworkers, or people in their household had received any training related to their HBT. Two scales were constructed, one for "training received by the employee," the second for "training received by others." Means were calculated for the responses to the four items listed in Table 1 (A) that formed the scale for employee training. (The item "managing others in the household"

Table 1. Training related to HBT and employer financial support for HBT costs

A. Has your organization provided you with training in any of the following areas related to working from home? (please tick all that apply)

Using the technology = 42%
Managing others in household = 0%
Running a home office = 4%
Occupational health and safety = 30%
Organizational communication = 6%

B. To what extent has your organization provided training that is relevant to your working from home to the following people ? (tick the most appropriate box in each case):

	Extensive	Moderate	Minimal	No training
Your manager	0%	11%	6%	83%
Your coworkers	0%	8%	11%	82%
People in your home	0%	2.5%	5%	92%

C. Who pays for the various costs incurred in working from home? (Please tick the most appropriate box in each case)

	I do	some me, some org	my organization
Who pays running costs?	12%	46%	42%
Who owns (leases or finances) the technology?	6%	40%	54%
Who pays for repairs?	8%	30%	62%
Who paid home modifications? (N/A 18%)	30%	22%	30%

was not included, as no respondents reported receiving this type of training.) For each item, a "yes" was coded "1" and a "no" was coded with a zero. For the scale "training received by others," responses to the three items shown in Table 1 (B) were averaged. These items were coded as follows: Extensive = 4; Moderate = 3; Minimal = 2; and No training = 1.

A separate scale was constructed to measure the perceived extent of employer financial support for HBT costs. Items were based on whether the employee, the organization, or both, paid for various costs. A scale, Organization-Pays, was formed as the average of responses to the four items listed in Table 1 (C). Responses to these items were coded as "I do" = 1; "some me, some org" = 2; and "my organization" = 3.

Results

Table 2 gives the demographic characteristics for the sample. Respondents were mainly from private sector organizations (42 out of 50). Females comprised 82% of our sample, which is consistent with other studies reporting that women are more likely to telecommute (Belanger, 1999; Iscan & Naktiyok, 2005; Lindorff, 2000). In our sample, 65% were aged in their 30s. An Australian Bureau of Statistics survey (2002) also found that the most common age group for remote workers was 35-44 years. Seventy percent had worked for their organization for 4 or more years. Barnes (1994) reported that those who work from home tend to be long-serving employees, consistent with our sample.

The results confirmed that our respondents worked from home on a regular basis and were experienced with this mode of work. Table 2 shows that 68% worked from home more than the eligibility criterion of 1 day/week. They had also persevered with HBT: Seventy percent have been working from home for their employer for at least 1 year. Thus, they might be familiar with the technology they are using at home, and be less de-

pendent on technology support than an employee who has just started to work from home.

Generally, respondents had initiated the decision to work from home themselves (84%), rather than it being mandated by their employer, and most (60%) preferred to continue spending about the same amount of time working from home as they currently did, with another 30% preferring to increase the amount of time a little.

With respect to technology use, almost all the respondents used e-mail and telephone, and about 70% used Internet and laptops when telecommuting. Respondents clearly were linked by technology to their employer: 98% replied "yes" to a question about needing to access their organization's computer system when telecommuting, and 92% reported it to be either extremely or quite easy to do. Thus, respondents did use technologies extensively while telecommuting.

Results for training are given in Table 1 (A) and (B). Training provided to HBT employees was mostly for using technology (42%), sometimes for occupational health and safety (30%), and for very little else. It was rare for training to be provided to anyone other than the HBT employee.

Table 1 (C) indicates considerable employer financial support for HBT expenses. Except for costs relating to home modifications, fewer than 12% of respondents paid for their own HBT costs. Even for home modifications, only about one third of the sample reported bearing the entire cost themselves, and the employer paid in an equal proportion of cases.

