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Knowledge Management, Organizational Memory, and Transfer Behavior

Global Approaches and Advancements

Murray E. Jennex

Knowledge Management, Organizational Memory, and Transfer Behavior:
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This short chapter focuses on two key issues, the relevance of KM to information systems research and the risk of KM becoming a fad like business process reengineering. The role of the integrator is introduced and the idea that KM is the solution to the productivity paradox is discussed. The chapter concludes with a discussion on the future of KM and proposes that KM can be the bridge to the knowledge society.

The aim of this chapter is to identify some of the gaps in the current body of knowledge about KM and in doing so to suggest extensions to its frameworks and to areas of investigation that build on its strengths. The authors propose a simple framework for what is termed Knowledge Fusion.

This chapter explores the concept of 'tacit knowledge' and how organizations can foster the sharing and exchange of tacit knowledge. Various views of tacit knowledge are discussed and a framework is developed distinguishing different conceptualizations of knowledge and how different types of knowledge are acquired, held in memory, and manifested. An understanding of these distinctions can aid in determining the best approach for transferring tacit knowledge and skills at the individual and organizational levels. Finally, I review various tacit knowledge transfer approaches based on the distinctions identified in the framework and discuss their suitability for different aspects of tacit knowledge transfer.

This chapter adds to our understanding of KM as an evolving body of concepts, relationships, strategies and practices. Using qualitative research methods, we examined activities of a community of practice for knowledge management professionals operating in a large metropolitan U.S. region. Accordingly, we produced an organizing framework that maps KM topics according to the tactical-strategic orientation of the KM issue and level of analysis (individual-group-enterprise). We constructed and populated the framework based on a content analysis of forty-four presentations made from 2001-2005, from survey data, from interviews conducted with key informants, and from data collected as participant-observers. The work provides insight into the decision-making processes of stakeholders with competing interests and adds to our understanding of collective sensemaking in a community of practice. From the data, we generated a framework that can be used by practitioners to allocate resources for KM activities, technologies, and projects.

Just as Porter's value chain model identifies classes of business activity that can be performed in ways that contribute to a firm's competitiveness, the knowledge chain model contends there are classes of KM activity that can be performed in ways that enhance firm competitiveness. These KM activities pervade the value chain, being inherent in the implementation of each value chain activity. Derived from a collaboratively engineered ontology of knowledge management, the knowledge chain model is supported by anecdotal evidence and a survey has found support for the propositions that its activity classes are linked to enhanced productivity, agility, innovation, and reputation. Here, we present a study of leaders of KM initiatives that examines each of the nine knowledge chain classes in terms of its competitive impact and the extent to which its positive impact on competitiveness is associated with the importance of technology in performing activities within that class. The study provides confirming evidence that each of the knowledge chain activity classes can be performed in ways that contribute to competitiveness. Moreover, we find that for five of the activity classes there is a significant positive correlation between impact on competitiveness and the importance of computer-based technology in implementing the class's activities.

A knowledge management system (KMS) project transcends functional departments and business partners. The success of KMS implementation is highly contingent upon a well-orchestrated integration of multiple systemic contexts, such as communication channels, user involvement, power structure among stakeholders, corporate culture, project champion, interorganizational networks, etc. These organizational factors are embedded throughout the life cycle of a KMS project and within an organization. Understanding the influences of these organizational factors to the success of KMS projects can provide lessons for systems developers and management to increase the success rate of system implementation. The study is based around AMC, a major Taiwanese motor company faced with the challenge of deploying a knowledge management system. Over a period of 3 years (1999-2002) structured interviews were conducted to examine organizational factors contributing to the success of KMS efforts in AMC. The major emphasis of this chapter is to apply the concepts of structuration theory to assess the interaction of corporate management with users of a knowledge management system. The findings suggest that management and users must be engaged in a sustained and reciprocal communication method when implementing a KMS. The pattern of communication, power structure, sanction power, and degree of cooperation are dynamically changed during the interaction process. Therefore, it is important to maneuver these factors into a win-win situation for management and users to successfully implement a KMS. Practical implications resulting from this research provide feasible real solutions to improve the relationship between users and management during a KMS implementation.

This chapter explores KM and KMS success. The inspiration for this chapter is the KM Success and Measurement minitrack held at the Hawaii International Conference on System Sciences in January of 2007 and 2008. KM and KMS success are issues needing to be explored. The Knowledge Management Foundations workshop held at the Hawaii International Conference on System Sciences (HICSS-39) in January 2006 discussed this issue and reached agreement that it is important for the credibility of the KM discipline that we be able to define KM success. Additionally, from the perspective of KM academics and practitioners, identifying the factors, constructs, and variables that define KM success is crucial to understanding how these initiatives and systems should be designed and implemented. This chapter presents results of a survey looking at how KM practitioners, researchers, KM students, and others interested in KM view what constitutes KM success. The chapter presents some background on KM success and then a series of perspectives on KM/KMS success. These perspectives were derived

The purpose of this chapter is to contribute to the improvement of the acceptance of information systems devoted to the codification and sharing of knowledge (a type of Knowledge Management Systems, KMS). A research model was developed through a multi-staged and multi-method research process and its test supports the hypotheses that the acceptance of KMS is determined, in addition to the classical constructs of the technology acceptance model (TAM), by a few organizational factors, and by the influence exerted on the user by individuals close to her/him.

While a great deal has been written about how information systems (IS) can be deployed to facilitate knowledge management for performance improvements, there is little empirical evidence suggesting such IS deployment can actually improve a firm's bottom-line performance. This study attempted to assess the impacts of IS support for two key KM activities, knowledge generation and knowledge transfer, on labor productivity and profitability with both survey and archival data. The potential moderating effects of firm-specific, complementary organizational resources on the performance impacts of the IS support were also examined and tested. The results showed that IS support for knowledge generation and IS support for knowledge transfer both had direct positive effects on labor productivity. Coupled with firm-specific, complementary organizational resources, both types of IS support exerted positive effects on profitability.

The goal of this chapter is to explore how national (Chinese) culture influences knowledge sharing in virtual communities of practice at a large U.S.-based multinational organization. The study involved qualitative interviews with the company's employees in China, and managers who are involved in managing knowledge-sharing initiatives. The study findings suggest that the influence of the national culture could be less pronounced in online knowledge sharing than what the literature has suggested. Although Chinese employees' tendency to draw sharp distinctions between in-groups and out-groups, as well as the modesty requirements were barriers to knowledge sharing online, the issue of saving face was less important than expected, and attention paid to power and hierarchy seemed to be less critical than what the literature indicated. A surprising finding was that despite widely assumed collectivistic nature of the Chinese culture, the high degree of competitiveness among employees and job security concerns seemed to override the collectivistic tendencies and resulted in knowledge hoarding. The reasons for these unexpected findings could be associated with differences between face-to-face and online knowledge sharing environments, the influence of the company's organizational culture, and the recent rapid changes of the overall Chinese cultural patterns.

This chapter updates earlier research on the state of the art of KM tools and presents key evaluation criteria that can be used by organizations to select the applications that best meet their specific KM needs. We briefly describe tools currently available in the software industry to support different aspects of knowledge management and offer a framework for understanding how these tools are clustered based on the functionality they support.

KM is a relatively young discipline. It has accumulated a valuable body-of-knowledge on how to structure and represent knowledge, or how to design socio-technical knowledge management systems. A wide variety of approaches and systems exists that are often not interoperable, and hence, prevent an easy exchange of the gathered knowledge. Industry standards, which have been accepted and are in widespread use are missing, as well as general concepts to describe common, recurring patterns of how to describe, structure, interrelate, group, or manage knowledge elements. In this paper, we introduce the concepts "knowledge pattern" and "knowledge anti-pattern" to describe best and worst practices in knowledge management, "knowledge refactoring" to improve or change knowledge anti-patterns, and "quality of knowledge" to describe desirable characteristics of knowledge in knowledge management systems. The concepts are transferred from software engineering to the field of KM based on our experience from several KM projects.

The purpose of this chapter is to examine the requirements of KM services deployment in a Semantic Grid environment. A wide range of literature on Grid Computing, Semantic Web, and KM have been reviewed, related, and interpreted. The benefits of the Semantic Web and the Grid Computing convergence have been investigated, enumerated and related to KM principles in a complete service model. Although Grid Computing model significantly contributed to the shared resources, most of KM tools obstacles within the grid are to be resolved at the semantic and cultural levels more than at the physical or logical grid levels. The early results from academia, where grid computing still in testing phase, show a synergy and the potentiality of leveraging knowledge, especially from voluminous data, at a wider scale. However, the plethora of information produced in this environment will result in a serious information overload, unless proper standardization, automated relations, syndication, and validation techniques are developed.

The creation and the use of knowledge have increasingly been regarded as important issues for management. A wide range of studies have investigated this topic during the past decade. Notwithstanding these contributions, very little systematic attention has been paid to the linkages between knowledge capabilities and strategy implementation. Drawing from knowledge capabilities theory and strategy implementation literature, two aspects of knowledge capabilities in an organization and their effect on strategy implementation effectiveness are investigated; knowledge process capabilities (KPC) and knowledge infrastructure capabilities (KIC). This study hypothesized that KPC affects strategy implementation effectiveness (SIE) and that KPC affects KIC. The third hypothesis proposed the effect of KIC on SIE by examining the mediating role played by KIC in linking KPC and SIE. 1,321 middle-managers were sent questionnaires via electronic mail and 162 were returned. The findings indicated the presence of a mediation effect of KIC on the relationship between KPC and SIE. This study provides guidelines for middle-managers to better understand how to develop activities of KPC and KIC for SIE. It is hoped that the results of this study will enhance our understanding of the strategic importance of knowledge in an organization, especially in the area of strategy implementation.

Preface

Introduct Ion

Welcome to the third volume in the Advance in Knowledge Management Research book series. This book series is dedicated to publishing top knowledge management (KM) research on an annual basis. Each of the below chapters was originally published in the third volume of International Journal of Knowledge Management with most being updated and expanded to include more data and discussion that could not be included in the journal version.

Knowledge management is at a cross roads. Fundamental research is maturing as models and theories are being developed and accepted. Applied research is evolving and making KM pervasive in many disciplines. This is resulting in less research focusing on what is knowledge and more research focusing on how can KM be applied in various disciplines and how can KM be done successfully. Additionally, KM is being applied globally, by countries and industries afraid of being left behind in a knowledge divide. The following chapters summarize much of this research.

Chapter I
Re.ections on Knowledge Management Resear ch and Practice / Murray E. Jennex
This short chapter focuses on two key issues, the relevance of KM to information systems research and the risk of KM becoming a fad like business process reengineering. The role of the integrator is introduced and the idea that KM is the solution to the productivity paradox is discussed. The chapter concludes with a discussion on the future of KM and proposes that KM can be the bridge to the knowledge society.

Chapter II
Knowledge Fusion: A Framework for Extending the Rigor and Relevance of Knowledge Management / Peter Keen and Margaret Tan
The aim of this chapter is to identify some of the gaps in the current body of knowledge about KM and in doing so to suggest extensions to its frameworks and to areas of investigation that build on its strengths. The authors propose a simple framework for what is termed Knowledge Fusion.

Chapter III
Tapping Tacit Knowledge / Hazel Taylor
This chapter explores the concept of 'tacit knowledge' and how organizations can foster the sharing and exchange of tacit knowledge. Various views of tacit knowledge are discussed and a framework is developed distinguishing different conceptualizations of knowledge and how different types of knowledge are acquired, held in memory, and manifested. An understanding of these distinctions can aid in determining the best approach for transferring tacit knowledge and skills at the individual and organizational levels. Finally, I review various tacit knowledge transfer approaches based on the distinctions identified in the framework and discuss their suitability for different aspects of tacit knowledge transfer.

Chapter IV
Advances in Knowledge Management: Mapping Ideas that Shape Practice / Andrea Hornett and Eric W. Stein
This chapter adds to our understanding of KM as an evolving body of concepts, relationships, strategies and practices. Using qualitative research methods, we examined activities of a community of practice for knowledge management professionals operating in a large metropolitan U.S. region. Accordingly, we produced an organizing framework that maps KM topics according to the tactical-strategic orientation of the KM issue and level of analysis (individual-group-enterprise). We constructed and populated the framework based on a content analysis of forty-four presentations made from 2001-2005, from survey data, from interviews conducted with key informants, and from data collected as participant-observers. The work provides insight into the decision-making processes of stakeholders with competing interests and adds to our understanding of collective sensemaking in a community of practice. From the data, we generated a framework that can be used by practitioners to allocate resources for KM activities, technologies, and projects.

Chapter V
Knowledge Chain Activity Classes: Impacts on Competitiveness and the Importance of Technology Support / Clyde W. Holsapple and Kiku G. Jones
Just as Porter's value chain model identifies classes of business activity that can be performed in ways that contribute to a firm's competitiveness, the knowledge chain model contends there are classes of KM activity that can be performed in ways that enhance firm competitiveness. These KM activities pervade the value chain, being inherent in the implementation of each value chain activity. Derived from a collaboratively engineered ontology of knowledge management, the knowledge chain model is supported by anecdotal evidence and a survey has found support for the propositions that its activity classes are linked to enhanced productivity, agility, innovation, and reputation. Here, we present a study of leaders of KM initiatives that examines each of the nine knowledge chain classes in terms of its competitive impact and the extent to which its positive impact on competitiveness is associated with the importance of technology in performing activities within that class. The study provides confirming evidence that each of the knowledge chain activity classes can be performed in ways that contribute to competitiveness. Moreover, we find that for five of the activity classes there is a significant positive correlation between impact on competitiveness and the importance of computer-based technology in implementing the class's activities.

Chapter VI
Developing a Knowledge-Based Organizational Performance Model for Improving Knowledge Flows in Discontinuous Organizations / Rahinah Ibrahim and Mark Nissen
Tacit knowledge attenuates particularly quickly in organizations that experience discontinuous membership: the coming and going of organizational roles or positions during a workflow process. Since knowledge flows enable workflows, and workflows drive performance, theory suggests that dynamic knowledge—particularly tacit knowledge—is critical for competitive advantage. This research seeks to extend established organization theory, through integration of emerging knowledge-flow theory, to inform the design of discontinuous organizations. Toward this end, we build a computational model based upon ethnographic study of an affordable housing project that experienced severe discontinuous membership. Analysis of this model reveals problematic theoretical gaps, and provides insight into how scholarly understanding of knowledge flows can extend organization theory to address discontinuous organizations. This research contributes new knowledge for designing knowledge-based organizations in discontinuous contexts.

Chapter VII

Accountability and Ethics in Knowledge Management / Frank Land, Urooj Amjad, and Sevasti-Melissa Nolas

The purpose of this chapter is to make the case for integrating ethics and with it accountability into research about KM. Ethics refers to the motives and methods for KM processes, and their impact on individuals, on organizations, and on society. Ethical issues are also relevant to the researcher studying KM, where the subject being researched and the way the research is conducted can raise ethical issues. The interaction of actors, processes, and technology in all aspects of KM from research to design, and actual use can raise a wide range of ethical dilemmas.

Chapter VIII

Social Capital and Knowledge Sharing in Knowledge-Based Organizations: An Empirical Study / Chay Yue Wah, Thomas Menkhoff, Benjamin Loh, and Hans-Dieter Evers

This chapter presents a study that aims to understand the social and organizational factors that influence knowledge sharing. A model of KM and knowledge sharing was developed inspired by the work of Nahapiet and Ghoshal. Data on KM processes and various social capital measures were collected from a sample of 262 members of a tertiary educational institution in Singapore. Rewards & incentives, open-mindedness, and cost-benefit concerns of knowledge hoarding turned out to be the strongest predictors of knowledge sharing rather than pro-social motives or organizational care. Individuals who are highly competent in their work abilities are less likely to share what they know when they perceive that there are few rewards or when sharing is not recognized by the organization. The findings provide evidence for the importance of social capital as a lubricant of knowledge sharing and 'engaging' performance management systems in knowledge-intensive organizations.

Chapter IX

A Structured Method for Evaluating the Management of a Knowledge Management System Implementation / Charlie C. Chen, Rong-An Shang, Albert Harris, and Zhi-Kai Chen

A knowledge management system (KMS) project transcends functional departments and business partners. The success of KMS implementation is highly contingent upon a well-orchestrated integration of multiple systemic contexts, such as communication channels, user involvement, power structure among stakeholders, corporate culture, project champion, interorganizational networks, etc. These organizational factors are embedded throughout the life cycle of a KMS project and within an organization. Understanding the influences of these organizational factors to the success of KMS projects can provide lessons for systems developers and management to increase the success rate of system implementation. The study is based around AMC, a major Taiwanese motor company faced with the challenge of deploying a knowledge management system. Over a period of 3 years (1999-2002) structured interviews were conducted to examine organizational factors contributing to the success of KMS efforts in AMC. The major emphasis of this chapter is to apply the concepts of structuration theory to assess the interaction of corporate management with users of a knowledge management system. The findings suggest that management and users must be engaged in a sustained and reciprocal communication method when implementing a KMS. The pattern of communication, power structure, sanction power, and degree of cooperation are dynamically changed during the interaction process. Therefore, it is important to maneuver these factors into a win-win situation for management and users to successfully implement a KMS. Practical implications resulting from this research provide feasible real solutions to improve the relationship between users and management during a KMS implementation.

Chapter X
Towards a Consensus Knowledge Management Success Definition / Murray E. Jennex, Stefan Smolnik, and David T. Croasdell
This chapter explores KM and KMS success. The inspiration for this chapter is the KM Success and Measurement minitrack held at the Hawaii International Conference on System Sciences in January of 2007 and 2008. KM and KMS success are issues needing to be explored. The Knowledge Management Foundations workshop held at the Hawaii International Conference on System Sciences (HICSS-39) in January 2006 discussed this issue and reached agreement that it is important for the credibility of the KM discipline that we be able to define KM success. Additionally, from the perspective of KM academics and practitioners, identifying the factors, constructs, and variables that define KM success is crucial to understanding how these initiatives and systems should be designed and implemented. This chapter presents results of a survey looking at how KM practitioners, researchers, KM students, and others interested in KM view what constitutes KM success. The chapter presents some background on KM success and then a series of perspectives on KM/KMS success. These perspectives were derived by looking at responses to questions asking academics and practitioners how they defined KM/KMS success. The chapter concludes by presenting the results of an exploratory survey on KM/KMS success beliefs and attitudes.

Chapter XI
An Evaluation of Factors that Influence the Success of Knowledge Management Practices in U.S. Federal Agencies / Elsa Rhoads, Kevin J. O'Sullivan, and Michael Stankosky
This chapter investigates the status of KM practices implemented across federal agencies of the U.S. government. It analyzes the extent to which this status is influenced by the size of the agency, whether or not the agency type is a Cabinet-level Department or Independent Agency, the longevity of KM Practices implemented in the agency, whether or not the agency has adopted a written KM policy or strategy, and whether the primary responsibility for KM Practices in the agency is directed by a CKO or KM unit versus other functional locations in the agency. The research also tests for possible KM practitioner bias, since the survey was directed to members of the Knowledge Management Working Group of the Federal CIO Council who are KM practitioners in federal agencies.

Chapter XII
Interdepartmental Knowledge Transfer Success During Information Technology Projects / Kevin Laframboise, Anne-Marie Croteau, Anne Beaudry, and Mantas Manovas
This chapter reports on a study that investigates the knowledge transfer between an information systems/technology (IT) department and non-IT departments during information technology projects. More specifically, we look into the link between the KM capabilities of the IT department and the effectiveness and efficiency of the knowledge transfer to a client department. KM capabilities are defined by Gold et al. (2001) as the combination of knowledge infrastructure capabilities (structural, technical, and cultural) and knowledge processes capabilities (acquisition, conversion, application, and protection). Data collected through a web-based survey result in 127 usable questionnaires completed by managers in large Canadian organizations. Data analysis performed using PLS indicates that knowledge infrastructure capabilities are related to the knowledge transfer success, and more specifically to its effectiveness whereas knowledge processes capabilities are only related to the efficiency of such transfer. Implications of our results for research and practice are also discussed.

criteria that can be used by organizations to select the applications that best meet their specific KM needs. We briefly describe tools currently available in the software industry to support different aspects of knowledge management and offer a framework for understanding how these tools are clustered based on the functionality they support.

Chapter XVII
Knowledge Patterns and Knowledge Refactorings for Increasing the Quality of Knowledge / Jörg Rech, Björn Decker, Eric Ras, Andreas Jedlitschka, and Raimund L. Feldmann
KM is a relatively young discipline. It has accumulated a valuable body-of-knowledge on how to structure and represent knowledge, or how to design socio-technical knowledge management systems. A wide variety of approaches and systems exists that are often not interoperable, and hence, prevent an easy exchange of the gathered knowledge. Industry standards, which have been accepted and are in widespread use are missing, as well as general concepts to describe common, recurring patterns of how to describe, structure, interrelate, group, or manage knowledge elements. In this paper, we introduce the concepts "knowledge pattern" and "knowledge anti-pattern" to describe best and worst practices in knowledge management, "knowledge refactoring" to improve or change knowledge anti-patterns, and "quality of knowledge" to describe desirable characteristics of knowledge in knowledge management systems. The concepts are transferred from software engineering to the field of KM based on our experience from several KM projects.

Chapter XVIII
Knowledge Elicitation and Mapping: Ontology as an Instrument of Design and Organizational Learning / Paul Jackson and Ray Webster
This chapter is concerned with engaging end-users in the design and development of KMS. The identification, capture and use of contextual knowledge in the design of KMS are key development activities. It is argued that tacit knowledge, while often difficult to capture, can be extremely useful as contextualising knowledge to designers of KMS. A methodology was developed to combine soft systems methodology, causal cognitive mapping, and brainstorming to provide a set of knowledge requirements. The methodology appears to offer an effective platform for making sense of non-routine yet rigorous knowledge work The interventions enacted by the consultant and involving project stakeholders and end users facilitates individual, group and organizational learning through a metacognitive process of understanding the relationships and dynamics of shared group knowledge. Engagement with the methodology, in addition to causing tacit knowledge to be made explicit, enables second-order 'deutero learning', or 'learning how to learn'. The combination of activities presented forms a metacognitive process which is both a form of proactive individual and organizational learning and an endeavour which adds to organizational memory. The identification, capture and use of contextual knowledge and their use in engaging end-users in the design of KMS will result in better user-system interaction.

Chapter XIX
Helping to Develop Knowledge Management Systems by Using a Multi-Agent Approach / Aurora Vizcaíno, Juan Pablo Soto, Javier Portillo-Rodríguez, and Mario Piattini
Efforts to develop KM have increased in recent years. However, many of the systems implanted in companies are still not greatly used by the employees because the knowledge that these systems have is often not valuable or on other occasions, is useful but employees do not know how to search for that which is most suitable. Moreover, employees often receive too many answers when they consult this kind of systems and they need to waste time evaluating all of them in order to find that which is most

suitable for their necessities. On the other hand, many technical aspects should also be considered when developing a multi-agent system such as what knowledge representation or retrieval technique is going to be used. To find a balance between both aspects is important if we want to develop a successful system. However, developers often focus on technical aspects giving less importance to knowledge issues. In order to avoid this, we have developed a model to help computer science engineers to develop these kinds of systems. In our proposal, firstly, we define a knowledge life cycle model that, according to literature and our experience, ponders all the stages that a knowledge management system should give support to. Later, we describe the technology (software agents) that we recommend to support the activities of each stage. The paper explains why we consider that software agents are suitable for this end and how they can work in order to reach their goals. Furthemore, a prototype that uses these agents is also described.

Chapter XX
Adopting the Grid Computing & Semantic Web Hybrid for Global Knowledge Sharing / Mirghani Mohamed, Michael Stankosky, and Vincent Ribière
The purpose of this chapter is to examine the requirements of KM services deployment in a Semantic Grid environment. A wide range of literature on Grid Computing, Semantic Web, and KM have been reviewed, related, and interpreted. The benefits of the Semantic Web and the Grid Computing convergence have been investigated, enumerated and related to KM principles in a complete service model. Although Grid Computing model significantly contributed to the shared resources, most of KM tools obstacles within the grid are to be resolved at the semantic and cultural levels more than at the physical or logical grid levels. The early results from academia, where grid computing still in testing phase, show a synergy and the potentiality of leveraging knowledge, especially from voluminous data, at a wider scale. However, the plethora of information produced in this environment will result in a serious information overload, unless proper standardization, automated relations, syndication, and validation techniques are developed.

Chapter XXI
The Effect of Knowledge Process Capabilities and Knowledge Infrastructure Capabilities on Strategy Implementation Effectiveness / Sineenad Paisittanand, L. A. Digman, and Sang M. Lee
The creation and the use of knowledge have increasingly been regarded as important issues for management. A wide range of studies have investigated this topic during the past decade. Notwithstanding these contributions, very little systematic attention has been paid to the linkages between knowledge capabilities and strategy implementation. Drawing from knowledge capabilities theory and strategy implementation literature, two aspects of knowledge capabilities in an organization and their effect on strategy implementation effectiveness are investigated; knowledge process capabilities (KPC) and knowledge infrastructure capabilities (KIC). This study hypothesized that KPC affects strategy implementation effectiveness (SIE) and that KPC affects KIC. The third hypothesis proposed the effect of KIC on SIE by examining the mediating role played by KIC in linking KPC and SIE. 1,321 middle-managers were sent questionnaires via electronic mail and 162 were returned. The findings indicated the presence of a mediation effect of KIC on the relationship between KPC and SIE. This study provides guidelines for middle-managers to better understand how to develop activities of KPC and KIC for SIE. It is hoped that the results of this study will enhance our understanding of the strategic importance of knowledge in an organization, especially in the area of strategy implementation.

Chapter I
Re.ections on Kno wledge Management Research and Practice

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Abstr Act

This is the third volume in the Advances in Knowledge Management and I thought it appropriate to start this volume with some reflection on where KM is at and where it is going. This chapter reflects on two key issues—the need to ensure KM is relevant and the risk of KM becoming a fad. The chapter concludes with reflection on the future of KM.

KM r elev Ance

In December 2006, I presented a keynote speech at the Australian Conference on Knowledge Management and Intelligent Decision Support, ACKMIDS. The theme of the conference was integrating "doing" and "thinking": KM as reflective practice. While preparing my talk I got to reflecting on KM and the differences between doing and thinking and contemplated the issues of rigor and relevance in KM research. Research relevance has been an issue in IS for several years (see the 2001 special issue on research relevance in the Communications of the Association of Information Systems, CAIS). It is argued that academic researchers are not looking at the problems of interest to business and are losing credibility from the perspective of practitioners. Researchers argue that basic research will ultimately lead to knowledge that can be used by practitioners but should not be judged on its immediate usefulness. Many believe this is leading to a relevance gap between practitioners and academics.

Is there a relevance gap between doing and thinking in the KM discipline? As editor in chief of the *International Journal of Knowledge*

Management, an active researcher and consultant, and a contributor to the research relevancy debate I believe there is a relevance gap in KM between doing and thinking. This section explores the differences between doing and thinking and proposes that a third function, integrating, is needed and should be done by researchers using qualitative research methods and who can reflect on KM. Integrating are those activities focused on bridging the gap between doing and knowing.

To begin this discussion lets define three groups of KM professionals, doers, thinkers, and integrators. Doers are those who build and implement KM systems, KMS, with the goal of solving business problems. This is the group associated with doing. Thinkers are those seeking to understand how and why KM and KMS work or don't work. This is the group associated with knowing. Doers are looking for solutions to help their specific organizations utilize knowledge better; they don't care about generic issues unless they affect their organization. Thinkers are looking at the organization as a unit of measure and interest, but aren't necessarily focused on changing or improving a specific organization. This leads to the need for integrators. Integrators understand the theory and transfer it to the doers using methods such as case studies, action research, actor-network theory, ANT, and socio-technical interaction networks, STIN. Integrators are focused on improving performance in specific or groups of organizations and on generating generic KM theory.

Thinkers and integrators tend to be academics but with differing philosophies. Thinkers tend to be positivists, academics who validate theory through quantitative methods. The academic world is dominated by positivists. The higher ranking journals tend to publish articles with heavy quantitative components and more credence is given to theory that has been "proven" through statistical analysis of large populations.

Integrators also tend to be academics but with a differing philosophy from positivism. Integrators tend to be interpretists, academics who discover theory and hypotheses through the direct observation of and sometimes participation within organizations. The higher ranking journals tend to not publish articles with heavy interpretist methodology with the result that most interpretist research tends to be published in the second tier journals (Note though that these are still quality journals).

So why do we need integrators? I have found that my jobs of consultant, engineer, manager, and now editor in chief have led me to being predominately an integrator. I found that I have little knack for doing basic KM research that I can't see as being able to be applied right away. If I never read another paper discussing the definition of knowledge I will be a happier person (this is a pure editorial comment and not meant to influence current or potential authors and journal contributors in any way, note that this book contains an article discussion basic tacit knowledge). This doesn't mean I can't do basic research, I think all good integrators can, but it means I want to see my work used and applied to helping solve problems right away. However, I am not a doer. I also have little knack for staying with one organization and doing the necessary but mundane tasks needed to build and implement a KMS. I find that integrators are those doing the job of walking around and applying theoretical knowledge to the problems and tasks that need it. This is where the integrator becomes important. Many doers do not have the time or desire to read the academic literature and to determine how the knowledge in them can be applied to real problems. Integrators do just that, and more. We also perform research focused on solving current business problems, only we use case and action research methodologies so that we can gain new insight into how something may have worked in an organization. This insight is what we provide back to the thinkers, we provide them the raw ideas and theories that need validation. We in effect take lessons learned from the doers along with our own observations and turn them into constructs that the thinkers can further investigate.

Is there backing for an integrator role? Integrators seem to be common to several disciplines. Some examples include registered nurses and nurse practitioners who act as integrators between the doctor thinkers and the mother and parent doers who are implementing healthcare in their homes. Another example are engineers and field engineers who integrate between construction manager and general contractor doers who are building things and the research engineer and physicist thinkers who do the basic research on materials and component design that ultimately gets incorporated into building designs. This seems to support the need for integrators; that they are used in many industries and organizations suggest they fill an important role.

Is this a good role to be in? I think so, for the academic who likes to get involved with their subjects and who likes to see their knowledge used to solve problems in real time being an integrator is good and rewarding. However, there is a danger. Integrators still need to publish and be perceived as legitimate academics in order to get tenure and promotion. This is a real issue, the top research institutions and academic journals tend to not reward this type of research. This may mean that integrating is not something new academics should try to pursue. This may be a function that more senior academics should be performing. I tend to like this view and believe it would also serve the secondary purposes of keeping senior academics involved and current in their field as well as providing a relevant base of knowledge and experience that can be used to enhance our teaching. I also tend to think that the integrators are the better teachers, they also bridge the doing knowing gap with students as they can answer the question of "how will I ever use this when I graduate?" Finally, we need to encourage journals to publish integrator work. I do seek out this work and give it access to the *International Journal of Knowledge Management* and encourage other editors in chief to do so.

This leads to the value of integrators and the conclusion of this section. KM needs integrator academics that can bring focus to KM research. Integrators need to be involved with practitioners to see what they are doing, to determine what is working at the specific organizational level so that they can bring this to the researchers as hypotheses and theories needing to be tested. This is also where the traditional academic journals are letting KM down. These journals don't want to publish this research and are leaving it for the newer KM focused journals to publish and push this research. The International Journal of Knowledge Management and the Advances in Knowledge Management book series are actively doing this, having issued calls for research in several areas deemed important to KM practice and building the KM discipline's body of knowledge, and it will continue to do so.

The Risk of Becoming a Fad

Peter Keen and Margaret Tan follow this chapter with a chapter discussing a knowledge fusion framework for KM research. Their concern is that KM research will get pigeonholed into endless discussion and debate on definitions of what KM and knowledge are. They want to help ensure that KM research has rigor and relevance. This is an important point and something we need to do. Research relevance has been an issue in IS for several years as discussed in the previous secton. However, as Keen and Tan point out, the converse of this, practitioners defining KM without regard to theory, research, and rigor is also bad and can lead to what they and I consider to be the greatest threat to the KM discipline, the risk of becoming a fad.

I believe KM is the answer to why IS/IT Matters and even the Productivity Paradox. KM is making organizations more productive, but is in danger of becoming a buzz word or a fad. Already some would rather call it Business Intelligence, Competitive Intelligence, Social Capital, or some other term other than KM and actually go to great pains to avoid the use of the KM term. We also have an identity crisis as to what KM is. Some consider KM to be a document management system, a data warehouse, a web portal, or a wiki or other collaboration tool.

First let me restate how I define KM (Jennex, 2005):

KM is the practice of selectively applying knowledge from previous experiences of decision-making to current and future decision making activities with the express purpose of improving the organization's effectiveness.

This does not quite agree with Keen and Tan but that is okay, we don't need to exactly agree but we need to have a starting point. This definition does fit what they call a corporatist view of KM in that it is mission focused on using knowledge as an asset to improve processes. I don't see this as a bad thing and go a step further by stating that KM is really about two issues:

- Leveraging what the organization "knows" so that it can better utilize its knowledge assets
- Connecting knowledge generators, holders, and users to facilitate the flow of knowledge through the organization

Also, I use the term "organization" very loosely. I view an organization as any group with a purpose. This means that an organization can be a formal business organization, a governmental organization, a multinational organization, or even an informal organization such as a community of practice. Also, an organization may have a formal command structure, an informal command structure, or be leaderless. This is a purposefully broad definition because we're finding that KM can help all sorts of "organizations." I'm realizing that organizations are evolving into a variety of structures with various governance approaches and with various knowledge needs and tying ourselves to a set view of an organization will only limit the application of KM.

Keen and Tan use Business Process Reengineering, BPR, as an example of a discipline that became a fad because of a lack of academic research understanding its concepts and supporting its development. While there is a great deal of academic research into KM, I also see there is a mismatch between what researchers are doing and what practitioners and consulting firms are touting as KM and KM solutions. The issue is over-selling what KM technology can do. Many vendors claim all in one technical solutions that solve all of an organization's knowledge needs. Many KM failures come from disappointment in not realizing expectations raised when the KM solution was purchased and implemented. Of course to be fair, it isn't necessarily the technology that is at fault, in many cases its other organizational factors that cause the failure such as culture, management support, etc. Additionally, many managers hear of the benefits of KM and see KM working in other organizations but don't understand what it means or what it takes to do it well. They are willing to purchase solutions promising success but then do not create the environment necessary for KM to succeed. When their KM investment doesn't provide the expected returns these managers blame the KM hype instead of trying to understand what happened. This is where academic research becomes important; academics can help managers understand the total KM picture. Academics understand that KM is a people, process, and technology discipline and that all are needed to work together for KM to succeed. This is the crux of what I consider our KM "crisis" the danger of becoming a fad or a buzz word because practitioners are not utilizing academic research to help create their KM "solutions".

I'm worried that the proliferation of new terms for what is essentially KM is a reflection on practitioners considering KM a fad. Some terms being used and their definitions include:

- **Business intelligence:** Using IT to gather and analyze data and information about an organization's processes to better understand how to make the organization more competitive.
- **Competitive intelligence:** Using IT to gather and analyze data and information about an organization's customers, competitors, and business environment to aid the organization in its strategic planning.
- **Social capital:** The advantage created by a person's location in a structure of relationships, it is used to describe a person's knowledge network.
- **Intellectual capital:** The advantage created by what a person knows, usually resulting in intellectual property and other intangible assets for the organization

While their adherents claim these terms are different than KM and should not be associated with KM, I look at them and see that they each apply to some facet of KM. Business and Competitive Intelligence are knowledge creation processes very much focused on decision-making. Social and Intellectual Capital are variations of organizational knowledge and knowledge transfer networks. Also, other variations in KM are becoming prominent, fields such as Supply Chain Management, SCM, Customer Relationship Management, CRM, and Data Warehouses. These fields combine KM with data/information management and business processes to create specialized variations of KM, as these fields also are focused on using knowledge to improve decision making. This is where I differ from Keen and Tan as they view the above areas as knowledge mobilization—situational uses of knowledge and not KM. Still, we all agree we need to take action to prevent KM from becoming a fad, and Keen and Tan's proposed Knowledge Fusion framework for providing a grounded theoretical foundation for KM is an essential piece of this action. Grounding KM in a KM theory (or theory that can be applied to KM) would provide a basis for practitioners and researchers to understand and apply KM as an organizational objective. The second part of this action is to add the integrator role. The integrator role is an interpretist research role focused on integrating theory into practice through action and case based research methods. The third part is an action I've started with the IJKM, integrating practitioner focused articles into research in an effort to join the two communities. I believe many of the articles appearing in the *International Journal of Knowledge Mangament* help fulfill these last two actions and we are starting to see more submitted articles coming jointly from practitioners and researchers. I also believe that by actively promoting and publishing these types of articles the IJKM is also fulfilling Keen and Tan's call for KM thought leadership. The IJKM has accepted the responsibility of leading KM research publication efforts and only time will tell how well we do at this and how well we are accepted as thought leaders.

the future of KM

Granted that we prevent KM from becoming a fad, we are looking at true changes in how organizations and people work and live. The knowledge organization will not be constrained by national boundaries or cultures limiting the capture and application of knowledge and will lead to the knowledge haves and have nots. The knowledge have nots will be those who are not aware of their knowledge, or who have not made investments in KM to create a knowledge infrastructure, or who have not implemented initiatives that utilize knowledge for specific decision-making (knowledge mobilization). The knowledge have nots may be companies that ultimately fail; and they likely will not be leaders in their field if their field involves the use of knowledge.

The knowledge haves will be those using KM to better utilize what they know and to better connect those that produce and/or possess knowledge to those that need to use knowledge; or, to use Keen and Tan's view, these are the organizations that have implemented knowledge mobilization along with an effective KM system, KMS. The KMS will utilize technology, processes, and people to capture, store, organize, and present data, information, and knowledge to those that need it when they need it. The typical KMS may use (all come from our research and the below is not an all inclusive list):

- A KM strategy that identifies critical knowledge, where it is, how it is to be stored, and how it is to be made available
- Technologies such as the semantic web to overcome cultural interpretations or codifications of knowledge
- Wikis or other collaborative technologies to facilitate the flow of knowledge and the generation of knowledge through collaboration
- Mapping techniques to facilitate the visualization of knowledge repositories and taxonomy
- Processes that incorporate knowledge capture and/or use
- Knowledge creators, holders, and/or users working within a knowledge sharing and using culture
- A KM governance structure that identifies metrics and KM policies and provides management support
- Knowledge mobilization initiatives such as SCM, CRM, BI, etc.

I actually see KM leading to less knowledge worker offshore outsourcing (although offshore sourcing for knowledge needs may increase) as it becomes difficult for organizations to maintain two or more classes of knowledge workers and wages and position will tend to equalize over national boundaries. I expect that quality of life concerns will guide knowledge workers to where they want to live and work and this will also support equalization of living standards and critical infrastructure. This will be disruptive to the organization as traditional management and governance structures will be stressed to handle distributed knowledge in a distributed organization. Workers may rethink traditional careers as they may work in organizations where they never physically meet their boss or colleagues and will be more loyal to local organizations and local social structures. This will likely increase transience, a trend I'm observing now in many organizations, and increased transience will likely lead to increased intellectual property and knowledge ownership issues. Also, hiring practices may change as organizations hire and retain staff based on the knowledge they possess, this may actually lead to a higher valuation of older, experienced workers (at least as I am now 50 I hope so!). This will tend to force knowledge workers into being lifelong learners if they are not already. Both increased transience and increased learning needs will be disruptive to knowledge workers as it influences family and social life and social activities may move from the softball field to the classroom.

Additionally, the knowledge society will not be constrained by national politics and MAY very well overcome the issues of ignorance and religion. Open source KM such as the open research initiative and other communal knowledge activities may make knowledge available to anyone with access to the Internet. My observation is that as more information and knowledge is made available to the people, attitudes change. We see this already in coverage of war as more people are realizing that war is not the glamorous and glorious adventure our ancestors thought it was.

It also becomes harder to hide oppression. I see this as the lesson from Tiananmen Square when telephone and fax machines made it impossible to hide an atrocity and in the lesson from YouTube and viral video where anyone can become a hero overnight and more importantly, any video can be posted to the world making it nearly impossible to hide anything. What has this to do with KM? I view knowledge as being the how and why of something. The last few years have seen Islamic organizations using this medium to present their views on the how and why of the war on terror. While I don't know how well this has translated into recruits for their cause, I do know that this has made this conflict one of the first where all people can see both sides' view points at will. I think it is only a matter of time before every social organization uses this medium to push their agendas on a world stage. While I don't always agree with their views, this is an embodiment of the American principle of free speech. I am not trying to start a debate on if free speech is "American," I'm not implying that at all, only that this was a concept first conceptualized in law by the United States Constitution and now made a practical reality for all people with access to the Internet. I will be the first to admit that many are not in favor of true freedom of speech, including many Americans, but it is what we are getting and I believe it is a very good thing. Now all beliefs, all knowledge, can be presented on a world stage and debated and I believe that ultimately this will be for the good of all mankind as those ideas and beliefs that have little merit or are shown to be false will be shown to be so to all the world.

This is also a very disruptive activity as it means the loss of control by governments and leaders over those they wish to lead. The debate will be in trying to limit the Internet. Already several governments limit the access to content that Internet Service Providers, ISPs, are allowed to provide to their subscribers. I see this as a continuing trend and a clear battle line between those who will control and those who want total access. I don't know how this will work out, my hope is that governments and leaders can stifle their urge to censor as I believe that truth will win out and this will strengthen the legitimacy of those governments and leaders that allow their constituents access to all content.

c onclus lon

KM has a risk of becoming a fad or a buzz word. This is not what we want and we need to take action now to prevent it. The knowledge fusion research framework is a first step towards focusing KM research. Adding academic integrators who can combine theory and practice is a good second step for ensuring KM doesn't go the way of BPR. Using the IJKM as a vehicle for KM thought leadership is a good third step.