Table 3 shows the descriptive statistics for all the scales. With respect to reliability, 9 of the 10 scales yielded adequate Cronbach alpha coefficients. Cronbach alphas for the *Satisfaction* and *Perceived Productivity* scales (.73 and .87, respectively) were acceptably high. Four of the organizational support scales had alpha values above the generally accepted value of about .70, and three were marginally below this value. One of the scales, *Appropriateness-of-Technology*, had an alpha coefficient of only .46. However, inspection

Table 2. Descriptive statistics for the sample

No. of respondents from various types of organizations:
Best Employers = 14, Largest Private = 5, Other Private Sector = 23
Public Sector = 8, Total = 50

Age:
Less than 30 = 4%, 30-39 = 65%, 40-49 = 18%, 50-59 = 10%, 60+ = 2%

Gender:
male = 18%, female = 82%

Length of time working for this organization:
Less than 1 year = 6%, 1-3 yrs = 24%, 4-10 yrs = 40%, over 10 yrs = 30%

On average, number of days per week work from home:
1 = 32%, 2 = 26%, 3 = 10%, 4 = 14%, 5 or more = 18%

Who initiated the decision for you to work from home?
I initiated it = 84%, Someone else in org = 14%, Other =2%

Would you prefer to increase or decrease the amount of time you spend working from home?
Decrease it a lot = 0%, Decrease it a little = 8%, Continue about the same = 60%,
Increase it a little = 30%, Increase it a lot = 2%

How long have you been working from home for this organization?
Less than 1 year = 30%, 1-5 years = 62%, more than 5 years = 8%

Do you ever need to access your organization's computer system when working from home?
Y = 98%, N = 2%
Of those that do, *How easy is it for you to access the organization's computer system:*
Extremely easy = 46%, Quite easy = 46%, Quite difficult = 8%

Which technologies/services do you use for work purposes when working from home?
(tick all that apply):
Desk top computer = 38%, Internet = 74%, Pager = 4%, Mobile phone = 60%,
Laptop = 70%, E-mail = 96%, Telephone = 92%, Facsimile = 48%

Table 3. Cronbach alphas, means and standard deviations for variable scales

Scales	Cronbach alpha	**Mean**	**S.D.**
Satisfaction	.73	4.07	0.68
Perceived-Productivity	.87	4.60	0.49
IT-Support	.74	4.34	0.64
Appropriateness-of-Technology	.46	4.17	0.67
Training –Employee	.62	0.20	0.26
Training -Others	.86	1.23	0.55
Organization-Pays	.79	2.36	0.56
Planning-for-HBT	.75	3.17	1.57
HR-Support	.63	3.68	0.93
Trust-by-Manager	.64	4.40	0.67

of the items comprising this scale suggests that this might be more appropriately regarded as a formative rather than a reflexive scale, with the three items representing different facets or aspects of the construct, rather than being indicators reflecting a single construct (see Edwards & Babozzi, 2000, for a discussion of the distinction between these two types of scales). As a formative scale, its adequacy does not rely on positive associations between its component items, or on a high value of the Cronbach alpha coefficient. Thus, despite the low measured value of its Cronbach alpha coefficient, the *Appropriateness-of-Technology* scale was included in the analysis.

With respect to the first category, technology-related support variables, our respondents evaluated the IT support they received and the technology they were using positively. On a 1-5 scale, where 5 was strongly agree, the mean for the *IT-Support* scale was 4.34, and for the *Appropriateness-of-Technology* scale was 4.17.

Construction of the scales and results obtained on the training and financial support variables, which are from the second category that was somewhat technology-related support variables, have already been reported. No items needed to be removed from these scales on the basis of examining the scale's reliability. Note that means are reported for these scales in Table 3 for completeness, but are not based on a 5-point rating scale, and should therefore not be compared to the means reported for the other support scales.

For the third category, nontechnological support, the variables were all measured on a 1-5 scale where 5 was strongly agree. The three variables yielded quite different means—*Planning-for-HBT (3.17)*, *HR-Support (3.68)*, and *Trust-by-Manager (4.40)*. Thus, *Trust-by-Manager* was evaluated more positively than the other two variables.

The results for Satisfaction and Perceived Productivity indicate that the respondents had positive reactions to HBT. Mean satisfaction was 4.07, on a scale of 1-5, where 5 was very satisfied. On a 1-5 scale, where 5 is strongly agree and represents

high perceived productivity, the mean rating was 4.60. Respondents' positive evaluation of HBT on these measures is consistent with their perseverance with HBT and their preference for spending at least the same amount of time working from home in future, as reported previously.

Correlations and Hypotheses Testing

Table 4 shows the correlations between the organizational support variables and the dependent variables. (Note that for tests of statistical significance, one-tail tests were used because of the directional nature of the hypotheses.) Partial correlations between these variables were also calculated, controlling for age, gender, tenure with this organization, and how long respondents had been working from home for this organization. For correlations with satisfaction and perceived productivity, number of days/week spent telecommuting was also included as one of the control variables, as was done in previous, similar HBT studies (McCloskey & Igbaria, 1998; Ramsover, 1985). Comparison of the partial and zero-order correlations showed only minor differences in magnitude, generally in the order of .05. All statistically significant zero-order correlations remained statistically significant. To save space, therefore, only the zero-order correlations are reported in this chapter.

Three of the support variables were significantly related to both *Satisfaction* and *Number of days/week spent telecommuting*, which suggests that they have broader impact on employees' reactions to HBT than the other support variables. They were *IT-Support* and *Appropriateness-of-Technology*, which were the two technology-related variables, and *Trust-by-Manager*, one of the nontechnological support variables.

Technology-related support does appear to be crucial for HBT, as proposed by Brown and Duguid (2000). However, at least one nontechnological support variable provided to the employee, manager's trust, also has comparable impact.

Table 4. Correlations between organizational support and reactions to HBT

Reactions to HBT:	Satisfaction	Perceived Productivity	No. days/wk HBT
Organizational Support:			
Technology-related variables			
IT-Support	.356**	.031	.347**
Appropriateness-of-Technology	.300*	.178	.392**
Somewhat related to technology			
Training–Employee	.187	.107	.098
Training–Others	.421**	.052	.072
Organization-Pays	.128	.291*	.231
Nontechnological variables			
Planning-for-HBT	.196	.092	.102
HR-Support	.304*	.213	.043
Trust-by-Manager	.374**	.192	.334**

* p <.05, 1-tailed   ** p <.01, 1-tailed

The overall results indicate that technology has a major effect on employees' reactions to HBT, but support that is more closely related to technology does not have more impact than support that is less closely related to technology. Thus, other factors also appear to be important.

Table 4 also shows that three of the employer support variables related to only one dependent variable, but it was not the same dependent variable in each case. *HR-Support* and *Training-Others* were related only to *Satisfaction*, *Organization-Pays* was related only to *Perceived-Productivity*.

Table 5, which shows the correlations amongst the three dependent variables, provides a possible explanation for these divergent relationships. There was a statistically significant correlation between *Satisfaction* and *Perceived-Productivity*, and between *Satisfaction* and *Number of days/week spent HBT,* but not between *Perceived-Productivity* and *Number of days/week spent HBT*. The correlations were not high, however, suggesting that the three measures do represent different aspects of HBT.

Perceived-Productivity also differs from the other two dependent variables in how it relates to the support variables. *Perceived-Productivity* related only to *Organization-Pays*, and not to the other support variables. Thus, when the organization pays more of the HBT costs, employees rate their HBT productivity more highly.

Satisfaction and *Number of days/week spent HBT* were more similar to each other in their relationships to the support variables: *IT-Support*, *Appropriateness-of-Technology* and *Trust-by-Manager* were significantly related to both.

The combined effect of the organizational support variables on each of the three dependent variables was evaluated by calculation of multiple correlation coefficients. Multiple correlations of the eight support variables with *Satisfaction*, *Perceived-Productivity,* and *Number of days/week spent HBT*, were .58, .41, and .51, respectively. Thus, *Satisfaction* and *Number of days/week spent HBT* were more strongly predicted by the combined effects (34.0% and 25.9% of variance explained, respectively) than was *Perceived-Productivity,* for which only 16.9% of the variance was explained. This suggests that organizations may be more able to influence *Satisfaction* and *Number of days spent HBT* than *Perceived-Productivity* through the support given to HBT employees.