KM will change the way organizations and societies operate. Knowledge workers will transform knowledge using organizations into transnational, distributed enterprises with new governance structures. Careers will be different and I anticipate that pay and position will equalize across borders. Open source and leaderless KM initiatives will increase the flow of knowledge to the general population. This will allow societies access to all ideas and will allow them to decide truth. The control exerted by governments and leaders will lessen as people can decide what they want to believe and what causes to support.

Both these outcomes will be incredibly disruptive as we move from "knowledge is power" to "using knowledge is power" and may lead organizations and societies to use security to limit KM. Security in KM is necessary to protect the value of knowledge to organizations that own it, but it shouldn't be used to prevent users from getting access to content they are entitled to see. The debate will be in how much security should be applied. I hope we will make the right choice

Ultimately I see a bright future for KM. I see KM as the answer to the debate of "Does IT

Matter?" and to the Productivity Paradox. Our research will make organizations of all types more productive. We just have to avoid the fate of becoming irrelevant and a fad or buzz word.

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Chapter II
Knowledge Fusion:
A Framework for Extending the Rigor and Relevance of Knowledge Management

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Abstr Act

The chapter proposes a simple framework termed 'knowledge fusion' to extend the rigor and relevance of knowledge management (KM). It points to some gaps in the current body of knowledge about KM, and provides a parsimonious set of 'partitions' that link to and from traditional knowledge management research and practice. It proposes that attention be paid to knowledge mobilization that reflects the demand side that is dominated by knowledge being part of individual identity and hence personal choice of whether, where, why and with whom to share knowledge and expertise as oppose to just understanding the traditional knowledge management that addresses only the supply side of information and the creation of environments for communication and collaboration, especially those "knowledge" largely being independent of the individual.

Introduct Ion

The aim of this chapter is to point to some gaps in the current body of knowledge about knowledge management (KM) and in doing so to suggest extensions to its frameworks and to areas of investigation that build on its strengths. We propose a simple framework for what we term knowledge fusion, based on the following line of argument that captures what knowledge management is as a field, rather than what many of its critics feel it should *not* be as a domain of intellectual study and social action:

1. Knowledge management is axiomatically a mission-driven, corporatist field. Its focus is not on knowledge but on management processes that use information resources and related corporate "assets" to enhance innovation and collaboration: knowledge creation, knowledge sharing, and knowledge dissemination. There are many valid and powerful alternatives to the axioms of KM, explicated by Ekbia and Hara (2004), Ekbia and Kling (2003), Wilson (2002), and Fuller (2001), but they basically reject KM for its mission as much as its methods and intellectual base. To a large degree, "membership" in the KM field of both research and practice involves accepting the corporatist mission. We choose the word "corporatist" carefully, since it captures the view of knowledge as organizational assets, the aggressive goal of innovation, and the purposive intentions of generating a high return on investment that drives KM in both the private and public sectors. This view generates conflict for many thinkers who do not believe that knowledge is to be valued mainly for its contribution to organizational payoff.
2. KM as a corporatist practice is in many ways an announcement by the information systems community that it has positioned to move beyond information organization to information deployment; that shift is signaled by the choice of "knowledge" as the target of "management." A constant tension in the KM field is the difference between information and knowledge, but at its core KM has been information-centric. It aims at connecting innovation and growth, the core goals of the enterprise, back to information-based capabilities, one of the obvious means to that end, and to raise its own centrality as a strategic force in and of itself rather than as a support base for change management, process innovation, and business capability development. KM is thus as much an organizational ambition as a domain of research and practice.
3. A major current limitation to progress in KM application and impact is that there is a very clear difference between the fundamental dynamics of knowledge management and of knowledge *mobilization*. Knowledge management addresses the supply side of information organization, creation of environments for communication and collaboration, leveraging of intellectual capital, and incentives for shifts in work practices, especially those that either impede or facilitate knowledge-sharing, with "knowledge" largely being independent of the individual; it is a corporate asset. Leonard's (1989) assertion is representative here: "Just as organizations are financial institutions, so they are knowledge institutions." Knowledge mobilization, by contrast, reflects the demand side that is dominated by knowledge being part of individual identity and hence personal choice of whether, where, why, and with whom to share knowledge and expertise (Keen, 2006; Qureshi & Keen 2005). Knowledge mobilization views information and knowledge in terms of situational needs—"what do *I* need to know *now*?"—while knowledge management tends to focus more on "what knowledge can we provide to our employees and what mechanisms can we put in place for them to make most effective use of it?" The push-pull tension between management and mobilization is captured in a comment by a manager that, "The organization does not understand how knowledge is shared here and I tend to ignore the knowledge management initiatives wherever I can" (Von Krogh, Roos, & Sloucm, 1994).
4. There can never be a universal "theory" of knowledge management, any more than there is any consensual agreement on what is knowledge in the mainstream of philosophy or any shared operational agreement as to its

nature across the arts, sciences, theological, and political fields. We highlight the word "never" here. KM relies on pragmatics to generate conceptions of knowledge that are actionable. There is a two-sided danger here: the pragmatics may be over-simplistic and also open to easy challenges from those who do not share the pragmatist perspective. Perhaps a larger and more damaging danger is that if the conception of "knowledge" remains a constant debating point and source of demurral, no one gains neither KM pragmatists, philosophical idealists, nor activists in the anticorporatist sphere. The discussion just gets cloudier instead of clearer.

5. KM thus should not get stuck in definitional debates, but it does need some shaping framework that encourages intellectual and pragmatic diversity and a balance between the thought leadership priorities of the pragmatists, often consultancy firms, and the research and scholarship excellence of the intellectual disciplines, mostly but not entirely in the academic communities. Our proposal is to "partition" the wider field of "knowledge" into four areas: knowledge *management*, the goal; knowledge *mobilization*, the enabler; knowledge *embodiment*, the study of what it means to "know"; and knowledge *regimes*, the organizational, political, and sociological factors that shape how knowledge is focused, authenticated, legitimized, and validated in the organizational and professional context. Each of these is a distinctive arena, in terms of its main fields of research and scholarship, axiomatic base, mode of investigation, and professional communities. Our knowledge fusion framework rests on the logic that contributions from these communities will come from how they link their specific body of theory and practice to the mission of knowledge management. We see three main links: (1) knowledge management and knowledge mobilization; (2) knowledge regimes and knowledge management; and (3) knowledge embodiment and knowledge mobilization.
6. As with total quality management (TQM) and business process reengineering (BPR), knowledge management is driven by two potentially conflicting traditions: thought leadership ambitions among leading consultants and consulting firms and research excellence priorities and practices in the academic community. TQM illustrates the fusion of these; consultants such as Deming, Juran, and Crosby led the field, drew on research by such figures as Ishikawa and on the management experience of many innovative companies, including Toyota and Motorola, to the benefit of all (Kruger, 2001). As BPR illustrates, thought leadership that is entirely detached from the scholarly and research communities lacks staying power, in that the gaps and contradictions in its claims and conceptions quickly erode its validity; it is more claims leadership than thought leadership. One of our aims in developing the knowledge fusion framework is to help KM be more like TQM than BPR. We suggest that just as academic research has formal criteria and standards that help define "excellence," thought leadership must be built around comparable criteria, which include its links to the intellectual traditions relevant to its claims and concerns.

We intend our framework to be commonsensical rather than controversial; we define a new commonsense as one that is obvious fifteen minutes after you hear it but that fifteen minutes beforehand you might never have thought of it.

The Grounded Theory Development of Knowledge Fusion

Our analysis of the KM field and formulation of the knowledge fusion framework is a grounded theory investigation that began from a wide-ranging scan of an almost unsurveyable field. Scholar Google lists 220,000 references to "knowledge management"; the fragmentation and breadth of the field is indicated by the fact that only a tiny fraction of these are cited in even twenty of the other close to a quarter of a million publications. A Google search on the term generates 57 million results. To put that in context, "business process reengineering" produces 1.3 million and "electronic commerce" produces 28 million (February 2006).

Such proliferation eliminates any practical possibility of a grand theory of knowledge management or a unified definition of "knowledge." Our approach to generating a grounded theory base for KM extension is to identify salient themes in knowledge management, such as communities of practice, knowledge sharing, knowledge creation, tacit knowledge, and intellectual property, and then to test how well conceptually and in practice they hold up. This process identified where we saw a need for new "codings." These are distinctions that we propose as part of a generic taxonomy of knowledge fusion and as researchable domains of investigation. For example, it became clear from our analysis that the widely-used distinction between explicit and tacit knowledge (Nonaka & Takeuchi, 1995) is not robust and has generated tautologies and challengeable conclusions, such as the claim that tacit knowledge is knowledge that cannot be made explicit and structured, followed by the statement that a goal for knowledge management is to make tacit knowledge structured and explicit (Gourlay, 2000; Haldin-Herrgard, 2000). Gray (2001) provides a succinct summary of the tacit-explicit knowledge distinction and states that "most organizations want to transfer tacit knowledge to explicit knowledge."

It is a substantive matter for the effectiveness of KM whether or not this transfer is possible and even conceptually meaningful. We propose, via Wilson (2002), a simple extension of the distinction to include implicit knowledge as the bridge between tacit and explicit. Implicit knowledge is what we take for granted, rarely think about, and are surprised to find that others do not share; many faux pas that we make when we travel abroad reflect the fact that a national culture has many areas of implicit knowledge concerning etiquette and social norms. The red-faced blunderer asks, "Why didn't you tell me about that?" One replies, "You didn't ask and it's obvious anyway." Our suggestion is that tacit knowledge be accepted as inherently tacit and that, using our coding distinctions, knowledge management should structure explicit knowledge, which is information-centric, explicate implicit knowledge through dialog, and leverage tacit knowledge through respectful collaboration.

Our grounded theory approach is more than taxonomic in its goals and less than ontological. It is a search for a parsimonious addition to the distinctions in the KM field which will help resolve conceptual contradictions and reported problems of application, such as the tacit-explicit contrast. This helps avoid getting caught in the definitional debate.

Clearly, new distinctions are needed for KM to achieve its targeted impacts. A review of the literature on disappointments and failures in knowledge management impacts (Lucier & Torsilieri, 1997), states that 84 percent of KM projects fail; Storey and Barnett (2000) and Barth (2000) thus pointed us to the needed distinction between knowledge management and knowledge mobilization that is at the core of our proposed framework. We did not "invent" knowledge mobilization nor redefine "knowledge" or "knowledge management" to incorporate it but instead added it as a new coding and then looked at where and how it contributes to the KM mission. That in turn pointed to the value of a new distinction in knowledge mobilization of three levels of personal knowledge identity in how individuals assess their own knowledge and how and when to share it: accountable, discretionary, and autonomous knowledge (Qureshi & Keen, 2005).

The final stage in the development of the knowledge fusion framework is to narrow down the very broad range of KM topics, distinctions, and concerns into a parsimonious set of "partitions" that link to and from traditional knowledge management research and practice. We propose that knowledge fusion has four main partitions:

- **Knowledge management:** The organizational mission for continuing the evolution of information management to become a core factor in business innovation; the supply and dissemination of knowledge-relevant information, communication and process capabilities, and the development of change management initiatives in order to build new knowledge-building and knowledge-sharing practices.

Given the mission, issues of technology options and methods are highly germane to this partition, whereas they are a distraction or even a red flag for commentators who largely oppose the main KM axioms. These critics stress that technology in and of itself is not relevant to knowledge. But it is highly relevant to knowledge management and there are many emerging developments in technology that are promising enablers of new knowledge work, especially in the library sciences, where exploration of and expertise in archiving the Semantic Web and library resource management are adding an often missing dimension to the mainstream information technology focus on data base management systems, data repositories, and Web portals (Khoo, Singh, & Chaudhry, 2006). Technology is very much part of this partition of knowledge fusion.

- **Knowledge mobilization:** The dynamics of the processes by which individuals make their own personal choices about information seeking, knowledge creation, and knowledge sharing. This demand side must be synchronized with the supply side for effective joint benefit. The discretionary and personal nature of knowledge activation and identity leads to many gaps in practice between corporate supply and individual use, between push and pull. In addition, more and more elements of personal knowledge creation and sharing lie outside corporate ownership and control. Blogs, for instance, are becoming a significant force in professionals' knowledge-sharing and in the impact of blogs on a company's reputation and a number of companies are harnessing them to create two-way communication links with their constituencies, in effect mobilizing both company and stakeholder knowledge-sharing. In Microsoft and Sun Microsystems, over a thousand employees publish their own blogs about life in the company, technology, and industry trends. Both firms claim that these blogs have significantly improved their ability to reach, communicate with, influence, and even recruit from the development community; that is, to broaden the reach of their knowledge mobilization (Scoble & Israel, 2006). Blogging illustrates the potential value of the partitioning approach to knowledge fusion. It is as yet little studied in the context of corporate knowledge management, though there is a growing body of work on the role of blogs in e-knowledge and distributed knowledge creation in professional communities (Norris, Mason, & Lafrere, 2004). Given the rapid growth in blogging (around 60 million in early 2006) and its increasing corporate focus, this is a topic that merits study and certainly organizations should make them part of their knowledge mobilization if not part of their knowledge management.

One of the main conclusions from our initial scanning of the KM field that directly led to the identification of the need for a knowledge mobilization partition supports the often criticized "relabeling" of information management as knowledge management. It is that after around forty years of sustained effort to "manage" information, the state of good practice has solved most of the main historical problems of structuring, integration, standards, interoperability, data management, networking, scaling, and so forth. It has moved from information "systems" to information and communication platforms. These platforms are now positioned to enable a very wide range of new practices, processes, and relationships. A decade ago, many such uses of IT were impractical and the opportunities for knowledge mobilization highly constrained. At last, we have the knowledge management platforms; knowledge mobilization now becomes higher on the urgency list in terms of both research and practice. Mobile technology in particular transforms the very nature of on-demand access to and delivery of information and services. (e.g., Keen & Mackintosh, 2002.)

This is signaled by the larger number of studies on KM failures; most of these reflect successful technical designs and implementations but problems in mobilization. (See Keen [2006] for a brief review of the 9/11 Commission Report which shows that the information needed to first prevent and then respond to the terrorist conspiracies was almost all in place and available. The Report describes a knowledge management success but a knowledge mobilization disaster.)

- **Knowledge embodiment:** The deep processes of "knowing" in the widest sense of the term. The pragmatic and axiomatic KM conception of knowledge as an organizational asset is obviously partial at best and many commentators claim that it is largely invalid and little more than a relabeling of information. (Wilson [2002] attacks the "nonsense" of knowledge management in this regard.) As we show later in the chapter, the KM conceptions are fully defensible in terms of its focus on knowledge as an organizational asset, and nonsensical only if the foundational organizational aims of KM are rejected.

That said, those aims do represent a selective and specialized view of the immensely wide world of knowledge creation, application, and use and will benefit from a complementary analysis, development, and application of theory from that wider world in order to extend and enrich knowledge mobilization. Many KM researchers are thus exploring reference disciplines, most obvious philosophy and epistemology, which address such topics as the social and political nature of knowing, speech act theory and the linguistic nature of knowledge, the nature of tacit knowledge, and ethical issues. Their goal is to enrich, not to attack KM.

Connecting such lines of investigation to the pragmatics of knowledge management concepts and applications is, in our view, best handled through viewing knowledge embodiment as a partition in and of itself, but one whose findings and frameworks can be brought into focus through being linked to the knowledge mobilization partition. The logic of this is that any effort to generate a consensual concept of knowledge will fail and that much of the research in this partition has had less impact on KM than it merits because it is positioned as a new approach to KM *as a whole*. We suggest that its power will come from rigorous scholarship and research made relevant by showing how and where it helps in increasing knowledge mobilization.

Knowledge fusion thus argues that the axioms, definitions, goals, and practices of KM form its chosen, deliberate, and selective bounding of the knowledge world and that rather than aim to impose competing, alternative, or conflicting views of knowledge embodiment on KM as counter theories, it is simpler and more pragmatic to map them into KM in a way that KM can absorb them. Anticorporatists and social theorists will reject this approach. And so they should. Our framework is not aimed at helping improve the rigor and relevance of the entire field of knowledge studies—that would be both absurdly pretentious and totally impractical—but only at helping the applied KM field to improve KM.

- **Knowledge regimes:** This term refers to the contextual rules, controls and processes that directly shape and constrain knowledge management. These include political, cultural, and sociological factors. Our identification of knowledge regimes as a partition of knowledge fusion was prompted by work in political science (Sowell, 1996), philosophy (Foucault, 1980), organizational decision making (Keen & Sol, in press), and the wide literature that links knowledge management to questions about capitalism and post-capitalism. The legitimacy, verification, use, and control of information are an integral part of what Foucault calls "Regimes of Truth" (Ebdia & Kling, 2003). Knowledge regimes are the sociopolitical forces that strongly affect the specific legitimacy, meaning, and effective rights of ownership of "knowledge." These include organizational design, information systems, professional associations, incentive systems, and "culture." Knowledge regimes vary widely between countries, with history, censorship, and social norms often creating bounds on knowledge embodiment, knowledge management, and knowledge mobilization.

Again, our proposal of knowledge regimes as a partition is intended to resolve the rigor-relevance tension in knowledge fusion. The mainstream of knowledge management is driven by relevance to business and organizational innovation and collaboration. It maintains that focus sometimes at the expense of rigor; the extreme instances of this are vendor claims that say document-management software is "knowledge," or the casual comment in a leading book on KM that begins, "Because of the human element in knowledge ……" (Davenport, De Long & Beers, 1997). Surely, any scholar in fields that address knowledge embodiment and knowledge mobilization would almost scream in reply that humans are not an element in knowledge but *are* knowledge. The remark makes more sense in its context of the conceptualization of knowledge as a corporate asset, much of which is embodied in information resources, not people. That said, this is certainly not a rigorous statement and it is typical of ones that critics of KM zero in on very quickly.

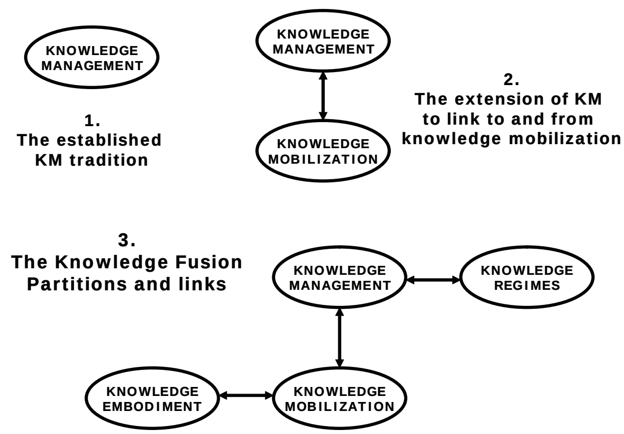
Conversely, discussions of knowledge regimes are often highly abstract and formalistic. They also often adopt very different axioms of "knowledge" than does KM. For example, Day's (2001) history of KM highlights "the European documentalist, critical modernist and Italian Autonomous Marxist influenced Post-Fordist traditions." Fuller's (2001) blandly titled *Knowledge Management Foundations* is anything but that; it is a resonant and complex exploration of "civic republicanism" and social epistemology. His KM manifesto includes discussion of "pseudo solutions" such as cyberplatonism, and academic bullionism (the "scourge of KM"). Both Day and Fuller offer a counterview to just about every assumption, goal, and application of knowledge management. An obvious question then is why they self-classify their work as KM, virtually guaranteeing that it will have no impact on the communities within the field? The logic of the knowledge fusion framework of partitions is that such work is a very valuable potential contribution to KM if, and only if, it can build linkages to the KM mainstream instead of trying to supersede it or bury it beneath a my-citations-are-more-obscure-than-yours bibliographic mountain.

Our proposal of partitions is aimed at helping improve both the rigor and relevance of the knowledge management field through appropriate use of reference disciplines. These are fields of scholarship and research—the two are not always equivalent—that offer insights, theories, and findings that are relevant to but not within the immediate academic and professional purview of KM. The knowledge management field as a whole will be enriched through such diverse and unconnected reference disciplines as epistemology, library sciences, and education (where there is an innovative stream of research and application on information-seeking, interface design, and learning behaviors directly relevant to knowledge mobilization) (Khoo et al., 2006), sociology (we are seeing a resurgence of references in KM articles to Berger and Luckman's [1966] work on the social construction of reality that is highly relevant to knowledge embodiment), political science (knowledge regimes), critical theory (e.g., Baudrillard, 1994), hermeneutics, economics, phenomenology, and computer science. Partitioning and linking to the core knowledge management plus knowledge mobilization fusion is a vehicle for making all this rigor relevant.

Figure 1 summarizes our knowledge fusion framework. To be of value, it must pass tests of parsimony (the knowledge management field does not need any increase in elaborate individual conceptual schema or in the vocabulary of terms floating across its many journals and topics), usefulness in helping provide a coherent and comprehensive high-level mapping of a very complex and fragmented field, and originality in pointing to new lines of investigation and lessons from existing research. That judgment will be made by our readers.

The recommended agenda for knowledge fusion is thus: (1) Maintain the mainstream focus in KM on harnessing organizational resources for the purpose of innovation, knowledge-creation, and collaboration; (2) Sharpen the focus on linking individual demand and use of peoples' own and others' knowledge (knowledge mobilization) to organizational supply and encouragement of new practices and processes (knowledge management); (3) Enrich the discussion of "knowledge" and knowledge embodiment and thus of opportunities for knowledge mobilization; and (4) Investigate

Figure 1. From knowledge management to mobilization to fusion



the impact of knowledge regimes on knowledge management assumptions and practices, including the role of dissent, and adapt those practices to meet the changing demands of other regimes, including those of customers, competitors, pressure groups, and social movements.

The Validity of the Axiomatic Base of Knowledge Management as a Mission-Led not Topic-Driven Field

Our entire line of argument centers on one core conclusion from our analysis of the KM field: that the very criticisms made of it are at the same time valid but in many instances irrelevant. Most of the criticisms address weaknesses in the "knowledge" component of KM. But knowledge management is not about the topic of knowledge as such but the mission of management. Knowledge management is in fact part of a corporatist regime of truth, in Foucault's sense of the phrase. It is fully valid to attack that regime on social, political, or moral grounds—KM is very much a part of Big Business—but criticisms made on the same terms about the validity of KM itself largely miss their mark.

Here are some standard criticisms of knowledge management:

- It uses fuzzy, inconsistent, and contradictory definitions of knowledge.
- It is largely a relabeling of information management through "search-and-replace" marketing.
- It is driven by consultants and vendors.
- It has produced poor practical results.

The first criticism is misleading in that it implies that elsewhere there is a body of consistent and reliable definitions of knowledge. No one on this planet has successfully generated an accepted and universal theory of knowledge after 2,500 years of continuous effort. The irresolvable debate or more often conflict between science and religion is a difference of belief about what is knowledge and hence "truth." Just try and synthesize a definition of "knowledge" and "truth" from a sampling of the great philosophers, whose entire careers were devoted to answering the question of what is knowledge: Plato, Aristotle, Descartes, Kant, Locke, Kirkegaard, Nietzsche, Heidegger, Wittgenstein, Foucault, Habermas, and Searle, to name just a tiny few. These are titanic thinkers whose concerns were epistemological and ontological, with Heidegger's *Meaning and Being* an indicator of the scope and depth of their search.

Knowledge management is far, far less ambitious and basically adopts axiomatic views of knowledge. The test of the value of these axioms and their implications is the domains of effective action that they enable in organizations. Their limitations come not from any definition of knowledge but of gaps between axioms, actions, and impact. But the test is not one of "truth."

It must be recognized the axioms of KM do limit application and impact and thus merit investigation, including drawing on the field of philosophy as a reference discipline. There are four main elements in KM axioms:

1. Knowledge is an organizational asset.
2. It can be managed like other assets.
3. The purpose of knowledge is action.
4. The primary goal of KM is to encourage knowledge-sharing and collaboration.

Each one of these axioms is open to challenge, but not if we replace the word "is" in each item on the list with "should be"; should be an organizational asset, should be managed, should be action, should be a priority target, and should be knowledge-sharing and collaboration. That simple substitution switches from KM as a topic and an intellectual claim to a mission. It establishes a knowledge regime that excludes certain types of knowledge and knowledge embodiment.

One of the authors of this chapter, for instance, knows much more about Shakespeare than about information technology, his main field of study and application relevant to KM. If the purpose of knowledge is action (Alavi & Leidner, 1999), then he is a complete failure; the only actionable value of this knowledge is to read more Shakespeare. Similarly, he is an expert on antique Egyptian stamps; the only contribution to action here is to motivate him to spend a lot of money on eBay.

From a knowledge identity perspective, his knowledge of books and his philatelic hobby is core to his sense of self, his knowledge-seeking, and the communities in which he shares his knowledge. It is completely irrelevant to knowledge management in the business and academic communities he works in; unless he decides to become a stamp dealer. The axioms and mission of KM *exclude* many domains of knowledge embodiment on the basis of "should be" as the intention for the KM mission and "is" as the axiom that drives that mission.

Consider substituting "should not be" for "should be" on the KM list of axioms and a very different intellectual discourse emerges, one that many commentators on knowledge regimes and knowledge embodiment are really trying to build: knowledge should not be managed as a corporate asset, the purpose of knowledge should not be action, and so forth. "Should not" defines an alternative regime of truth, one that places civil society ahead of corporatist modernization, for instance. Ebdia and Kling (2003) dissect the degree to which the financial analyst, shareholder value, and business press regimes of truth explain how Enron so easily deceived the public and how complicit these regimes were in helping them do so. This is a powerful attack on the "recipe" that business has constructed as its social reality (Berger & Luckman, 1966). Such a view cogently states that that the problem with knowledge management is knowledge management. It stands outside the field of KM, looking in on it.

In our view, the entire field of KM will be improved in its intellectual focus by sharpening the being in and looking in distinction. Should KM be about the "shoulds?" That is an irrelevant question. It *is* about them. Should it move towards the "should not" extreme? Then it would not be knowledge management as a corporatist regime but something else. Knowledge fusion then means that the relevance test for linking research in reference disciplines in the partitions of knowledge embodiment, mobilization and regimes to knowledge management is to help turn "should" into "is." Epistemology, phenomenology, and post-Fordist social capital Italian Marxism may rigorously propose the "should not" viewpoint, but that is irrelevant to KM.

We do not intend in any way to make our analysis here a defense of knowledge management as a socially constructed reality and a corporate regime of truth. Indeed, our ongoing study of the impact of the Internet on corporate reputation, which alerted us to the growing impact of blogs, raises a complex question as to how organizations can avoid being so locked into their knowledge regimes that they exclude information and knowledge that may later turn out to be relevant to their success and even survival, and how they can include appropriate dissent and "whistle blowing." A cautionary tale here is the degree to which Wal-Mart's knowledge management strategies overlooked what was obvious to many observers who read *The Nation*, *Mother Jones,* and *Progressive* instead of *The Wall Street Journal*: the company was accumulating a reputation as an callous employer, union-buster, sexual discriminator, brutal exploiter of suppliers, ruthless outsourcer, and callous corporate machine indifferent to anything except its own growth. In 2005, Wal-Mart moved from being the darling of the business knowledge regimes to the Darth Vader of many of the political and social conscience knowledge regimes.

The issue here is not whether or not these accusations and the vivid adjectives we use in the above paragraph are "true"—they are certainly seen as truths in liberal democratic circles—but that Wal-Mart's knowledge regimes blocked out the information. Now, the company has installed a massive new knowledge mobilization capability, a "war room" (Barbaro, 2005) that monitors the entire Web, including blogs, to alert the company to positive and negative coverage, respond, communicate, and, perhaps most important of all, listen. In 2006, it began to reach out to the bloggers with offers of information and communication that, with their permission, Wal-Mart would provide for them to incorporate in their in their own knowledge mobilization: publishing, discussion, and community-building. Given that several surveys suggest that 2-8 percent of Wal-Mart's more affluent customers are beginning to boycott the company (Barbaro, 2005), Wal-Mart would have benefited from more and earlier attention to Web-enabled knowledge mobilization rather than just internal knowledge management.

This suggests that research in the knowledge regimes partition on the role of dissent, dialectics, and critical enquiry (Courtney, 2001) may offer valuable lessons for knowledge management and mobilization. It may well be that such research begins from rigorous obscurity and over time will establish its relevance.

The Consultants' Role in KM: Thought Leadership vs.—or With—Research Excellence

The second major criticism of KM as a field is that it is largely vendor- and consultant-driven. Wilson's (2002) excoriation of the nonsense of knowledge management states in its opening sentence that the growth of KM as "a strategy of consultancy companies is one of a series of such strategies dating from Taylor's (1911) 'scientific management'." The implied logic of this statement is to suggest that the source of intellectual development matters as much as its nature, and that consultancy-driven work has some inherent built-in limitation, most obviously definitional weaknesses and biases ("in management consultancy it is, perhaps, not too serious to fail to distinguish between related concepts ….. the task of the academic researcher is to clarify the use of terms so that the field of investigation has a clearly defined vocabulary").

That certainly puts Taylor in his place (perhaps had he been an Assistant Professor at the Stevens Institute of Technology, to whom he left the bulk of his estate, scientific management would be legitimate), along with the other consultants who profoundly shaped management thought and stimulated a wide range of research that went a long way beyond clarifying terms: Deming, Juran and Crosby in TQM; Follett, the "prophet of management", whose work in the 1930-1950s on constructive conflict and "co-ordination" was immensely influential in its time and that has increasingly been recognized as foundational for organizational theory; and Beckhard, uniformly acknowledged by his colleagues at MIT as a core figure in the development of the modern human relations school. What makes them relevant to the development of the knowledge management field is that they are noted for what leading consulting firms routinely talk about as their goal for innovation: "thought leadership." A Google search on the term plus the name of any of the leading consulting companies produces between 20,000 and 200,000 results. "Knowledge management + thought leadership" generates 650,000.

There is some evidence that, contrary to the view that knowledge management was largely driven by consultancies in order to find a new revenue stream after the drying up of the largesse generated by Y2K and ERP implementation, the main factor was instead their own need to innovate. As many areas of their markets commoditized, including large scale information systems development, they needed to increase their internal productivity, which mainly meant improving collaboration and knowledge-sharing, particularly about projects, clients, and in-house expertise; in other words, they had to invent knowledge management. While the title of CIO (Chief Information Officer) originated in business, that of CKO (Chief Knowledge Officer) was very much the domain of the large consultancies. Much of the most influential work on KM has originated in the same firms, often written by individuals who have spanned the worlds of academia and consulting (such as Davenport, a professor at the University of Texas and Boston University and also director of KM research centers at Ernst and Young and Accenture.)

Thought leadership (TL), wherever it originates, plus research excellence (RE) would appear to be a powerful combination for a mission- rather than discipline-driven field. Our knowledge fusion framework implies that thought leadership will tend to center on the management-mobilization link, since that is where so many of the practical problems and disappointments of KM investments appear to be generated (Qureshi & Keen, 2005). Excellence in research will tend to focus on the regimes-management or embodiment-mobilization linkages.

Our line of argument obviously accepts the primacy of the corporatist view of the organizational purpose of KM for the evolution of the field, accepts that much of KM is really an extension of information management as a force for innovation and collaboration, and accepts the value of thought leadership being driven by consultants as well as academics. That said, thought leadership based on weak thought will not create a sustainable forum for strong research and its momentum will inevitably evaporate as realism intrudes on assertion. The total quality management and business process management fields provide contrasting examples in this regard.

TQM was built on consultant evangelism (Juran, Crosby, Deming), supported by brilliant application by managers, most obviously Toyota's Ohno, and extended by a wealth of first-rate research (e.g., Ishikawa). The result is a field that continues to grow in terms of academic research outputs. Using Google plus Scholar Google as a rough comparative index for degree of interest plus degree of research activity respectively, commonsense would suggest that if the first is huge and the second tiny, then this is a field that is likely to be just a fad; the reverse would signal a specialist academic field. The contrast between TQM and BPR is shown in Box 1.

One might argue that the research/buzz ratio is higher for BPR than for TQM, but what these figures suggest is that few serious scholars now have any interest in BPR. Yet BPR certainly established a powerful thought leadership position for its best-known proponents, an MIT professor (Hammer) and the head of a leading IT consulting firm (Champy) that had a very distinguished record in the IT field in generating many of the most influential "big ideas" of the 1970-80s.

Unlike TQM, somehow BPR did not generate the creative tension and integration between thought leadership and research excellence that our formulation of knowledge fusion aims at

Box 1.

	Google	Scholar Google
Total quality management	139 million	1.2 million
Business process reengineering	1.3 million	21 thousand

encouraging. If KM is to be effective in generating a lasting impact on research and practice, it simply must ensure that the acronymic equation is KM = TL + RE. However, the pragmatics of KM as organizational mission opens the door to what might be termed intellectual sleight of hand: finessing problems by avoiding them. Hammer and Champy did this basically by not defining what a business process is and making almost casual assertions without a single citation to others' work. There is an aggressive anti-intellectualism in their work, illustrated by the command on the book jacket to "forget all you know about business; it's wrong."

Thought leadership demands intellectualism, in the form of the synthesis of experience and disciplined development of reliable methods that so marks the work of the TQM leaders, and scholarship-backed articulation of principles, exemplified by many writers who move between the worlds of academia and consultancy such as Hamel in corporate strategy and Davenport in knowledge management. Many of the critics of the KM field almost axiomatically assume that it does not need such thought leadership, and that good scholarship and applied research will generate momentum, credibility, implementation, and impact. We argue that thought leadership is integral to the very goals of KM, and that just as there are formal criteria for assessing research quality, there is a need for a comparable if less formal set of broad categories for intended though leadership. We suggest the following list:

- **A succinct and robust articulation of a "management lens."** A genuinely different perspective on some practical aspect of either the field as a whole or some specific area within it where the new lens opens up major opportunities for innovation and collaboration, the two basic reasons for investing in KM, however defined.
- **An explicit inclusion in the articulation and explication in the article or book of the axiomatic base underlying the new focus and of the limits of the domain of applicability**. This, rather than the much-debated issue of a definition of knowledge or knowledge management, appears to us to be key in moving KM forward. There can never be a universal grand schema for knowledge management. It should be perfectly acceptable for contributors to the field to state that, for instance, the purpose of knowledge is action but they need to recognize explicitly that that is an axiom not a truth and that it immediately limits the nature, domains, and methods the lens applies to. It also excludes many areas for investigation in the partition of knowledge embodiment in that it implies a narrow range of epistemological considerations (for instance, it implicitly defines what "expertise" means and how it should be leveraged).

Our knowledge fusion perspective argues for much more careful presentation of "here is one way of viewing XYZ" instead of "this is *the* way." How much richer and more dynamic a field might BPR have become had its leaders couched their message in such wording as, "Here is one perspective on business processes that emphasizes an industrial engineering approach…… it highlights as targets of opportunity….. it does not apply so well to processes that are less structured and that rest on negotiations and tacit knowledge……" Equally, we suggest that the quality of intellectual discussion in KM will be improved by critics and commentators getting away from attacks that basically begin, "ABC's paper claims that…… It is wrong and based on an incorrect definition… Here is the correct one."

- **An active search in the scholarly and research literature for grounded support for the conceptions and claims.** The famous science fiction writer, Theodore Sturgeon, replied to a statement from the audience that

> "90 percent of sci-fi is crud"; "Madam, 90 percent of *everything* is crud." A responsibility of anyone staking a claim to thought leadership, whether through a consulting firm's "white paper," a business press article, a book, or an article in a research journal, is to know and build on the 10 percent. Fields such as TQM, BPR, and KM that are action- and mission-driven run the risk of becoming ahistorical. They look ahead at organizational "transformation" and stress the newness of their perspectives.

In passing, we note that in our view, Wilson's attack on KM as nonsense richly sampled the 90 percent of crud; many of the quotes and examples he provides are simply silly, vapid, ephemeral, consigned to the ashcan of dead trees, and unlikely (one hopes) ever to be cited again. For instance, Wilson ably garrotes a five line KM course description (whose Week 1 is a "collage overview"); written no doubt by a professor who had no idea that it would be selected as evidence of the flaws in the entire KM field. But his ability to mine the KM field and find so many nuggets of coal, not gold, is for us a warning signal that intellectual quality control must apply to white papers, MBA college curricula, trade press articles, guru interviews, and any other formal statement of a position on KM. Again, we hope that our partitioning of the field may contribute, if only a little, to sharpening its scholarly focus and perhaps to help highlight the 10 percent that matters. (In the spirit of knowledge mobilization, we have begun a program funded by Nanyang Technological University to build a blog/portal/literature repository/Semantic Web implementation that highlights the best of thought leadership and research excellence. Of course, "best" implies a particular knowledge regime and key general question for the Semantic Web: *whose* semantics, not which semantics).

One area of gold, not coal, for thought leadership is the scholarship of management theory. It is noteworthy that the leading books on knowledge management rarely investigate the literature of management and organizational theory. It is as if the knowledge worker somehow came into being around 1969 (when Drucker announced the coming of the knowledge economy) and that knowledge management as a discipline emerged in 1990 with Svelby's book that appears to be the first that explicitly uses the term. There is a wealth of earlier literature that addresses many of the core themes and concerns of KM but is rarely mentioned in the field. We referred to Follett's work on constructive conflict, to which should be added the Carnegie School's astonishing stream of thought leadership plus research excellence exemplified by March, Simon, and Cyert. Simon's *Sciences of the Artificial* and *Administrative Behavior*, for example, are directly about, not just relevant to, the goals and themes of KM and helped earn him a Nobel Prize. Other scholars whose work addresses knowledge regimes but that is relatively infrequently referenced by the KM thought leaders include Argyris, Schon, Galbraith, Churchman, Barnard, and Thompson, to name just a few.

In our articulation of knowledge fusion, we have largely emphasized how the partitions of knowledge mobilization, embodiment, and regimes can enhance that of the knowledge management partition. We suggest that as a partition within knowledge fusion, there is value for KM to link far more closely than it has to the resonant scholarship of management theory.

c onclus Ion

At the core of our framework is a single distinction that we view as fundamental to the effective development and impact of knowledge management as both a field and an area of management practice: knowledge mobilization. Initially, our investigation was targeted at arguing that knowledge management should incorporate and even convert to our viewpoint. Our work remains centered on knowledge mobilization but we quickly realized that unless we carefully maintained a respectful boundary between knowledge management and knowledge mobilization, we would merely add to the blur and multiplicity of KM and get caught up in the definitional debates. To establish our own axioms and distinctions, especially that of knowledge as identity with three levels of activation – accountable, discretionary, and autonomous knowledge – we would need to move into intellectual assault mode, attacking the axioms of knowledge as corporate asset and as independent of the individual. That made no sense at all; it would represent an intellectual arrogance, negativism, and waste of effort that impedes rather than contributes to a cumulative tradition of research and practice.

As we moved consciously to adopt a grounded theory approach to positioning our conceptions of knowledge mobilization, and activation, we increasingly acknowledged the extent to which knowledge management is axiomatic rather than definitional in its very varied domains of theory and practice and that in many ways the axioms drive the theory and practice. The heterogeneity of these domains is both the opportunity and the problem for knowledge management. They are an opportunity, for instance, in that the work of Habermas (1984), Rorty (1991) and Searle (1995) in the field of philosophy appears more and more as of direct practical relevance to our understanding of knowledge mobilization. They are a problem in that discussions of their work at the theoretical level and from the perspective of their own axioms do not connect well if at all to the mainstream of KM.

But it should do so. Partitioning the semi-infinite reference disciplines relevant to "knowledge" helps achieve this. The central test of the validity and value of our knowledge fusion framework is whether the proposed partitions parsimoniously but also comprehensively both capture the scope of the disciplines and focus them insights on knowledge management, rather than knowledge.

Our framework has a selfish purpose: to help us leverage our work. We hope that it helps others in the knowledge management field leverage their own. We have no interest in promoting knowledge fusion as a new theory or "model." We developed it to guide our own investigation and collaboration with colleagues. We offer it as a vehicle for knowledge mobilization in the knowledge management field. Every single one of the themes and viewpoints that we review in this chapter has been addressed by dozens and even hundreds of KM thinkers and practitioners and our bibliography does not do justice to the range and volume of work that we reviewed or the work we overlooked; it is largely illustrative. The diversity and quantity in many ways motivated our study; there is too much of it, it does not seem to be generating a cumulative tradition of study on which results build on each other, and at times KM is almost a haystack in which almost any needle can be found just by digging around. Something has to be done to frame KM, not to homogenize it, but to give it more shape. We hope that our framework offers a useful starting point.

Finally, we listed as one of the main criticisms of knowledge management as a field the claim that it so far has generated disappointing results. Compared to, say, the field of supply chain management (SCM), where the total costs of logistics have been reduced by 40 percent as a percent of gross domestic product (Earle & Keen, 2000) and commentators can point to companies such as Dell, Wal-Mart, UPS, and Li & Fung, whose growth and spectacular success were built on SCM. We have as yet no comparable large-scale successes in knowledge management, and the "learning organization" and "knowledge company" remain distant dreams. Binney (2001) states that we have many knowledge management *applications* but very few knowledge management *systems*. In the end, the validity of knowledge management as a field will be determined by its results. Knowledge fusion is aimed at helping mobilize critical enquiry, in the widest sense of the term, thought leadership and research excellence to influence and hopefully add value to the efforts of the managers who will build the KM equivalents of Dell and Toyota. That may be a long way off, but that is the reality test for the field of knowledge management.

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Chapter III
Tapping Tacit Knowledge

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Abstr Act

This chapter explores the concept of 'tacit knowledge' and how organizations can foster the sharing and exchange of tacit knowledge. Various views of tacit knowledge are discussed and a framework is developed distinguishing different conceptualizations of knowledge and how different types of knowledge are acquired, held in memory, and manifested. An understanding of these distinctions can aid in determining the best approach for transferring tacit knowledge and skills at the individual and organizational levels. Finally, I review various tacit knowledge transfer approaches based on the distinctions identified in the framework and discuss their suitability for different aspects of tacit knowledge transfer.