Table 5. Correlations amongst the three dependent variables

Scales	Perceived Productivity	No. days/wk HBT
Satisfaction	.326*	.244*
Perceived Productivity		.171

* p <.05, 1-tailed ** p <.01, 1-tailed

Planning-for-HBT and *Training-Employee* were not related to any of the dependent variables. Training in using technology, a component of the *Training-Employee* scale, was also not related to any of the dependent variables.

Table 6 shows the correlations amongst the various organizational support scales. It indicates that these scales are all positively related, with most of the correlations statistically significant at the .05 level. The highest correlation was between the two technology support scales, *Appropriateness-of-Technology* and *IT-Support*, and each of these was related to five of the other support scales. Thus, in this sample, an HBT employee who received technology-related support was also likely to be receiving other forms of organizational support for HBT.

Discussion and Implications

In the study described, we examined the relationship between employees' reactions to HBT and organizational support variables that differed in how closely they relate to technology use, in a sample of experienced HBT employees. The results indicated that some types of organizational support have a broader impact than others. Having sufficient IT support, appropriate HBT technology, and being trusted by the manager were all related to both satisfaction and to spending more days/week working from home. Two of these support variables are technology-related and one is nontechnological.

With respect to our research question, whether technology plays a crucial role in explaining the slow growth of telecommuting, our study therefore leads to the conclusion that, even for experienced HBT employees, the technology-related support they receive influences their reactions to HBT. Thus, technology does still play a crucial role in HBT. This conclusion is consistent with the position of Brown and Duguid (2000), that it is the HBT technology that is slowing the growth of HBT. It is supported by an in-depth study of

Table 6. Correlations amongst organizational support scales

Scales	1	2	3	4	5	6	7
1. IT-Support							
2. Appropriateness-of-Technology	.604**						
3. Training – Employee	.189	.284*					
4. Training – Others	.257*	.139	.396**				
5. Organization-Pays	.253*	.375**	.225	.098			
6. Planning-for-HBT	.286*	.465**	.508**	.149	.162		
7. HR-Support	.405**	.522**	.497**	.358*	.188	.534**	
8. Trust-by-Manager	.519**	.342**	.133	.208	.147	.121	.236

*p <.05, 1-tailed ** p <.01, 1-tailed

HBT at Lloyd's of London, showing that the effectiveness of the ICT adopted influences employee perceptions of HBT (Collins, 2005).

However, the results for the three categories of support variable studied (technology-related, somewhat technology-related, nontechnological) do not indicate that support that is more closely related to technology affects reactions to HBT more than support that is less closely related to technology. Therefore, our overall results are more consistent with the predominant view in the telecommuting literature, which is that a broader, multifactor approach is more appropriate for understanding HBT than the study of single factors.

It was surprising that Brown and Duguid (2000) took a single-factor approach to explaining HBT after nearly 2 decades of wide-ranging research into HBT, and it was also surprising that technology-related support emerged as an important factor in our study, which was limited to experienced HBT employees. The impact of technology had been ignored in recent years as researchers focussed on other categories of factors. These other categories can be grouped into those relevant to the individual, their household, their manager, their work-groups, and their organization. The factors from each of these categories are likely to be influenced by factors from another category; for example, an organizational culture in which managers are expected to share information and delegate decision making is likely to influence the manager's attitude towards HBT and also the design of jobs within that organization. There are also likely to be flow-on effects within the workgroups when an employee begins to work from home; for example, increased structure may be required to replace chance encounters and informal discussions (Pearlson & Saunders, 2001), although the extent of effects is likely to depend on how many days per week employees telecommute and the proportion of employees who telecommute (Bailey & Kurland, 2002). In addi-

tion, there may be multiple, contradictory impacts of HBT, as examined in the next section.

Contradictory Impacts of HBT Technology

A more encompassing view of HBT technology, in line with the suggestions of Poole and Van de Ven (1989) and Lewis (2000) that opposition should be incorporated in explanations, is that technology both facilitates and hinders the growth of HBT. Technology has been shown to play contradictory roles, when differing consequences result from the implementation of the same technology in a single organization (Robey & Boudreau, 1999), and when it is implemented in different social contexts (Robey & Boudreau, 2000). We now provide three illustrative examples of how technology could have contradictory impacts on HBT outcomes.

The question of how HBT employees are able to work at home alone without the technical and peer support that Brown and Duguid (2000) argue is necessary provides the first example. Recall that our respondents were largely long-serving employees who can be assumed to have absorbed both technology expertise and their organization's culture. It has been reported that some organizations require a minimum number of years of working with the company before an employee is allowed to telecommute (Barnes, 1994; Kraut, 1989). Thus, organizational tenure may provide experience in solving technological problems that substitutes, to some extent, for technical and peer support. This substitution effect, the overcoming of the usual negative consequences of a "discontinuity" by factors from a different level within a complex situation, has been identified by Watson-Manheim, Chudoba, & Crowstow (2002) in other virtual work environments.

A second example of apparent contradiction concerns the importance of manager's trust in satisfaction with HBT that we and others

have found. On the one hand, this indicates that managers need to pay more attention to building relationships and trust with HBT workers (Gerke, 2006). At the same time, other research is indicating that HBT increases employee autonomy and, consequently, lessens the manager's importance in the employee's professional concerns (Dambrin, 2004). The effects of professional status and hierarchy are also reduced, as technology facilitates communication across levels. This raises the question of how salient relationships with managers are in HBT, particularly when appropriate accountability measures are in place.

The third example builds on a recent study of IBM employees who, in contrast to most HBT employees that have been studied, considered their home as their primary work site (Hill et al., 2003). These IBM employees held an optimistic view of their opportunities for career advancement, which is also contrary to most other studies (McCloskey & Igbaria, 2003). Hill et al. (2003) suggest that HBT has been used so extensively and for so long in IBM that these arrangements have become normalized. Apparently, IBM provides a different social context for HBT from most other organizations.

In summary, we have suggested that technology be viewed as both facilitating and hindering the development of HBT, and provided examples of contradictory impacts on HBT outcomes. This approach is consistent with calls to consider the broader context for IT generally (e.g., Robey & Boudreau, 1999) as well as for HBT specifically (e.g., Baruch, 2000; Raghuram et al., 2001).

Managerial and Research Implications

In practice, understanding the technological and other factors that facilitate or impede HBT is important, particularly given the expectations about workplace trends of senior executives in North America and Europe. A survey revealed that these executives expect information technol-

ogy to enable growth in more distributed and collaborative working, including HBT (Barber, Laing, & Simeone, 2005).

Our study contributes to the understanding of how employer organizations can assist their HBT employees. The results indicate that technology-related, as well as nontechnological support, can influence reactions to HBT, extending earlier findings in a number of ways. Hartman et al. (1991) found that technical and emotional support was related to telecommuting satisfaction but not to perceived productivity. We measured technical and emotional support as three separate variables (as IT-Support, Appropriateness-of-Technology, and Trust-by-Manager) and confirmed the Hartman et al. (1991) findings, in that each of these three variables was significantly related to satisfaction, but not to perceived productivity.

The results also increase our understanding of influences on employee assessments of HBT. Perceived productivity was related to only one of the support variables, the organization paying some HBT costs. This form of support may signal serious organizational support to HBT employees. Our analysis of the combined effects of the support variables on each of the three dependent variables indicates that organizations are more able to influence satisfaction and number of days spent telecommuting than perceived productivity. In any case, the three measures do seem to reflect distinct aspects of HBT, and this should be taken into account when managing HBT employees and in future research on HBT.

Number of days/week spent telecommuting was introduced in this study on an exploratory basis as a possible behavior-based measure of employee reactions to HBT to supplement the two ratings-based measures. It was found to have a low (.244) but significant correlation with satisfaction, and to be somewhat similar to satisfaction in terms of its relationships with support variables. It would therefore appear to be a useful supplementary measure of reactions to HBT in situations where the employees have some discretion over HBT

decisions. The degree of discretion should be assessed directly in future telecommuting research involving professionals, who apparently do have more choice of work location than operative workers who telecommute (Felstead et al., 2002; McCloskey & Igbaria, 2003).