Introduct Ion

Increasingly, firms are turning to management of their knowledge assets for gaining a competitive edge in the market place (Coff, Coff, & Eastvold, 2006; Nonaka, 1994). As one would expect, the term "tacit knowledge" arises often in discussions of management of an organization's knowledge, but it is frequently used with inadequate definition as a catch-all phrase for any knowledge that is not formally recorded (Styhre, 2004). The notion of tacit knowledge is intuitively appealing and seems to be something that we all instinctively understand as the knowledge that people have in their heads, rather than knowledge that is written down and recorded (Koenig, 2003). However, as Day (2005) notes, this 'folk-psychology' notion of tacit knowledge is simplistic and leads to the expectation that tacit knowledge can easily be transferred simply by having the knowledge holder reflect on and articulate the knowledge. In fact, the real concept of tacit knowledge remains ambiguous, with researchers applying the term with a variety of meanings and characterizations. Consequently, there is some confusion and debate over what tacit knowledge is, and is not, and whether or not it can be 'captured' or articulated (Berry & Dienes, 1993; Castillo, 2002; Tsoukas, 2003). This ambiguity brings significant challenges for firms as they manage and attempt to transfer the tacit dimensions of knowledge within their organizations.

This chapter aims to bring some clarification to the proliferation of ideas and interpretations surrounding the idea of tacit knowledge. I firstly give an overview of the historical beginnings of the tacit knowledge concept, and then review the related concept of implicit learning. In the following section, I discuss various categories of tacit and explicit knowledge that have been proposed by researchers, and develop a framework of categories of knowledge, based on distinctions it is useful to make in order to understand the various aspects of knowledge that might be managed within an organization. In particular, I identify how different types of knowledge are manifested, i.e., how we know that a particular dimension of knowledge actually exists, and how different aspects of knowledge can be acquired. Such a categorization is essential if we are to understand how to identify and transfer knowledge within organizations. Finally, I review approaches that can be used in the business domain to transfer the different dimensions of tacit knowledge identified in the framework.

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The origin of the tacit knowledge concept is usually attributed to Polanyi (1966), who laid a theoretical foundation, and coined the often quoted phrase "we can know more than we can tell". Drawing on Ryle's work (1949), Polanyi focused on two dimensions of knowing, "knowing what" and "knowing how", arguing that these two aspects of knowing are always both present in any instance of a person's knowledge. According to Polanyi, we know that tacit knowledge exists because we can see the practical outcomes of its application and can thus infer that there must be some implicit or tacit knowledge that the person has but cannot articulate. Polanyi argued that the aim of explicitly and objectively formalizing all knowledge may not be achievable, as the implicit or tacit aspects of knowledge cannot be fully replicated as formal explicit knowledge.

More recently, the knowledge management literature has been heavily influenced by Nonaka's (1994) Socialization, Externalization, Combination, Integration (SECI) model of knowledge conversion. With this model, Nonaka proposes that knowledge creation occurs through a process of socialization between individuals to share tacit knowledge; externalization to translate or convert individual tacit knowledge to explicit knowledge; combination to capture and disseminate new explicit knowledge; and internalization, whereby the organization's explicit knowledge is internalized by individuals so that it becomes tacit again. However, empirical evidence examining the conditions that support the SECI process stages, particularly the externalization stage, is limited (Gourlay, 2006a) and the model has come under increasing criticism as being based on a flawed understanding of the nature of tacit knowledge and the degree to which it can be articulated and 'translated' into explicit knowledge (Gourlay, 2006a; Keane & Mason, 2006; Tsoukas, 2003). While these criticisms have been primarily based on philosophical arguments, empirical research in the cognitive psychology field on implicit learning suggests that the extent to which tacit knowledge can be articulated depends, at least in part, on the way in which the tacit knowledge was originally acquired.

IMpl IcIt le Arn Ing

Implicit learning has been the focus of a wide range of studies in the social sciences. Implicit learning occurs when a person acquires knowledge without a conscious attempt to do so, and largely without explicit awareness of what was acquired (Reber, 1993). Thus, it is difficult for the person to articulate or describe the resulting knowledge acquired. There is some confusion in the literature over the implicit-explicit distinction, with some researchers referring to the type of knowledge possessed, while others refer to the different learning processes of acquiring knowledge (Berry & Dienes, 1993). In general, explicit knowledge is knowledge a person can easily explain or describe, while implicit or tacit knowledge is knowledge that a person may be unaware of having, and that is difficult to articulate. Explicit learning occurs in more formal teaching and learning settings or when conscious learning strategies are applied. In contrast, implicit learning occurs when a person acquires knowledge without the use of conscious strategies, and often without being aware of the knowledge gained.

Just as Polanyi considered that the two aspects of knowing (knowing what and knowing how) are always present in any instance of knowledge, so Reber (1993) argues that implicit and explicit learning are not completely separate, but are interactive or co-operative processes existing along a continuum. In particular, in complex learning situations a person's performance is likely to involve both implicit and explicit learning processes (Anderson, 1982; Argyris & Schön, 1978; Berry & Dienes, 1993; Nonaka, 1994).

Several laboratory studies have investigated implicit learning, including studies on artificial grammar learning (Reber, 1989), rule-governed stimulus sequences (Lewicki, Hill, & Bizot, 1988), and the control of complex systems (Berry & Dienes, 1993). Studies of patients suffering from neurological or psychological impairment have also supported the idea of a distinction between implicit and explicit learning (Berry & Dienes, 1993; Reber, 1993). These studies have demonstrated that subjects can acquire knowledge that they are unaware of. For example, in artificial grammar learning experiments (Reber, 1989) subjects were able to learn to apply grammar rules derived from sequences of letters that they had been shown previously in order to determine whether a new sequence was grammatically correct. Even though their success rate was significantly better than could be expected by chance alone, the subjects had no awareness of and could not explain the rules they were applying. Typically, they reported that they were just guessing or using intuition. This effect has also been noticed more recently in a study comparing different training methods for learning negotiation skills (Nadler, Thompson, & van Boven, 2003). In this study, the students who learned by observation of a skilled negotiation session alone, with no explicit instruction, showed the largest increase in performance, and yet were unable to explain or articulate the negotiation principles that they had (implicitly) acquired.

While these laboratory studies have demonstrated the acquisition of tacit knowledge, there is still speculation about how that knowledge is stored and subsequently accessed by the holder. Two possible structures have received attention (Berry & Dienes, 1993; Reber, 1993). The first is the abstract view, where people develop mental models or rules that they can apply to new situations of a similar type. The second is the exemplar view, where people use analogous past experiences to help determine a response to a new but similar situation. Berry and Dienes suggest that the relative abstractness of tacit knowledge may lie on a continuum, while Reber argues that an abstract tacit knowledge base may gradually develop as the number of past experiences becomes large. Stanley et al. (1989) propose that people typically use exemplars or close analogies to (implicitly) determine their responses, but if pressed to describe or explain their actions they will attempt to do so using a mental model or rule-based approach. Like Reber, Stanley et al. suggest that the more abstract, mental model approach is likely to develop as experiences increase, and they note that mental models and rules are more explicit in their nature, reflecting the continuous nature of explicit and implicit modes.

Implicit knowledge is not always acquired implicitly, nor is explicit knowledge always acquired explicitly. Some researchers (Anderson, 1982, 1983; McCloy, Campbell, & Cudeck, 1994) have hypothesized that *skills* acquisition passes through three stages, from explicit to implicit. The first stage is an explicit or declarative stage where the learner knows *what* to do but cannot demonstrate skilled performance in practice. In the second stage, the learner develops the procedural knowledge to execute the skill proficiently, while the final stage occurs when the knowledge about how to execute the skill, originally learned explicitly, is 'internalized' or held implicitly. Typically, people can articulate details of the initial declarative knowledge about a skill, for example the skill of driving a car, but find it difficult or even impossible to articulate the procedural knowledge, because this knowledge can only be acquired through experience, by performing the skill until a level of proficiency is reached. Building on Anderson's model, Nonaka and his colleagues (Nonaka, 1994; Nonaka, Toyama, & Konno, 2001; Takeuchi, 2001) developed the SECI model, discussed earlier, of the acquisition of the more cognitive aspects of knowledge. In this view, cognitive knowledge acquisition spirals through stages from implicit to explicit and back to implicit knowledge again, through continuous externalization and internalization processes.

The manner in which tacit knowledge is acquired—explicitly and then internalized, or implicitly without explicit awareness of the acquisition—has implications for the extent to which the knowledge can be later articulated. Thus, as discussed in more detail later, tacit or implicit knowledge that has had at least some explicit aspect to its acquisition can be converted to explicit knowledge by "reflection in action" (Schön, 1983), by the use of metaphor and analogy (Nonaka, 1994; Nonaka & Konno, 1998), or by using mentoring and story-telling (Swap, Leonard, Shields, & Abrams, 2001). However, Stanley's (1989) insight – that tacit knowledge holders may implicitly use analogy to determine a response, but explicitly try to explain that response through a derived mental model – suggest that attempts to elicit tacit knowledge may result in the holders reporting their theories of action rather than explicating their actual practice (Argyris & Schön, 1978). Indeed, although it is possible to 'externalize' some parts of implicit knowledge, some aspects of implicit knowledge, particularly those acquired implicitly and related to creativity, intuition, and skill performance, are unlikely to ever be made completely explicit (Leonard & Sensiper, 1998; Polanyi, 1966; Reber, 1989; Tsoukas, 2003).

cAtegor les of Knowledge

In the business domain, interest and research in tacit knowledge has increased in recent years. However, in applied management studies, differing views on the nature of tacit knowledge and the extent to which it can be articulated have resulted in the use of various terms and concepts to describe types of knowledge, with a corresponding lack of consistency in the operationalization of the tacit knowledge concept, and in what distinguishes tacit knowledge from explicit knowledge (Ambrosini & Bowman, 2001; Castillo, 2002; Gourlay, 2006b). Following Polanyi's view of two aspects of knowing, many management theorists view tacit and explicit as elements or dimensions of all knowledge, rather than as mutually exclusive categories of knowledge (Edmondson, Winslow, Bohmer, & Pisano, 2003; Hislop, 2002; Keane & Mason, 2006; Tuomi, 1999-2000). Much interest, however, has focused on whether the tacit aspects of knowledge can be converted or made explicit, and this has led researchers to develop various categorizations of the characteristics of tacit and explicit aspects of knowledge.

While most writers have simply used the term *explicit* to describe those aspects of knowledge that are formally learned and easily articulated, Spender (1996) uses the term *conscious,* Ambrosini and Bowman (2001) use the term *objective,* and Blackler (1995) and Lam (2000) have followed Collins (1993) in using the term *embrained* to refer to this dimension of knowledge. While there is general agreement on the use of the terms *implicit* or *tacit* to refer to the broad dimension of knowledge that individuals find difficult to articulate and have learned by experience, by practice ('doing'), or by 'osmosis', researchers have used different degrees of granularity, and different terms, in discussing types of implicit knowledge. Other researchers have also investigated the idea of collective explicit and implicit knowledge – knowledge that is held by a group or an organization rather than a single individual. Again, various terms and definitions have been used. I review research related to individual and collective tacit knowledge in detail next and summarize the various concepts, terms, and definitions in Table 1. In particular, as shown in Table 1, I identify key differences in how different aspects of knowledge are learned, how they are held in memory, and how they are manifested (i.e. how we know they exist). These distinctions are particularly important for researchers seeking to understand how to facilitate the elicitation and transfer of tacit elements of knowledge.

Individual t acit Knowledge

Of the group of researchers focusing on individual tacit knowledge, some, such as Ambrosini and Bowman (2001), view tacit knowledge as relating solely to an individual's *skills* development, while others (Blackler, 1995; Castillo, 2002; Lam, 2000) make no distinction between tacit skills and tacit knowledge. Nonaka (1994) and Takeuchi (2001), however, believe that tacit knowledge can have both a technical and cognitive dimension. *Technical* tacit knowledge is skills know-how, learned implicitly through experience, and it is usually not possible for an individual to articulate or describe this technical know-how. *Cognitive* tacit knowledge is knowledge that is developed implicitly using "mental models" or exemplar situations. These mental models are so ingrained that we take them for granted. While experts can be asked to articulate their cognitive tacit knowledge, their verbal reports may be inaccurate as they don't really know at a conscious level why they choose certain actions (Schön, 1983; Stanley et al., 1989). Consequently their explanations may be more related to what they think ought to underpin their knowledge, rather than what actually does (Hsia, 1993; Johnson, 1983; Parnas & Clements, 1986).

Researchers have also focused on distinguishing levels of individual tacit knowledge or skills relating to the extent to which the knowledge can be articulated. Both Castillo (2002) and Ambrosini and Bowman (2001) differentiate three levels of implicitness of an individual's tacit knowledge. Castillo's first level, *nonepistle* tacit knowledge, is knowledge that is the result of implicit learning and is completely inarticulable, or "deeply ingrained" in Ambrosini and Bowman's terms. This nonepistle tacit knowledge is extremely difficult, if not impossible for individuals to access, and therefore is unlikely ever to be explicitly articulated (Ambrosini & Bowman, 2001; Castillo, 2002; Leonard & Sensiper, 1998). Castillo's second level of tacit knowledge is *sagacious* knowledge, corresponding to Ambrosini and Bowman's "imperfectly articulated tacit skills" and Nonaka's (1994) cognitive form of tacit knowledge. *Sagacious* knowledge is a tacit form of knowing that "emanates in an acute and keen practical sense". While sagacious tacit knowledge is typically acquired implicitly, Ambrosini and Bowman concur with Nonaka in viewing this knowledge

Table 1. Categories and subsets of knowledge

How learned	How held	How manifested and articulated	Terms used	References
Individual tacit or implicit knowledge				
Implicit	Implicit	Manifested in outcomes or actions. Most likely skills-based. Inarticulable.	Nonepistle tacit knowledge Deeply ingrained tacit skills Embodied knowledge Technical skills know-how Subset of automatic knowledge	(Castillo, 2002) (Ambrosini & Bowman, 2001) (Blackler, 1995; Collins, 1993; Lam, 2000) (Nonaka, 1994; Takeuchi, 2001) (J.-C. Spender, 1996)
Implicit	Implicit	Manifested in outcomes or actions, and demonstration of an "acute and keen practical sense" (Castillo, 2002). Most likely cognitively based, with mental models or exemplars. Perhaps partially articulable, but attempts to explain may be inaccurate.	Sagacious tacit knowledge Imperfectly articulated tacit skills Tacit knowledge – cognitive dimension Practical thinking Practical intelligence – tacit knowledge Subset of automatic knowledge	(Castillo, 2002) (Ambrosini & Bowman, 2001) (Nonaka, 1994; Takeuchi, 2001) (Scribner, 1986) (Sternberg et al., 2000; Sternberg & Horvath, 1999; Wagner, 1987) (J.-C. Spender, 1996)
Explicit	Implicit	Manifested in common or shared understanding of technical foundations and abstract expressions of expert area. Explicit knowledge that has been "internalized". Articulable.	Semantic tacit knowledge Tacit skills that can be articulated Internalized knowledge (from explicit to tacit) Subset of conscious knowledge	(Castillo, 2002) (Ambrosini & Bowman, 2001) (Nonaka, 1994; Takeuchi, 2001) (J.-C. Spender, 1996)
Individual explicit knowledge				
Explicit	Explicit	Manifested in individual's ability to explain items from the collective store of 'hard data'. Readily articulated.	Objective knowledge Conscious knowledge Embrained knowledge Declarative knowledge	(Ambrosini & Bowman, 2001) (J.-C. Spender, 1996) (Blackler, 1995; Collins, 1993; Lam, 2000) (Anderson, 1983)
Collective or social implicit knowledge				
Mainly implicit but can be explicit	Implicit	Manifested in social interactions and shared understandings of social norms and behaviors. May be rule-driven, but cannot be fully articulated or explicated, as each application of the rule is dependent on the social context.	Encultured knowledge Subset of embedded knowledge (shared beliefs and understanding)	(Blackler, 1995; Collins, 1993) (Lam, 2000)
Explicit and implicit	Implicit	Resides in systemic routines. Manifested as "many individual kernels of tacit and explicit knowledge that jointly determine a … system of facts, procedures, and routines …" Can be articulated in systems terms in the relationships between technologies, roles, (unwritten) formal procedures and routines (Blackler, 1995).	Embedded knowledge Subset of embedded knowledge (organizational routines) Sociocultural tacit knowledge Collective knowledge Tacit routines	(Blackler, 1995) (Lam, 2000) (Castillo, 2002) (J.-C. Spender, 1996) (Ambrosini, 2003)

continued on following page

Table 1. continued

How learned	How held	How manifested and articulated	Terms used	References
Collective or social explicit knowledge				
Explicit	Explicit	Held in repositories such as libraries, books, formal data media, written rules and procedures (or in verbally transmitted lore for oral societies). The sum of explicit knowledge in a group, organization or society. Readily articulated either verbally or in written form.	Encoded knowledge Objectified knowledge	(Blackler, 1995; Collins, 1993; Lam, 2000) (J.-C. Spender, 1996)

as being partially articulable through metaphor and analogy.

Finally, Castillo's third level of tacit knowledge is *Semantic* knowledge, which is explicit knowledge that has been made implicit, or internalized in Nonaka's terminology. Semantic knowledge is often discerned in conversations between experts, who base their communication on the implicit assumption that they share a common understanding of the technical foundations and abstract expressions of their expert area, and thus never explicitly discuss basic terminology and definitions (Castillo, 2002). However, Semantic knowledge was once explicit and so can be articulated relatively easily if the right questions are asked (Ambrosini & Bowman, 2001; Castillo, 2002; Nonaka, 1994).

Collective Tacit Knowledge

Several researchers, including Ambrosini (2003), Blackler (1995), Lam (2000), Spender (1996), and Collins (1993), have hypothesized about collective knowledge and sub-categories of collective knowledge. There is some confusion in terminology among these researchers with the same term being used for different definitions of collective knowledge. The general term, collective knowledge, has been used to describe the totality of the knowledge, both explicit and tacit, held by all members of a group, organization or society, with different individuals within the group holding differing sets of knowledge (Lam, 2000; J.-C. Spender, 1996). Researchers have distinguished between collective explicit and collective implicit knowledge as follows. Collective explicit knowledge, called *encoded* knowledge by Collins, Blackler and Lam, and *objectified* knowledge by Spender, is viewed as being held in common repositories such as libraries, books, and formal data media (or in verbally transmitted lore for oral societies). As such, it is readily accessible by all (authorized) members of the group, and is typically transferred by formal learning procedures.

Collective implicit knowledge, termed *tacit routines* by Ambrosini (2003), *embedded* knowledge by Blackler (1995) and Lam (2000), *socio-cultural* knowledge by Castillo (2002), and simply *collective* knowledge by Spender (1996), resides in systemic routines, and the relationships between technologies, roles, and (unwritten) formal and informal procedures in the group, organization or society. Collective implicit knowledge may be thought of as "the way we do things round here". As such, it will comprise elements of individual members' explicit and implicit knowledge, since much of an individual's knowledge of group procedures and routines can be easily articulated. The key point is that, although individual members can articulate much of this knowledge, it has not been formally captured and recorded in the group's explicit knowledge repository, and thus it remains at the implicit level for the group as a whole. Therefore it is only accessible to other members of the group if they know the right person to ask, and is not accessible to people outside the group. Blackler distinguishes a further subset of collective implicit knowledge, *encultured* knowledge, which refers specifically to the knowledge that individuals hold about the cultural or social norms regarding how to behave or interact with others in the group in specific situations. Individuals usually learn encultured knowledge implicitly as part of an on-going socialization process. Although it is rule-driven, in that members of a group can usually explain the rule about appropriate behavior in a given context, the rule will change for each social context, and it is impossible to completely specify all appropriate behaviors for all contexts (Collins, 1993).

t Ac It Knowledge tr Ansfer Mech An Is Ms

I turn now to the question of how the different levels of tacit knowledge discussed above can be elicited and/or transferred between individuals and among groups of individuals. Table 2 summarizes the types of tacit knowledge (adopting Castillo's (2002) terminology for individual dimensions of tacit knowledge and Blacker's (1995) terminology for collective dimensions) and appropriate transfer mechanisms for each dimension. The type of tacit knowledge and the extent to which it can be articulated determines the best transfer approach. Clearly, for inarticulable or partially articulable, tacit knowledge, methods focused on asking the individual to explain or describe his or her knowledge are likely to be only partially successful at best. Thus, drawing on the implicit learning research discussed earlier, I first review observational and experiential methods of acquiring nonepistle tacit knowledge without language, which have more promise for transferring highly inarticulable dimensions of tacit knowledge. Most empirical work, however,

Table 2. Transfer mechanisms for dimensions of knowledge

Type of knowledge	Extent of articulation	Transfer mechanisms
Individual tacit	Nonepistle: Inarticulable	Demonstration, observation, apprenticing, actual practice, mentoring
	Sagacious: Partially articulable	Metaphor, analogy, storytelling, critical incident studies, behavior modeling
	Semantic: Articulable with prompting	Questioning to elicit or 'surface' the underlying explicit knowledge base
Individual explicit	Explicit: Readily articulated	Formal learning procedures, e.g. schools, reading, formal training, etc.
Collective tacit	Encultured: Partially articulable but context dependent	"Socialization", observation, informal behavior modeling. Also direct explanation of the rule in a particular context.
	Embedded: Articulated or partially articulated in formal and informal procedures and routines	Informal observation; on-the-job training of "the way we do things round here"; group causal mapping.
Collective explicit	Encoded: Readily articulated, usually in writing	Formal learning procedures

has focused on surfacing the articulable aspects of tacit knowledge, and I discuss critical incident interview approaches (Sternberg et al., 2000) to eliciting sagacious tacit knowledge and behavior modeling training (Decker & Nathan, 1985) as a means of transferring the elicited sagacious tacit knowledge. Finally, I discuss organizational level approaches for surfacing and transferring encultured and embedded tacit knowledge.

Nonepistle Tacit Knowledge Transfer

Nonepistle tacit knowledge is implicitly learned and inarticulable, and hence cannot be surfaced and transferred in an explicit manner. However, novices can acquire the tacit knowledge or skills of experts without language, by the methods of apprenticing, observation, and mentoring (Leonard & Sensiper, 1998; Nonaka, 1994; J.-C. Spender, 1996). While apprenticeship is a centuries-old tradition, it has been typically viewed as a vocational skills training method and its potential application in the management training arena has been largely unrecognized (Hammer, Leonard, & Davenport, 2004). However, there is evidence that knowledge workers and managers develop much of their knowledge and experience through informal apprenticeship arrangements (Kempster, 2006), particularly through observation of other experts in the field. In a related area, apprenticing or contextual inquiry has been shown to be an effective systems analysis method for capturing implicit system requirements that are difficult to surface through traditional analysis interview methods (Beyer & Holtzblatt, 1995). Thus, formalized apprenticeship models would seem to have considerable potential as a tool for development of knowledge workers and for transfer of the nonepistle aspects of tacit knowledge.

One key aspect of the apprenticeship situation is the opportunity for the apprentice to observe skilled on-the-job behavior, and observation is another key tool for transfer of nonepistle tacit knowledge. As noted in the section on implicit learning, the opportunity to observe experts in a field can result in a novice's improved performance, even if the novice is unable to explain what he or she has learned (Nadler et al., 2003). The importance of observation in this context has been encapsulated by Collins (2001) in his analysis of the eventual transfer of a Russian scientist's tacit knowledge related to measurements of quality factors in sapphire. Even though detailed descriptions of the experiments had been provided, a team of Scottish scientists could not replicate the measurements until they were able to observe the leader of the Russian team actually carrying out the work. By watching the actual practice of the Russian team leader, the Scottish group was able to detect small and subtle differences, which were almost impossible to describe, in the way the procedures were carried out. Had these observations been made at the start of the replication attempt, the non-epistle tacit knowledge would have been easily transferred and the replication would have been quickly confirmed. In the more typical knowledge work context, observation opportunities to facilitate non-epistle tacit knowledge transfer can be provided through job rotation and the pairing of new employees with experienced staff.

Mentoring has received more attention in the management field as a mechanism for the transfer and retention of managerial knowledge (Geisler, 2007; Swap et al., 2001). Mentoring has much in common with apprenticeship, but tends to be more informal with mentors providing guidance and advice rather than specific on-the-job training. While there is little evidence that mentoring increases the pool of organizational knowledge, empirical studies have shown a relationship between mentoring and job performance and job satisfaction (Bryant, 2005; Swap et al., 2001). Indeed, it seems that much of the knowledge transfer between mentor and protégé relates to embedded tacit knowledge about organizational routines and political systems (Swap et al., 2001). However, recent research into peer-to-peer mentoring suggests that peer-mentoring relationships between new and established employees at the same level may provide an important avenue for job-related nonepistle knowledge transfer (Bryant, 2005).

sagacious and semantic tacit Knowledge transfer

Sagacious tacit knowledge is implicitly learned and partially articulable, although simply asking the tacit knowledge holder to articulate what he or she knows is likely to result in inaccurate reporting. In contrast, Semantic tacit knowledge is learned explicitly and internalized, and thus can be readily accessed by asking the right questions. Hence, methods that can elicit sagacious tacit knowledge will also surface Semantic tacit knowledge. Nonaka and Takeuchi argue that these types of tacit knowledge can be made at least partially explicit by story-telling using metaphor, analogy and prototype. While unstructured story-telling in the form of 'war stories' shared by senior staff may be more effective in transferring embedded tacit knowledge about "the way we do things round here" (Schön, 1983; Swap et al., 2001), Sternberg and Wagner (1986) and Klein et al. (1989) have both developed interview techniques based on the use of story-telling approaches to facilitate the elicitation of partially articulable tacit knowledge.

Sternberg et al. (2000) define the concept of tacit knowledge as *practical intelligence*, i.e., quite simply as knowledge acquired implicitly, from everyday experience, that is difficult for the holder to articulate or explain. Sternberg and his colleagues have examined tacit knowledge as practical intelligence in several different settings, including academia, military leadership, sales and business management, and they have devised an approach to measuring tacit knowledge that takes into account the contextual and experience-based nature of the knowledge. Their approach relies on a critical incident approach (Flanagan, 1954) to interviewing domain experts in order to tap into any tacit knowledge they may possess. Sternberg et al.'s use of the critical incident interview approach is designed to achieve the surfacing of sagacious tacit knowledge by encouraging respondents to tell 'stories' of specific examples of good or poor performance in the area of interest. Sternberg et al.'s studies have demonstrated that the critical incident/story-telling approach does elicit sagacious tacit knowledge, at least to some extent. In order to determine what aspects of the knowledge elicited is tacit, Sternberg et al. use a comparison of expert and novice respondents, arguing that novices in the field will have some explicit knowledge but little tacit knowledge. Thus, knowledge items held by the experts and not known by the novices are likely to be tacit. A key limitation of this approach is that even when tacit knowledge is elicited, there is no measurement of its worth. Therefore, Sternberg et al. recommend that an independent set of experts should be asked to judge the tacit knowledge items that have been uncovered.

Even when sagacious tacit knowledge can be surfaced using a method such as Sternberg et al.'s, it is still difficult to achieve effective transfer simply by telling a novice, because not all aspects of sagacious tacit knowledge can be made fully explicit. However, given a sufficient foundation for the knowledge, a training program can be developed using behavior modeling, which combines an understanding of the explicit aspects of the knowledge with expert demonstration of the desired behaviors and opportunities for the novice to practice and gain feedback. Behavior modeling is based on social cognitive theory (Bandura, 1986), which suggests that effective performance will be enhanced if the learner has first had an opportunity to observe others performing the behavior (Compeau & Higgins, 1995). A recent extensive meta-analysis of 117 behavior modeling training studies (Taylor, Russ-Eft, & Chan, 2005) found that while trainees' explicit knowledge decayed over time, improvements after training in skills and job behaviors remained stable or even increased, suggesting that this type of training has considerable potential for transfer of sagacious tacit knowledge.

Encultured Tacit Knowledge Transfer

Encultured tacit knowledge can be viewed as the socio-cultural knowledge people develop over time that enables them to function acceptably according to the norms of the society or group that they belong to. In an organizational context, this knowledge is encapsulated in Schein's (1992) concept of "the way we do things round here". Thus, much of encultured tacit knowledge is transferred implicitly as part of the orientation and socialization process that new employees typically experience. Some organizations have attempted to foster socialization through the encouragement of communities of practice, or informal horizontal groups of workers that span departmental or organizational boundaries (Cox, 2005). While there has been little empirical work assessing the extent to which such communities foster collective tacit knowledge exchange, a case study reported by Desouza (2003) suggests that provision of social areas in the work place can facilitate knowledge sharing, although it appears that much of the knowledge transferred was largely explicit, since the amount of knowledge transferred was measured by counting postings to a knowledge database.

Embedded Tacit Knowledge Transfer

Embedded tacit knowledge describes the knowledge embedded in an organization's formal and informal rules and procedures, and much of this knowledge is explicit. However, over time, the routines for carrying out tasks get embedded in everyday work and the knowledge and rationale for certain processes become tacit to at least some of the workforce. Thus, drawing on Schein's description of organizational culture as "the way we do things round here", we can view an organization's knowledge as being embedded in its routines, routines that can be highly firm-specific, taken for granted, and deeply ingrained in organizational memory. The socialization transfer mechanisms described above for transfer of encultured tacit knowledge are also important for embedded tacit knowledge transfer and, as noted earlier, informal or formal mentoring can facilitate the acquisition of this type of knowledge by new employees.

As with encultured knowledge, there is little empirical research examining the elicitation and transfer of embedded tacit knowledge. However, in an in-depth case study within a single organization, Ambrosini (2003) explored collective tacit knowledge as a source of organizational competitive advantage by examining the tacit routines and ways of doing things that people within the organization are involved in. Such routines are difficult for people to verbalise; are about doing; and are context specific. Ambrosini noted that some routines were explicit and already codified within the organizational policies and procedures, while others were deeply ingrained. In between these two extremes lay, firstly, tacit routines that were unarticulated simply because no-one had ever asked the right question, and secondly, tacit routines that were difficult to articulate but that can be surfaced through metaphor or story-telling. Ambrosini used a causal mapping approach in combination with in-depth probing to reveal these underlying tacit routines related to organizational ways of working that contributed to the organization's success. After participating in the mapping sessions, employees were provided with copies of the maps and asked to identify those routines that had been tacit to them prior to the group session. Some routines were known to everyone, some were tacit to a few group members, while a few were tacit to most group members.

As with Sternberg et al.'s approach, a great deal of interpretation was required from the researcher to determine whether, indeed, any of the routines truly represented tacit knowledge, and whether such routines were useful or valuable tacit knowledge. Moreover, tacit knowledge at the organizational level is typically only tacit to some members of the organization, while being explicit to other members. Ambrosini highlighted that key routines within an organization could be tacit to managers, in particular, either because the managers do not know about them, or because they did know about the routines but did not understand their value. While Ambrosini's focus was at the collective level of tacit knowledge, in fact, her elicitation approach was applied at the individual level. The key difference here seems to be the emphasis on identifying knowledge or routines that are both tacit to key organizational members and practically useful at the organizational level, rather than both tacit and practically useful at the individual level.

conclus Ion

Tacit knowledge is an appealing concept that people intuitively understand but it is often used loosely and imprecisely. While much interest centers around the management of tacit knowledge, it is important for researchers and practitioners alike to be clear about what aspect of the tacit dimension of knowledge they wish to focus on. As shown in Table 1, only certain types of tacit knowledge are likely to ever be rendered explicit, while nonepistle dimensions are inarticulable and can be transferred only by processes of apprenticeship, observation, and practice. Although tacit knowledge has been the subject of many theoretical articles, empirical research actually operationalizing the concept is limited. Typically, such operationalizations focus on those cognitive aspects of individual tacit knowledge that can be surfaced and articulated indirectly. While some theorists argue that tacit knowledge can exist at a collective level, the operationalizations targeting this level of tacit knowledge still operate at the individual level, with the key difference being not in who holds the knowledge or how it is held, but rather in to whom it is tacit and to whom or what it is valuable and practically useful.

The key issue with the management of tacit knowledge revolves around whether to attempt to capture it, for example as a 'lessons learned' or 'best practice' exercise or whether to foster an environment where it can be shared informally without ever actually explicitly surfacing it. An understanding of the type of tacit knowledge likely to be involved can help in this decision. Much of the literature on knowledge management systems addresses issues such as how to facilitate the creation, storage and transfer of knowledge (Alavi & Leidner, 2001). However, such systems by their very nature can only handle explicit codified knowledge, and there is little guidance on how to render tacit knowledge explicit so that it can be processed by the system. As shown in Table 1, much tacit knowledge is likely to be impossible to codify, or at best to require a difficult and lengthy process to surface it, and thus non-verbal and non-explicit transfer mechanisms such as those in Table 2 will be more effective than codification efforts. Perhaps, as Malhotra et al. (2001) conclude, rather than focusing on systems to codify knowledge, we should instead concentrate on systems that facilitate collaboration between knowledge holders and those needing the knowledge.

Indeed, recent research has already begun to recognize the need to incorporate support for person-to-person knowledge sharing when designing knowledge management systems in order to facilitate the transfer of complex, context-specific knowledge (Brown, Dennis, & Gant, 2006). The knowledge management success model developed by Jennex and Olfman (2006) emphasizes the need for knowledge management systems to include both stores of knowledge and linkages or pointers to people with knowledge expertise. A better understanding of the various characteristics of the tacit knowledge dimension, as detailed in this chapter, will assist researchers and practitioners in the development of more sophisticated knowledge management systems that can adequately address knowledge users' needs for both codified knowledge and interaction with human sources of knowledge.

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Chapter IV
Advances in Knowledge Management:
Mapping Ideas that Shape Practice

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Abstr Act

This chapter adds to our understanding of knowledge management as an evolving body of concepts, relationships, strategies and practices. Using qualitative research methods, we examined activities of a community of practice for knowledge management professionals operating in a large metropolitan U.S. region. Accordingly, we produced an organizing framework that maps KM topics according to the tactical-strategic orientation of the KM issue and level of analysis (individual-group-enterprise). We constructed and populated the framework based on a content analysis of forty-four presentations made from 2001-2005, from survey data, from interviews conducted with key informants, and from data collected as participant-observers. The work provides insight into the decision-making processes of stakeholders with competing interests and adds to our understanding of collective sensemaking (Weick, 1995) in a community of practice. From the data, we generated a framework that can be used by practitioners to allocate resources for KM activities, technologies, and projects.

Introduction

This work adds to our understanding of the field of knowledge management (KM) through an examination of the sensemaking activities of a KM practice group. Members of such groups are knowledge workers and emblematic of the knowledge society (Drucker, 1969). They learn from a variety of interactions with vendors, peers, colleagues, and other stakeholders in an attempt to understand the practice of knowledge management through the application of tools, methods and technologies. Participation in networks and communities of practice (Barab & Duffy, 2000; Lave & Wenger, 1991; Wendger, McDermott & Snyder, 2002) is important to this learning process. This study focuses on the sensemaking activities of one such group by analyzing the KM topics it selected over a five year period from 2001-2005. The results of this analysis help us to identify the dominant ideas and concepts pertaining to KM, to clarify the "ambiguity inherent in the concept of knowledge management" (Swan & Scarbrough, 2001, p. 54), and to map the KM practices common to most business organizations.

Significance and Contribution

The study contributes to our understanding of sensemaking (Brown & Duguid, 1991; Weick, 1995) in a multi-stakeholder environment for practice and provides empirical support for the hypothesis (e.g., Iverson & McPhee, 2002) that knowledge management is a function of the unique interactions that occur between people and technologies. It also offers a better understanding of the theory and practice of knowledge management as organizations attempt to respond to new strategic initiatives and innovations in KM-enabling technologies and builds upon case studies of knowledge management in projects and companies (Scarbrough & Swan, 1999). Additionally, this work augments bibliographic studies of KM communities based on published sources only. For instance, Raub and Ruling's (2001) content analysis of over 400 articles about KM over an 18 year period among IT/IS professional make the point that:

> *In order to substantiate .... propositions concerning the development of the knowledge management discourse as well as the relationship between the different groups of actors gathering around knowledge management, future research should complement the more 'macro'-oriented view taken in the present paper with a closer look at actual knowledge management practices* (p. 126).

This chapter accomplishes that end and is a contribution to this area of research because it examines the actual words and practices of a KM community not filtered by peer review or editorial processes.

Rationale and Relevant Literature

Knowledge Management

This work was motivated by the theory that knowledge management processes such as knowledge creation, sharing and use and KM strategies are crucial for successful firms of the 21st century (Dixon, 2000; Davenport & Prusak, 1998). Knowledge originates in and with people; it creates networks, communities and routines whose life spans exceed that of the tenure of the individual members (Czerniawska & Potter, 2001; Leibowitz, 2000). The salient appeal of knowledge management for corporations is that the value of knowledge endures beyond the minds of specific individuals who may have participated in the creation of that knowledge. In addition, KM systems offer opportunities for employees to access best practices, build on previous knowledge, reduce cycle time, improve quality, and provide access to expertise. However, a KM strategy does not have to rely on large investments in technology; it can focus on social processes and the creation of networks and communities. For instance, Nonaka and Takeuchi (1995) identify socialization as an aspect of knowledge management in connection with knowledge creation, transfer and use. Communities and networks of practice can be viewed as an economical means for integrating people and technology around a shared interest (Stein, 2005); i.e., they are a low cost entry into a corporate knowledge management strategy. Vera and Crossan (2001) note that "knowledge exists in socially-distributed activity systems, where participants employ their situated knowledge … which is itself constantly developing" (p. 621). From this perspective, knowledge, action and learning are intertwined. People and organizations who seek to capture, transfer, and recall ideas, practices, routines and concepts of value to their work are all engaged in some form of knowledge management.

c ommunities of practice

We chose to study knowledge management in the context of communities of practice for several reasons. A community of practice is a set of people who share a concern, a set of problems, or a passion about a topic (Wenger et al., 2002). These people improve their knowledge and expertise (Scarbrough, 1996) in the topic area by interacting on an on-going basis (Wenger et al., 2002). These communities can arise spontaneously when like-minded people meet (Brown & Duguid, 2000), and they can persist over time when carefully cultivated by the membership (Wenger, et al., 2002). Communities of practice provide several benefits to modern organizations including access to expertise, improved collaboration, and increased performance (Davenport, 2005).

An analysis of research on communities of practice over the past fifteen years suggests five necessary conditions for their formation and development (Stein, 2005):

1. A knowledge domain of interest
2. A set of interested and interconnected participants
3. Opportunities for on-going processes of sensemaking, knowledge sharing, and discovery within the domain of interest
4. A set of resources related to the domain of interest including methods, tools, theories, practices, etc., that are acquired, retained and accessible by the community; and
5. Processes by which the community maintains and refreshes its membership.

As a consequence of these five characteristics, communities of practice enable interaction among the members and provide the means to share interests in ways that result in a common repertoire of stories, methods, and shared mental models (Stein, 2005). Accordingly, communities of practice are a form of learning organization (Argyris & Schon, 1978; Baets, 2005; Brown & Duguid, 1991; Chawla & Renesch, 1995; Starkey, et al., 2004; Schwandt & Marquardt, 2000; Senge, 1990), and knowledge system (Tsoukas & Mylonopoulis, 2004). Because these groups support learning, they serve as venues for knowledge creation, knowledge sharing, knowledge storage and other aspects of knowledge management. For all of these reasons, communities of practice provide an excellent opportunity to observe and analyze KM processes and to understand how KM practitioners make sense of KM technologies, practices, and strategies.[4]

s ensemaking

Finally, we utilized sensemaking because it is a rich and compelling construct that offers insight into the cognitive activities of social systems and in particular, is a distinguishing feature of communities of practice (Stein, 2005). Sensemaking has at least seven characteristics according to Weick (1995). It is "grounded in identity construction, retrospective, enactive of sensible environments, social, ongoing, focused on and by extracted cues," and "driven by plausibility rather than accuracy" (Weick, 1995, p. 17). Further, sensemaking is grounded in both individual and social activity (Weick, 1995). These characteristics suggest that communities of practice are venues for sensemaking and, conversely, sensemaking may help create communities of practice as on-going venues for identity construction. By examining the sensemaking activities of a KM community of practice, one may be able to understand the evolving world of ideas comprising the field of knowledge management.

r ese Arch Quest Ions

The primary research question motivating this study was: How is the body of knowledge that comprises KM changing and evolving over time and what are the social mechanisms that influence such changes? KM represents a set of concepts and ideas about the ways human beings create, manage, and use knowledge. The literature includes a variety of case studies (e.g. Baets, 2005; Dixon, 2000; Scarbrough & Swan, 1999), and guidance informed by extensive experience (Davenport & Prusak, 1998; Leibowitz, 2000), with few opportunities to build a general schema of the breadth and depth of the domain from grounded experience. This study aimed to map that schema. As the field of knowledge management matures, we would expect to see some shifts in the priorities for particular concepts, topics, or practices as negotiated by the participants. In short, we wanted to know what concepts were more important today than they were five years ago. We were also interested in the mechanisms for topic selection and how the domain of knowledge management ideas might be shaped over time.

Methodology

We chose to explore these questions using qualitative research methods. Qualitative methods are best employed when concepts are not well defined and testable hypotheses have not been formulated:

In a qualitative study, one does not begin with a theory to test or verify. Instead, consistent with the inductive model of thinking, a theory may emerge during the data collection and analysis phase of the research or be used relatively late in the research process…… (Creswell 1994, pp. 94-95)

Since KM is a relatively recent area of research requiring exploration in support of grounded theory development (Glaser & Strauss, 1967), and given the paucity of research addressing the research questions we posed, this was a good fit. We decided to look at the ways one KM community of practice was engaged in sensemaking and were interested in answers to:

1. Which topics were covered over time (e.g., five years)?
2. Can we discern changes or patterns in the selection of topics?
3. What were the influences and mechanisms that enabled the group to make its selections?
4. Can we build a useful map of the KM knowledge domain from these data?