Our study also indicates that organizations wanting to support positive HBT relationships may need to change their focus. Currently HBT employees appear to be provided with technology and about 42% with training in the use of the technology. Our results indicate that ongoing IT support and emphasis on the appropriateness of the technology are both particularly important to HBT employees, consistent with previous studies. In addition, there seems to be symbolic value attached to the financial support provided to cover the extra expenses incurred when working from home, and many employers appear to recognise this. Positive relationships were also found for the feeling that managers trust HBT employees when the latter are working from home, and for support from the HR department.

Our results for training may surprise IT and training departments. Employee training in its current forms was not related to any of the dependent variables, and training in using technology, which was measured as a separate component, was also not related to any of the dependent variables. Less than half the sample received HBT-related training, and the training that was provided had a narrow focus on using technology or occupational health and safety, rather than on broader issues such as how to communicate with the office more effectively or how to manage other members of the household. Our findings on training suggest that employers should explore a broader approach to HBT training, and research should be carried out on the relation of this training to HBT reactions.

The results also point towards extending training to the nontelecommuting employees and managers who work with the telecommuters. We found that it was rare for training to be provided to anyone other than the telecommuting employee, although practitioner reports suggest that companies that have successful HBT programs train both the potential HBT employees and their managers to deal with the changes HBT brings to working conditions and relationships (Deeprose, 1999). Kurland & Cooper (2002) also found that telecommuting training was sparse, even though HR personnel held a contrary belief, and these researchers recommended more adequate training of the HBT employees, their managers, and their coworkers. For our sample, training of others was related to HBT satisfaction, and, in fact, had the highest correlation with satisfaction of any of the support variables. Although these correlations were based on small numbers because few nontelecommuters received training, it appears that when training of others does occur it has a considerable effect, reinforcing the advice from the practitioner literature.

Although HR managers are regarded as prime decision-makers in whether HBT should be adopted (Pérez, Sánchez, & de Luis Carnicier, 2003), we suggest researchers approach the IT departments, in addition to HR departments, to locate HBT employees. When information about HBT is centralized within an organization, it is more likely to be in the department supplying the technology infrastructure. It is also the IT department that needs to be made aware of the importance of broader approaches to training, and of the need to provide nontechnological, as well as technology-related support for HBT employees. It is encouraging that employers providing technology-related support in our study were likely to provide some nontechnological support as well.

Given indications of possible gender differences in how telecommuting is done (Haddon & Brynin, 2005; Tremblay, 2003), we also suggest that gender differences should be examined within a broader framework. There were no statistically significant gender differences for the variables we studied, but this may not be a reliable result,

given the preponderance of females (82%) in the sample, and findings that gender, combined with stage of the life cycle, predict HBT experiences better than gender alone (Ammons & Markham, 2004). Examining telecommuters' motivations and concerns, Mokhtarian, Bagley, and Salomon (1998) found that women rated the advantages of telecommuting more highly, were more likely to have family, personal benefits, and stress reduction as motivations for telecommuting, and to have concerns about lack of visibility to management. However, this is also contentious, given more recent findings that men and women do not differ in their motives for engaging in HBT (Tremblay, 2003), and that employers' requirements, rather than work-family demands, explained the majority of HBT in a Canadian study (Tremblay, Paquet, & Najem, 2006). In general, HBT employees are concerned about the impact on their careers (McCloskey & Igbaria, 2003).

Organizations intending to support their HBT employees should try to do so in a way that addresses these potential disadvantages. Recent literature suggests that doing so will benefit both male and female employees and the employer. Hill et al. (2003) found that the IBM employees they studied held an optimistic view of their opportunities for career advancement, and suggested this was because HBT arrangements have become normalized within IBM. Stavrou (2005) reported that there has been a shift during the past decade among employees towards desiring a better balance for their work and nonwork responsibilities, and that providing home-based work and teleworking options was related to improved organizational performance and reduced absenteeism. Furthermore, addressing employee concerns about HBT may open employment opportunities for disabled people and others currently excluded from the labor market (Baker, Moon, & Ward, 2006; Kaplan, Weiss, Moon, & Baker, 2006).

Finally, as advances are made in the technology used by telecommuters, the importance of technology-related support relative to other organizational supports may change. Communication between HBT employees and others is likely to be improved by changes to transmission media and the technology used in the home. However, it is not clear whether this will increase or decrease the role of technology in HBT, so it will need to be studied at the time.