The organization we selected for study (The Knowledge Management Group of Philadelphia) provided an ideal place to examine these questions because the community and its Executive Committee had to wrestle with the selection of KM topics for presentation at meetings held each month (see the Appendix for background on the case organization). The choice of topic each month was especially important to this organization because topics were the primary reason for attending meetings according to prior research (Stein, 2005) and a recent survey (see Appendix), which indicated that nearly 60% came for the quality of the topic and 19% would not come to a meeting if the topic was not of interest.

Another reason we chose this organization was because of our unique role as active members of the organization. As participant-observers (Yin, 2003), we had access to files and documents collected by the organization from 2001-2005 and attended monthly presentations and planning meetings, thereby having the opportunity to directly observe the processes of sensemaking. In short, we had both an academic and an experiential understanding of the organization. In the parlance of Schon (1983), we operated as "reflective practitioners." Schon argues that practitioners have the greatest opportunity to develop theory if they engage in reflection about their experiences.

Sources of Data

We used multiple data sources from the case to cross-check and ensure the trustworthiness of our findings and to limit bias as suggested by Yin (1989, 2003), Guba (1981) and others. The primary data for this research were documents containing the titles, summary descriptions and PowerPoint presentations made each month by speakers to the community. Five years of data (2001-2005) were content analyzed (See Appendix, Table A for a complete list of the topics over the period). Other primary data included a survey conducted in 2005 of the community members via email regarding KM topics and motivation to attend meetings. We kept notes of our own observations over the five year period and obtained helpful verbal and written feedback from key informants at the study organization during last stage of the research. Finally, we audio-taped feedback from a group of key members of the organization and transcribed the results.

Coding and Methods of Analysis

We content analyzed the topic/presentation data using two pre-defined categories relevant to the field of KM. We also ran frequency counts of the entire data set and rendered the results as sorted tables and word association networks. These techniques are common in qualitative data analysis as the researcher strives to reach both conceptual and empirical coherence (Miles and Huberman, 1994).

Content analysis (Krippendorff, 1980) is an effective technique for the analysis of textual material and has been used to analyze both published (e.g., annual reports) and unpublished sources.

As a technique for gathering data, it involves codifying qualitative and quantitative information into pre-defined categories in order to derive patterns in the presentation and reporting of information. Content analysis seeks to analyze ….information systematically, objectively and reliably (Guthrie et al., 2004, p. 287)

It has been used in KM-related fields such as intellectual capital reporting (Guthrie et al., 2004) and the evaluation of KM projects (Loermans and Fink, 2005). Reliability and validity is increased by using multiple coders and using categories in the coding instrument that are well-defined and distinct (Guthrie, 2004).

The first pre-defined coding scheme used was based on eight categories relevant to the knowledge management process formulated by Grant (2005) who aligns knowledge management with strategy. Topics that did not fit into one of these categories were coded as "other." These categories were arranged in Table 1 to correspond (top to bottom) to the generally accepted parsing of the knowledge management process into phases: knowledge generation, knowledge organization, and knowledge utilization.

*Table 1. Pre-defined KM Coding Categories**

#	Code	KM Process	Definition
1	KC	Knowledge Creation	Generating new knowledge. Examples: original research; product design
2	KA	Knowledge Acquisition	Acquiring existing knowledge. Example: recruiting new personnel
3	KId	Knowledge Identification and Location	Identifying the sources of knowledge in people or systems. Examples: taxonomies; search engines; expert locators.
4	KSt	Knowledge Storage and Organization	Process of retaining, indexing and maintaining knowledge. Example: capturing business rules in knowledge bases and software
5	KS	Knowledge Sharing	Sharing and enriching knowledge among groups of people. Example: communities of practice
6	KI	Knowledge Integration	Integrating streams of knowledge among people and through time and place. Example: new product development
7	KR	Knowledge Replication	Applying knowledge from one context to a different context. Example: implementing best practice; knowledge transfer
8	KMr	Knowledge Measurement/Use	Measuring the use and impacts of knowledge on organizational outcomes: Examples: after-action reviews; Intellectual Capital Accounting; ROI, ROA
9	Other	na	Examples: conferences on knowledge sharing; the future of KM

** Items 1-8 from Grant, 2005*

Table 2. A Priori Socio-Technical Coding Categories Used

Code	Orientation	Examples
S	Social or management orientation	Establishing mentoring programs; organizing a community of practice
T	Technical orientation	Learning about the features of a new KM technology; e.g., a document management system; an expert locator.
ST	Socio-technical orientation	Implementing a new technology for strategic reasons with awareness of human behavior.

The second pre-defined coding scheme we used distinguished between topics that had a technical emphasis, a social orientation, or a joint socio-technical (Cherns, 1976) orientation (see Table 2). This distinction was important since the literature typically defines KM as a function of both people and technologies.

Next, we took the entire data set of topic descriptions, presentation notes and slides and ran a frequency count of the all the words in the set. The software program, TextStat (http://www.niederlandistik.fu-berlin.de/textstat/software-en.html) was used to generate the frequency counts. Initially these were presented as tables sorted from the most to least frequent words appearing in the texts. While useful, these lists lack depth. To better visualize the clustering of words, we used another technique known as co-word analysis. This technique is often used in bibliographic studies to map the diffusion of ideas appearing in journals and on the web (Leydesdorff 2005, 2006; Leydesdorff & Zhou, 2005). To perform this analysis, we used a program named FullText (http://users.fmg.uva.nl/lleydesdorff/software/fulltext). Fulltext generates a symmetrical matrix of frequently used words ordered according to similarity. Words that are "similar" are words that appear frequently with other words in the input documents. For example, the word-pairs "virtual" and "community" might appear together and would be considered similar. This word-pair would be connected to other word pairs, thus forming a network of words and concepts. To better visualize these data, another program named Pajek (http://vlado.fmf.uni-lj.si/pub/networks/pajek) was used to scale the words in a two-dimensional space where words that co-occur are positioned closer to each another on the page. This analysis generates a kind of two dimensional map of the knowledge domain that highlights the dominate vocabulary used by a group of people. We found this approach complemented our earlier analysis using pre-defined coding schemes.

Key Infor MAnt Input And f eedb Ac K

In the final phase of the study, we discussed the research questions and the preliminary findings with members of the Executive Committee. At the final meeting, which we audio-taped, we asked the members to respond directly to the research questions we posed. Following that discussion, we showed them the tables and maps we had constructed and asked for feedback. The comments of the group help to validate many of our assumptions and clarify others. We fed this information back into the interpretation of findings section. Finally, we shared the study with about 30 people present at one of the KM group's monthly meeting and obtained useful feedback regarding the findings.

r esul ts of the c ontent AnAl ys Is

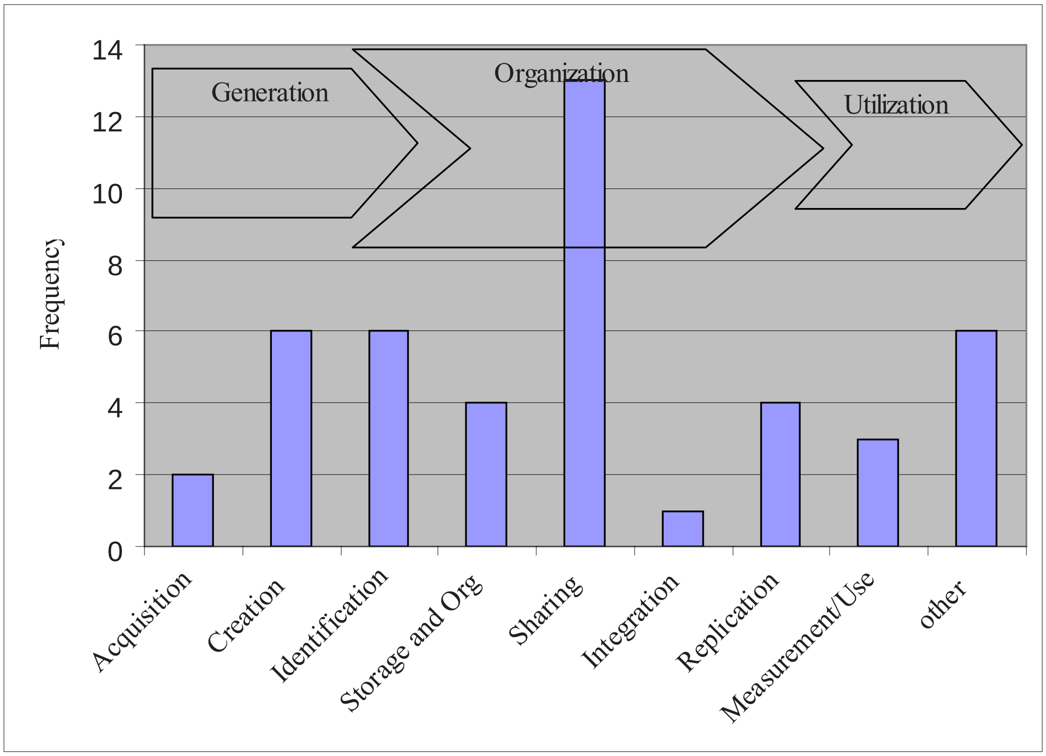
r esults of the KM process c oding Analysis

Figure 1 displays the frequency that topics were assigned to the KM process categories previously defined (see also Appendix-Table A). Knowledge sharing is the dominant category with more than twice the occurrence of any other category. This is the area where both technology and human behavior most obviously intersect, and thus appeals to technologists, managers and consultants (i.e., stakeholders). Next most frequent are knowledge creation and knowledge identification. This is not surprising since a number of members of the organization represent pharmaceutical companies where managing intellectual assets is a full-time job. Knowledge replication and knowledge storage/organization are the next frequent topic area. These sessions tended to be more technical in nature. Knowledge measurement is next followed by knowledge acquisition and integration. Measuring KM outcomes in terms of value to the organization is one of the most important areas of interest to KM practitioners but is under-represented simply because there are few experts in this speciality and the choice of methods is the subject of on-going debate. The "other" category included reports on trends at KM World and Gartner Group conferences, sharing information on the APQC benchmarking studies, or discussing the future of KM.

r esults of the s ocio-t echnical c oding Analysis

Figure 2 displays the frequency that topics were assigned according to its socio-technical orientation as previously defined (see also Appendix-Table B). Of the forty-four sessions analyzed, twenty one (21) primarily emphasized aspects

Figure 1. Frequency of topics by KM Process categories (2001-2005)



of human behavior and motivation; sixteen (16) focused on the use of tools, software or systems; and seven (7) combined both perspectives in a socio-technical systems approach (Cherns, 1976; Eason, 1988; Mumford, 1983).

r esults of e mergent c oding and c o-w ord Analysis

A content analysis of 44 summaries and presentations at the sessions (20618 words) illustrates the dominance of certain ideas as part of a shared language and "concept map." Table 3 shows the relative frequencies of keywords used by members of the organization and by presenters as determined by a TextStat analysis of the topic descriptions and presentation notes. 'Knowledge' is the most ubiquitous word followed by 'KM', 'technology', 'community' and so on.

Next, we performed a co-word analysis of these keywords using FullText and employed an approach similar to Criscuolo, Salter and Sheehan (2006). The program constructs a symmetrical co-occurrence matrix with the keywords in the rows and columns. Cells contain the number of times each keyword co-occurs with another keyword. This matrix was normalized using Salton's (1983) cosine coefficient as implemented in FullText. See Leydesdorff (2005, 2006) and Leydesdorff and Zhou (2005) for a complete discussion of the efficacy of this technique. The normalized matrix was provided as input to Pajek, a social network analysis program, and the results are displayed in Figure 3. In the figure, each word is a node in a network where the words are connected by their co-occurrence with other words. The size of the node indicates the relative frequency of the word appearing in the texts. Words that co-occur more

Figure 2. Frequency of topics by Socio-Technical Orientation (2001-2005)

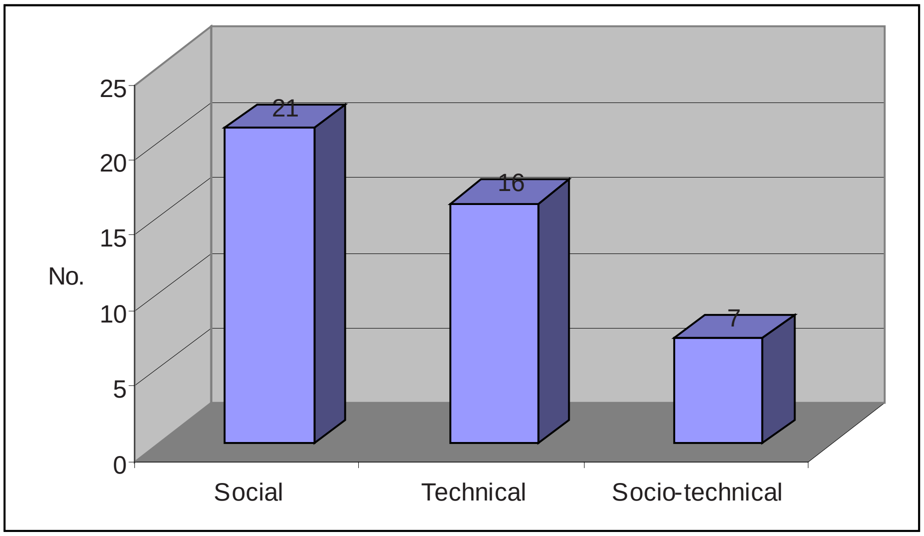
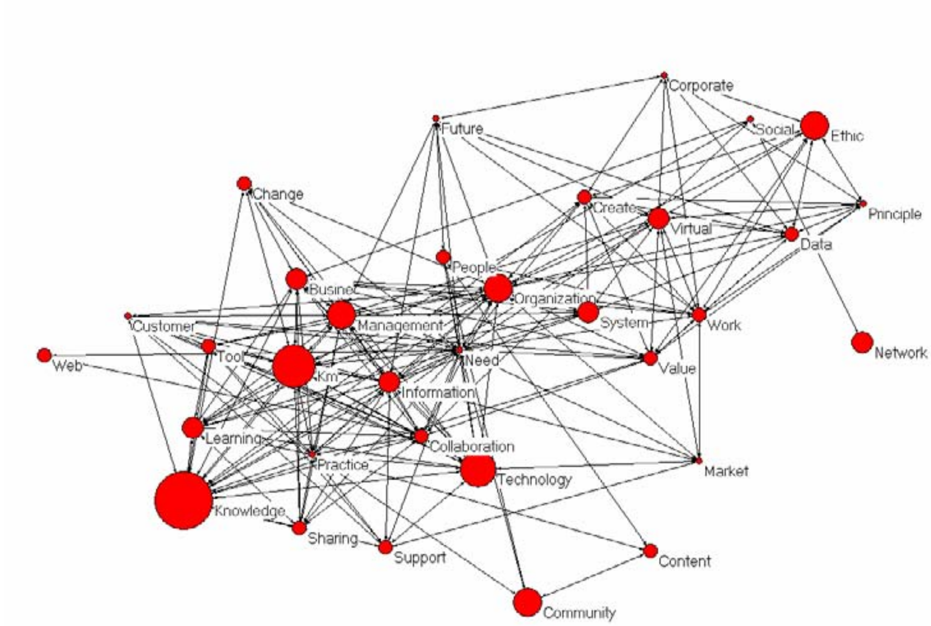


Table 3. Most frequently used words in KMG presentations

word	count	word	count
knowledge	180		
KM	146	collaboration	38
technology	101	support	37
community	89	work	36
management	87	people	32
organization	82	create	31
Ethic	81	change	30
Virtual	75	tools	30
business	71	web	29
System	71	corporate	25
information	69	principle	25
Learning	62	customer	24
Network	55	market	24
Content	48	future	23
Data	47	need	23
Value	45	practice	21
Sharing	44	social	20

Figure 3. KMG Knowledge Map - Cosine-normalized co-word map of 33 keywords from Presentations (connecting lines are displayed at the threshold level of cosine >0.5)



frequently are located closer to one another; less frequent co-occurrence is indicated by greater distance. The algorithms in Pajek perform the distance scaling using measures of similarity (see Pajek manual for a complete discussion of these techniques).

In Figure 3 we see a map of the KM knowledge-space and the dominance of the discourse around certain key concepts and ideas. As can be seen, the technique is very useful at converting raw text into an empirically-grounded picture of the keywords of the knowledge domain and their relationships. For instance, the ideas of 'practice,' 'sharing,' 'learning,' 'collaboration,' 'tool,' 'management,' and 'information' are located near 'knowledge' and 'KM." 'Social,' 'virtual' and 'ethics' form another cluster of ideas at the opposite end. We see references to 'technology', 'web,' 'system,' 'tool,' as well as to several non-technical words such as 'management,' 'organization,' and 'ethics.' This map helped us to see relationships among the words and ideas used by the community of practice.

Interpret At Ion of fI nd Ings

r esearch Questions 1 & 2: KM t opics

With regard to the question of what topics were selected by the group over time, we interpret the data that the early years of the group were spent exploring knowledge management as a nascent practice and that it shared information on some of the technologies that were offered to corporate consumers. The group was interested in learning about anything that related to the general topics of knowledge management and how it was defined. Monthly topics were sometimes selected opportunistically based on speaker and venue availability. Later the group spent more of its time on aspects of knowledge sharing: how to do it, how to reward it, and how to make it part of the culture. In general, topics moved from defining KM and how to go about it to understanding KM as a part of corporate strategy. A continuous theme was how to share knowledge so that practitioners could create links between KM strategies and business value. Means for doing this include providing access to knowledge through portals, expert locators, e-collaboration, social networks, story telling, and virtual communities.

As is seen in Figure 2, the majority of topics of interest had a social or management orientation. This suggests that although technology was important, KM challenges were chiefly viewed as non-technical or socio-technical. A key informant told us, "*This is no surprise. We're driving it*." However, another claimed, *"I would have guessed 15 social, 20 technical and the rest something in between."* A third pointed out that the requirements of providing an interesting presentation necessitated emphasizing the organizational aspects of a case and de-emphasizing the technical aspects. The field of knowledge management requires both social and technological considerations (Appendix, Table B) and its discourse necessarily includes language from both realms: human learning and performance and technology and software. This is also evident in Figure 3.

r esearch Question 3a: Mechanisms of s election

The quest for new topics required a process to assign priorities. Accordingly, we asked: what were the mechanisms that enabled the group to make its selections? The document analysis did not alone yield an apparent answer to this question. However, as participant-observers on the Executive Committee, we were able to make connections and construct some plausible hypotheses based on the findings and our experiences, and these were validated by the study's key informants serving on the Executive Committee.

Throughout the five years, the KM Group, primarily through the action of its Executive Committee, met monthly to consider topics and approach potential speakers and identify venues. *"In the beginning,* [one of the founders] *drove the topics."* Now, the workload is more evenly distributed. Each "semester" the group responds to the threads of past discussions and the emerging interests of the members. Sometimes, the Committee led with innovative ideas (e.g. The Great Debate in 2000 that playfully questioned the entire practice of knowledge management). The Executive Committee played a primary role in selecting topics and speakers and scheduling the sessions. Another added that, *"It still is largely driven by our interests. We need to take ownership of that."*

Supporting the topic and speaker selection activity, a variety of sources played roles in surfacing issues to the Committee's attention. Members volunteered to share their experiences. Networks of relationships yielded topic ideas, speaker ideas, or both, and in 2005, the Committee conducted a survey to prompt ideas from members. However, this description fails to depict the weeding and threshing processes of the Executive Committee. "*First, we brainstorm,"* a key informant explained; "*then, it's consensus-making or sensemaking…. You convince your friends that it's a good thing to do, that the topic is valid. Then, you commit to finding a speaker. Scheduling him is not an easy thing to do*." Another adds, *"There's an element of who we can get when."* Accordingly, the Committee works with four to six months of ideas at a time. A topic that looks good for October may be moved to January to accommodate a speaker's availability. *"The audience is topic-driven. They're as month-to-month as we are."*

The Executive Committee's deliberations involved implicit criteria that sessions be of interest to at least 20-40 members and address other factors such as relevance to the field of KM, balance theory and practice, restrict commercial messages, and maintain speaker quality, among others. The Executive Committee made these tacit rules explicit (Nonaka & Takeuchi, 1995) by writing down guidelines for presenters to assist them in understanding the audience and the nature of the group; in a sense, this was a form of socialization. In addition, a member of the Executive Committee was in contact with each speaker to ensure good quality. So, it was in this context that the Executive Committee attempted to effectively respond to a variety of stakeholders and competing interests. "*We try to mitigate risk in finding* [a topic or speaker] *and scheduling,"* an informant explained. Another claimed: "*there's a real technology track throughout*." Another claimed: "*there's a shift to specific relevance today, more focused than conceptual as it was at the beginning*." Another key informant claimed: "*There's still new stuff we're pulling in*." "*The field has grown and membership has changed."*

The Executive Committee acknowledged considering themes in the past to provide more structure but opting instead for staying open to, *"leveraging topics and discussions into future sessions."* In this way, the Executive Committee deliberately chose to "*be haphazard*" and to employ *"serendipity"* because *"a talk generates new topic ideas for us even though we have back-pocket ideas to fill in where we need to."*

All progress involves consensus. There is no quid-pro-quo on topics, no trading support or cutting deals. Each topic advances to a scheduled speaker and venue when the entire group supports it. *"No one has veto power."*

For instance, one of the members of the KM group was exploring new social research techniques, had interesting data, and volunteered to make a presentation. Some on the Committee were in favor of the presentation; others were not. Some thought it was appropriate while other members thought it might be too "academic" to be of interest to the general membership. For a year, this topic would surface for discussion but no consensus could be reached and was kept on the "back burner." The issue was resolved by pairing this presentation with the work of an external expert on the topic. The invited speaker made a presentation and the member mentioned above (and another KM group member) commented on the main presentation. The issue was resolved to everyone's satisfaction by constructing a session that offered multiple perspectives and balanced theory with application.

r esearch Question 3b: s takeholder n eeds

The Executive Committee managed the needs of several different stakeholders. Some sought tactical, practical applications. Some wanted strategies. Others held an enterprise perspective or needed to advocate at the enterprise level. Some stakeholders were primarily concerned with the work teams in the organization. Some were stewards of communities of practice and advocates of spreading communities throughout their enterprises. Other members needed to make a good business case with executives to secure resources for what they were selling or implementing in the organization. The longevity of the KM Group suggests that they had a sensemaking process that selected topics and speakers relevant to this new KM world (Bennet & Bennet, 2004), and in implicit consideration of the socio-technical aspects of KM. The value of the topic to a stakeholder depends on the maturity of that person's perspective. "*You grasp it depending on your perspective. Some are academic; some practical; some theory. You hear depending on where you're coming in from. That determines the stickiness* [of the message]."

r esearch Question 3c: e vidence of s ensemaking

The KM Group exhibits each of the seven properties Weick (1995) identifies in sensemaking: identity construction; enactive of sensible environments; social; ongoing; focused on and by extracted cues; and driven by plausibility rather than accuracy; and it is retrospective. A key informant explained: "*this is active*." Another said: "*you know people. There's lots of discussion back and forth*."

'Grounded in identity construction' means that members of a sensemaking organization hold some core beliefs in common and these enable them to define their space (Weick, 1995) and make strategies within it. The KM Group's website clearly articulates its identity as an organization and mission but more than that, the presentations and topics for five years give rich context to the KM Group's space and to the members' understanding of what constitutes knowledge management. "*Comes down to what we think is interesting. It's what captures our attention*," claimed a member of the Executive Committee.

Weick notes that struggles over identity are at the root source of sensemaking. This is the nature of the KM Group's monthly Executive Committee meetings. It is here that the members create a space for articulating and negotiating topics and speakers in an on-going dialogue about identity and purpose. Some topics and presentations have been more successful than others in terms of popularity or currency but all topics and presentations have served to define the KM Group identity and to color the perceptions of all members no matter how active. Accordingly, "sensemaking is the feedstock for institutionalization" (Weick, 1995, p. 36). Therefore, the topics and presentations reinforce the identity of the organization while also defining the concepts of knowledge management. The KM Group is as the KM Group does. In this way, the KM Group as a sensemaking organization enacts its environment. This environment is the focus and the sustenance of the KM Group in a self-reinforcing dynamic of ontological oscillation (Weick, 1995). The KM Group is primarily a sensemaking organization and the sense that it makes sustains it as an ongoing group.

Sensemaking is ongoing Weick (1995) says, meaning that it is a flow, neither starting nor stopping, and it is 'focused on and by extracted cues', meaning that people use simple, familiar structures as representations of more complex concepts. Indeed, the monthly meetings of the KM Group necessarily focus on topical, pragmatic elements that form useful cues for the participants to enact their environments, subject to the politics of interpretation. In this regard, the consensual nature of the KM Group's Executive Committee suggests this community of practice is at a nascent stage of development, absent rules, codes, or polarities of practice. Harmony is achieved because sensemaking is about "plausibility, pragmatics, coherence, reasonableness, creation, invention, and instrumentality" (Weick, 1995, p. 57). A potential participant who does not perceive value in a KM Group session in advance will most likely not attend, thus insuring an audience with agreement around the potential for value. "*Our membership is changing and we're still questioning whether we need to offer a primer for new people*," said an informant. Sensemaking is a social process "contingent on the conduct of others" (Weick, 1995, p. 39) because human thinking and social functioning are aspects of each other (Weick, 1995). The nature of the process is such that a sense of community as an aspect of both identity and process is inevitable. Further, people are conscious of what we have done never the doing of it, and thus sensemaking is retrospective. In all these ways, these findings provide empirical support to Wenger's theory of cultivation (Wenger et al., 2002) of communities of practice.

r esearch Question 4: b uilding a KM c oncept Map

We began this study with the assumption that we would discern a clear pattern of KM topics or be able to depict patterns yielding a picture of the evolution of KM as a field of inquiry. What we

Figure 5.KM Concept Map with presentation examples and topic incidence

	Individual	Group	Enterprise
Strategic	(2) Strategic Story-telling //////////////////// SNA Tools (3)	(6) Stewardship of a CoP ////////////////////////////// GDSS (4)	(8) KM and ROI //////////////////////////// IT for Business Intelligence (3)
Tactical	(1) Performance Management ///////////////////// Electronic Signatures (5)	(3) After-Action Reviews //////////////////////////// e-Learning (2)	(1) KM and New Product Developmt //////////////////////////// Portal Development (6)

Notes:

1. *The split box provides examples that are socio- (top) or technical in nature (bottom)*
2. *Numbers in each box indicate number of socio (top) and technical (bottom) presentations*
3. *GDSS=Group Decision Support system*
4. *CoP=Community of Practice*
5. *KM=Knowledge Management*
6. *ROI=return on investment*
7. *SNA=Social network analysis*

found was both more complex and more dynamical than anticipated. Our knowledge of the organization revealed that the Executive Committee was influenced by a variety of stakeholders as noted earlier and attempted to respond to their diverse needs. The focus of the various stakeholders ranged from narrow tactical concerns at the individual level to making teams more effective to much more far-reaching strategic enterprise concerns. We built a map with two well-known dimensions used to analyze organizations: strategic orientation (tactical-strategic) and levels of analysis (individual-group-enterprise). Distinguishing between individual, group, and enterprise levels is common in organizational research and sociology. The tactical-strategic orientation has been used extensively in strategic planning (e,g., Ackoff 1981) and organizational research. We were able to successfully position topics within this space including those with a socio- or technical orientation. This map is shown in Figure 5 and includes examples of topics representing the differing needs, values and perspectives of the multiple stakeholders of the KM Group.

This map shows that the field of knowledge management attracts a variety of stakeholders whose concerns range from tactical work processes to business strategy. As such, the map is useful to KM practitioners trying to discern a sensible pattern in the chaos. The KM Group effectively negotiated the needs of these various stakeholders as represented in the dimensions of the map through its sensemaking abilities.

Of the forty-four presentations, twenty-one were clearly managerial in orientation and sixteen were clearly technical in orientation. Seven were mixed. For purposes of the map in Figure 5, the seven socio-technical sessions were coded with the technical sessions.

Eleven presentations focused on the individual; fifteen on group; and eighteen on enterprise issues, with the sociological orientation to strategic enterprise issues ranking as the single largest category of topics. Tied for second place are the technical focus on tactical aspects of enterprise KM and the sociological focus on strategic issues for groups.

The most surprising finding is that every aspect is covered. Without conscious intention, the Executive Committee has offered something for each of the twelve issue constituencies of KM over the five years. Conversely, this map of the five years of topics reveals twelve distinct topic areas or issue constituencies in the KM Community of Practice. Of the forty-four presentations, only three did not fit within the structure of these constituencies. One was a session that reviewed three previous sessions, each already coded. One was a debate about the future of KM and one was the fifth anniversary party with a presentation on the community's life cycle (Stein, 2005). Accordingly, this map of gradations from tactical to strategic levels and multiple foci (individual to enterprise) gives illustration to the competing values and constituencies in the domain of knowledge management.

IMpl IcAt Ions for KM t heor y, Method, And pr Act Ice

This work contributes to, and has implications for, knowledge management theory, method, and practice in several ways.

Contribution to Theory. First, this work provides a rich longitudinal empirical description of CoP's based an analysis of over five years of data, thus contributing to the development of a grounded theory of CoP's. The analysis thus provides a base upon which other researchers can build theory and test well-formed hypotheses. Second, we now have empirical evidence of what KM practitioners actually talk about and have identified the topics of interest. Third, the study provides empirical evidence of the notion of the "cultivation" of communities of practice as suggested by Wenger (2002). Our analysis of the role of the Executive Committee and the topic selection process illustrates cultivation at work. Elements of Nonaka's notion of "socialization" are also evident. More research is needed to further explore the connection with these two streams of thought. Furthermore, the work sheds light on sensemaking in a unique organizational context and how it was part of the selection process. Weick's notion of sense-making continues to bear examination in new contexts and research settings.

Finally, the study broadens our notion of a community of practice. This study describes a community of practice holding a shared interest in knowledge management while simultaneously containing multiple stakeholders and competing interests, values, and perspectives. The use of the label 'community' clearly does not mean homogeneity. It is not a melting pot. It is a complex, dynamic system of needs and priorities, with members split between managerial (i.e., socio-) and technical orientations. The community of practice we examined negotiated these conflicts for over five years and this process is evidence of robust sensemaking. Future research should acknowledge and explore this more complex understanding of the term community. There may be significant differences between diverse "at-large" communities such as the one studied here and communities that lie wholly within an organization; this should be the subject for future study. The failure of some communities of practice to negotiate implicit dichotomies within the 'community' might explain their demise.

Contribution to Method. The work offers methodological insights for KM researchers specifically through the analysis of textual material and the application of co-word analysis. We illustrated how content analysis using pre-defined categories is performed. Grant's (2005) categories of KM activities presented face validity and worked well for sorting KM topics in this study. This scheme and the socio-technical split were found to be useful pre-defined classifications that others may wish to employ. On the other hand, there may be some limitations to Grant's categories. Since the completion of this study, the KM group has had several presentations on web technologies that do not easily fit within any of Grant's categories. It may be that the interests motivating KM professionals are morphing and moving beyond these categories. More research is needed to explore this question.

We also showed how to generate insights using emergent coding techniques using frequency counts, co-word analysis, and a form of scaling using the software program Payjak. These techniques are useful for visualizing KM discourse and we would like to see more organizational research using these methods. However, the emerging taxonomy as illustrated in Figure 5 raises as many questions as it may answer about KM concepts and their relationships. More research is needed to explore data sets such as these.

Contributions to Practice. The 12-category map in Figure 5 provides a practical "scorecard" approach (Kaplan and Norton, 1996) for evaluating KM activities and projects across the enterprise. Such a map can be used to set priorities among competing KM projects. When we presented this model to about thirty people attending one of the monthly meetings, the group responded favorably to this finding. They indicated that it seemed plausible and useful for analyzing investments in KM activities and tools. Future research should be done to refine and further test this framework in a variety of organizations.

Study Limitations

The primary weakness of this work is that is constrained by the unique aspects of one organization. We studied this issue in the context of one KM practice group located in a metropolitan city of the United States in existence since 1999. We can not generalize from this study to all other knowledge management groups, networks, or communities of practice since the characteristics of this organization are unique. Longitudinal research in other communities of practice needs to be done in order to generalize these findings with confidence.

As in any qualitative research, there are issues of bias in interpretation and coding. To mitigate these concerns, we used multiple data sources to cross-check our findings. During the coding of textual material using pre-determined categories, we worked in tandem to cross check our classifications and assumptions. We also obtained feedback about our findings from key informants and members at large at the study organization to validate our interpretations and assumptions. Another potential bias of the study is that both authors are members of the case organization and operated as participant-observers. The strengths and limitations of such research methods are widely known and accepted. We believe that the strengths of this research method outweighed the weakness by affording us an opportunity to develop rich descriptions of the KM processes.

Summary and Conclusion

We were fortunate enough to have access to five years of data of an active community of practice centered on KM practice. As researchers, we became curious about the ways the group made its selections of topics for presentation to the general membership. What we learned was that a sub-set of the community (Executive Committee) negotiated each month to determine which topics would be selected based on both individual and group sensemaking. We also learned that the topics the organization ultimately chose did fit a pattern and could be partitioned into one of several categories in most cases, thus providing empirical support for some existing classifications. From the data, we generated our own framework that can be used by practitioners to allocate resources for KM activities, technologies and projects. Finally, we enriched our notion of community to be the result of an on-going negotiation between stakeholders with competing interests.

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Append Ix

exh Ib It 1: cA se c h Ar Acter Ist Ics

The group under study, the Knowledge Management Group of Philadelphia (see Stein, 2005), is an organization of approximately 300 members formed in April, 1999. The diverse membership includes several large companies in the Philadelphia-Wilmington metropolitan region of the United States (e.g., Astra-Zeneca, DuPont, Rohm & Haas, SAP, Unisys, and Vanguard), universities such as Penn State and Drexel University, consultants, and other companies and institutions. Monthly meetings typically generate attendance from thirty to fifty people, depending on topic and location. This interaction is supplemented by an on-going electronic chat room (Yahoo Groups) where discussion and related information is shared and stored.

The KM Group's Web site (www.kmgphila.org) explains that it was "formed to address the needs of area organizations in managing knowledge assets." Knowledge assets include intellectual capital (e.g. what employees know; patents), procedural knowledge contained in documents and administrative structures, and knowledge embedded information systems. The goals of the group are to "promote the sharing of KM best practices, to provide a forum for group problem solving on KM problems and to encourage networking and professional collaboration in the area of KM. Knowledge management includes the activities related to the creation, capture, organization, maintenance, retrieval, and use of organizational knowledge to promote improved decision-making and performance" (www.kmgphila.org).

A small, self-selected group within the larger group manages the work of arranging venues, identifying and soliciting speakers, selecting topics, and maintaining the website and the Yahoo! Groups collaboration space. This group calls itself the Executive Committee and currently includes seven members. They meet monthly within two days after each session. These meetings provide an opportunity to evaluate the session and plan future meetings. During 2005-2006, the Executive Committee included representatives from Astra-Zeneca, DuPont, Hilt & Associates, Rohm and Haas, Penn State (2), and SAP. In the course of this study, these people served as key informants.

We treated the organization as a community of practice because it met the five criteria identified for communities of practice noted earlier: a domain of interest (e.g., knowledge management practice), a set of interconnected participants (e.g., area businesses and universities and bound by strong to weak ties), opportunities for sense-making (e.g., monthly meetings and on-line connections), tools and supporting resources (e.g., knowledge retained in people's heads and documents produced by the community), and mechanisms for renewal (e.g., the organization has grown to a few hundred members over five years).[1] A key informant strongly argued that the group was a community of practice because "*the group shares ideas*" and "*both personally and professionally people are being heard in a push-pull and that's community.*" Another observed,it was not an association or simply a network because, "*an association is a card in your wallet and a network is an e-mail list*." Given these data (and since the group's classification is incidental to the objectives of the study), we designate it as a community of practice throughout.

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Appendix continued

Exhibit 2: Results of the Membership Survey 2005

Q1. What is your primary reason for attending a KM Group Meeting?

Response	Number	%
Topic	38	59 %
Networking	11	17 %
Stay current in field	6	9 %
Don't attend	4	6 %
Speaker	2	3 %
Other	3	5 %
Total	64	100 %

Q2. What is the primary reason you would not attend a meeting?

Response	Number	%
Schedule conflict	27	43 %
Inconvenient location	15	24 %
Topic not of interest	12	19 %
Inconvenient day/time	5	8 %
Not notified soon enough	1	2 %
Not notified at all	1	2 %
Other	2	3 %
Total	63	100 %

Table A: Topics Covered 2001-2005 at the KM Group of Philadelphia

Key:	Title	'01	'02	'03	'04	'05
KC	Customer Relationship Management	x				
KS	6 Types of Virtual Organizations – implications for KM	x				
KMr	KM & Measurement	x				
KId	Journey to a Knowledge Based Organization at Quaker Chemical	x				
"	Highlights from the Gartner Conference: Knowledge Workplace 2001: Transforming Your Business for the New Economy	x				
"	Part One: Creating a Framework to Understand What KM Technologies are Out There	x				
"	Part Two: Before Selecting KM Technology: How do you get the more Technology Savvy and Less Technology Savvy to Understand Each Other?	x				
"	KM Technology: Demoes of Decision Support, Collaboration Software, and Document Management	x				
KS	In-house design and development of e-Learning	x				
KC	KM from the Customer Point of View		x			

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KS	From Roman Chariots to Palm Phones: Lessons Learned Using e-Collaboration at DuPont		x			
KS	Virtual Communities: Latest Views from Europe		x			
KR	Electronic Records and Electronic Signatures		x			
KSt	Quality Indexes for Taxonomies and Classifications: Complexity, Performance, Usability, and Maturity Metrics		x			
KSt	Real Time Collaboration and KM Archiving		x			
KI	Highlights from the Delphi Group's Annual KM Conference		x			
"	Applying KM on yourself: How Identification and Use of Your Invisible Intangible Assets Can Positively Impact Your Career		x			
"	The Great KM Debate: What is the Future of KM?		x			
KC	Emerging Technologies			x		
KS	Expertise Location and Management					
KS	Launching a Portal: Lessons Learned in an Enterprise Environment			x		
KS	Selling the Big Idea			x		
KS	Unisys Knowledge Community Enablement			x		
KS	Social Networks: Discovery, Analysis & Tools			x		
KR	APQC Benchmarking Study Part 1			x		
KR	APQC Benchmarking Study Part 2			x		
KR	Follow Through Management			x		
KI	After Action Reviews: 5 Years of Experience			x		
KI	A Theory of Social System Order: How Theory Guides Positive Change in Day-to-Day Relationships, Conversations, and Actions in a Large Healthcare Organization			x		
KC	KM in New Product Development				x	
KS	Strategic Story Telling				x	
KS	eCollaboration Tools				x	
KS	Shared Knowledge				x	
KSt.	Ethical Issues: Managing Knowledge in Virtual Environments				x	
KSt.	Enterprise Search & Taxonomy: A Report from the Trenches				x	
KMr	Show me the money: A Practical Framework for KM Metrics				x	
KI	Anatomy of a Diverse Community of Practice				x	
KC	Enabling Tools for Self-Service Tech Support					x
KC	Designing a KM System by Users vs For Users					x
KA	Ethics in the Virtual KM World – Emerging Issues					x
KA	KM and Business Intelligence					x
KS	Secrets of Successfully Introducing New Technologies					x
KS	KM Share the Power: Growing and Sustaining a Learning Culture for Bottomline Results					x
KMr	KM and the CFO					x

Key: KA – Knowledge Acquisition; KC – Knowledge Creation; KI – Knowledge Integration; KS – Knowledge Sharing; KMr. – Knowledge Measurement; KId – Knowledge Identification; KR – Knowledge Replication; KSt – Knowledge Storage. Note: Not every topic fits within this classification system. Categories from Grant (2005).

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Append Ix cont Inued

t able b: t opics c oded as primarily t echnical (t), s ocio(s) or s ocio-technical (st) in orientation

#	Key:	Title	Code
1	KC	Customer Relationship Management	ST
2	KS	6 Types of Virtual Organizations – implications for KM	S
3	KMr	KM & Measurement	S
4	KId	Journey to a Knowledge Based Organization at Quaker Chemical	ST
5	"	Highlights from the Gartner Conference: Knowledge Workplace 2001: Transforming Your Business for the New Economy	S
6	"	Part One: Creating a Framework to Understand What KM Technologies are Out There	T
7	"	Part Two: Before Selecting KM Technology: How do you get the more Technology Savvy and Less Technology Savvy to Understand Each Other?	T
8	"	KM Technology: Demoes of Decision Support, Collaboration Software, and Document Management	T
9	KS	In-house design and development of e-Learning	T
10	KC	KM from the Customer Point of View	S
11	KS	From Roman Chariots to Palm Phones: Lessons Learned Using e-Collaboration at DuPont	T
12	KS	Virtual Communities: Latest Views from Europe	S
13	KR	Electronic Records and Electronic Signatures	T
14	KSt	Quality Indexes for Taxonomies and Classifications: Complexity, Performance, Usability, and Maturity Metrics	T
15	KSt	Real Time Collaboration and KM Archiving	T
16	KI	Highlights from the Delphi Group's Annual KM Conference	ST
17	"	Applying KM on yourself: How Identification and Use of Your Invisible Intangible Assets Can Positively Impact Your Career	S
18	"	The Great KM Debate: What is the Future of KM?	S
19	KC	Emerging Technologies	T
20	KS	Expertise Location and Management	T
21	KS	Launching a Portal: Lessons Learned in an Enterprise Environment	T
22	KS	Selling the Big Idea	S
23	KS	Unisys Knowledge Community Enablement	ST
24	KS	Social Networks: Discovery, Analysis & Tools	S
25	KR	APQC Benchmarking Study Part 1	S
26	KR	APQC Benchmarking Study Part 2	S
27	KR	Follow Through Management	S
28	KI	After Action Reviews: 5 Years of Experience	S
29	KI	A Theory of Social System Order: How Theory Guides Positive Change in Day-to-Day Relationships, Conversations, and Actions in a Large Healthcare Organization	S

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Append Ix cont Inued

Table B (continued): Topics Coded as Primarily Technical (T), Socio(S) or Socio-technical (ST) in orientation

#	Key	Title	Code
30	KC	KM in New Product Development	S
31	KS	Strategic Story Telling	S
32	KS	eCollaboration Tools	ST
33	KS	Shared Knowledge	S
34	KSt.	Ethical Issues: Managing Knowledge in Virtual Environments	S
35	KSt.	Enterprise Search & Taxonomy: A Report from the Trenches	T
36	KMr	Show me the money: A Practical Framework for KM Metrics	ST
37	KI	Anatomy of a Diverse Community of Practice	S
38	KC	Enabling Tools for Self-Service Tech Support	T
39	KC	Designing a KM System by Users vs For Users	T
40	KA	Ethics in the Virtual KM World – Emerging Issues	S
41	KA	KM and Business Intelligence	T
42	KS	Secrets of Successfully Introducing New Technologies	T
43	KS	KM Share the Power: Growing and Sustaining a Learning Culture for Bottomline Results	S
44	KMr	KM and the CFO	ST

Key: KA – Knowledge Acquisition; KC – Knowledge Creation; KI – Knowledge Integration; KS – Knowledge Sharing; KMr. – Knowledge Measurement; KId – Knowledge Identification; KR – Knowledge Replication; KSt – Knowledge Storage. Note: Not every topic fits within this classification system. Categories from Grant (2005).

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Append Ix cont Inued
t able c : 2005 Membership s urvey r esults Question 3

KMG Philadelphia membership in September 2005 via electronic survey sent to 200+ members (65 surveys were returned). Responses to Question 3: Topic Suggestions for Future Programs:

- Retaining tribal knowledge – convincing organizations that sharing info is job security
- KM Benchmarking, ROI methods, KM change management
- Best practices in the integration of CRM with KM
- More technical talks – real life applications
- KM intranets and extranets – real case studies and experiences
- More case studies and practical "How did you do that" sessions
- Case studies of failed KM initiatives – what did we learn? What's the future for KM? Engaging users in communities of practice? You get what you measure. How do you measure the ROI for KM?
- Innovation Market Intelligence
- Creative usage of KM platform (SharePoint) interactively with other MS applications
- KM value to targeted communities, e.g. sales
- Using KM for SOX (Sarbanes-Oxley) compliance and user accountability.
- Virtual tours of KM group members' intranets
- Vendor demoes / models of KM (Microsoft, SAP, etc.)
- KM gurus – e.g. Tom Davenport
- Search tools
- Content management: creating taxonomies; classification systems that can be easily adapted to meet constantly changing business needs or focus – lean, mean, flexible classification systems
- How to best do KM with small budgets and few resources
- Intranets – search vs browse
- Practical aspects more than theoretical ones, although its always good to stretch one's mind
- A process approach to knowledge management; how to structure and staff a KM department or operation
- Automated and successful implementations of KM systems in Large Pharma. Since location is an issue, have there been any thoughts around WebEx types of meetings?
- The Power of the Network: Knowledge Management and Executive Recruiting. I have been a KM in the Executive Search business for the past 10 years and do quite a bit of speaking on the topic. From what I've learned studying Km in other industries, I believe we're quite advanced in the field -- out of necessity for the most part since our database of information on senior executives is our lifeblood. I thought the group could be interested in learning how we employ deep and broad (job history, relationship and third-party commentary on 2 million executives round the world) to reduce the degrees of separation between talented leaders and prospective employers. Not sure if you take self-nominations, but I would be happy to speak at one of your meetings if you find this topic of interest.

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t able c : continued

- Establishing the value of KM projects within an organization. KM in practice. Review of good KM related applications. Discussion of KM books, articles, etc.
- Portals
- KM: Lessons Learned
- KM Metrics. Alex Bennet – deputy CIO for US Navy responsible for their metrics guide.
- Content management: setting one up; getting top-down buy-in
- Career Opportunities in KM
- KM ROI
- Company case studies
- Techniques to increase KM contributions
- KM issues / tools / processes (activities) for individuals
- KM issues and tools /processes (activities) focused on groups and teams
- KM issues and tools /processes (activities) for organizations
- Implementation of web wikis etc. as tool for massive? Group contribution, re-write, and editing of work documentation. Problems and opportunities.
- How to foster knowledge sharing
- I am primarily interested in tools and development efforts
- I thought the presentation at last spring's STC meeting was excellent. Very creative. The institutional problems with keeping a KM initiative fresh is an interesting topic. Lots of war stories here.
- Business Process Management – Operational Effectiveness; Combining KM into structured business processes.
- I really like the mix of very practical talks and conceptual speeches.

endnote

1 One could argue that the group is closer to a network of practice, but such distinctions are fuzzy at best (see for example Brown and Duguid, 2001)

Chapter V
Knowledge Chain Activity Classes:
Impacts on Competitiveness and the Importance of Technology Support

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Abstr Act

Just as Porter's value chain model identifies classes of business activity that can be performed in ways that contribute to a firm's competitiveness, the knowledge chain model contends there are classes of knowledge management (KM) activity that can be performed in ways that enhance firm competitiveness. These KM activities pervade the value chain, being inherent in the implementation of each value chain activity. Derived from a collaboratively engineered ontology of knowledge management, the knowledge chain model is supported by anecdotal evidence and a survey has found support for the propositions that its activity classes are linked to enhanced productivity, agility, innovation, and reputation. Here, we present a study of leaders of KM initiatives that examines each of the nine knowledge chain classes in terms of its competitive impact and the extent to which its positive impact on competitiveness is associated with the importance of technology in performing activities within that class. The study provides confirming evidence that each of the knowledge chain activity classes can be performed in ways that contribute to competitiveness. Moreover, we find that for five of the activity classes there is a significant positive correlation between impact on competitiveness and the importance of computer-based technology in implementing the class's activities.

Introduct Ion

Interest in knowledge management (KM) as a research field has exploded over the past decade. In the information systems (IS) faculty directory of 1996, one person reports "knowledge management" as a major topic of research focus (DeGross, 1996); by 2006, the IS faculty directory identifies over 600 people with a "knowledge management" research focus (http://www.isfacdir.org/). A flurry of special issues on KM in leading journals from 2001 to 2003 has matured into launches of new scholarly journals devoted to KM (e.g., *International Journal of Knowledge Management, Knowledge Management Research and Applications*) to complement *Journal of Knowledge Management* and *Knowledge and Process Management* which date from the mid-1990s. Sufficient critical mass has developed to warrant major KM reference books such as a 1500-page handbook (Holsapple, 2003) and 900-page encyclopedia (Schwartz, 2006), plus KM tracks in major conferences (e.g., ICIS, AMCIS, DSI, HICSS) have become standard.

One driving force for this interest is a need to understand the relationship between KM and competitiveness (Dutta, 1997). Knowledge is considered the most valuable and powerful asset that an organization can posses (Stewart, 1997). Being able to effectively manage knowledge has been noted by researchers in the field of competitive advantage as the only factor that can provide an organization with a competitive edge (Prusak, 1996). In order for practitioners to manage knowledge effectively, it is imperative that they have some type of guidelines when developing their KM initiatives. Such guidance could come from a definitive model that gives practitioners a structure for organizing their analyses of activities involved in KM and for understanding how they impact competitiveness.

The knowledge chain model is an initial step in this direction (Holsapple & Singh, 2000). This model is based on part of a KM ontology developed by an international panel of KM practitioners and researchers (Holsapple & Joshi, 2000, 2001, 2002). The knowledge chain model identifies nine activity classes that are performed by organizations in their conduct of KM. Evidence from experiences reported in the KM literature indicates that each of these classes of activities is a potential source of competitive advantage and that this source of competitive advantage can be approached from one or more of four angles: productivity, agility, innovation, and/or reputation – the PAIR directions (Holsapple & Singh, 2001). To date, the one empirical study of the knowledge chain model offers support for the proposition that each of the nine basic KM activities can be performed in ways that enhance a firm's performance in one or more of the PAIR directions (Holsapple & Singh, 2005). Here, we report on a further empirical study of the knowledge chain model which examines linkages of KM activities with both performance and technology usage. It uses a survey methodology and analyzes perceptions of leaders of KM initiatives. For each of the model's nine KM activities, we examine two propositions. First, the KM activity can contribute to an organization's competitiveness. Second, the greater the importance of technology support in performing the activity, the greater the contribution to competitiveness realized from that activity.

Results of this study furnish an understanding of contemporary practices and views regarding the relationships between performance of KM activities and impacts on competitiveness, with particular emphasis on the role of technology in performing KM activities in ways that enhance competitiveness. For practitioners, this understanding can help in recognizing both needs and opportunities as they evaluate and plan their own organizations' KM initiatives. For researchers, this understanding can inform and help stimulate future investigations of the relationship between KM and competitiveness. For technology vendors, this understanding can point out gaps in present KM technologies and, perhaps, spur advances in those areas.

The rest of this article is organized as follows. The next section offers a brief overview of the knowledge chain model. The third section develops dual propositions for each of the knowledge chain's nine KM classes. Next, we describe the research methodology for exploring these. Results of the study are then presented, followed by a discussion section. We conclude by pointing out implications for practitioners and researchers.

The Knowledge Chain Model

Knowledge management in an organization manifests as patterns of KM episodes (Johnson, 1991; Wagner, 1992). Each knowledge management episode begins with the recognition of a knowledge need (or opportunity) and ends when the need is either satisfied or the effort is abandoned (Joshi, 1998). KM episodes can be independent or interdependent. One KM episode can influence other episodes or even spawn flows of subsidiary episodes. In the course of a KM episode, some subset of an organization's knowledge processors undertake various knowledge manipulation activities that operate on relevant knowledge resources in an effort to meet the knowledge need or seize a knowledge opportunity. The knowledge processors can be human, social, computer-based, and/or hybrids of these. The patterns of which processors are involved, in which activities, and manipulating which knowledge resources may unfold in a serendipitous manner. On the other hand, what happens within a KM episode may be more orchestrated. Arrangements of related episodes may also be orchestrated, rather than occurring in a chaotic, unguided, or random fashion.

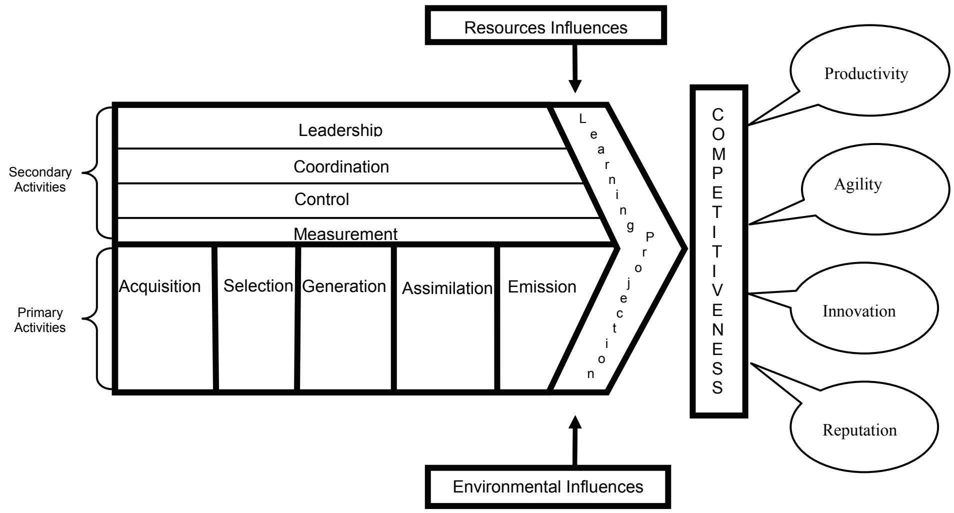
Orchestration involves execution of secondary KM activities that influence the primary manipulation activities manifesting within and across episodes: which manipulations are performed, in what ways, by which processors, in what configurations, using which knowledge resources. Because knowledge (Porter & Miller, 1985) and its management (Prusak, 1996) are sources of competitive advantage, it follows that those KM activities—both manipulative and orchestral—involved in KM episodes can be keys in determining an organization's competitiveness. That is, an organization may be able to perform at least some of these activities in ways that differentiate it from competitors in terms of achieving superior productivity, agility, innovation, or reputation. This differentiation may include both the methods and technologies used in executing KM activities.

The knowledge chain model was developed from a KM ontology created by an international panel of over 30 KM practitioners and academicians (Holsapple & Joshi, 2002, 2004; Joshi, 1998). The ontology identifies five classes of primary activities (acquisition, selection, generation, assimilation, and emission) that manipulate knowledge within an episode, and four classes of secondary activities that orchestrate the KM episodes (measurement, control, coordination, leadership). Each of the nine KM activity classes is described more fully in the next section.

As Figure 1 shows, the model indicates that implementing combinations of activities in the nine classes results in organizational learning and projections. Learning refers to alterations in the state of an organization's knowledge resources, while projections refer to manifestations of an organization's knowledge that are projected into its environment (e.g., products, services, announcements, actions).

By affecting the PAIR of an organization's learning and projections, the ways in which KM activities are implemented can impact the organization's competitiveness. In other words, productivity, agility, innovation, and reputation are four facets of competitiveness, any one of

Figure 1. The knowledge chain model (Adapted from Holsapple & Singh, 2000)



which is a candidate for benefiting from the way in which one or more of the nine kinds of activity are performed.

As the figure suggests, the knowledge chain model also recognizes that an organization's resources and environment can impact learning and projections, and therefore competitiveness (in one or more of the PAIR directions). However, our focus in this study is strictly on the model's contention that the nine activities can be sources of competitiveness and that technological support may contribute to their impacts on an organization's competitiveness. Propositions to this effect for each of the nine activity classes are developed in the next section, along with a characterization of each KM activity class.

propos It Ion develop Ment

Knowledge Acquisition

Knowledge acquisition refers to a processor's act of acquiring knowledge from external sources and making it suitable for subsequent use. Activities in the knowledge acquisition class first identify knowledge in the organization's external environment, then capture that knowledge, and ultimately turn it into a representation that is usable to processors in the organization. Activities belonging to the knowledge acquisition class include obtaining/licensing data sets; obtaining/licensing patents and copyrights; using competitive intelligence, looking for windows of opportunity, and obtaining trade secrets; soliciting knowledge from external sources; reviewing professional literature; monitoring technological advances; receiving external training; participating in collaborative acquisition; indirectly acquiring knowledge en masse (via merger); and indirectly acquiring knowledge on an individual basis as in hiring a new employee (Holsapple & Jones, 2004).

In a study of international joint ventures, Lyles and Salk (1996) find a significant linkage between knowledge acquisition and performance. In a study of 74 enterprise application integration projects in the medical sector, Mitchell (2006) finds that knowledge acquisition (referred to as access to external knowledge) is directly and positively related to the successful completion of projects. Because successful project completion likely has a positive impact on overall performance, it follows that knowledge acquisition can be done in ways that contribute to competitiveness. Considerable anecdotal support for a linkage between knowledge acquisition and competitiveness has been documented (Holsapple & Singh, 2001). More recently, a survey of leaders of KM initiatives has found evidence of an association between knowledge acquisition and the PAIR directions, most notably for the innovation and reputation dimensions of competitiveness (Holsapple & Singh, 2005). Thus, we pose the following proposition:

- **Proposition KAc1**: Knowledge acquisition can contribute to competitiveness.

Numerous studies in the information systems literature indicate that the use of computer systems can enhance a firm's ability to achieve a competitive advantage. In two case studies, Malhotra (2005) finds that the way in which KM is integrated into business processes is a key for using information technology to enhance strategic agility. However, prior studies do not directly examine the possible linkage between competitiveness, on the one hand, and technological support of particular organizational activities on the other hand (such as those identified in the knowledge chain). In the knowledge management literature, specific examples of the importance of technology in performing knowledge acquisition activities are identified (Holsapple & Singh, 2001; Maswera, Dawson & Edwards, 2006). Thus, we posit:

- **Proposition KAc2:** The greater the importance of technology support in knowledge acquisition, the greater the degree of competitiveness realized.

In other words, as technology becomes increasingly crucial to an organization's knowledge acquisition efforts, the organization realizes increasing degrees of competitiveness via these efforts. That is, certain uses of technology may allow the organization to acquire knowledge in a more productive, agile, innovative, and/or reputable fashion than competitors. Competitiveness is increased in one or more of these PAIR directions by giving technology an important role to play in the way acquisition is performed. Examples of such technology include Web crawlers, search engines, competitive intelligence systems, Internet portals/conferencing, data bank subscription, community of practice/interest systems, intelligent agents, and messaging systems.

Knowledge selection

Knowledge selection refers to selecting needed knowledge from internal sources and making it suitable for subsequent use. Knowledge selection and knowledge acquisition are counterparts. Knowledge selection activities are concerned with an organization's existing knowledge resources, rather than acquisitions from knowledge resources existing in the organization's environment. Selection activities identify needed knowledge within an organization's existing knowledge base, then capture that knowledge, and ultimately package it in a representation(s) that is usable to a processor(s) for use in performing other instances of KM activity. The knowledge selection class includes the activities of participating in in-house training; seeking out people's know-how, know-what and know-why; awareness of processes and events in the organization, looking for windows of opportunity, and observing behaviors of participants in the organization; recalling from a technological repository; and, recalling from a non-technological repository (Holsapple & Jones, 2004).

Tsai (2001) finds empirical support regarding the linkage between a person's access to knowledge created by other units within a company and better performance. As with knowledge acquisition, there is also anecdotal support for a linkage between knowledge selection and competitiveness (Holsapple & Singh, 2001), and empirical evidence of an association between knowledge selection and the PAIR directions (Holsapple & Singh, 2005). This suggests the following proposition:

- **Proposition KS1:** Knowledge selection can contribute to competitiveness.

As with knowledge acquisition, anecdotes suggest that technology can be important in performing knowledge selection (Holsapple & Singh, 2001). To the extent that knowledge selection can be performed in ways that contribute to competitiveness, it may be that the importance of technology support for this selection approach is essential for achieving superior results. However, this suggested linkage between a firm's competitiveness and its technological support of knowledge selection activities has yet to be examined empirically. As in the case of knowledge acquisition, the realization and actions of an organization regarding the importance of technology support for knowledge selection activities may enhance the company's ability to perform these activities. Thus, we consider the following proposition:

- **Proposition KS2:** The greater the importance of technology support in knowledge selection, the greater the degree of competitiveness realized.

Examples of such technology include search/retrieval query systems, indexing, push/alerting/monitoring technologies, expert finders, and intranet portals/conferencing.

Knowledge g eneration

Knowledge generation refers to the production of knowledge from existing knowledge. The knowledge management ontology specifies that generation can occur through discovery (creativity, insight) or derivation (procedures, logic) (Holsapple & Joshi, 2004). In developing this ontology, it was found that knowledge generation and knowledge acquisition are very distinct activity classes, even though some frameworks subsume the latter into the former (e.g., Davenport & Prusak, 1998). The knowledge generation class includes devising or developing strategies; developing products and processes; mining; creating; generating through collaboration; learning lessons and sense making; making decisions; analytical derivation; and inferential derivation (Holsapple & Jones, 2004).

As with knowledge acquisition and selection, there is anecdotal support for a linkage between knowledge generation and competitiveness (Holsapple & Singh, 2001). Lee and Choi (2003) contend that the knowledge chain model explains the relationship between KM enablers and organizational performance via knowledge processes. They offer empirical evidence of an association between knowledge generation and organization performance. In a study of 62 quality improvement projects performed in a company during a 10-year time span, Mukherjee, Lapre, and Van Wassenhove, (1998) do a factor analysis that finds three learning constructs. OLS regression results for these find that knowledge generation activities (termed conceptual learning) play a large role in the organization reaching its goals. Another study finds evidence that the way in which knowledge generation is performed can yield PAIR enhancements (Holsapple & Singh, 2005). These suggest the following proposition:

- **Proposition KG1:** Knowledge generation can contribute to competitiveness.

As in the cases of acquisition and selection, anecdotal evidence has been found regarding the importance of technology support in knowledge generation activities (see Holsapple & Singh, 2001). More recently, in a study of 58 firms, Lee and Choi (2003) find that technology has a positive impact on knowledge creativity (in the sense of knowledge combination). Thus, we consider the following proposition with respect to knowledge generation:

- **Proposition KG2:** The greater the importance of technology support in knowledge generation, the greater the degree of competitiveness realized.

In other words, as technology becomes increasingly crucial to an organization's knowledge generation efforts, the organization realizes increasing degrees of competitiveness via these efforts. Examples of such technology include online analytical processing, collaboration systems, data/text/Web mining technology, expert systems, case-based systems, structured argumentation technology, content analysis software, simulation, and modeling software.

Knowledge Assimilation

Knowledge assimilation refers to the class of activities that alters the state of an organization's knowledge resources by internally distributing and storing acquired, selected, or generated knowledge. A processor performing a knowledge assimilation activity receives acquired, selected, or generated knowledge and impacts the organization's state of knowledge by either disseminating or storing this received knowledge (possibly filtering, reorganizing, and repackaging it along the way). Activity types in the knowledge assimilation class fall into the categories of formal internal publishing, informal internal publishing, formal internal interaction, and informal internal interaction (Holsapple & Jones, 2004).

As with knowledge acquisition, selection, and generation, real-world anecdotes suggest a linkage between knowledge assimilation and competitiveness (Holsapple & Singh, 2001), and empirical evidence finds associations between knowledge assimilation and PAIR, particularly in the innovation direction (Holsapple & Singh, 2005). Mitchell (2006) finds empirical evidence that knowledge assimilation activities (referred to as ability to integrate internal knowledge) are significantly related to success. Davenport, De Long, and Beers (1998) note that providing multiple channels for employees to practice knowledge assimilation can lead to project success; this is an example of an approach to accomplishing assimilation that may lead to greater competitiveness. Thus, we advance the following proposition:

- **Proposition KAs1:** Knowledge assimilation can contribute to competitiveness.

Similar to the previous activity classes, we consider an additional proposition with respect to knowledge assimilation:

- **Proposition KAs2:** The greater the importance of technology support in knowledge assimilation, the greater the degree of competitiveness realized.

Examples of such technology include document management systems, organizational memory/retention systems, knowledge capture/codification systems, data filtering/cleansing technology, category/taxonomy builders, knowledge mapping, training systems, and enterprise networking systems.

Knowledge emission

Knowledge emission refers to embedding knowledge into organizational outputs for release into the environment. These outputs include not only traditional goods and services, but also knowledge products (e.g., where a firm treats what it knows as a product to be packaged, marketed, and sold). Knowledge emission is similar to knowledge assimilation except the target audience for the produced knowledge is external to the organization rather than internal. Activity types involved in the knowledge emission class are formal external publishing; informal external publishing; formal external interaction; and informal external interaction (Holsapple & Jones, 2004).

From focus group research, Smith and McKeen (2003) characterize knowledge products as bringing a "mother lode" of value to an organization. It follows that these, and more traditional products, if properly emitted can improve the organization's performance. As with the other four primary activities in the knowledge chain, real-world anecdotes suggesting a linkage between knowledge emission and competitiveness have been documented (Holsapple & Singh, 2001), and there is empirical evidence of associations between knowledge emission and PAIR, particularly in the productivity and reputation directions (Holsapple & Singh, 2005). This leads us to the following proposition:

- **Proposition KE1:** Knowledge emission can contribute to competitiveness.

Similar to the knowledge chain's other four primary activity classes, we consider the following proposition with respect to knowledge emission:

- **Proposition KE2:** The greater the importance of technology support in knowledge emission, the greater the degree of competitiveness realized.

Examples of such technology include Web publishing, customer relationship management systems, EDI technology, manufacturing systems, Internet messaging/conferencing/training, and technologies for electronic marketing/advertising.

Knowledge Measurement

Knowledge measurement, a secondary or "orchestral" activity in the knowledge chain, refers to assessing values of knowledge resources and knowledge processors, and their deployment in processes within and across KM episodes. These knowledge measurement activities identify and recognize value-adding processors and resources, assess and compare the execution of KM activities, and evaluate the impacts of an organization's conduct of KM on the bottom-line performance. Activity types included in the knowledge measurement class are determine/develop quantitative measures; determine/develop qualitative measures; measuring knowledge resources; measuring KM abilities/skills of processors; measuring KM activities; tracking stakeholder information; valuing knowledge; managing/monitoring KM; and measuring effects of KM (Holsapple & Jones, 2005).

Hanley and Malafsky (2003) describe a variety of performance measures for KM, stressing that they are valuable in focusing attention on desired behaviors and results. It follows that such focus may boost the extent to which desired performance is achieved (compared to relative inattention in the absence of measurement). Anecdotal support for linkage between competitiveness and knowledge measurement has been identified (Holsapple & Singh, 2001). In addition, there is evidence that knowledge measurement strongly contributes to PAIR, with agility and innovation being leading beneficiaries (Holsapple & Singh, 2005). Thus, the following proposition deserves investigation:

- **Proposition KM1:** Knowledge measurement can contribute to competitiveness.

Previously reported research does not examine linkages between competitiveness and technological support of knowledge measurement activities. However, specific instances of the importance of technology in performing knowledge measurement have been identified (Holsapple & Singh, 2001). Thus, we posit:

- **Proposition KM2:** The greater the importance of technology support in knowledge measurement, the greater the degree of competitiveness realized.

In other words, as technology becomes increasingly crucial to an organization's knowledge measurement efforts, the organization may realize increasing degrees of competitiveness via these efforts. If research supports this proposition, further investigation is warranted to identify specific technologies for which it holds, situational factors that may influence its applicability, and whether the cost is offset by competitive gains. Examples of technology that may be beneficial for measuring include enterprise systems, knowledge valuation modeling, monitoring technologies, and event/usage tracking.

Knowledge c ontrol

Knowledge control refers to activities that ensure needed knowledge processors and knowledge resources are available in sufficient quality and quantity, subject to security requirements. There are basically two themes to this governance of knowledge: quality assurance and protection. Activities in the knowledge control class focus on ensuring the quality of the knowledge housed within the organization and focus on ensuring that the appropriate individuals have access (or did not have access) to that knowledge. Specific activities in the knowledge control class are controlling financial resources available for KM; controlling KM processors; ensuring quality (i.e., validity and utility) of knowledge resources; auditing knowledge and its processing; protecting/providing access controls; using a risk management standard; and managing/monitoring KM (Holsapple & Jones, 2005).

Jamieson and Handzic (2003) assert that knowledge management governance needs to ensure that KM objectives are incorporated into an organization's strategic planning process. Because strategy typically is concerned with devising plans for achieving desired levels of organizational performance or competitiveness, it follows that the nature of attention given to knowledge control (or lack thereof) in a particular organization can play a role in the organization's performance. As with knowledge measurement, anecdotal support for a linkage between this knowledge control and competitiveness has been documented (Holsapple & Singh, 2001). Also, there is some evidence that knowledge control can contribute strongly in the PAIR directions (Holsapple & Singh, 2005). Thus, we pose the following proposition:

- **Proposition KCon1:** Knowledge control can contribute to competitiveness.

Although anecdotes about the importance of technology in performing knowledge control have been identified (Holsapple & Singh, 2001), empirical studies have not systematically examined whether there is a linkage between competitiveness and technological support of knowledge control activities. Thus, we posit:

- **Proposition KCon2:** The greater the importance of technology support in knowledge control, the greater the degree of competitiveness realized.

In other words, as technology becomes increasingly crucial to an organization's knowledge control efforts, the organization realizes increasing degrees of competitiveness via these efforts. Examples of relevant technology include knowledge auditing, security systems, quality assurance technology, performance evaluation software, and asset management systems.

Knowledge c oordination

Knowledge coordination refers to managing dependencies among KM activities to ensure that proper processes and resources are brought to bear adequately at appropriate times. It is concerned with ensuring that knowledge processors with the appropriate skills are available for executing various KM activities, with arranging KM activities in time, and with integrating KM activities into an organization's normal operations. In other words, knowledge coordination is concerned with effectively leveraging an organization's knowledge-related assets on a continuing basis across a portfolio of KM processes. Viewpoints on ways to accomplish such processes include those of Nonaka and Takeuchi (1995), Davenport et al. (1998), and Zack (1999).

Storck and Henderson (2003) introduce a framework of four broad strategies for approaching knowledge coordination as a way to understand how the leveraging of knowledge-related assets can improve organizational performance. Providing a clear purpose and language and providing incentives for participation in knowledge management has been noted lead to project success (Davenport et al., 1998).

There is also anecdotal support for linkage between competitiveness and knowledge coordination (Holsapple & Singh, 2001), plus empirical evidence that knowledge measurement strongly contributes to the PAIR directions, with innovation and agility receiving the strongest impacts (Holsapple & Singh, 2005). Thus, we posit:

- **Proposition KCoo1:** Knowledge coordination can contribute to competitiveness.

Analogous to the other secondary activities, we advance the proposition that as technology becomes increasingly crucial to an organization's knowledge coordination efforts, the organization will perform the activities better and therefore realizes increasing degrees of competitiveness via these efforts:

- **Proposition KCoo2:** The greater the importance of technology support in knowledge coordination, the greater the degree of competitiveness realized.

Anecdotes of computer-based systems that play a role in knowledge coordination have been documented (Holsapple & Singh, 2001), but this proposition has not heretofore been studied systematically. For example, study of possible linkage between workflow technology and competitiveness would shed some light on this proposition. Examples of technology that may be important for knowledge coordination include workflow systems, structured argumentation technology, negotiation support systems, groupware, structured collaboration systems, enterprise systems, supply chain management systems, incentive management systems, and push technologies.

Knowledge Leadership

Knowledge leadership refers to establishing conditions that enable and facilitate fruitful conduct of KM. Important traits for knowledge leadership are detailed by Bennet and Neilson (2003), and Amidon and Macnamara (2003). Activity types involved in the knowledge leadership class are analyzing the business case for KM initiatives; aligning KM with business strategies; establishing KM guidelines; instilling a cohesive and creative KM culture; delegating KM activities; and sharing knowledge (e.g., teaching, mentoring) (Holsapple & Jones, 2005).

Creating the proper culture and providing senior management support has been noted to lead to project success (Davenport et al., 1998). Based on their experiences with many firms, O'Dell, Elliott, and Hubert (2003) maintain that strong leadership is essential for success of major KM initiatives in terms of supporting the greater organizational strategy. Because such strategy typically is directed toward superior performance and competitive advantage, it follows that appropriate execution of knowledge leadership can positively impact an organization's performance. Fedor et al. (2003) also report evidence that KM leadership and support are critical components in performance. As with the other secondary activities, there is anecdotal support for linkage between competitiveness and knowledge leadership (Holsapple & Singh, 2001). Moreover, it has been found that knowledge leadership often strongly contributes to all PAIR directions (Holsapple & Singh, 2005). This leads to the following proposition:

- **Proposition KL1:** Knowledge leadership can contribute to competitiveness.

For symmetry with the other eight activities in the knowledge chain, the final proposition suggests that as technology becomes increasingly crucial to an organization's knowledge leadership efforts, the organization realizes increasing degrees of competitiveness via these efforts:

- **Proposition KL2:** The greater the importance of technology support in knowledge leadership, the greater the degree of competitiveness realized.

From their experiences in working with a variety of firms' KM efforts, O'Dell et al. (2003) contend that technology is necessary (albeit not sufficient) for successful knowledge transfer. Because transfer of knowledge is involved in most activities belonging to the knowledge leadership class, it may well be that leadership approaches in which computer support is integral are prone to yield better firm performance. Examples of technology support that may be of particular importance for knowledge leadership include executive information systems, digital dashboards, internal conferencing/messaging/portal systems, training systems, and community of practice technology.

Method

The questionnaire used to study the 18 propositions is organized into nine sections, one for each class of KM activities. Each section begins with a description of a KM activity class to give respondents a clear anchor for answering the questions that follow. One of these questions asks for the respondent's assessment of the activity's contribution to his/her organization's overall competitiveness. Specifically, "How instrumental was the activity for competitiveness?" A second question asks the respondent to rate the importance of computer-based technology in supporting the implementation of activities in the class. Specifically, "How important was technology in supporting this activity?" Responses are given on a 7-point Likert-type scale, ranging from (1) "Not at all" to (4) "Moderate" to (7) "Extreme". In addition to the nine sections, demographic items are included to characterize the respondent's organization in terms of company size, geographic area, number of people on the KM staff, and type of industry. Demographics about the respondent are also collected, including job title, number of years with the organization, number of years in KM, and background and training in approaching KM.

The instrument was pilot tested for clarity and revised accordingly. The pilot testing also revealed a need for a couple of extensions in terms of possible responses. First, a "not applicable" option is included for each class, and a respondent is instructed to choose this response if his/her organization does not perform activities in that class. Second, an "unknown" choice is added to each measurement scale for all questions. This allows a respondent to indicate that while his/her organization does perform a particular activity or use technology in its implementation, he/she cannot answer the question asked.

Data Collection

Respondents are persons experienced in leading or directing KM initiatives. These people hold positions such as Chief Knowledge Officer, Chief Learning Officer, Chief Information Officer, Director of KM, and/or positions that report to these people. A total of 235 candidates were identified for participation in the study. The list of candidates was created by identifying leaders of KM initiatives who have been presenters at KM conferences, listed on company Web sites as the KM contact, members of KM associations, or have written articles regarding their KM experiences. These are persons who are likely to have had successful KM experiences dealing with KM efforts that have indeed contributed in some manner to their organizations' competitiveness. Because the propositions are concerned with understanding possible relationships between KM activities, competitiveness, and technology importance, it is essential to collect the informed perceptions of persons who have had successful KM experiences.

The initial 235 candidates were reduced to a pool of 164 valid candidates, because 58 were found to have incorrect addresses and 13 turned out to be inappropriate for the study (e.g., not leaders of KM initiatives, not in positions to know enough about the KM initiatives). Of the 164 valid candidates, 33 (20.1%) chose to participate in the study. Two of these are not included in the study results due to missing information in their responses. Nonrespondents for whom we had e-mail addresses were asked to provide reasons why they did not participate. The most common explanation received was that, while they found the survey interesting, they also found it difficult to allocate time for completing it.

Each questionnaire was given a unique identification number so it could be determined which candidate respondents had yet to reply. The candidates were asked to return their responses within two weeks. For those who had not responded within two weeks, a reminder was sent. In the reminder, an option for the candidate to be removed from the candidate list was included. For those candidates who did not ask to be taken off the candidate list, but who still had not responded, periodic reminders were sent. The responses from the early and late respondents were compared. Assuming that late respondents shared traits with those who ultimately did not respond to the survey, the group of late respondents is compared to the group of early respondents to check for possible nonresponse bias. T-tests performed on the two groups' averages show no statistically significant differences in characterizing KM initiatives or demographics. This suggests that results of the study are generalizable to a larger population of persons who have had experiences with successful KM projects.

Sample Characteristics

The respondents have a variety of job titles, with the majority of being either CKO/KM directors (30%) or some other type of upper management (30%). Almost one-third of the respondents lead KM initiatives in consulting companies, and 68% of respondents lead KM initiatives in non-consulting companies. The latter are fairly widely distributed across diverse businesses; 14% in manufacturing firms, another 14% in R&D companies, and the remaining 40% scattered across government organizations, professional associations, and such industries as health care, communication, information technology, financial services, and construction.

Forty-two percent of respondents have worldwide responsibilities and 32% operate in North America. The respondents approach KM from very diverse backgrounds. The largest group, at 19%, has an information systems background. This group, together with organizational development, cognitive science, and engineering backgrounds account for 60% of the respondents; the remainder approach KM from such orientations as library science, communications, philosophy, sociology, education, finance, journalism, biology, and neuroscience. Over 60% of respondents have been with their organizations for at least five years. Over 70% of the respondents have at least five years of KM experience.

r esul ts

Using data collected from questions about each KM activity classes' impact on competitiveness, relative frequency distributions are calculated. For each activity, the distribution shows the extent to which the activity is assessed as having a strong impact on competitiveness; it also shows how widespread a weak impact on competitiveness is. Relative frequency distributions are also used to portray the extent to which technology support is strongly or weakly important for each activity class in the knowledge chain. Correlations are calculated to study the relationship between the importance of technology support for an activity class and the realization of competitiveness via the way that activity is performed. A statistically significant positive correlation between the two variables suggests a need to further study this relationship.

For each of the nine classes, Table 1 shows the sample size, mean, median, variance, and two relative frequencies for the "impact on competitiveness" question ("How instrumental was the activity for competitiveness?"). The first relative frequency is the percentage of respondents who perceive the way in which their organization performs the activity as strongly contributing to competitiveness. For purposes of this analysis, "strong" means a response of either 6 or 7 on the seven-point scale. The table also shows the percentage of respondents regarding his/her performance of the activity class as only a weak contributor to the competitiveness of their organizations (a response of 2 or 3 on the seven-point scale).

Results depicted in Table 1 show that a range of 24% (knowledge control) to 57% (knowledge generation) of respondents perceive the KM activities performed in their organizations as producing strong contributions to their organizations' com-

Table 1. Knowledge chain classes' contributions to competitiveness

Knowledge Chain Class	Sample Size*	Mean	Median	Variance	Strong Contribution to Competitiveness	Weak Contribution to Competitiveness
Knowledge Acquisition (Proposition KAc1)	30	5.32	5.54	.79	50%	12%
Knowledge Selection (Proposition KS1)	30	5.36	5.50	.59	54%	5%
Knowledge Generation (Proposition KG1)	28	5.50	5.65	.45	57%	11%
Knowledge Assimilation (Proposition KAs1)	28	5.33	5.25	1.27	53%	12%
Knowledge Emission (Proposition KE1)	28	5.45	5.75	1.33	51%	14%
Knowledge Measurement (Proposition KM1)	27	4.45	4.22	1.33	34%	25%
Knowledge Control (Proposition KCon1)	25	4.52	4.71	1.68	24%	18%
Knowledge Coordination (Proposition KCoo1)	29	4.76	5.00	1.78	42%	15%
Knowledge Leadership (Proposition KL1)	29	5.26	5.33	1.26	52%	11%

**For each activity class, this omits respondents who chose "not applicable" (e.g., whose experience was insufficient to comment on competitive implications of this activity).*

Table 2. Importance of technology support for the knowledge chain classes

Knowledge Chain Class	Sample Size	Mean	Median	Variance	Strong Importance of Technology Support	Weak Importance of Technology Support
Knowledge Acquisition	30	4.33	4.09	1.71	27%	27%
Knowledge Selection	30	4.64	4.68	1.40	35%	26%
Knowledge Generation	28	4.27	4.67	1.58	26%	26%
Knowledge Assimilation	28	4.75	5.00	2.06	39%	22%
Knowledge Emission	28	4.32	4.38	1.91	21%	38%
Knowledge Measurement	28	3.78	3.79	1.95	16%	26%
Knowledge Control	26	3.94	3.86	2.08	21%	26%
Knowledge Coordination	29	3.75	4.14	1.44	16%	27%
Knowledge Leadership	27	3.30	3.33	1.76	6%	34%

**For each activity class, this omits respondents who chose "not applicable" (e.g., whose experience was insufficient to comment on technology support for this activity).*

petitiveness. The median is at least 5.0 for seven of the nine propositions, and above the midpoint of 4 for the other two. These results solidly support the first proposition for each knowledge chain activity class; those activities in each knowledge chain class can be performed in ways that contribute to an organization's competitiveness.

For each of the nine classes, Table 2 shows the sample size, mean, median, variance, and two relative frequencies for the "importance of technology" question ("How important was technology in supporting this activity?"). The first relative frequency is the percentage of respondents who indicate a strong importance of technology support for that particular knowledge activity class. For purposes of this analysis, "strong" importance means a response of either 6 or 7 on the seven-point scale. The table also shows the percentage of respondents who indicate only weak importance of technology support for the knowledge class (a response of 2 or 3 on the seven-point scale).

The respondents report a range of 6% (knowledge leadership) to 39% (knowledge assimilation) for strong technology support in performing knowledge chain activities. The median is above the midpoint for six of the nine activity classes. Table 2 shows that technology can play a highly important role in implementing most knowledge chain activities, especially for the primary classes. However, for each class, there are also substantial percentages of respondents who view technology as having been of little importance for implementing knowledge chain activities in their organizations. This leads us to ask whether the strength of technology importance for an activity class is associated with the impact of that class on an organization's competitiveness. That is, do the data lend support to the second proposition for any of the knowledge chain's activity classes?

To help answer this question, Table 3 shows correlations between the respondent's indication of each class's contribution to competitiveness and the respondent's indication of importance of technology support for each class. Notice that all correlations are positive and over half of them are statistically significant. These results provide insight into the second propositions for each of the knowledge classes. For knowledge acquisition, assimilation, emission, measurement, and coordination, organizations that realize competitive advantages through the approaches they use to perform these activities tend to rely on technology as an important ingredient in implementing those approaches. Conversely, those that rely on technology as an important ingredient in their approach to performing a knowledge chain activity tend to realize competitive advantages via that activity in the cases of acquisition, assimilation, emission, measurement, and coordination.

dIscuss Ion

This research contributes to understanding KM phenomena in general and the knowledge chain model in particular. In doing so, it provides guidance for practitioners as they evaluate their KM initiatives and suggests future research directions for the KM field.

Analysis of the data supports all nine of the "impact on competitiveness" propositions, indicating that the phenomena described in these propositions are real and deserving of further larger-scale study. For each of the knowledge chain classes, at least 24% of the respondents indicate that their organizations are able to perform the class's KM activities in ways that yield *strong* impacts on competitiveness. In six of the cases, the percentage is at least 50%, with knowledge generation ranking the highest at 57%.