Limitations and Future Research

The main limitation was the small number of respondents, due to the difficulty of locating full-time employees who telecommute on a regular basis. Although this difficulty is likely to remain, future researchers are advised to seek respondents via an organization's IT department rather than just through HR. Also, our results are limited to those who are in a professional role, and may be different for nonprofessionals.

In addition, our study was based on employee perceptions rather than on direct evidence. Further studies could utilize direct measures of the existence and quality of training programs, financial support and other support variables, as well as level of productivity. Also, this study could only capture the reactions of the HBT employees at one point in time. To better understand the adaptations that telecommuters, their households, and their coworkers go through, research should be conducted longitudinally.

A further limitation is that, although we included variables relating to HBT that are commonly reported in the academic literature and practitioner reports, additional variables could be studied in future. The four factors identified by Baruch (2000), the telecommuting interface, job, individual, and organization, provide a useful framework for exploring them. Thus, telecommuting interface variables could include the characteristics of the household, number and ages of any children, and whether there is sufficient space for HBT. Job variables might include the interdependence of the work,

provision of feedback, and the career paths available. Individual variables could be personal characteristics, work motivations, and preferred work-style. Organization variables might cover the culture, management style, and policies related to HBT.

Finally, future studies could examine some of the contradictory relationships between individual variables and satisfaction with HBT following recent research indicating that the relationship between the amount of HBT and satisfaction could be U-shaped. Supporting this hypothesis, results from a sample of 321 professional employees suggest that satisfaction plateaus at more extensive levels of HBT (Golden & Veiga, 2005). Here some of the isolation and other negative aspects of HBT may dominate satisfaction. In addition, the nature of the relationships between HBT employees and their managers, coworkers, and family should be included in future studies, given their curvilinear relationship with HBT satisfaction (Golden, 2006).

CONCLUSION

While technology is generally acknowledged as an enabler of telecommuting, it has also recently been blamed for the slow growth of home-based telecommuting (Brown & Duguid, 2000). In this chapter, we examined the role that technology currently plays when employees work from home on a regular basis. We reported on a study that compared the impact of employer support variables, which differed in how closely they related to technology use, on employees' reactions to HBT. Two technology-related support variables (IT support and appropriate technology) and being trusted by the manager were significantly related to both satisfaction and number of days/week spent telecommuting. Thus, even for experienced HBT employees, technology-related support has a broad effect on their reactions to HBT. This indicates that technology does still

play a crucial role in home-based telecommuting, which is consistent with the argument of Brown and Duguid (2000). However, in contrast to their single-factor approach, the overall pattern of results indicates that HBT is better understood within a multifactor framework that acknowledges that HBT takes place within a complex social and organizational context. We suggested adopting a more encompassing view, namely that technology both facilitates and hinders the development of HBT. This approach encourages studies that help us to better understand the contradictory role of technology, and may thus lead to improved employer support for HBT employees.

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APPENDIX A

Items for the five organizational support scales given next were presented to respondents in a single section, in mixed order. For the formation

of summative scales, items indicated by "(Rev)" were reverse coded.

IT-Support

- I receive as much technological support as I need when working from home.
- The quality of the technological support I receive when working from home is not high. (Rev)
- When I have a technology-related query from home, someone in the organization is always accessible.

Appropriateness-of-Technology

- My organization provides me with appropriate technological resources to do my work at home successfully.
- My organization responds promptly to my requests for technological resources (e.g., fax, mobile phone).
- The technology I use when working from home is not easy to cope with. (Rev)

Planning-for-HBT

- My organization did not assess my home for its suitability for working from home. (Rev)
- My organization ordered me to start working from home. (Rev) [removed]

- My organization assessed my work and personal needs prior to me starting working from home.

HR-Support

- No specific person in my organization is responsible for the people side of working from home. (Rev)
- The quality of the support for the people side of working from home that I receive is not high. (Rev)
- I receive as much support as I need to resolve issues related to working from home when they arise.

Trust-by-Manager

- My manager doesn't think I slacken or goof off when I'm working from home.
- My manager worries that I am not getting on with the job when I work from home. (Rev)
- My manager is trusting me more and more as I continue to work from home.

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