When interpreting the results, care must be taken not to assume that activities at the lower end of the strong contribution range (e.g., knowledge control) are somehow unnecessary or deserving of less attention. Indeed, these may well be where the greatest opportunities for competitive differentiation await. While it is clear that a considerable portion of organizations have found approaches strongly actualizing such potential, many have not. There are several possible reasons for this: a lack of attention to the activity; a lack of sufficient

Table 3. Correlations for the knowledge chain classes

Knowledge Chain Class	Correlation between Impact on Competitiveness and Importance of Technology Support
Knowledge Acquisition (Proposition KAc2)	.734**
Knowledge Selection (Proposition KS2)	.325
Knowledge Generation (Proposition KG2)	.224
Knowledge Assimilation (Proposition KAs2)	.525**
Knowledge Emission (Proposition KE2)	.441*
Knowledge Measurement (Proposition KM2)	.679**
Knowledge Control (Proposition KCon2)	.115
Knowledge Coordination (Proposition KCoo2)	.692**
Knowledge Leadership (Proposition KL2)	.055

** Correlation is significant at the .05 level*

*** Correlation is significant at the .01 level* competencies (or budget) to perform the activity in ways that strongly contribute to competitiveness; a decision to allocate greater resources to other knowledge chain activities; a lack of recognition of the actual competitive yields for the activity; and environmental or resource factors (recall Figure 1) that impact the organization to constrain the competitiveness that can be realized through the activity.

Practitioners who are just beginning their KM programs or looking for areas to focus on may find that giving attention to the highest ranked classes would give the most immediate benefit. For those activities that show the strongest impacts on competitiveness, practitioners will want to be sure these types of KM activities are being performed, and being performed well, in their organizations in order to keep pace with competitors. On the other hand, if focusing on the KM activities with the smaller percentages of strong impacts, it may be more challenging to devise ways to implement these activities for a strong competitive impact; but successfully doing so may differentiate a firm from a larger proportion of its competitors.

At the other end of the spectrum, consider ranking the classes by the weakest impacts on competitiveness. Weak impact ranges from 25% (for knowledge measurement) to 5% (for knowledge selection). Activities at the low end of this range are those that a firm should already be performing in ways that aid competitiveness. A class at the high end may suggest an opportunity for gaining a competitive edge. If an organization can find ways to perform activities in this class that yield strong impacts, there is greater likelihood that they will produce a competitive advantage beyond just avoiding a competitive disadvantage.

Analysis of the data finds support for most of the nine propositions concerning the relationship between impact on competitiveness and importance of technology support. As the importance of technology support for activities in one of these knowledge chain classes increases, the impact that class of activities has on competitiveness increases. This is important to know when developing competitive strategies, as it indicates that technology should be carefully considered as being an important ingredient in the ways the knowledge class activities are performed. The results shown in Table 3 spawn several derivative questions that deserve to be studied by researchers and pondered by practitioners. To what extent does the technology-competitiveness proposition hold for each of the specific activities that comprise a knowledge chain class? For what specific technologies does the proposition hold in the case of a given knowledge chain class? What situational factors (e.g., resources, environment) influence the proposition's applicability for each activity class? Does the degree of competitive gain more than offset the cost of technology? In which of the PAIR directions is technological support of the knowledge classes likely to have the greatest effect or potential? Answers to these questions can aid practitioners in evaluating alternative approaches to the implementing knowledge classes.

In the four cases of where a statistically significant correlation is not found, possible explanations include one or more of the following: technologies that could foster competitiveness via a activity class do not exist (although they may exist in the future); such technologies do exist, but tend not to be successfully deployed in ways that promote competitiveness; there may be frequently occurring (although not necessarily universal) contextual situations that reduce the utility of technology for supporting performance of activities in a knowledge chain class in ways that strongly contribute to competitiveness. Jones (2004) reports a case where the technologies used for knowledge selection are widely used and effective at the individual level. However, technologies that were meant to be used at the organizational level were indeed not widely used and therefore did not contribute to corporate level competitiveness. In another case, the technology in place for knowledge control, while supported greatly, actually negatively impacted productivity (e.g., obstacles such as too many passwords needed to access data).

Implications for practitioners

The top-line finding from the data analysis is that each of the nine knowledge chain activity classes is capable of being performed in ways that have a strong positive impact on an organization's competitiveness. In addition, we find that the more important computer-based technology is in performing most of the activity classes, the more likely it is that greater competitiveness is realized from those activities. However, this technology relationship does not hold for several of the knowledge chain classes. Even though we do not yet know which specific technologies are particularly effective for which knowledge chain activities (and this can vary depending on various factors), these findings furnish some basic guidelines for KM practitioners.

Our results imply that the knowledge chain model can guide an organization's efforts at auditing its own practices. The model's nine activity classes form a checklist or scorecard for assessing KM initiatives. For each initiative, the practitioner can systematically go down the list and ask such questions as: Is this activity class important for my KM initiative? Should this activity be performed for this initiative? Are we performing this activity in a way that contributes to our competitiveness? How do our competitors (or other organizations) perform this activity? Can we improve the manner in which we perform this activity so as to improve our organization's productivity, agility, innovation, and/or reputation?

It may be useful for practitioners to review if and how they are performing those knowledge chain activities for which the strongest impacts on competitiveness are commonly found. If they are already performing these activities, but not seeing the strong competitive results reported by many respondents, it may be that the methods being used to perform these activities could be substantially improved. On the other hand, situational factors (e.g., the organization's socio/economic/regulatory environment, dynamics of the organization's markets or industrial sector, the organization's financial resources) can be overriding factors in determining actual competitive impacts of each activity class in the knowledge chain.

For activity classes whose strong impacts on competitiveness are less widespread or for which weak impacts on competitiveness are relatively frequent, some organizations have still found ways to leverage these into competitive advantages. Thus, these classes should not be automatically dismissed from consideration, although it could be more challenging to coax competitive advantages out of such knowledge chain activities.

For the five activity classes in which strength of impact on competitiveness has significant positive correlations with the importance of technology, practitioners face such questions as: How technology intensive is this activity in our organization? Are there more effective technologies that we should be considering for this activity? Can we devise novel technologies for improving how this activity is accomplished? Certainly, it appears that practitioners in substantial proportions of organizations successfully address such questions.

Consider knowledge acquisition, for example. This study furnishes evidence that when technology is very important in performing knowledge acquisition, strong competitive impacts tend to be realized through this activity class. Yet, only 27% indicate that technology is very important in accomplishing knowledge acquisition in their organizations. We conclude that among the other 73%, there are many organizations that could boost their competitiveness by giving technology a stronger role in the performance of knowledge acquisition. Similar conclusions hold in the cases of the knowledge assimilation, knowledge emission, knowledge measurement, and knowledge coordination classes of activities. The latter two are the most striking, with only 16% indicating that technology is very important in accomplishing knowledge measurement or coordination in their organizations, even though strong technology use for these activity classes tends to be associated with strongly positive competitive impacts. This implies that, for many practitioners, there are open avenues for increasing competitive impacts for some knowledge chain activities via technological means.

Implications for r esearchers

First, this study finds support for all of the propositions regarding the nine activity classes' impacts on competitiveness. By doing so, it not only reinforces the importance of KM in an organization's attempts at being competitive, it suggests that larger-scale and more detailed studies of knowledge chain impact on competitiveness are warranted. Although this study provides evidence that activities within the KM classes can be performed in ways that yield strong impact on competitiveness, it does not identify the specific activities within the classes for which this strong impact is found. Further research needs to investigate each of the specific activity types found within each class to determine which activities can contribute to competitiveness and which (if any) do not. For those that can yield strong competitive impacts, research is needed to find what specific practices actualize this potential in varying resource and environmental situations. This further research could give practitioners more detailed guidance for molding their KM initiatives in ways that provide their organizations with the best chances of gaining competitive advantages.

Second, the study finds support for five of the nine propositions regarding the relationship between impact on competitiveness and importance of technology support. Future research should focus on these pairings to determine factors that may be influencing this relationship. Such investigation may explain why this relationship is found for some of the knowledge chain classes, but not for others. It may identify the most appropriate technologies for each activity within a class. More detailed analysis should be performed to determine which of the specific activities within a KM class benefit the most (from a competitive impact standpoint) from strong technology support. It is quite plausible that even though there is not a significant correlation between competitive impact and technology importance for an activity class as a whole (e.g., knowledge selection), there may be significant positive correlations for some of the activities that comprise that class.

Researchers can use the knowledge chain model to frame and design their investigations of KM and competitiveness. For instance, a study of best practices could be constructed to identify and explore such practices for each of the activity classes. A study of lessons learned processes could strive to understand the role each of the nine activity classes plays in successful organizational learning. A study of failed KM initiatives could seek sources for the failure in each of the knowledge chain activity classes. Research into new KM technologies could be organized in terms of the nine activity classes, or in terms of the classes not having a significant correlation between competitive impact and technology importance.

The knowledge chain model identifies four aspects of competitiveness: productivity, agility, innovation, and reputation. The study presented in this article does not address these aspects. Future research could investigate where the impacts of the KM classes are found among these four approaches to competitiveness. The results would offer guidance to practitioners in determining the best classes in which to focus to achieve a particular competitive strategy. For example, if an organization's main strategy is to improve agility, identifying the KM classes for which a strong impact on competitiveness is found along the agility dimension would signify to the practitioner the classes of activities that are strong candidates to focus on in implementing this strategy.

c onclus Ion

Based on collaboratively-engineered knowledge management ontology, the knowledge chain model asserts there are nine classes of KM activities that can serve as sources of competitiveness or competitive advantage. Previous research finds multiple published anecdotes that illustrate this assertion in the case of each of the nine activity classes (Holsapple & Singh, 2001) and finds evidence that each of these activities can affect an organization's productivity, agility, innovativeness, and/or reputation (Holsapple & Singh, 2005). The study reported here offers empirical support for the propositions that there are activities in each of the nine knowledge chain classes that can be performed in ways contributing to an organization's competitiveness. Furthermore, for five of the activity classes, the study offers empirical support for propositions that, as technology is more important in the way activities are performed, those activities yield more strongly positive competitive impacts.

By buttressing the knowledge chain theory, this study suggests that the knowledge chain is relevant and important to those concerned with practicalities of designing, implementing, and evaluating KM initiatives. Furthermore, its finding of a linkage between technology and competitiveness in performing at least five of these activity classes suggests that technology is relevant and important in designing, implementing, and evaluating approaches to accomplishing these activities. This descriptive study's support of the propositions gives sufficient evidence to justify further studies of the knowledge chain that are larger in scale, more detailed in depth, and even normative in orientation. Finally, this study's support for knowledge chain theory suggests that the knowledge chain concepts can be useful to educators in organizing the presentation and study of KM issues related to competitiveness and technology.

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Chapter VI
Developing a Knowledge-Based Organizational Performance Model for Improving Knowledge Flows in Discontinuous Organizations

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Abstr Act

Tacit knowledge attenuates particularly quickly in organizations that experience discontinuous membership: the coming and going of organizational roles or positions during a workflow process. Since knowledge flows enable workflows, and workflows drive performance, theory suggests that dynamic knowledge—particularly tacit knowledge—is critical for competitive advantage. This research seeks to extend established organization theory, through integration of emerging knowledge-flow theory, to inform the design of discontinuous organizations. Toward this end, we build a computational model based upon ethnographic study of an affordable housing project that experienced severe discontinuous membership. Analysis of this model reveals problematic theoretical gaps, and provides insight into how scholarly understanding of knowledge flows can extend organization theory to address discontinuous organizations. This research contributes new knowledge for designing knowledge-based organizations in discontinuous contexts.

Introduct Ion

Tacit knowledge does not flow well through the enterprise. It attenuates particularly quickly in organizations that experience discontinuous membership: the coming and going of organizational roles or positions during a workflow process. Since knowledge flows enable workflows, and workflows drive performance, theory suggests that dynamic knowledge—particularly tacit knowledge—is critical for competitive advantage (Nissen 2006a). Indeed, our research elucidates how managing flows of knowledge may be as important to competitive advantage as managing project cost is.

For instance, qualitative research by Ibrahim and Paulson (2005) reveals how incomplete knowledge flows can impact competitive advantage in the construction industry. Discontinuous membership surfaces regularly in property development projects, for example, as specific professional team members are employed only when and where their particular expertise is required to complete the tasks involved in a particular workflow process. As such, discontinuous membership involves an apparent tension between containing cost and promoting knowledge. On the one hand, limiting membership involvement to only those tasks requiring a specific professional expertise is helpful to curtail costs, which is important for financial success in this competitive industry. But on the other hand, moving different people and teams in and out of the workflow process inhibits the flows of knowledge through an enterprise, which in severe cases has been observed to cause a project to be abandoned entirely, and hence create a competitive disaster. The term discontinuity, relates to when an organization has to 'switch' the mode of operation (for example, from tacit-dominant to explicit dominant operating environment) that requires a totally new set of organization to oversee the workflow. This term was used by Anderson and Tushman (1990) to describe the 'break' that happened when technology advancement would force previous technology to discontinue hence forcing organizational change. In our context, the term explains the discontinuity of an organizational structure caused by the change in the workflow characteristics due to environmental influences.

Further, the impacts of managing costs are understood very well, and the kind of cost containment noted above in the property development context is heralded as textbook project management. Alternatively, the impacts associated with inhibited knowledge flows are neither understood well nor addressed by extant management theory (see Nissen 2006b). Likewise, designing organizations with relatively stable membership has been studied extensively, and such stable membership is implied in most organizational design textbooks. But a dearth of research addresses designing organizations with discontinuous membership. Indeed, our established theories on management and organization seem to be relatively ignorant of knowledge flows and discontinuous membership, even though such phenomena are known now to be important, complex and problematic.

The research described in this article uses computational methods and tools to understand how discontinuous membership affects organizational design. Specifically, we seek to extend established organization theory, through integration of emerging knowledge-flow theory, to inform the design of discontinuous organizations. Toward this end, we build a computational model based upon an ethnographic study of an affordable housing project that experienced severe discontinuous membership. Analysis of this model reveals problematic theoretical gaps, and provides insight into how scholarly understanding of knowledge flows can extend organization theory to address discontinuous organizations. This research contributes new knowledge for designing knowledge-based organizations in discontinuous contexts.

In the following section, we present a motivating background problem, and draw from organization theory to explain the affordable housing enterprise's characteristics. Then we describe the computational model developed to emulate the complex housing development process. We present our analysis and results in turn, and conclude with a discussion on integrating organization and knowledge-flow theories, along with recommendations for knowledge management design, and future research in this challenging area of study.

Motivating Background Problem and Literature

This section describes our motivating background problem, and discusses what current, diagnostic organization theory says about the situation. Several years ago, a San Francisco Bay Area property developer, using his accumulated tacit knowledge and experience, agreed with a town council board to maintain an oak grove at one corner of a property site planned for a new development. A few months into the property development process, his building permit application was rejected, however, because the mechanical engineer (ME) had submitted a building plan that routed the water piping system through this oak grove. From the perspective of the ME, using his accumulated tacit knowledge and experience, this pipe-routing plan was logical, and reflected high professional competence. That corner was the location for all major water in-take points to the site, and that route would be the cheapest since it was the shortest. The ME had assumed that the architect—as the professionally competent leader of the design consultancy team—would incorporate any special requirements (e.g., oak grove preservation) explicitly into the proposed building's drawings. Such incorporation would have formalized the developer's tacit knowledge of the requirement into an explicit form, and would have made the drawings accurate in their depiction of this special requirement. Similarly, the property developer who headed the regulatory team had presumed that the architect—a professionally competent member of the authority regulatory team—would forward the preservation requirement to every member of the design team. It is norm for the architect to provide a set of building drawings void of landscape detailing to the ME because it is 'irrelevant' to the ME. On contrary, the architect would include landscape drawings to the electrical engineer because he has to design the night lighting. Here, knowledge in one part of the workflow process (i.e., known by the property developer) failed to flow to another (i.e., to the ME), as the ME's discontinuous membership did not privilege him to the verbal discussions about the oak grove. This is only one example of many "horror stories" in the construction industry that attracted Ibrahim and Paulson (2005) to investigate the phenomenon of discontinuous membership, and that attract us to study the associated knowledge-flow interactions.

Here we introduce the term *property development life cycle* as a sequence of activities in a workflow process associated with developing a new building. Such life cycle is comprised of five sequential phases: *feasibility, entitlements, building permit, construction,* and *property management* (Ibrahim, 2001). Each phase involves an individual set of workflow process tasks to be completed. The feasibility phase starts as soon as a property developer reviews a parcel with the idea of eventually developing it, and ends when the property developer applies formally for a development permit. The succeeding entitlements phase begins with the formal application for development permit, and ends when construction commences at the site. Knowledge flows are particularly important during these two early phases, when the majority of influential decisions are made (Paulson, 1976). Hence we combine these two early phases into a single *feasibility-entitlements* phase to focus on knowledge flows.

In terms of organization theory, we adopt the diagnostic, contingency theoretic perspective of Burton and Obel (2003) to evaluate the property development organization described above. This organization also provides the focus of the ethnographic fieldwork conducted by Ibrahim and Paulson (2005), upon which we build in the present study. To begin, the focal property development organization illustrates a high complexity environment, with multiple interdependency links, and multiple, concurrent and sequential workflows (i.e., five sequential processes plus two concurrent processes). The matrix-style, project organization is employed in this property development context to help manage such complex, environmental, interdependency and workflow interactions. Further examination of this process also reveals many uncertainties, stemming principally from decision-making processes that involve extra-organizational, public and governing authorities—processes over which the decision maker has neither authority nor control. Uncertainty surrounds decisions in this construction industry, particularly those pertaining to whether or not a development project will obtain funding or permit approval. These decision processes can postpone progress, or even render it infeasible to continue a particular project. Equivocality is evident too, caused often by ad-hoc, external, random and unpredictable requests to accommodate certain public and authority conditions that influence the design and its process. For example, the financier of one affordable family housing project, who came into the picture many months after its inception, understood that the housing project was intended for residential families, and that the children would need spaces to congregate and play together. Hence he requested the property developer to include a children's play structure in the project. Although such knowledge was clearly known within the financing team, it was not articulated via the original proposal, and hence remained unknown within the development project team.

Theory predicts that such facility development enterprises would be organized best in terms of low vertical differentiation and centralization (Burton and Obel, 2003, p. 184). Field observations from the ethnographic study are consistent with this proposition, as project managers are allowed great latitude and authority to devise the best development approach (e.g., that gives good financial return, is feasible to construct, has community acceptance). Low vertical differentiation and centralization allow the project manager to orchestrate all consultants under him, yet relatively unconstrained from above, reporting only to a single, executive manager. Alternatively, our field observations conflict with theory pertaining to formalization. Theory says (ibid.) that organization in terms of low formalization would be best in this property development context, but the focal organization of study exhibits surprisingly high formalization, even where decisions and designs change often (esp. during the early, feasibility-entitlements phase of the project). Moreover, formalization increases as the development project progresses toward the construction phase, and the organization becomes highly formalized throughout the property management phase.

Theory predicts further a tendency by managers to get overloaded in such organizations, which tend to operate in ad-hoc or functional matrix forms (Burton and Obel 2003, p. 193). Here our focal organization is consistent with theory again, because the more experienced project managers, for example, were observed working concurrently on multiple workflow processes, including design, financing, and asset management. Alternatively, because some project managers had accumulated many years of experience, their corresponding tacit knowledge served to ameliorate the impacts of work overload.

Table 1 illustrates the time allocation that each participant in the facility development process commits to a particular *matrix*. Here, each "matrix" (i.e., City, Building, Owner) refers to a separate, matrix-style, project organization with its own sets of (discontinuous) members and workflow processes. For example, notice in the right-hand column that the project manager

Table 1. Distribution of FTE's for team members in city, building, and owner matrices

DEPT.	AFFILIATION	STAFF POSITION	MATRIX FTE'S			TOTAL STAFFING FTE'S	TOTAL POSITION FTE'S
			CITY	BUILDING	OWNER		
OWNER	DEVELOPER OWNER	EXEC. DIRECTOR	0.20		0.10	0.30	0.30
		PROJECT MANAGER	0.20	0.10	0.10	0.40	0.40
		DESIGN-CONSTRUCTION MANAGER		0.10	0.40	0.50	0.50
		PROPERTY DIRECTOR			0.10	0.10	0.10
		SERVICE DIRECTOR			0.10	0.10	0.10
CONSULTANTS-BUILDER	FINANCE CONSULTANT	FINANCE ADVISOR			1.00	1.00	1.00
	LEGAL CONSULTANT	LEGAL ADVISOR			1.00	1.00	1.00
	ENVIRONMENTAL CONSULTANT	ENV. STAFF			1.00	1.00	1.00
	GEOTECH CONSULTNT	GEOTECH STAFF			1.00	1.00	1.00
	CIVIL ENGINEER	CIVIL ENGINEER		0.20	0.80		
	ARCHITECT	PROJECT ARCHITECT 1		0.20		0.20	1.0
		PROJECT ARCHITECT 2		0.20		0.20	
		CONCEPT ARCHITECT 1			0.80	0.80	
	GENERAL CONTRACTOR	GENERAL CONTRACTOR 1		0.05	0.10	0.15	0.15
		GENERAL CONTRACTOR 2		0.10	0.90	1.00	1.00

puts in 0.40 Fulltime Equivalent (FTE) for this particular housing project (he is involved simultaneously with other projects not reflected in Table 1), of which he allocated 0.20 FTE for the City Matrix, 0.10 FTE for the Building Matrix, and 0.10 FTE for the Owner Matrix. As implied by the names, the objective of the City Matrix is to consolidate public and financing support from the local jurisdictions, while the Building Matrix's is to consolidate the planning, design, and technical aspects of the affordable housing project that ensures compliance to build. Entries in this table illustrate how discontinuous membership exists through variations of the organizational structure, across the various matrices, as different roles and positions appear in some—with varying levels of intensity and duration suggested by the FTE values—but not others. As suggested above, current theory has little to say about organizing for discontinuous membership as such.

Additionally, theory suggests the use of rich media to overcome high equivocality, uncertainty, and complexity (Burton and Obel, 2003, p. 193). Media richness indicates the form, amount, and kind of information involved with communications. Daft (1992, p. 286; cited in Burton and

Obel, 2003) discusses this in terms of the *information-carrying* capacity of communication media, and proposes the following order (from richest to poorest): 1) face-to-face, 2) telephone and other personal electronic media, 3) letters, notes, and memos, and 4) bulletins, computer reports, and data reports. The focal organization in our study reflects a mixture of rich and poor media utilization, which varies in part with the project's life cycle phase. For instance, our fieldwork reveals abundant media-rich sources employed during the feasibility-entitlements phase, as project manager conduct numerous, repeated, face-to-face meetings to gauge and obtain accurate understanding of certain public or authority requirements. Then, as the project progresses through subsequent phases of the life cycle, we find decreasing media richness, even as the number and variety of different participating members increases—discontinuously—on the design team. For instance, a mechanical engineer will provide formal, written, heating, ventilation, and air-conditioning data, and an electrical engineer will provide formal, written, lighting and energy data to the design workflow. By the final, property management phase, property developers tend to use only computer databases for report making. As media richness decreases, opportunities for sharing tacit knowledge decrease commensurately. This kind of longitudinal regression of media richness through the course of a property development process provides novel insight into how choices of communication media may impact knowledge flows, and into how we manage knowledge in an enterprise.

Finally, theory suggests providing result-based incentives within a highly uncertain operating environment (Burton and Obel, 2003, p. 196). However, Ibrahim and Paulson (2005) find differing incentive schemes (and hence different goals) among the design team versus the finance team, for example. As one instance, the design team aims to complete the design documents promptly, in order to collect its professional fees without delay. But the finance team aims instead to obtain project funding, with much less concern for time since without funding, the project will be abandoned. Further, the finance team is often willing to comply with—at times very costly—additional conditions, which can increase project cost, complicate the design, and require rework by the design team. The design team is more reluctant to comply with such conditions. As discussed above, late inclusion of a children's play structure provides an example of this empirical finding.

Overall, we find mixed empirical support for the diagnostic, contingency theoretic prescriptions noted above. Although the property development process takes place within an environment of high complexity, uncertainty and equivocality—and reflects the kinds of low vertical differentiation and centralization prescribed theoretically also—we find in contrast: longitudinally increasing levels of formalization; project management experience ameliorating overload; multiple, concurrent matrix organizations; a longitudinal regression of media richness; and a mixture of incentive schemes (and hence goals) across various members. Such latter empirical findings run counter to the theoretical prescriptions summarized above.

For this reason, we review the organization theory literature more broadly, expanding beyond diagnostic contingency theory, in an attempt to explain these counter-theoretical findings. Four theoretical points pertain in particular. First, we find much concentration on organization formation and behavior (March and Simon, 1958; Cyert and March, 1963; Galbraith, 1974 and 1977; Mintzberg and Westley, 1992; Scott, 2003; Burton and Obel 2003) in the organizational behavior literature. Most researchers focus upon hierarchy as the basic structure for organizing complex social activity where cooperation among members is achieved through vertically imposed bureaucratic processes (Grant, 1996; Weber, 1947). Rules and programs are developed to coordinate behavior between interdependent subtasks (March and Simon, 1958). However, the three, interdependent, matrix organizations from above do not conform well to such, hierarchical organization descriptions, nor do they mirror other, archetypal organizational forms (e.g., as articulated by Mintzberg 1979) well.

Second, Galbraith's (1974, 1977) *information-processing* model has become a well-established theory for organizational design. Galbraith proposes that a major portion of organizational work involves information processing; that decision makers in particular need to process information well during exception handling in order to promote organizational performance; and that the greater the task uncertainty, the greater the amount of information that members in an organization must process. Similarly, when an organization faces greater uncertainty—such as in the property development environment—its members face increasingly frequent situations for which they lack sufficient organizational routines (Nelson and Winter, 1982; cited in Scott, 2003) or rules to guide their decision making, or to inform their work performance. In such an environment, the norm is for lower ranked staff members to seek guidance or information from their supervisors to handle exceptions. The key drawback of Galbraith's model is that it assumes that only the supervisor has the knowledge to respond to emerging problems and exceptions. This model is not suited well for current situations, in which peer-to-peer problem solving is emerging, and especially not in organizations where information technology (IT) dominates (Fruchter, 1999). Furthermore, Monge and Contractor (2003) find that vertical communications and exception-handling structures are inadequate in an IT-dominated, knowledge-based, networked workforce.

Further explanation by Scott (2003) states that people and tasks have evolved around attainment of specific goals; hence, reflecting a *rational* view. However, a second, complementary *natural* view perceives organizations first and foremost as "collectivities" with many seemingly irrational aspects. In this study, we continue to focus on Galbraith's rational, *information-processing* model of organization, but we also expect results that reflect the seemingly irrational behaviors of natural systems. This is because the Ibrahim and Paulson (2005) ethnographic study demonstrates that the complex property development life cycle (assumed as impossible to standardize by Carillo, et al., 2004) can be rationalized (e.g., with the understanding of several sequential or concurrent workflows combined with the identification of critical convergent points).

Finally, we refer to Grant (1996) who proposes that the key to integrating the natural but irrational environmental factors in a knowledge-based firm is ensuring the linkages of interdependent tasks among the multiple workflows. Grant's linkages are similar to the convergent points that Ibrahim and Paulson describe for property development. Their function is to enable the movement of knowledge between interdependent workflows within a complex process. We expect to see this effect via our computational models, in that any change to one, knowledge-based workflow task will trigger more responses in one or more, different, knowledge-based workflow tasks that are linked, and therefore in turn, will affect the overall property development life cycle. These offer promise to help us to explain current gaps in organization theory regarding discontinuous membership.

rese Arch Methodology

As noted above, we build upon our prior ethnographic work to develop a computational model of the affordable housing development project studied previously. Recall that such project experienced severe discontinuous membership, hence it represents an exemplary case for study (Yin, 2003). However, in addition to studying this development project as it took place historically, we also wish to *change the organization* somewhat, in order to provide greater insight into the effects of discontinuous membership and knowledge flows. Although research methods for case study are abundant and well-understood, it is clearly impossible to change the operational organization of a project that took place in the past. Alternatively, we turn to computational organization theory (COT) as a *bridge method* (Nissen and Buettner, 2004) that provides us with a powerful mixture of fidelity, validity and control, and which enables us to *study the project as it might have been*, as well as examining it as it was. Combining these two parts, our research method can be described best as the hybrid approach *computational case study*: we employ COT methods and tools to conduct a (virtual) comparative case study, with our computational models and case analyses rooted firmly in the details of ethnographic work by Ibrahim and Paulson (2005).

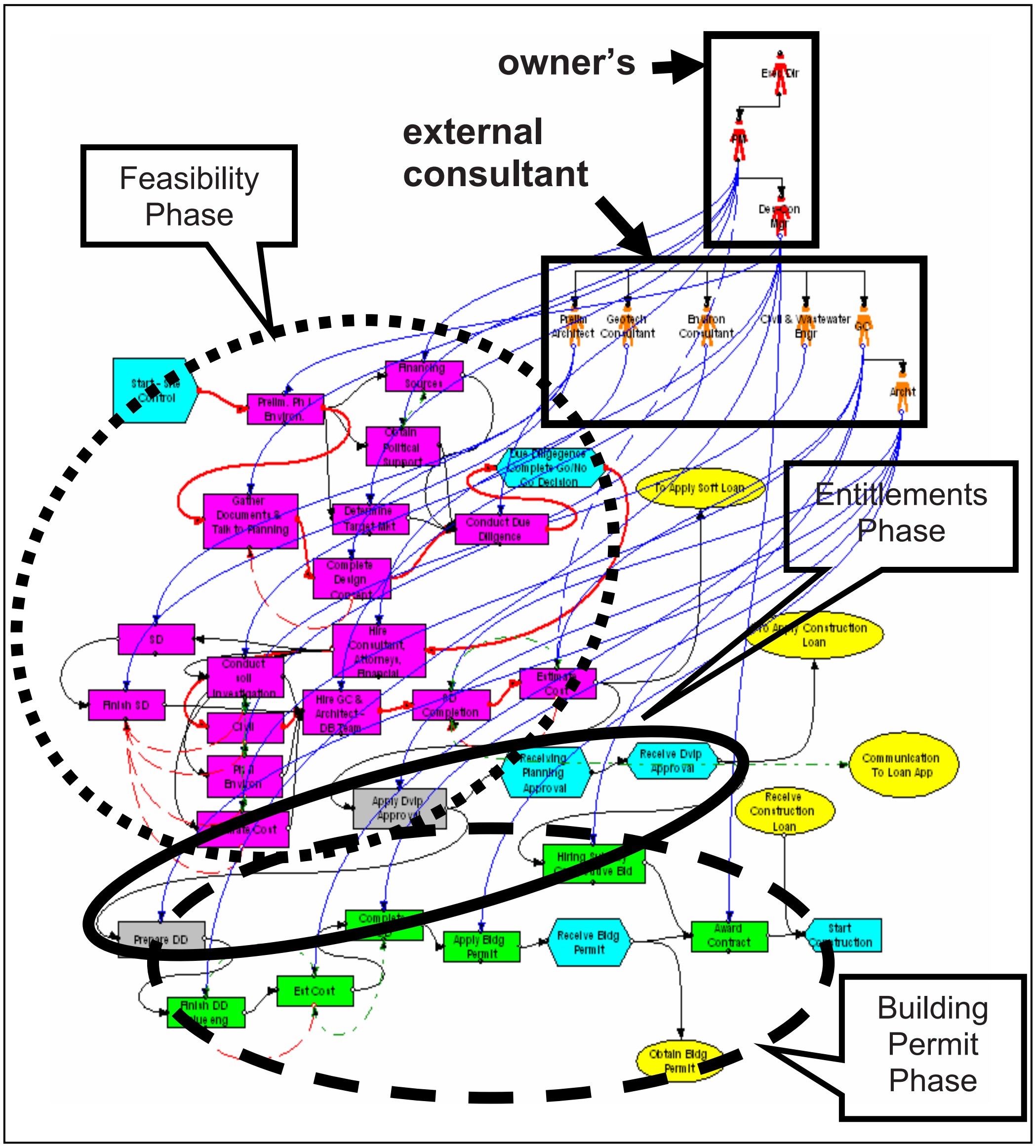
The key is to develop a baseline model first, which captures the key details and behaviors of the project studied through ethnographic work, and then to manipulate this model to instantiate discontinuous membership. With these two models, we can compare the relative organizational structures and behaviors with prescriptions and explanations from organization theory, and can develop insights into how understanding knowledge flows may inform such theory to explain better how to design organizations with discontinuous membership.

Toward this end, we adopt the Virtual Design Team (VDT) computational modeling environment, which embeds Galbraith's information-processing theory (see Jin and Levitt, 1996), and which has been validated extensively with respect to real-world organizations in practice (e.g., see Christiansen, 1993; Thomsen, 1998). The VDT model uses an agent-based representation (Cohen, 1992; Kunz, et al., 1998), which reflects well-accepted theories regarding micro-level organizational behaviors, and which has been proven over several studies (e.g., Horii and Levitt, 2005; Levitt, et al., 1994) as a virtual organization laboratory. The large numbers of validated, organizational and individual level behavioral parameters available in the VDT modeling environment offer good potential to represent the project organization with fidelity. We draw from the details of the ethnographic study to calibrate the model parameter settings. This provides us with good confidence that the structure and behavior of our computational model reflect well those of the focal organization studied in the field. Further, we build upon precedent studies of knowledge flows using this same modeling environment (esp. Nissen and Levitt, 2004), which provide relatively fine-grain insight into how different knowledge flows affect their enabled workflows, which in turn drive differential organizational performance. Our specific implementation is called SimVision, a commercial version of the VDT modeling environment.

Model Speci.cation

To preserve continuity for the non-modeler, we maintain this discussion at a relatively high level. The interested reader can find details pertaining to VDT elaborated by Jin and Levitt (1996), and can contact the authors for copies of the computational model described in this article. Our unit of analysis is the focal organization described above: a 43-unit, affordable family housing development for farm workers located in the San Francisco Bay Area. The family housing project has been in operation since June 2001, but has been plagued with civil- and wastewater-related problems since construction. In reflecting the high complexity environment with multiple interdependency links, we model two *projects* that run concurrently: Design-Construction (Des-Cons) and Finance-Asset Management (Fin-Assm). See Figures 1 and 2 respectively. As one would expect, every task included in the model (tasks are represented by rectangular icons in the figure, and are separated into the different life cycle phases for reference) represents project work identified via ethnographic study, and every organizational

Figure 1. Baseline Design-Construction Model

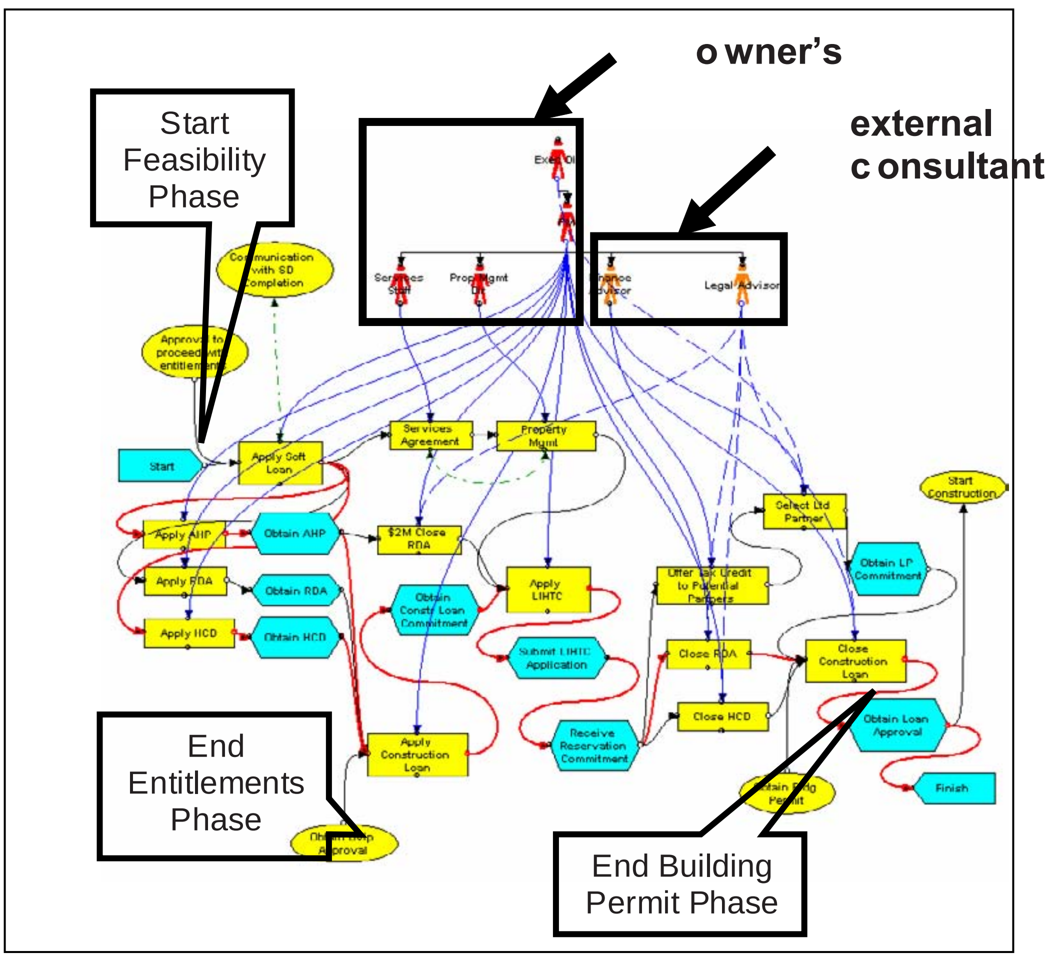


actor (actors are represented by people icons in the figure, and are separated into the different matrices for reference) corresponds to a specific person or position observed in the field organization. The interested reader can refer to Ibrahim and Paulson (2005) for details.

In SimVision, a *project* represents work that an organization must perform to achieve a major business outcome (e.g., obtaining financing or a building permit; represented as *milestones* in the model). Together, the Des-Cons and Fin-Assm projects consist of 39 tasks with twelve milestones. The Des-Cons project has three company staff members and six external consultants. The Fin-Assm project has four company staff members and two external consultants. Remember that both projects run concurrently, and some organizational actors and matrices are involved in both—intermittently as well as simultaneously. The project start date in the model is set June 2, 1997, when the developer obtained site control in the case.

Drawing details from the ethnographic study, and recalling our discussion of organization theory above, we set the theoretically relevant Baseline Model parameters as follow. The variable *centralization* is set to low; the variables *team experience, formalization,* and *matrix strength* are all set to medium; *information exchange probability* is set to 0.7, *noise probability* to 0.2, and both *functional* and *project error probabilities* to 0.05. We also parameterize the work volume to 8 hours per FTE in a 5-day week. The work volume includes direct and indirect work (i.e., coordination, rework, and waiting period) based on the historical schedule and related documents from observation of the project in the field. Together, these settings capture the theoretical concepts of centralization, differentiation, formalization, ad-hoc and functional matrix forms, and media richness. Alternatively, the VDT ontology is not equipped well to model result-based incentives. Hence, we are able to address most but not all of the theoretical concepts gleaned from the literature.

Figure 2. Baseline Finance-Asset Management Model



In the Baseline Model, we represent the organizational actors through positions with attributes and parameters reflecting characteristics of the people actually involved in the development project (refer to Table 1 for their time allocation). In this baseline case, all such actors are represented in a manner that keeps them within a single project team throughout the duration of the project. Notice that this represents the case of *continuous* membership, and hence reflects the manner in which organization theory should have relevant prescriptions and explanations for organizational structures and behaviors on the project.

The Matrix Model is very similar to its baseline counterpart specified above. Indeed, we make only one, targeted adjustment to parameter settings of the baseline: the FTE allocations in the Matrix Model differ to reflect *discontinuous* membership of organizational actors across the two, concurrent projects. Such allocations are based on observed participation in the three organization matrices noted above: *City*, *Building*, and *Owner*. For example, the project manager's position is staffed with a total of 0.4 FTE (total of City, Building, and Owner FTEs) in the Des-Cons project, compared to 0.3 FTE (total of City and Owner FTEs) in the Fin-Assm project. This is because the Des-Cons project has all three matrix teams working on it, compared with only two matrix teams working on Fin-Assm project. (See Table 1).

Further, both the Baseline and Matrix Models illustrate the close task interdependencies observed between the Des-Cons and Fin-Assm projects. We use the SimVision element *ghost connectors* (ghost connectors are represented by the oblong icons in the figure with solid lines, and has a reciprocal pair in the other project), which provide modeling connections or constraints between workflows of the parallel projects. Ghost connectors can also be used to represent explicit knowledge flows via the model. Similarly, we use the SimVision element *ghost communications* (ghost communications are represented by the oblong icons with dashed lines in the figure, and has a reciprocal pair in the other project), which reflect communication between Des-Cons and Fin-Assm teams. Ghost communications can also be used to represent tacit knowledge flows via the model. With this, our Baseline and Matrix Models reflect the details from ethnographic study; represent the effects of discontinuous membership; and capture behaviors associated with knowledge flows.

Model simulation and Analysis

We run a Monte Carlo simulation 100 times each for the Baseline and Matrix Models, and compare the organizational performance results. Principal dependent variables include *simulated duration*, *total work volume* (and its four components: *work volume, rework volume, coordination volume, decision wait volume*), *functional risk index, project risk index, process quality risk*, and *communication risk*. We also measure peak *backlog* for the project manager in both the Des-Cons and Fin-Assm projects. The meaning and relevance of each dependent variable should become clear in the context of our analysis below. The interested reader can refer to Jin and Levitt (1996) for reference. We analyze the results in two parts. First, we assess how well micro-level results support theory. Second, we examine how well each model can identify the tasks that failed in the actual project (i.e., as observed via ethnographic study).

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In this section we present our simulation results (see Table 2) and two-part analysis. Notice first how the simulated duration for the Baseline (695 days) is less than for the Matrix (760 days). This captures a first-order effect of discontinuous membership, and reveals how it impacts the duration of a project. Indeed, the simulated duration for the Baseline is indistinguishable from what would be projected using the generally optimis-

Table 2. Simulation results

Dependent Variable	Baseline	Matrix
Simulated Duration (days)	695	760
Total Volume (Person-days)	735	715
Work Volume (Person-days)	659	659
Rework Volume (Person-days)	29	17
Coordination (Person-days)	44	37
Decision Wait (Person-days)	3	2
Functional Risk Index (FRI)	0.54	0.75
Project Risk Index (PRI)	0.58	0.48
Communications Risk	0.38	0.38

Table 3. Peak project manager backlog

Phase	Baseline	Matrix
Design-Construction (days)	29	26
Finance-Asset Management (days)	43	59

tic, Critical Path Method (CPM). Interestingly, however, total (work) volume (i.e., the total work effort expended on a project) for the Baseline (735 person-days) is greater than for the Matrix (715 person-days). Theory would predict that the organization experiencing the greatest amount of work would require the longest period of time to complete the associated project. Here we see how even seemingly small differences in organization can affect performance considerably.

Notice second that the work volume is identical for the two models (659 person-days). This indicates that the amount of planned or direct work is the same for both organizations. Indeed, we hold work volume constant across the models to ensure their comparability. The difference in total volume stems from greater levels of rework (29 vs. 17 person-days), coordination (44 vs. 37 person-days) and decision wait (3 vs. 2 person-days) for the Baseline. This seemingly anomalous result is theoretically insightful: it provides a clue that knowledge flows may influence organizational performance in ways that organization theory does not explain well at present. We follow this clue more closely below.

Next, notice how the three risk measures reflect high absolute levels, and differ appreciably across models. Here, the Baseline and Matrix Models both have *FRI* (i.e., risk of incomplete rework and residual exceptions at the functional task level) and *PRI* (i.e., risk of incomplete rework and residual exceptions at the project integration level) values above 0.5. These indicate a very high likelihood of project component and task quality failures. Interestingly, the two organizations experience comparatively high risks but along different dimensions. The Matrix exhibits greater functional risk (0.75) than the Baseline (0.54) does, indicating that problems are more likely to become severe at the functional level (i.e., stemming from performance of individual tasks represented in the model). Apparently, discontinuous membership affects the quality of functional work. Alternatively, the Baseline exhibits greater project risk

(0.58) than the Matrix (0.48) does, indicating that problems are more likely to become severe at the project level (i.e., stemming from integration of individual tasks represented in the model).

In reviewing the top ten most critical tasks in the Des-Cons and Fin-Assm projects, experts confirm that the 'Civil Survey' is the riskiest task in the Des-Cons workflow in terms of schedule growth. Civil survey reports help the civil engineer to design optimal structural and infrastructure components—including the problematic septic tank system—which are suited best for a given property's soil condition. This leads us to look more carefully at the Civil Survey task in the model. Such task requires effective communication between the Project Manager (PM) and Civil Engineer. The model suggests that communication overall is problematic (0.38 *Communications Risk* for both models) on this project, but also that communications suffer from problems (e.g., missed meetings, telephone calls, and like opportunities for exchange and interaction) on this, critical task in particular. Since knowledge—particularly tacit knowledge—flows often along the lines of communication links, our analysis points to knowledge clumps via problematic communications as a plausible candidate to explain both the high and the differential project risk levels across the two models.

Notice further the mixed results in terms of the PM backlog, both across the two models and across the two, concurrent projects. In the Baseline, the PM experiences a higher peak backlog (29 days' work) than in the Matrix (26), but backlog levels in both cases are exceedingly high, *indicating that the PM has nearly one month's overdue work piled up in his in-box*. Empirical experience suggests that the optimal backlog is one day, which means the position is fully busy but is not behind in its work, and that levels up to three or four days remain unproblematic generally. Such high backlog levels affect performance in several ways: making it difficult for the PM to prioritize tasks, and hence increasing the likelihood of performing tasks out of desired sequence; missing important deadlines and due dates, and hence having to rework late information products, and to respond to new penalties and problems; not disseminating information, and not making decisions, in a time manner, and hence delaying others and debilitating their performance; increasing the likelihood of making mistakes; and others. Indeed, high levels of peak backlog are highly diagnostic of knowledge-flow issues: here, knowledge clumps severely within the PM, but the organizational design places this actor at the center of many, critical, concurrent workflows.

Notice finally that backlog levels are even higher in the Fin-Assm project (43 and 59) than in the Des-Cons (29 and 26). In discussions with project experts, we learn that the project manager admitted to having difficulties with understanding the civil engineer, and had to make a number of less-informed decisions when the design-construction manager responded too late to requests for critical information. Hence the different problems experienced on the project compound one another: communication difficulties increase project backlog, as organizational actors handle the associated exceptions; and backlog strains communications, as organizational actors try to dig out from under their mounting piles of overdue work.

The second part of our analysis examines how well the two models can indicate the source of known failure in the affordable housing project. Such analysis can be viewed as a variation on *backcasting*: using the model to make what would be *ex-ante* predictions, based on partial knowledge that was available to organizational actors at the time (see Kunz et al., 1998). The micro-level analysis above points directly toward the Civil Survey task as one critically at risk. It also points toward the PM as critically overloaded, even to the point of failure that jeopardizes the whole development project.

Clearly from the discussion above, the PM must have realized that he was backlogged and behind schedule; that he was missing meetings, deadlines and due dates; that people were waiting for long periods of time for him to provide important information and to make critical decisions; that the Civil Survey was important; and other factors elucidated through analysis of the computational models. The PM may not have been able to quantify such effects as we have here via computational modeling, but he must have been aware of the qualitative effects. Indeed, interviews subsequent to the ethnographic study confirmed that this was the case. Moreover, had the PM run our models *while the project was underway*, he may have generated an unprecedented opportunity to identify the mounting organizational problems before the project drifted out of performance bounds. This highlights a contribution of our computational modeling approach. Likewise, the computational model points toward the Civil Survey task as problematic. Had the PM or others been exposed to these model results during project planning, or even in early execution, they may have been able to ameliorate the associated issues and problems that emerged.

Other benefits emerging from our simulation and analysis follow as well. Computational modeling allows us to observe visually the supportive characteristics of the affordable housing development's operating environment. The most significant include critical path changes of workflows due to additions or reductions in task duration and lag time, along with changes in team members' staffing when risk levels increase. We find the task and lag durations to be quite sensitive to the actors' risk exposures, leading us to note potential knowledge-flow problems caused by individual impacts on organizational performance as aforesaid. Unless informed of any changes that happen in a particular workflow, the actors in another workflow would not know to change their schedules for delivering tasks, hence causing potential knowledge clumping. This scenario provides a plausible explanation for why knowledge loss keeps occurring in property development projects; that is, why project organizations fail to learn, organizationally, over time and with experience. This phenomenon supports the finding about the role of the convergent points (Ibrahim and Paulson, 2005) in a complex process that becomes the trigger for cascading changes across multiple, interrelated project workflows.

We infer from the COT modeling efforts that the discontinuous membership of the project manager represents a primary source for knowledge-flow problems. Since the overburdened project manager is too busy attending to mounting work backlogs, there is less opportunity for him to ensure rich and timely flows of knowledge through the organization. In such situation, we cannot expect smooth tacit knowledge flows, and such, tacit knowledge may not flow at all. Alternatively, explicit knowledge flows appear to be more robust to the kinds of organizational problems discussed in this article, and to be more likely to obtain, albeit later in time, at higher risk, and with lower quality than without encountering such problems. Task interdependency appears to aggravate the complex state of knowledge flows in the property development life cycle process because of the rippling effects of one problem source on its corresponding workflow, in addition to cascading across other workflows because of existing interdependency links.

Although we are unable to use the computational model or the ethnography study to measure knowledge flows, through modeling and analysis, we are able to observe visually the changes of explicit knowledge flows in the critical path when exceptions occur. We can infer problems that both cause and affect tacit knowledge flows along communication lines. The results highlight that higher task interdependencies between multiple workflows will impede knowledge flows in discontinuous enterprises, and they provide us with confidence to utilize computational models for future studies to develop knowledge constructs, to measure organizational learning, and to track dynamic flows of knowledge within an enterprise.

conclus Ion

Tacit knowledge attenuates particularly quickly in organizations that experience discontinuous membership: the coming and going of organizational roles or positions during a workflow process. Since knowledge flows enable workflows, and workflows drive performance, theory suggests that dynamic knowledge—particularly tacit knowledge—is critical for competitive advantage. This research seeks to extend established organization theory, through integration of emerging knowledge-flow theory, to inform the design of discontinuous organizations. Toward this end, we build a computational model based upon ethnographic study of an affordable housing project that experienced severe discontinuous membership. Analysis of this model reveals problematic theoretical gaps, and provides insight into how scholarly understanding of knowledge flows can extend organization theory to address discontinuous organizations.

In analyzing the COT simulation results, it was clear that the discontinuous membership of the project manager causes the position to eventually fail in keeping up with the overwhelming exception handling and coordination. The inefficient knowledge movement from the design-construction manager to the project manager caused the position to withhold incoming knowledge and caused knowledge to clump in that position. A simple redesign of the organization can be made to reduce the project manager's overloading—thereby, allowing knowledge to flow well—by providing a civil engineer position to assist the project manager. The results from building and simulating the COT models for this study support our concern about fitting discontinuous organization into Burton and Obel's (2003) six contingency factors: *management style, climate, size/ownership, environment, technology,* and *strategy*. In our article, we concentrate on the environment contingency. The results do not correspond well to the situational fit proposed by the scholars. In this section, we would like to discuss how emerging knowledge flows studies could assist extending organization theory to cater to discontinuous organization, highlight issues to knowledge management scholars that may affect a system design for such enterprise, and provide recommendations for further studies on how discontinuous membership affects the organizational performance of an enterprise.

Extending Organization Theory. Our knowledge-based COT models provide evidence that discontinuous membership (via the matrix formation in the Matrix Model) does affect the structural information-processing of an organization. Our position is supported by the results of the COT models that although the work volume for the Matrix Model is technically reduced, the simulated duration increased. We posit that the increase may be caused by inefficient knowledge flows between the two *projects* caused by the clumping of information at the project manager's position. The dilemma in managing knowledge flows in a discontinuous organization is that the organization continues to evolve during the sequential process while another is maintained in another concurrent process. The interdependent, but loose, connection is the only link for knowledge flows to happen between the different organizations. It is easy for knowledge loss to occur when the connectivity between the organizations is loose, and made worse with discontinuous membership as evidenced by our study. In a discontinuous organization, new team members contribute new knowledge, while members who leave bring out some knowledge with them. Therefore, we are proposing the emergence of a new structural configuration of an organization called *discontinuous*.

The *contingency fit* (as stipulated by Burton and Obel, 2003) is unable to recommend any means for formal integration in a discontinuous enterprise, but instead recommends an appropriate incentive system to coordinate the various activities. In this regard, we find evidence of conflicting incentives to various organizations within the property development enterprise. For instance, the need for some kind of formalization (having standard operating rules) is required by the property developer because of the need to integrate the financing requirements with the project's design. It promotes good credibility standing for for-profit property developers in the eyes of their investors while ensuring the success of obtaining competitive funds for the non-profit property developers. Prudent knowledge management is good practice for long-term property management. On the other hand, members of the design team are working towards financial rewards as contracted by their professional services. The incentive systems for such an enterprise may as well be based on the level of its *reachness* (i.e., from individual to group, organization, or inter-organization) as an additional design parameter property if the organization wants to ensure knowledge flows efficiently throughout such an uncertain environment. The need for knowledge to flow through the organization through the interdependent links (represented by the ghost connectors in the models) is critical to mitigate knowledge clumping due to discontinuous membership. We recommend further studies on how such mechanisms can take place in a discontinuous organization.

Knowledge flows in different phases—sequential or concurrent—depend on the dominant knowledge type most likely to transpire within the phases. Discontinuous members have to ensure the movement of knowledge through the convergent points (Ibrahim and Paulson, 2005) of the workflow processes. Tacit knowledge would move through the property development life cycle if they were coming from tacit-dominant phases and explicit if they were coming from explicit-dominant phases. Furthermore, accumulated and yet different knowledge types must flow as well. The effectiveness of the knowledge flows is very much dependent on its knowledge type especially when the ethnographic study highlights a longitudinal regression in media richness. That means the movement of tacit knowledge depends on how much socialization and internalization (i.e., meetings, discussions, etc.) (Nonaka, 1994) could take place that encourage knowledge flows to occur efficiently, or how much knowledge is externalized in a formal form (i.e., drawings, memos, etc.). If discontinuous membership could be detrimental to an organization, we pose that the *explicitness* level of knowledge is key to determining how effective and efficient an organization would be in various properties and structural configuration fit.

The proposal for *reach* as a design parameter property supports Nissen's (2005a) claim that future organization design can be based on knowledge flows. Moreover, the article also recommends that the *explicitness* (Nonaka 1994) level of knowledge is a key in determining how effective and efficient an organization would be in various properties and structural configuration fit. Since *reach* (Nissen, 2002) and *explicitness* (Nonaka, 1994) are established constructs in knowledge flows dynamics, we would like to recommend further studies to determine if we can establish *knowledge* as the seventh contingency factor (i.e., as articulated by Burton and Obel 2003) for the design of organizational structure with *discontinuous* as a new structural configuration.

Issues affecting KM Design. The property development life cycle operates on a combined complex, uncertain, and equivocal environment. On the other hand, the organization structure for the concurrent phases remains constant and parallel to multiple, sequential phases. These changes present different demands—both constraints and opportunities—on organizations than do placid and stable environments. Hence, more resources and effort must be devoted to coordinating the various activities and to resolving conflicts among members to facilitate knowledge flows in such enterprise. Maintaining the production flows and feedback loops of input, throughput, and output production flows in such an organization is problematic. We recommend knowledge management scholars to develop methodologies to maintain the movement of knowledge that could cater to the peculiarities of the dual-formatted organization—combined stable and discontinuous. In addition, we recommend detailed studies on the convergent points (Ibrahim and Paulson, 2005) that are the gateways to different organizational format and different type of dominant knowledge areas (and with different explicitness level) in a workflow process.

The regressing media richness in a combined hierarchical and non-hierarchical organization provides novel insight for the choices of communication media that would enable knowledge management scholars to capture the different types of knowledge creation throughout a complex property development life cycle. Tacit knowledge within the organization flows principally through socialization and internalization (Nonaka, 1994) especially during the high media rich period—i.e., during the feasibility and entitlements phases. In this case, communication patterns among the various team members during different workflow processes are the key for capturing knowledge. Since researchers can no longer assume that an organization assumes only one mode of knowledge communications pattern, we recommend further studies to determine these communication patterns. The results can guide us in charting ways and means to capture knowledge creation throughout the complex workflow processes.

Promising solutions for enabling effective knowledge movements. We describe herewith two promising solutions for enabling effective knowledge movements in the construction industry. The first tackles the need to maintain early decisions on spatial functional requirements made by the property developer throughout the property development process. Maintenance of all early decisions is critical while allowing the design team the flexibility to change the building form, and integrating the technical requirements for supporting a building's functions. In a study by GhaffarianHoseini and Ibrahim (2007), they propose using the *centrality's* structural link from social network analysis (Scott 2000) to continuously retain the relational link between two spatial nodes on an architectural floor plan. Their study reports the possibility of maintaining a structural link despite repeated nodal location shifting—either vertically or horizontally—by the architect. This potential solution has promising advantages to designers since making multiple changes to any architectural floor layout tend to omit earlier decisions in future documents.

The second promising solution is using virtual reality (VR) technologies to bridge the tacit- and explicit-dominated workflow processes at selected interdependent tasks. PourRahimian and Ibrahim (2007) propose the utilization of 3D sketching in augmented reality (a subset of VR) that addresses fundamental concepts of design and intuitive interactions. Their study intents to close the gap between creative experimentation and precise manufacturing-oriented modeling in an effort leading towards integrating conceptual design with engineering design. However, more studies are required to encourage architects to utilize this tool in the most critical task of the property development lifecycle, i.e., the conceptual design in the schematic design phase. Utilizing limited immersive environments, their study inspires trans-disciplinary teamwork that would enable professionals to save and amplify design semantics throughout a project development life cycle. Hence, it supports 3D sketching technology and methodology for moving forward towards a 4D construction implementation.

In conclusion, the COT modeling illustrates that knowledge flows could impact the organizational performance of a discontinuous enterprise. It affirms that we can use VDT, a COT tool, to study how knowledge flows impact the organizational performance of a discontinuous enterprise. The article recommends the consideration for *discontinuous* as another structural configuration measure, and *reach* as another design parameter property measure for the design of discontinuous organizations. The article also recommends that the *explicitness* (Nonaka 1994) level of knowledge is a key to determining how effective and efficient an organization would be in various properties and structural configuration fit. Therefore, we would like to recommend further studies to determine if we can establish *knowledge* as the seventh contingency factor (i.e., as articulated by Burton and Obel 2003) for the design of organizational structure. In addition, the article highlights the need for knowledge management scholars to consider dual-formatted organization (stable and discontinuous), and indirectly the combination of different knowledge types in ensuring efficient knowledge movement during the design of a successful knowledge management system for a complex process, such as the one for the property development industry. This research contributes new knowledge for designing knowledge-based organizations in discontinuous contexts.

Ac Knowledg Ment

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Chapter VII
Accountability and Ethics in Knowledge Management

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Abstr Act

The purpose of this chapter is to argue the case that the study of Knowledge Management should embrace considerations of ethics and accountability. Knowledge Management—a relatively new discipline—is often seen as a necessary but benign component of any modern business organization. This chapter suggests that underlying modern notions of knowledge management are the far older practices comprising the management of knowledge prevalent in most spheres of human activity. Many of these are political in nature, and distort and manipulate knowledge to achieve ends which may include criminal activity and fraud, but often merely serve to further the aims of organizational actors. The discipline called Knowledge Management has much to learn from the ancient art of the management of knowledge.

In science, knowledge is an unmixed good; in ethics and politics it is bad as well as good
John Gray (2003)

Introduct Ion

The purpose of this discussion paper is to make the case for integrating ethics and with it accountability into research about Knowledge Management (KM). Ethics refers to the motives and methods for KM processes, and their impact on individuals, on organizations, and on society. Ethical issues are also relevant to the researcher studying KM, where the subject being researched and the way the research is conducted can raise ethical issues. The interaction of actors, processes, and technology in all aspects of KM from research to design, and actual use can raise a wide range of ethical dilemmas.

KM has been described by a range of commentators as comprising of practices used by organisations to identify, create, represent, store, distribute and share information. It has been an established discipline since 1995 with a body of university courses and both professional and academic journals dedicated to it. Knowledge Management programs are typically tied to organisational objectives such as improving performance, competitive advantage, innovation, transfer of lessons learned, and the general development of collaborative practices.

Motivation and behaviour related to KM initiatives are necessarily embedded in power relations. Such power relations play a role in the design, implementation, use and research into KM systems, and assumptions, motivation and dilemmas, sometimes explicit, but more often tacit, may affect behaviour. At the same time, the widespread public discussion around the relationship between business organizations and 'social responsibility' is a relatively recent phenomenon though it has now develpoed an extensive literature, for example (Gray & Owen, 1996). The discussion has been a useful one for reminding business organizations, and government at times, of their position, relationship, and responsibility to a social world beyond their corporate boundaries. In doing so discussions about accountability have highlighted the ethical responsibilities associated with KM systems, processes and research. In our chapter we draw attention to the distinction between the subject matter of Knowledge Management and the much older topic, not specifically articulated within the IS discipline, of the Management of Knowledge. The latter is much more concerned with the manipulation (and often distortion) of knowledge to obtain desired outcomes (Land *et al,* 2004).

The chapter draws on examples where the design, implementation, and use of KM systems and processes have, sometimes deliberately, overlooked questions of accountability – what we have called the dark side of knowledge management (Land *et al* 2005a,b). Examples are provided from both the business and public sector. The first part of the chapter establishes why an ethics dimension is necessary in KM theory and practice; and the second part identifies questions on how an ethics dimension could be integrated with current KM research and practice.

Why KM Research and Practice Needs an Accountability Dimension, Accountability, and Ethics

Ethics relates to codes of conduct regarded by a community as 'right' and 'good'. They may be based on notions of morality or values. They may be faith based, determined by rules of proper conduct laid down by some higher authority. As such, we note the conflicts that can arise where values clash or rules differ. Ethical principles are rarely the subject of absolute standards. Nevertheless, conforming to ethical standards does require some consensus at least within defined communities such as those represented by professional associations. Some communities consider ethics sufficiently important to subject their activities to scrutiny by an ethics committee, which may operate on a mandatory basis with legal sanctions against those who flout its rulings. Others work on the basis of voluntary agreement. The medical profession has led the way in being subjected to mandatory ethical audits as well as voluntary agreements.

In this context it is of interest to note that codes of conduct, which might be defined as ethical, can also apply to communities of practice outside the normal establishment. The notion of 'honour', which helps to sustain an organization such as the Mafia, with its strict adherence to Omerta (silence), is an example of the manifestation of a darker code of ethical conduct. Such extreme examples illustrate that ethical principles are rarely absolute; instead they are both relative and contextually bound, arising as they do out of particular situations and circumstances.

In the following section we distinguish between various situations in which issues of ethics and accountability surface in relation to KM and the Management of Knowledge. However, we do not claim to provide a complete or comprehensive classification. Instead, the situations noted are put forward as an indication of the range of issues which the IS and KM communities need to address.

For the purposes of discussion we have chosen to highlight the ethical issues according to four dimensions. The first dimension relates to issues around intentionality in Knowledge Management practices, the second relates to the design and implementation of knowledge based systems, the third dimension relates to issues related to intellectual property rights and the final dimension relates to knowledge production activities using research as an illustrative example.

Intentionality in Knowledge Management practices

It has been suggested that beyond the rhetoric advocating the value and efficacy of KM practices and systems there is a hidden agenda (Bryant 2005). Bryant suggests that the drive to introduce such systems includes an underlying but rarely explicit motivation – to increase the power of the organization over the knowledge worker. By capturing what the knowledge worker knows in knowledge stores such as data warehouses, the knowledge worker becomes less valuable and can even be dispensed with. Indeed is the hidden agenda, behind the importance attached to making tacit knowledge explicit in the KM literature (for example, Nonaka, 1998), related to the attempt to extract maximum value from the knowledge worker, in such a way that he/she becomes more vulnerable to downsizing? Bryant suggests that KM practices like BPR, for example, are merely a euphemism for downsizing. It is easy to dismiss this as mere conspiracy theory, but the prevalence of spin, propaganda and PR in the modern world of business as well as politics, suggests it needs to be taken seriously.

Indeed, organizational and political studies emphasize the instrumental use of knowledge. For example, Sussman and her colleagues (Sussman *et al*, 2002) define the organization as a "*political system, a network of interdependent members using power, influence, and political manoeuvring to achieve their goals.*" Politics can be defined as an intentional social influence process in which behaviour is strategically designed to maximize short term or long term interests and the management and manipulation of knowledge and information provide one of the principal means to achieve this. This raises a range of ethical issues related to the behaviour of private corporations and public administrations.

t he design and Implementation of KM systems

What are the ethical responsibilities of those who design and implement KM systems which themselves might create situations which may be regarded as unethical? Do we need an ethics committee, as is widespread in adjudicating the appropriateness of medical practice, to evaluate proposals involving design and implementation of innovative systems in the IS arena? As Hosein (2005) points out in his case study of data mining for DARPA—the Total Information Awareness Program[12], subsequently renamed the Terrorist

Information Awareness Program—the ethical issues regarding data mining were not raised by the IS or KM communities, indeed quite the opposite. Some of the designers, members of the IS community, took pride in the power of the systems. Instead, criticism has come from sources outside the ICT community – in this case from students of policy making. It is they, who in pointing out the ethical problems, have managed to get the systems, described in the example below, suspended.

The object was to design and implement a data mining system which could be used to gather and correlate data about the activities of citizens, engaged, for example in activities themselves lawful, such as attending peaceful protest marches. The data mining techniques were designed to collate data from a number of sources to create profiles of groups of citizens, identifying them a potentially constituting a threat even though the majority of those participating were wholly innocent of creating such a threat. Further, the information was to be made available for selling on to third parties without the knowledge of the citizens concerned and where its use could offend against notions—or even legislation—regarding human rights.

Intellectual property r ights

The Management of Knowledge and Intellectual Property Rights are firmly linked. What type of knowledge can be shared, and who has ownership of knowledge as a valued asset, is frequently determined by the laws and norms related to Intellectual Property Rights (Baskerville and Dulopovici, 2006b). As such, questions around ethical behaviour face both the employer and employees. Employers may unfairly exploit the knowledge of employees without providing them with due rewards for pooling the knowledge they have contributed. Conversely, an employee may face ethical dilemmas by withholding or distorting knowledge attributable to the employer or the team, for personal gain. But the issues are broader than those of individuals and often relate to the balance between the rights of the corporation to limit access to knowledge as against the rights of society to share in that knowledge for the benefit of society as a whole.

One example highlighting the relativistic notions underlying ethical issues is the debate stemming from the unravelling of the Human Genome (Ferry and Sulston, 2003). A team, directed by Francis Collins, and working under the auspices of the US Government (the Department of Energy and the National Institute of Health), held that the intellectual property rights for the human gene sequence belonged to the organization sponsoring the research, and as such their methods and results could and should be patented. Indeed the mission statement from the US Government suggested:

An important feature of the project was the federal government's long-standing dedication to the transfer of technology to the private sector. By licensing technologies to private companies and awarding grants for innovative research, the project catalyzed the multibillion-dollar U.S. biotechnology industry and fostered the development of new medical applications.[3]

Another team working in Cambridge, led by John Sulston (Ferry and Sulston, 2003), held that the human genome belonged to all humanity and the outcomes of its elucidation should be available to all and should not be exploited solely by sectional interests. The project,

…worked so well because the community held an ethos of sharing from the beginning. We gave all our results to others as soon as we had them. From sharing, discovery is accelerated in the community. Research is hastened when people share results freely [4].

Despite their differences in the research ethos, the two teams collaborated and in the end agreed to make their joint findings available to all. The example demonstrates that well meaning people can operate with different value systems each of which raise ethical issues. At the same time it highlights the dilemma facing the various actors when value systems conflict with examples of principal actors changing sides.

However, as Kyle Jensen and Fiona Murray of MIT recently reported, 20% of the known human genome has, in the USA, been patented mainly by private biotechnology and pharmaceutical companies (Guardian, 14th October, 2005, page 11). Empirical research, (Murray and Stern, 2005) indicated that the use of patents in biomedical research had had an impact on reducing the amount of communication between complementary research projects. Nevertheless the debate between those who regard the maintenance of intellectual property rights as a condition for research and discovery, and those who favour an open stance as encouraging discovery as well as following ethical principles, rages on.

Conversely, the Open Source movement, in which individuals contribute their skills and knowledge to a co-operative project, has turned older notions of intellectual property right on their head. The Open Source movement raises a number of ethical issues including the problem of distribution of rewards when partners of the venture contribute to knowledge.

For example**,** the construction of a new encyclopaedia represents a KM activity. One such project, the creation of the Internet located Wikipedia, based on open source principles, invites individuals to contribute their knowledge to the evolution of Wikipedia. Contributors receive no reward. Wikipedia is available free to anyone who has access to the internet. Wikipedia follows none of the normal rules of KM and the question of intellectual property rights is ignored. Articles are not reviewed. But all users are entitled to make corrections. However, the venture raises its own ethical issues. The development of Wikipedia provides an opportunity for special interest groups to add their own special slant to entries and for other special interest groups in opposition to these to attempt to ban Wikipedia. Thus one group has appealed to GOOGLE to remove Wikipedia from its listings.

Nevertheless, the two examples, the Human Genome project and Wikipedia, represent what is perhaps a new ethical stance for the KM community. Knowledge sharing—a key aspect of KM—is also related to the principles enshrined in the notion of intellectual property rights which set a limit, defined in legal terms, with whom knowledge may be shared and under what conditions.

r esearch as a Knowledge production Activity

Ethical issues exist in all steps of the research process. Research can be defined as a knowledge production activity involving the researcher making decisions about design, collection, storage, distribution, and sharing of knowledge. Included in the list are the protection of new knowledge from access by unauthorised persons or organizations and the notion of intellectual property rights.

Aside from the ethical issues typically associated with research (e.g. anonymity, confidentiality, non-attribution), the special case of action research brings additional ethical dilemmas to the forefront. In research such as action research, which involves the researcher intervening in the activities of the organization being studied, what are the obligations of the researcher to make clear the possible consequences of the intervention on individuals and the organization? Should, for example, the researcher take the role of whistle blower in cases where the researcher comes across dubious or illegal practices? Or should the research take a more distanced approach and just describe the situation?

In IS research the action research example, and the ethics it raises, becomes relevant when thinking about the discipline in its more applied form, and in particular in case of collaboration between academia and industry. According to Hosein (2005), IS researchers, in particular those whose research is closely tied to the design and implementation of systems, have been slow in flagging ethical issues. Certain issues remain taboo subjects – in part because research funding and collaboration depends on the good will of sponsors whose sponsorship maybe conditional on arriving at findings not inimical to the interests of the sponsor. The condition is rarely made explicit but is nevertheless recognised by the researcher or by the researcher's employer. In other words, it appears that the IS researcher being preoccupied with the 'management' perspective and the 'managing' of information and knowledge for the benefit of the organization, and with the impact of the research on their own careers, researchers may 'forget' to worry about any of the broader issues.

Knowledge management as an inter-disciplinary field of research also provides examples that help to illustrate ethical issues and dilemmas, citation being the case in point. Citing references is itself an act of knowledge management and needs to be carried out in an ethical manner – that is it is the duty of the researcher to cite adverse as well as supportive references. But providing a comprehensive reference list can be burdensome and in particular where multidisciplinary research is involved. Perhaps, the role of the referee in peer reviewed research needs to include the explicit obligation to ensure ethical frontiers are not transgressed and the Journals evaluation form needs to include an ethical rating.

ORGANISATIONAL PROCESSES AND ACCOUNTABLE KNOWLEDGE MANAGEMENT

KM systems provide an opportunity to manipulate and control knowledge in all phases from the discovery and collection of knowledge, to its storage and distribution (Alter 2006). Knowledge can be created, omitted or withheld, suppressed, amplified or exaggerated, diminished or distorted. Thompson refers to knowledge derived from such activities as counter knowledge (Thompson, 2008). Such activities may arise by accident or mischance (perhaps a virus attack), but often the manipulation is instrumental. Two examples illustrate such manipulations of knowledge in two different contexts: private sector and civil society.

Enron, for example, had a reputation amongst its employees of sharing knowledge for the benefit both of the organization and its employees (Cruver 2003). At the same time the senior management of the company was engaged in a massive fraud engineered with the help of the management of knowledge on a vast scale. In its final stages this involved the destruction of information, and hence knowledge, about the affairs of Enron, by means of shredders abetted by the company's auditors. Enron is a high profile example but there are many similar examples where knowledge is manipulated to achieve what turn out to be fraudulent and criminal outcomes. In the real world practices involving knowledge manipulation are widespread even if they do not break the boundaries of criminal laws on the scale of Enron.

With regard to accountability in civil society organizations, Ebrahim (2003) argues that non-governmental organizations (NGOs) must consider how information flows from the local level NGO, up to the level of the international funding agencies. The manipulation of knowledge when it travels from a poorly resourced NGO in India, for example, is motivated by the need for survival. The way budgets are validated is itself a political process used for determining priorities. Ebrahim notes the need for accountability from international level agencies, down to the local level NGOs as a way of ensuring proper, ethical, conduct.

Knowledge Management Origins

To provide answers to the many issues raised there is a need to draw on a very wide range of sources coming from many disciplines. Baskerville and Dulipovici (2006a) suggest that a number of disciplines contributed to our current notions of KM. Table 1 reproduced from their paper summarises these sources.

But there are other sources and ideas which current thinking about KM has tended to neglect, but which throw a somewhat different light on some of the issues and in particular the ethical issues. Examples drawn from outside the realm of IS or KM, include the notion that the management of knowledge relies on communicative actions. McLuhan (1964) warned us that modern methods of communications are used to distort the truth, while Habermas' (1987) Theory of Communicative Action provides us with valuable insights relevant to the issues raised in this paper, in particular how the way we use language in part determines responses and behaviour.

Knowledge Management and *Management* of Knowledge

The ***Management*** of Knowledge provides a rich context in which to expand and re-evaluate our ideas around KM systems and processes, beginning with organizational politics. There has been a certain amount of discussion in the KM literature of the part played by politics in organizational behaviour, drawing on the literature of organizational politics and pointing to the political and ethical issues related to KM (Pettigrew 1973; Mintzberg 1983; Wilson 1995; Pfeffer 1997; Sussman *et al* 2002). Nevertheless, the discussion of these issues has not been more than marginal.

The link that seems to us to be missing, is the one between 'knowledge management' and the 'management of knowledge'. Newer forms of KM are part of the older, what may be termed, ***Management*** of Knowledge and must be reviewed and evaluated in that context. By examining KM in the context of the broader ***Management*** of Knowledge, as viewed (but not so named) by a range of authors (Schulze 1999; Grover and

Table 1. Disciplines contributing to current notions of KM

Theoretical Foundation	Key Knowledge Management Concepts Drawn from This Foundation	Applied Purpose in Knowledge Management	Developed Knowledge Management Concepts
Information Economics	Intellectual Capital	Rationale	Knowledge Economy
Strategic Information Systems	Core Competencies	Rationale	Dumbsizing, Knowledge Alliances
Organizational Culture	Tacit and Articulated Knowledge	Process Definition	Knowledge Culture
Organizational Structure	Goal-seeking Organizations	Process Definition	Knowledge Organizations
Organizational Behaviour	Creativity, Innovation, Organizational Learning, Organizational Memory	Process Definition	Knowledge Creation, Knowledge codification
Artificial Intelligence	Knowledge-base Systems	Process Definition	Knowledge Infrastructure
Quality Management	Risk value Benchmarking	Evaluation	Qualitative Frameworks

Davenport 2001; Earl 2001; Wilson 2002, Lowell and Claudia, 2005, Land *et al,* 2005a), the ethical issues become clearer. Knowledge Management as discussed in the IS literature is young—approximately 15-20 years old. The ***Management*** of Knowledge however is older and encompasses a wide range of practices which are widely known and have been discussed over the centuries by philosophers, theologians, educationalists, criminologists, among many others (see also, Land *et al*, 2004; Land, *et al*, 2005a; Land, et al, 2005b).

Much of the published writing on KM systems and practices is guided by expectation that such systems and practices are naturally benign and necessarily designed, implemented and used with the improvement of the condition of mankind in mind. However, this is only half the story and we find that many other KM type practices, perhaps the most discussed in existing literature and perhaps more often related to the ***Management*** of Knowledge rather than KM *per se*, have more malign objectives or are, at the least, self serving and do not result in the desired or planned improvements.

Examples include the use of propaganda and spin in politics (see Colonel Kenneth Allard, Strategy Expert, reported in the Guardian Newspaper, 8th January, 2004, for a good example); the imposition of censorship in relation to religious dogma, the construction of national curricula in education which have xenophobic or racial overtones; the use of the 'need to know' principle in industrial management practices such as Taylorism whereby the individual worker on an assembly line is only provided with that minimum knowledge enabling a fragmented task to be carried out; the use of less than truthful advertising and PR in marketing; and the manipulation of knowledge for criminal activities including corporate fraud. The list of examples is long. Ethical issues relating to this older form of the management of knowledge have been articulated and much discussed. The new discipline of KM, too, has to concern itself with the ethical issues which human behaviour inevitably gives rise to.

c onclus lon

The chapter identified issues and questions that establish an agenda for further debate and research that may contribute to a wider understanding and hence improvement in ethical conduct and its concomitant requirement for accountability. The sort of ethical questions that we can begin to ask around knowledge management systems and processes include:

1. What ethical issues such as discrimination, and domination, arise from the interaction of sponsors, designers, implementers and users?
2. How is accountability built into all aspects of KM from research to practice? And can we devise systems of accountability in ways which do not stifle initiative, entrepreneurship and innovation?
3. Who promulgates ethical standards and acts as their enforcer?
4. How are disputes involving contested value systems and ethical standards resolved?
5. All new systems have unintended consequences. Some of these may themselves raise ethical questions. How do we respond to these?
6. How do we ensure transparency and uncover the hidden agendas?

The above questions are relevant to both researchers and practitioners of KM systems.

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endnotes

[1] http://en.wikipedia.org/wiki/Information_Awareness_Office

[2] http://epic.org/privacy/profiling/tia/

[3] (see: http://www.ornl.gov/sci/techresources/Human_Genome/home.shtml)

[4] (see: http://www.sanger.ac.uk/Info/Press/2002/021007.shtml)

Chapter VIII
Social Capital and Knowledge Sharing in Knowledge-Based Organizations:
An Empirical Study

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Abstr Act

The study aims to understand the social and organizational factors that influence knowledge sharing. A model of knowledge management and knowledge sharing was developed inspired by the work of Nahapiet and Ghoshal. Data on KM processes and various social capital measures were collected from a sample of 262 members of a tertiary educational institution in Singapore. Rewards and incentives, open-mindedness, and cost-benefit concerns of knowledge hoarding turned out to be the strongest predictors of knowledge sharing rather than prosocial motives or organizational care. Individuals who are highly competent in their work abilities are less likely to share what they know when they perceive that there are few rewards or when sharing is not recognized by the organization. The findings provide evidence for the importance of social capital as a lubricant of knowledge sharing and engaging performance management systems in knowledge-intensive organizations.

Introduct Ion

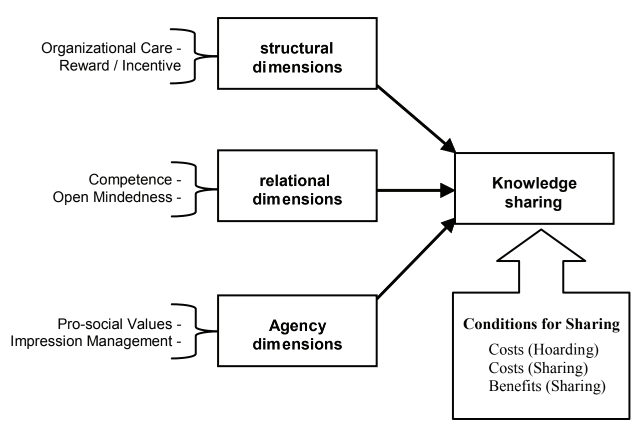
There has been a proliferation of literature on knowledge management with the advent of the knowledge economy (Beck, 1992; Evers & Menkhoff, 2004; Stehr, 1994; Von Krogh, 2003) as indicated by an increasing body of work in organizational studies, information systems, marketing and the social science disciplines of sociology, psychology, and economics. However, notwithstanding the substantial insights generated about knowledge management issues in contemporary business organizations (Menkhoff, Chay & Loh, 2004; Nonaka, 1994; Von Krogh, 1998,) the development of robust theoretical concepts and models, which could explain why members of organizations do share knowledge, has been slow. It seems that the phenomenon of knowledge sharing, identified as an important component in the management of knowledge workers in organizations, is still something like a black box.

This essay[1] seeks to address this gap by theorizing about knowledge sharing in contemporary organizations based on empirical data collected in a tertiary educational institution in Singapore. The theoretical arguments we are developing in this chapter are rooted in the concept of social capital, and draws together perspectives from the sociology of organizations, economic sociology, social psychology, and the broad umbrella of organizational studies, which encompass literature such as knowledge management, organizational behavior, and strategic theory of the firm (Adler & Kwon, 2002; Wenger et al., 2002). In understanding the social and organizational factors that influence knowledge sharing, a model of knowledge sharing was developed based on the work of Nahapiet and Ghoshal (1998). The key objective of the essay is to identify some of the key antecedents of knowledge sharing behavior in organizations (see Figure 1) and to test respective hypotheses empirically.

Knowledge shAr Ing

Helmstadter (2003) defines knowledge sharing in terms of “voluntary interactions between human actors [through] a framework of shared institutions, including law, ethical norms, behavioral regularities, customs and so on … the subject matter of the interactions between the participating actors is knowledge. Such an interaction itself may be called sharing of knowledge” (p. 11). His definition of knowledge sharing highlights the role of social interactions which lends support to the theory of social capital where participation in groups and the deliberate construction of sociabil-

Figure 1. A model of the antecedents of knowledge sharing



ity is a prerequisite for the purpose of creating resource, in this case knowledge.

However, Helmstadter's definition of "voluntary interactions" is not unproblematic as it fails to consider issues of politics and power in such interactions. While knowledge sharing, particularly in the context of economic organizations, is often encouraged through incentive systems (Bartol & Srivastava, 2002), the corollary also holds when involuntary interactions in the sharing of knowledge are often enforced by appraisals and incentive systems whereby employees who do not share their knowledge may be penalized and risk retarding their career advancement in the organization. Studies on knowledge sharing have thus far been "heavy on notion of negotiation and trust between members of the network and exceptionally light on domination and power-relations-independent relationships based on reciprocity and mutual trust, where self interest is sacrificed for the communal good" (Knights, Murray, & Willmott, 1993, p. 978). The writers further argue that such interactions are often embedded in institutional power relations that are hierarchical, competitive, coercive and exploitative (see also Aldrich & Whetten, 1981; Walsham, 1993). This aspect of politics and power in knowledge sharing will be considered later in this section as one of the conditions whereby involuntary knowledge sharing can occur.

Writers (e.g., Polanyi, 1967) have argued that knowledge comprises both an implicit and an explicit component. Through discourse, reflection and discovery, tacit knowledge (knowledge that is internalized but is not articulated or made public) can be transformed into an explicit form that can be shared in the form of data, scientific formulae, specifications and so on. The very process by which such knowledge is transformed is described by Nonaka (1994) as socialization, externalization, combination and internalization (see also Nonaka, Konno & Toyama, 2001; Nonaka & Takeuchi, 1995.)

While there is a paucity of research specifically addressing the mechanisms of knowledge sharing between individuals in organizations, this essay argues that Nonaka's conceptualization of socialization, externalization and combination is of particular importance in explaining the process of knowledge sharing. Both these processes parallel the basic premise established by Helmstadter's (2003) definition of knowledge sharing, which involves the "interactions between human actors [through] a framework of shared institutions" (p. 11).

Being socialized into a profession, for example, usually implies substantial knowledge sharing between an expert and an novice. Externalization, that is articulating tacit knowledge into explicit forms and sharing it through social exchange or via a knowledge based system, is another important knowledge process. Combining different types of knowledge and/or expertise through intense brainstorming sessions or via communities of interest often leads to new and sometimes unexpected insights and product/service innovations as indicated by the case of the Swatch watch where various groups of people provided inputs and ideas. All of these modi require a certain degree of internalization, Nonaka's fourth so-called knowledge creation modus, as part of the respective knowledge is being internalized by both knowledge transmitter and sender during the knowledge sharing process. As internalization usually does not involve direct social interaction, we find internalization less relevant in the context of our study.

Conceptualizing the knowledge sharing process from a social interaction point of view is also attractive as it supports the premise of social capital as a structural relationship resource (Bourdieu, 1985, p. 248).

Dimensions of Social Capital

Bourdieu (1985) defines social capital as "the aggregate of the actual or potential resources which are linked to possession of a durable network or more or less institutionalized relationships of mutual acquaintance or recognition" (p. 248). This definition focuses on the benefits accruing to individuals by virtue of participation in groups and on the deliberate construction of sociability for the purpose of creating this resource. Bourdieu (1985) argues that "the profits which accrue from membership in a group are the basis of the solidarity which makes them possible" (p. 249). The definition implies that social capital is a major aspect of social structure and that it can be put (like other forms of capital) to productive use (Coleman, 1990 p. 302.) As Putnam (1993) has pointed out, "social capital here refers to features of social organization, such as trust, norms, and networks, that can improve the efficiency of society by facilitating coordinated action" (p. 167).

As a resource, social capital facilitates actions of individuals "who are within the structure" (Coleman, 1990, p. 302) in different ways. First, network ties can provide individuals with useful knowledge about opportunities and choices otherwise not available (Granovetter, 1992; Lin, 2001). Network ties may prompt an organization and its members on the availability of such knowledge resources. Second, these network ties play an important part in influencing decision-making depending upon the strategic location of actors within a network (Burt, 2002). Third, social credentials of an individual (Lin, 2001) reflect his or her social standing in the network, and other members may seek to acquire the resource of such credentials by forming alliances with such individuals. And finally, social relations are expected to reinforce identity and recognition to gain public acknowledgement of his or her claim to resources (Lin, 2001).

The relationship between social capital and knowledge is interesting and complex (Adler & Kwon, 2002). Knowledge which we define as manifest ability of purposeful coordination of action is arguably a type of social capital (Zeleny, 1987). People who are knowledgeable and experienced often gain a certain reputation which often helps to increase their social capital. In that sense we can argue that knowledge produces social capital. In our context, however, we are mainly interested in social capital as a driver of knowledge sharing. In order to structure the various social and organizational factors that influence knowledge sharing with the help of the social capital concept, this essay adopts three dimensions, namely structural, agency and relational (Roberts, Simcic-Brønn & Breunig, 2004.) The following section presents the different components of these dimensions of social capital, the significance of which will be discussed later in the essay.

Structural dimension. The structural dimension of social capital, in this essay, refers to organizational climate factors that can aid such interactions and networks. Among the most important facets of this dimension are *organizational care* (Von Krogh, 1998; Von Krogh, Ichijo, & Nonaka, 2001) that examines conditions of low-care and high-care environments in facilitating social exchange, and *reward/incentives* (Bartol & Srivastava, 2002).

Relational dimension. The second dimension is concerned with the relational aspects of social capital. Granovetter (1992) described the concept of relational embeddedness as the kind of personal relationships people develop with one another through a history of interactions. This concept focuses on the building of trust into the relations individuals have that influence their behavior (Cohen & Prusak, 2001; Putnam, 1993; Fukuyama, 1996, 1999). Among the key facets of this dimension are *competence* (Blau, 1964; Hosmer, 1995; Luhmann, 1979; Schurr & Ozanne, 1985) and *open-mindedness* (Tjosvold, Hui & Sun, 2000).

Agency dimension. The agency dimension of social capital examines the role of individual motives in engaging in social interactions that would enable them to acquire the resources available in such interactions (Archer, 1995; Cicourel, 1973; Rioux & Penner, 2001). This dimension is a relatively new contribution to social capital theory and has yet to be empirically tested. The adoption of motives as a variable in the agency dimension was influenced by Portes' (1998) recommendation to investigate "the motivations of the donors, who are requested to make these assets available without any immediate return" (pp. 5-6) as a research direction of social capital. Among the key facets identified to explain motives in this dimension are *pro-social motives* (Rioux & Penner, 2001) and *impression management* (Cicourel, 1973; Conte & Paolucci, 2002; Goffman, 1969; Jensen, 1998).

A model of these components of knowledge sharing is presented in Figure 1.

Clearly, a number of antecedent factors facilitate the sharing of knowledge in organizations. In addition to the structural, relational and agency dimensions, the existing literature suggests other important conditions necessary in allowing individual actors to engage in knowledge sharing through socialization, externalization and combination. The conditions of sharing identified for study (see Figure 1) are the authors' formulations based on a critique of Helmstadter's original definition emphasizing "voluntary interaction" whereby knowledge sharing can, indeed, be involuntary in nature and is fraught with issues of power and politics (Knights et al., 1993).

For knowledge sharing to take place through socialization, externalization and combination, it is important to understand the individual's *expectation of the benefits* he or she would derive from the exchange when engaging in knowledge sharing. This has often been linked to an organization's incentive system. As argued by O'Reilly and Pondy (1980), the probability of actors routing information and knowledge to other actors is positively related to the rewards they expect from doing so. The relationship between sharing of knowledge and the expectation of benefits has been further supported by Gupta and Govindarajan (2000) as well as Quinn, Anderson and Finklestein (1996) who studied the incentive systems of organizations and found that significant changes had to be made to these systems to encourage organizational actors to share their knowledge.

Furthermore, another important aspect of knowledge sharing concerns the actor's *expectation of the costs of not sharing knowledge* which is based on the formulation of involuntary interaction as established earlier and Knights et al.'s (1993) argument that knowledge sharing can, indeed, be involuntary in nature and is fraught with issues of power and politics. While individuals may not receive tangible or intangible benefits from sharing the knowledge, the costs of not sharing knowledge, for example through coercive appraisals and the withdrawal of incentives, may warrant an individual to involuntarily share what is known. This formulation has not surfaced in recent literatures and remains to be tested empirically.

potent IAl pred Ict ors of Knowledge shAr Ing

By way of summary, the previous sections established the following arguments. Firstly, knowledge sharing between actors is facilitated through socialization, externalization and/or combination mechanisms in an organization. Secondly, there are a number of conditions that affect the knowledge resources and motivation to share knowledge through socialization, externalization and/or combination. And thirdly, in reviewing the literature on social capital and knowledge sharing, there is much evidence to support the view that socialization, externalization and/or combination of knowledge are complex social processes that are socially embedded in structural, agency and relational resources and relationships as represented in the concept of social capital.

Considering the social embeddedness of knowledge sharing, this essay suggests that the evolving theory of knowledge sharing is likely to be grounded in social relationships. The following section explores related theoretical arguments by examining empirical links between the *dimensions of social capital and knowledge sharing behavior*.

While the focus of the present research considers the impact of each dimension of social capital independently from the other dimensions, it is recognized, however, that these dimensions of social capital may likely be interrelated in important and complex ways. For example, particular structural configurations, such as those with strong communication channels and reward systems, have consistently been shown to be associated with the relational aspect of work group trust (Bartol & Srivastava, 2002).

We argue that social capital can facilitate the sharing of knowledge by affecting the necessary conditions for such a process. To explore this proposition, this essay now examines the ways in which each of the three dimensions of social capital—structural, agency and relational—influences knowledge sharing behavior.

potential predictors of Knowledge sharing: development of hypotheses

Structural Dimension of Social Capital as Driver of Knowledge Sharing

The main argument in this section is that, within the context of the framework of socialization, externalization and combination adopted in this essay, the structural dimension of social capital, encompassing the various facets of organizational climate factors, is a key antecedent of knowledge sharing.

Organizational care. According to Von Krogh (2003), care is a social norm in human relationships and institutions "which involves the dimensions of trust, active empathy, access to help, lenience in judgment, and the extent to which the former four dimensions are shared in the community" (p. 382). In caring for another, Von Krogh et al. suggests that a care provider, such as a fellow colleague or senior management in the organization, may provide support and valuable knowledge for the purpose of task execution or integrate a person into the organization and network and so on. This type of support characterizes an organization as one possessing high-care (Von Krogh et al., 2001, p. 38) and concern for employees. A low-care organizational climate, on the contrary, is where there is a low propensity to help and care is not a shared value in the organization's culture. Thus, we hypothesized the following:

Hypothesis 1: Organizational care is positively related to knowledge sharing.

Rewards and incentives. Bartol and Srivastava (2002) as well as Thompson, Kruglanski & Spiegel (2000) suggest that rewards and incentives are central to the motivation of an individual to pursue resources through strategic linkages or alliances. In the context of knowledge sharing, Davenport, De-Long, and Beers (1998) suggest that knowledge is "intimately and inextricably bound with people's egos and occupations" (p. 45). According to O'Reilly and Pondy (1980), the probability of actors routing information to other actors is positively related to the rewards they expect from sharing the knowledge. These two different perspectives suggest that the sharing of knowledge may likely be influenced by the desire to obtain recognition (or the pursuit of strategic alliances through opportunistic motives). Therefore, we proposed the following hypothesis:

Hypothesis 2: Rewards and incentives are positively related to knowledge sharing.

Agency Dimension of Social Capital as Driver of Knowledge Sharing

The main argument in this section is that, within the context of the framework of socialization, externalization and combination adopted in this essay, the agency dimension of social capital, encompassing the various facets of individual motives, is an important driver of knowledge sharing behavior.

Pro-social motives. The concept of pro-social motives is more commonly used as a psychometric variable in the field of psychology and has been used in recent years in the study of organizational citizenship behavior (Rioux & Penner, 2001). We argue that pro-social motives of an individual may have important relevance to explain why individuals may pursue resources available in interactions characterized by social capital. Pro-social motives, in this case, are defined by the sociability and the propensity of individuals to relate to another because of personal compatibility or liking, and may volunteer knowledge to help another as a result of this compatibility. Based on this formulation, we proposed the following hypothesis:

Hypothesis 3: Individual pro-social motives are positively related to knowledge sharing.

Impression management. The formulation of this variable is a response to Portes (1998) suggestion to investigate the motives behind individuals to volunteer information or resources in a social capital transaction. Impression management is postulated here to be influenced by the expected costs of *not* sharing knowledge, for example withdrawal of incentives, that may lead the individual to share knowledge to keep up appearances. We hypothesized that:

Hypothesis 4: Impression management (may influence opportunistic behavior) and is positively related to knowledge sharing.

Relational Dimension of Social Capital as Driver of Knowledge Sharing

In the following section we argue that the relational dimension of social capital, encompassing the various facets of work-group trust, is positively related to knowledge sharing.

Competence. It has been argued by Blau (1964) as well as Schurr and Ozanne (1985) that the ability to perform work tasks, also known as *proficiency or competence*, builds trust amongst colleagues an individual interacts with in an organization. This is based on the assumption that ability fulfils some measure of trust on the particular individual in successfully completing a given task. In terms of knowledge sharing, it denotes an ability to relay trustworthy information to the work group. In order to understand the influence of ability as a facet of trust in social capital, we hypothesized the following:

Hypothesis 5: *Competence will be positively related to knowledge sharing.*

Open-mindedness. Tjosvold, Hui, and Sun (2000) suggest that open-mindedness integrates people in a community and confers harmony and trust that new ideas and practices will not be discounted but accepted. In the context of knowledge sharing, we hypothesized the following:

Hypothesis 6: Open-mindedness is positively related to knowledge sharing.

Interaction Effects Model

While some studies (e.g., Bock & Kim, 2002) indicate the reward-incentive motive as a primary driver of propensity to share, the findings reported mostly concern the main effects of reward-incentives on outcome measures. Arguably, this motive may be mitigated by the nature of the knowledge to be shared and specific know-how the individual possesses (Chow, Harrison, McKinnon & Wu, 2000). For instance, what is there to share if I do not have the knowledge that others seek? The extent of whether one shares knowledge therefore seems to also depend on the value of the knowledge the individual perceives one has relative to others. It is likely to be related to the individual's perceived competency. We were, therefore, interested in also looking at the joint influence of rewards-incentives and competence on sharing.

Method

Sample and Procedure

An online survey was developed and subsequently administered in a tertiary educational institution (academic staff, administrators and students) in Singapore. E-mail invitations were sent to all individuals in the organization. A total of 213 persons responded to the survey giving a response rate of 35.5%. 42.3% of respondents were male (N = 90) with 75.1% (N = 160) of Chinese ethnicity. Indians made up 11.3% (N = 24), Malays 4.7% (N = 10) with the remaining 8.9% belonging to other ethnic races. The academic community of respondents comprised 36.6% students, 50.7% administrative staff, and 12.7% faculty members (see Table 1). Because of missing data, the final usable sample size ranged from 169 to 190.

Measures

Knowledge sharing, organizational care and the various dimensions of social capital were assessed using scale measures developed and adapted from the current literature.

Knowledge Sharing: A 5-item measure adapted from Liebowitz (1999) was used to measure knowledge sharing orientation. Response options ranged from (1) strongly disagree to (5) strongly agree. Sample items are, *Ideas and best practices are shared routinely*, and *It is part of the culture of this organization to share knowledge*. The scale's alpha reliability in this study is 0.93.

Social Capital: Structural Dimension

Organizational care and *rewards/incentives* were the main organizational climate variables assessed under the structural dimension factor.

Organizational Care: A 4-item scale developed by Rioux and Penner (2001) was used to measure the extent to which staff valued the organization. Sample items are, *I care about this company*, and *The organization values my contributions*. Response options ranged from (1) strongly disagree to (5) strongly agree. The scale's alpha reliability in this study is 0.91.

Rewards and Incentives: the authors developed this 4-item scale. Sample items are, *Our appraisal/ staff evaluation system encourages knowledge sharing*, and *People who share knowledge are given due recognition in this organization through*

Table 1. Sample distribution: Higher educational institution

		Frequency	Valid Percent	Cumulative Percent
Valid	Students	78	36.6	36.6
	Admin Staff	108	50.7	87.3
	Faculty	27	12.7	100.0
	Total	213	100.0	

rewards/incentives. Response options ranged from (1) strongly disagree to (5) strongly agree. The scale's alpha reliability in this study is 0.92. This scale mostly reflects the incentives offered by the organization.

Social Capital: Agency Dimension

Pro-social motives and *impression management* were the motivational factors assessed in the agency dimension.

Pro-social motives: A 6-item measure adapted from Rioux and Penner (2001) was used to measure pro-social motives. Response options ranged from (1) strongly disagree to (5) strongly agree, for each of the items. Sample items are, *People here always put themselves first*, and *I want to help my colleagues in any way I can*. The alpha reliability in this study is 0.95.

Impression management: We constructed a 4-item measure based on insights gained by Goffman (1969) and Portes (1998). Sample items are, *I want to avoid looking bad in front of others as if I did not contribute*, and *I want to avoid being blacklisted by my boss*. The alpha reliability in this study is 0.89.

Social Capital: Relational Dimension

For the relational dimension, *Competence* and *open-mindedness* were the two trust-related factors assessed.

Competence: This 4-item scale was adapted from Gefen (2000). It measures the competency and knowledge of co-workers. Sample items include *My colleagues are competent in what they do at work*, and *My colleagues are knowledgeable about their job*. The scale's alpha reliability in this study is 0.95.

Open-mindedness: A 4-item scale adapted from Payne and Pheysey (1971) was used. Response options ranged from (1) not at all likely to (5) extremely likely for one of the items and, (1) strongly disagree to (5) strongly agree for the other three items. Sample items are, *One of the most important values emphasized in my work-group is open-mindedness*, and *My co-workers speak out openly*. The scale's alpha reliability in this study is 0.76.

Other Variables

Other variables evaluated included *costs of hoarding knowledge as well as costs & benefits of knowledge sharing*.

Costs of knowledge hoarding: We constructed a 4-item measure. Sample items are, *I might be excluded from information within the organization if I do not engage n knowledge sharing*, and *It will be very difficult to create new knowledge if I do not exchange knowledge with others*. Response options ranged from (1) strongly disagree to (5) strongly agree. The alpha reliability in this study is .85.

Costs of knowledge sharing: We constructed a 4-item measure. Sample items are, *Sharing knowledge in this organization may lead to criticism and ridicule*, and *Sharing knowledge in this organization is like pointing a gun at your face* and may imply all kinds of disadvantages. Response options ranged from (1) strongly disagree to (5) strongly agree. The alpha reliability in this study is 0.93.

Benefits of knowledge sharing: the authors constructed a 4-item measure. Sample items are *Knowledge sharing makes innovation easier*, and *I make more informed decisions with the inputs of my colleagues*. Response options ranged from (1) strongly disagree to (5) strongly agree. The alpha reliability in this study is .95.

As stated above, measures were taken from existing scales as far as possible. A few were developed by the authors (see Appendix) in collaboration with organizational behavior experts (expert panel). Items were pretested, slightly revised and then pretested again to ensure relevancy and understanding. The primary focus of the study is to explore the drivers of knowledge sharing. The research is not a study concerned with the development of new psychometric measures. Although the scale measures comprise only four to five items, we have established the reliability of the scale measures using exploratory factor analysis.

AnAl ys Is

Hierarchical regression analysis was used to examine the predictors of knowledge sharing. Explanatory (independent) variables were entered into the regression in a specified order as a means of determining their individual and joint contributions to explaining the outcome variable. The hierarchical regression analysis used to test the hypotheses is presented in Table 3. Three covariates, age, full-time work experience, and gender were entered in the first step. Gender was coded (0) male and (1) female. Each of the variables were then entered in the following sequence: Step 2, the six agency, structural, and relational variables; Step 3, costs of hoarding knowledge, expected benefits of KS, expected costs of KS; Step 4, the interaction terms for reward recognition, competence and costs of knowledge hoarding. As outlined above, we focused our analysis mostly on the main effects of reward-incentives on outcome measures. As this might be mitigated by the nature and perceived value of the knowledge to be shared (Chow, Harrison, McKinnon, & Wu, 2000) as well as the knowledge and skills the individual perceives one has relative to others (see Bock & Kim, 2002), we were, therefore, interested in also looking at the joint influence of rewards-incentives and competence on sharing.

r esul ts

The means, standard deviations and inter-correlations of measures of knowledge sharing and the various social capital dimensions are shown in Table 2.

The results of the correlation analysis are consistent with the proposed hypotheses, indicating support for each of structural, agency, and relational dimensions of social capital as drivers of knowledge sharing. Furthermore, costs of sharing was negatively related to sharing; when costs of sharing was high, knowledge sharing was low. The independent variables were tested for mutlicollinearity and the results indicated there were no concerns with this issue.

As Table 3 indicates, rewards and incentives, open-mindedness and cost concerns with regard to both knowledge hoarding and sharing turned out to be the strongest predictors of knowledge sharing rather than pro-social motives or organizational care. Furthermore, two interaction terms, over and above the main effect model was also significant in the results of the hierarchical regression. The results are used to graph the presentation of the interaction between rewards and incentives and competence (see Figure 2).

Figure 2 shows relation between knowledge sharing and reward-recognition for high and low competence individuals. It graphically presents the joint influence of reward-incentive and competence on knowledge sharing. For low competence individuals (1 SD below mean), knowledge sharing remained relatively consistent irrespective of the level of reward-incentive. In contrast, this effect was very marked for high competence (1 SD above mean) individuals. The line representing high competence individuals shows that knowledge sharing is strongly and positively related to competence; knowledge sharing is lowest when they perceive that reward-incentive is low.

In short, individuals who are highly competent in their work abilities are less likely to share what they know when they perceive there are few rewards or when the sharing is not recognized by the organization. Individuals who are low on competency, relative to their colleagues, tend to

Table 2. Means, standard deviations and pearson intercorrelations of major variables

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Knowledge Sharing	***.93***												
2. Gender	.19*	***(–)***											
3. Age	-.17*	-.13	***(–)***										
4. Work Experience	-.18*	-.05	.71**	***(–)***									
5. Organizational Care	.55**	.10	.07	.03	***.91***								
6. Reward-Incentive	.69**	.08	-.19 *	-.23**	.46**	***.92***							
7. Impression Management	.36**	.09	-.19*	-.23**	.38**	.38**	***.89***						
8. Competence	.49 **	.13	.09	.01	.74**	.45**	.35**	***.95***					
9. Open-mindedness	.70 **	.14	-.12	-.16*	.61**	.72**	.42**	.62**	***.76***				
10. Pro-Social Motives	.41**	.16*	.06	-.01	.74**	.30**	.37**	.59**	.48**	***.95***			
11. Costs Hoarding	.62**	.12	-.05	-.07	.52**	.56**	.43**	.44**	.53**	.53**	***.85***		
12. Benefits Sharing	.45**	.09	.04	-.04	.71**	.33**	.41**	.71**	.48**	.71**	.58**	***.95***	
13. Costs Sharing	-.05	.03	.15	.14	.14	- .04	.27**	.09	.02	.31**	.33**	.25**	***.93***
Mean	3.05	.54	30.78	8.13	3.65	2.85	3.24	3.69	3.12	3.66	3.18	3.90	2.83
SD	.83	.50	10.74	9.20	.77	.89	.82	.81	.72	.71	.69	.82	.83

* Correlation is significant at the 0.05 level (2-tailed) .

** Correlation is significant at the 0.01 level (2-tailed) .

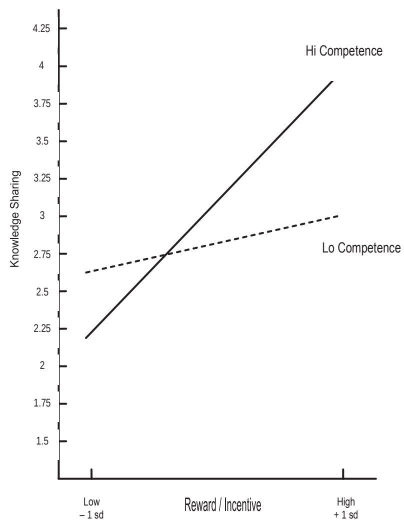
†Cronbach's Alpha reliability value shown in brackets

Table 3. Regression model of the predictors of knowledge sharing[a] (N = 172)

Variable	Model 1	Model 2	Model 3	Model 4[2]
Intercept	3.05***	3.05***	3..05***	3.03***
Age	-.01	-.01	-.01	-.01
Work Experience	-.01	-.01	.01	.01
Gender	.29*	.13	.12	.12
Organizational Care		.18	.12	.16
Reward / Incentive		.32***	.20***	.16*
Impression Management		-.05	-.04	.01
Pro-social Motives		-.03	-.07	-.04
Competence		-.05	-.07	-.03
Open-mindedness		.42***	.38***	.42***
Costs of Hoarding Knowledge			.34***	.33***
Expected Benefits of Knowledge Sharing			.06	-.03
Expected Costs of Knowledge Sharing			.20***	-.18***
Reward Incentive x Competence				-.20***
Reward Incentive x Costs of Knowledge Hoarding				.12*
F	3.357**	25.098***	24.140***	22.773***
R^2	.065	.647	.701	.721
ΔR^2	.065	.582	.054	.020

* $p \leq .05$
** $p \leq .025$
*** $p \leq .01$

Figure 2. Relation between knowledge sharing and reward / incentive for high and low competence



share their knowledge regardless of whether there are organizational incentives to do so.

dIscuss Ion And conclus Ion s

The conceptual view of knowledge sharing presented here in this essay is a social one. It has been argued that structural, agency and relational dimensions of social capital influence knowledge sharing.

The findings suggest that contemporary organizations, which engage in knowledge-intensive and knowledge-generating activities, need to institute an environment conducive to the development of all three dimensions of social capital in order for effective knowledge sharing to take place. Particular emphasis needs to be put on organizational climate variables such as rewards and incentives, which turned out to be very critical predictors of knowledge sharing.

As the study's findings show, the structural dimension of social capital matters and so does the relational dimension. The criticality of open-mindedness as another predictor of knowledge sharing implies that organizations need to implement proper recruitment and screening processes so as to attract a particular type of person who has the required demographic traits, which may make sharing easier. The plausible assumption that personal compatibility predicts knowledge sharing will have to be examined in the context of another study. Voluntary interactions between human actors aimed at exchanging information and experiences often occur when people are comfortable with each other, for example due to social similarities. An important question in this context is how knowledge sharing can be facilitated in multi-cultural and diverse settings where actors have different cultural value systems, mind sets and worldviews.

The study also shows that organizational members consider the possible costs of knowledge sharing and hoarding very carefully before they act. Pro-social motives do not matter much in the context of our sample which might be a function of the fact that many of the respondents were highly qualified knowledge workers who are known to have a unique orientation (e.g., they are loyal to their own profession but not necessarily to their employer). Individuals who are highly competent in their work abilities turned out to be less likely to share what they know (in contrast to individuals who are low on competency) when they perceive that there are few rewards or when sharing is not recognized by the organization.

Overall, the findings provide evidence for the importance of an effective performance management system with specific knowledge sharing standards and respective performance appraisal procedures if an organization wants to successfully manage the transition from a "knowledge is power culture" to a high-performing organization where knowledge sharing is seen as a key enabler of improved business performance and value innovation.

The findings suggest that the incentive structure of a knowledge firm (= work context) represents a key behavioral reference point and that knowledge about meaningful rewards are crucial if management wants to achieve certain outcomes. In other words: if one wants to achieve behavioral change, relevant behavioral rewards/incentives need to be given. An engaged workforce and trusting beliefs that outcomes are appreciated (socially) are important preconditions, somewhat similar to the "procedural justice" ideas (see Greenberg, 1993). In that respect it is important to recall that there are hi-trust and low-trust global work climates: Asia often scores low in respective global surveys while Scandinavia high which would make the replication of the study within a German or Scandinavian setting worthwhile.

Some limitations were observed in the development of the framework. First, the impact of each dimension of social capital had been considered independently from the other dimensions. It was noted that these dimensions of social capital might likely be interrelated in important and complex ways. As the primary objective of the analysis was to focus on the independent effects of those dimensions on knowledge sharing, the richness of the exploration was limited. Future research, therefore, should consider the interrelationships of these dimensions as intervening explanatory factors that could further uncover the mechanisms and dynamics of why knowledge sharing takes place.

Secondly, the different facets chosen to represent the dimensions of social capital are by no means exhaustive. Various other facets such as network ties, norms, and obligations dominant in the social capital literature could have been used as well. However, as this essay attempts to relate social capital robustly with knowledge sharing, the choice of social capital variables was limited to the most relevant.

As the research was confined to just one organization, the findings (although they are highly plausible) cannot be generalized. More research covering different types of organizations and sectors with a focus on the various types of knowledge exchanged are necessary to further support the study approach.

Furthermore, there might be cultural issues that affect the findings. Problems such as knowledge hoarding are often intensified in multi-cultural contexts and "knowledge sharing hostile environments" (Hutchings & Michailova, 2004) perpetuated by a high level of mistrust towards outsiders. The implications of national culture with regard to knowledge sharing and hoarding will have to be explored in another study.

Nevertheless, it is believed that this essay has made an important theoretical-empirical contribution to the rapidly progressing field of KM and the development of a stronger theoretical base. This is important since the topic of knowledge sharing is often discussed from the viewpoint of practitioners who stress more on attributes and formulas for effective knowledge sharing rather than theory-driven explanations.

There are several possible avenues where future research on the theory of knowledge sharing can embark on. More attention should be given to the agency dimension of knowledge sharing which, following Archer's (2003) concept of the internal conversations of private individuals, could examine how different reflexivities can influence the individual's decision-making in participating in resource-based knowledge sharing activities that could benefit their career or life trajectories. This would entail examining the tacit-dimension of knowledge and how such knowledge is explicated and structured to explain decisions that are subsequently made. This essay points towards a psychometric tool and questionnaire, the Tacit Knowledge Inventory for Managers, by occupational psychologists Richard Wagner and Robert Sternberg from Yale University (Sternberg, 1999; Wagner & Sternberg, 1985) as a reference for such a research direction.

Furthermore, it would add an interesting angle to compare the theory of knowledge sharing in different organizational settings, such as the military where a top-down hierarchical structure may elicit different knowledge sharing dynamics, and a flat-structured business organization. Different national and cultural settings may also produce different observations (Bhagat, Harveston & Triandis, 2002). The research possibilities are rich and worthy to be explored further.

Append Ix: Me Asures

Knowledge Sharing: A 5-item measure adapted from Liebowitz (1999) was used to measure knowledge sharing orientation. Response options ranged from (1) 'strongly disagree' to (5) 'strongly agree'. Items are:

- Ideas and best practices are shared routinely here.
- It is part of the culture of this organization to share knowledge.
- Knowledge sharing is often facilitated here through special events, meetings etc/.
- There is a lot of collaboration here between different departments and units.

The scale's alpha reliability is .93.

Organizational Care: A 4-item scale developed by Rioux and Penner (2001) was used to measure the extent to which staff valued the organization. Response options ranged from (1) 'strongly disagree' to (5) 'strongly agree'. The scale's items are:

- I care about this company.
- The organization values my contributions.
- I feel proud to belong to this organization.
- I want to keep up with the latest developments in the organization.

The scale's alpha reliability is .91.

Rewards and Incentives: The authors developed this 4-item scale. Response options ranged from (1) 'strongly disagree' to (5) 'strongly agree'. Sample items are:

- Our appraisal / staff evaluation system encourages knowledge sharing.
- People who share knowledge are given due recognition in this organization through rewards / incentives.
- Sharing knowledge is part of our culture here.
- In this organization employees are rewarded if they share knowledge.

The scale's alpha reliability is .92.

Prosocial Motives: A 6-item measure adapted from Rioux and Penner (2001) was used to measure pro-social motives. Response options ranged from (1) 'strongly disagree' to (5) 'strongly agree' for each of the items. Sample items are:

- People here always put themselves first.
- I want to help my colleagues in any way I can.
- I feel it is important to help my colleagues in any way I can.
- I would like to get to know my colleagues better.

The alpha reliability is .95.

Impression Management: We constructed a 4-item measure based on insights gained by Goffman (1969) and Portes (1998). Response options ranged from (1) 'strongly disagree' to (5) 'strongly agree' for each of the items. Sample items are:

- I want to avoid looking bad in front of others as if I did not contribute.
- I want to avoid being blacklisted by my boss.
- I want to look like I am busy.

- I want to impress my colleagues.

The alpha reliability is .89.

Competence: This 4-item scale was adapted from Gefen (2000). Response options ranged from (1) 'strongly disagree' to (5) 'strongly agree' for each of the items. Sample items include:

- My colleagues are competent in what they do at work.
- My colleagues are knowledgeable about their job.
- My colleagues will follow through an assignment.
- When my colleagues tell me how to approach a particular task, I can rely on what they say.

The scale's alpha reliability is .95.

Open-Mindedness: A 4-item scale adapted from Payne and Pheysey (1971) was used. Response options ranged from (1) 'not at all likely' to (5) 'extremely likely' for one of the items and, (1) 'strongly disagree' to (5) 'strongly agree' for the other three items. Sample items are:

- One of the most important values emphasized in my workgroup is open-mindedness.
- My co-workers speak out openly.
- My co-workers tend to be cautious and restrained when they talk to others.
- Errors and failures are talked about freely so that others may learn from them.

The scale's alpha reliability is .76.

Costs of Knowledge Hoarding: We constructed a 4-item measure. Response options ranged from (1) 'strongly disagree' to (5) 'strongly agree'. Sample items are:

- I might be excluded from information within the organization if I do not engage n knowledge sharing.
- It will be very difficult to create new knowledge if I do not exchange knowledge with others.
- My status in the organization will be affected negatively if I engage in knowledge hoarding rather than knowledge sharing.
- I might lose out on certain financial rewards (e.g., salary increments) if I do not share knowledge with others.

The alpha reliability is .85.

Costs of Knowledge Sharing: We constructed a 4-item measure. Response options ranged from (1) 'strongly disagree' to (5) 'strongly agree'. Sample items are:

- Sharing knowledge in this organization may lead to criticism and ridicule.
- Sharing knowledge in this organization is like 'pointing a gun at your face' and may imply all kinds of disadvantages.
- People may be exploited if they share their knowledge in this organization.
- Sharing of knowledge is not reciprocated by others in this organization.

The alpha reliability is .93.

Benefits of Knowledge Sharing: The authors constructed a 4-item measure. Response options ranged from (1) 'strongly disagree' to (5) 'strongly agree'. Sample items are:

- Knowledge sharing makes innovation easier.
- Knowledge sharing saves a lot of time since we do not have to reinvent the wheel again and again.
- I make more informed decisions with the inputs of my colleagues.

- The sharing of experience-based knowledge helps avoid costly mistakes.

The alpha reliability is .95.

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Endnotes

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2. The ß values are the unstandardized coefficients from the final regression equation, each term being corrected for all other terms.

Chapter IX
A Structured Method for Evaluating the Management of a Knowledge Management System Implementation

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Abstr Act

A knowledge management system (KMS) project transcends functional departments and business partners. The success of KMS implementation is highly contingent upon a well-orchestrated integration of multiple systemic contexts, such as communication channels, user involvement, power structure among stakeholders, corporate culture, project champion, interorganizational networks, etc. These organizational factors are embedded throughout the life cycle of a KMS project and within an organization. Understanding the influences of these organizational factors to the success of KMS projects can provide lessons for systems developers and management to increase the success rate of system implementation. The study is based around AMC, a major Taiwanese motor company faced with the challenge of deploying a knowledge management system. Over a period of 3 years (1999-2002) structured interviews were conducted to examine organizational factors contributing to the success of KMS efforts in AMC. The major emphasis of this chapter is to apply the concepts of structuration *theory to assess the interaction of corporate management with users of a knowledge management system. Our findings suggest that management and users must be engaged in a sustained and reciprocal communication method when implementing a KMS. The pattern of communication, power structure, sanction power, and degree of cooperation are dynamically changed during the interaction process. Therefore, it is important to maneuver these factors into a win-win situation for management and users to successfully implement a KMS. Practical implications resulting from this research provide feasible real solutions to improve the relationship between users and management during a KMS implementation. Theoretically, this chapter contributes to the growing body of knowledge management (KM) literature from the structurational theory perspective.*

Int r oduct Ion

The extensive research investigating the field of knowledge management (KM) has primarily emphasized the philosophical or practical perspective. The philosophical perspective illustrates the concepts and procedures used to manage organizational knowledge (Choi et al., 2008; Guo and Sheffield, 2008; Davenport, 1997; Nissen & Espino, 2000; Nonaka & Takeuchi, 1995; Polanyi, 1962; Quinn, Anderson & Finkelstein, 1996; Seviby, 1997). The consensus reached by organizational members can lead to common perceptions and actions in the process of establishing knowledge management based on the grounded theory (Kjaergaard and Kautz, 2008). Employees' positive aggressive attitude and collaborative efforts can enhance organizational learning, thereby improving business performance (Chen, 2007). User involvement in developing KM systems can increase the rate of success from the social-technical perspective (Patrick and Dotsika, 2007). The practical perspective suggests prescriptions for management of organizational knowledge (Davenport & Prusak, 1999; DeLong & Fahey, 2000; Ruppel & Harrington, 2001). One case study finds that a firm can accelerate the process of new product development by simultaneously promoting the formation of a horizontally integrated network between internal and internal communities (Shibata and Kodama, 2007). Few KM studies have addressed the impacts of human-to-human interaction on the implementation of knowledge management systems (KMSs). This area of study is the primary focus of scholars interested in adopting a new information system (Lyytinen & Ngwenyama, 1992; Orlikowski, 1996). There is also a notable shortage of well-grounded theory and methodology on how to address the organizational aspects, social aspects, and issues relevant to a knowledge management system implementation.

Baskerville and Pries-Heje (1999) identified five general theories about KM: (1) intellectual capital theory; (2) knowledge economy theory; (3) core competence management; (4) dumbsizing; and (5) knowledge alliances. The first two theories view KM from the perspective of information economics; the other theories view KM from the perspective of strategic information system (IS) theory. This study adopts the latter view and regards knowledge as a resource for a firm's competitive advantage. Employees' tacit knowledge and explicit knowledge are important pieces of organizational knowledge. Unless employees create and share their knowledge, individual knowledge cannot be amplified and elevated into organizational knowledge. Without extracting, combining, and applying individual knowledge and other knowledge embedded in organizational culture, routines, policies, documents, etc., a firm cannot utilize intangible "know-how" to compete successfully in the market (Grant, 1996; Nelson & Winter 1982). KMSs are being integrated into organizations to facilitate the transformation process from individual to organizational knowledge. Many scholars assert that when a new IS is introduced, it is important to consider the organizational factors and to assess the interaction between the IS and users (Lyytinen & Ngwenyama, 1992; Poole & DeSanctis, 1994; Orlikowski, 1996, 2000; Shanks, 1997). The introduction of a new information system like a KMS can cause organizational changes, reflected in the usage behaviors of management and the users of the new system, and the interaction modalities between users and management and among users.

This study aims to explore the dynamic relationship between management and users when implementing a KMS. The KMS project was led by individuals including senior managers, project managers, and project champions. Through the life cycle of the KMS project, there were many changes in their relationships with the users, through such areas as communication methods, power structure, retaliation, and other social and organizational behaviors. Many precious KM lessons can be learned by understanding these relationship changes.

AMC has implemented several KMS projects since 1999. This study used an interpretive case study approach and applied structuration theory to examine the relationship between management and users at the AMC. The interpretive case study is an appropriate methodology for this research because the aim of the study was to understand the context of the KMS at AMC, and the processes whereby the use of the KMS influences and is influenced by users and management (Walsham, 1993). This chapter focuses on the full complexity and reality of the users-management relationship as the KMS was implemented (Kaplan & Maxwell, 1994). Another objective of this study was to assess the applicability of structuration theory to explain the social and organizational changes of the dynamic relationship between managers and users when implementing a KMS.

To achieve these objectives, the research question addressed in this study was:

How do key factors, such as the patterns of communication, power structure, and sanction power between management and users, affect the KMS implementation?

THEORETICAL BACKGROUND

To address the stated question, we examined IS literature in the areas of knowledge management and knowledge management systems, the implementation of a KMS and structuration theory and its impact on KMS implementation. Each of these areas is discussed in the following paragraphs.

Knowledge Management and Knowledge Management Systems

The term knowledge management refers to the activities of knowledge creation, dissemination, and utilization (Newman, 1991). Knowledge is different from information at the individual and organizational level. Individual knowledge is experience and practices that can be captured in diaries, notes, or other written form. Organizational knowledge can be captured in documents, manuals, operating procedures, a repository, and so forth, and can contain organizational routines, processes, practices, and norms (Davenport & Prusak, 1999).

There are two general types of knowledge: tacit knowledge and explicit knowledge (Polanyi, 1962). Tacit knowledge is stored in the mind of the knower, such as mental models and experiences (Bourdreau & Couillard, 1999). Explicit knowledge is stored in distributable documents, such as manuals and operating procedures. The objective of KM practices at the organizational level is to manage both tacit and explicit organizational knowledge. Alavi and Leidner (1999) asserted that an effective KM could be viewed as the management of knowledge as a state of knowledge or a process, which focuses on applying an employee's personal knowledge to the organizational needs. In order to effectively share knowledge, Nonaka and Takeuchi (1994) proposed a knowledge spiral cycle concept to convert tacit knowledge into explicit knowledge (externalization), and vice versa (internalization).

Many benefits of KM practices are intangible (Davenport & Prusak, 1999). Intangible benefits may include a more trusting work environment, faster turnaround time, or improved ability to solve more complex problems that can be translated into a lower operating cost. Specialized and hard-to-copy knowledge can be used as an organizational core competency to compete in today's hyper-competitive business environment. For instance, HP-Compaq would have trouble imitating Dell's "build-to-order" practices that have been developed through years of experiences in managing international supplier relationships. The can be defined in several ways (see Figure 1). In general, there are six stages to manage knowledge before new knowledge is generated: (1) capture, (2) organize, (3) formalize, (4) distribute, (5) apply, and (6) evolve (Nissen & Espino, 2000). We simplified the KM processes into four sequential stages because of some overlapping features between these stages: knowledge creation, knowledge acquisition (organization and formalization), knowledge expansion (distribution and application), and knowledge innovation.

A KMS is an information system used to effectively manage the KM life cycle (Alavi & Leidner, 1999). To achieve this objective, a KMS needs to utilize the telecommunication infrastructure, computer supported cooperative work system, e-mail, document management tools, data warehousing, workflow management applications, and other related systems. Expert systems or decision support systems can be used to generate even more useful knowledge.

Implementation of a KMs

From the perspective of IT diffusion theory (Cooper & Zmud, 1990), a KMS implementation can be defined as an organizational effort directed toward diffusing knowledge within an organization. According to Lewin's (1952) change model, there are six general stages when implementing change: (1) initiation, (2) adoption, (3) adaptation, (4) acceptance, (5) routinization, and (6) infusion. We believe these stages are relevant when implementing a KMS. In addition, it is important to assess the organizational culture and users when implementing a KMS.

Many studies on the implementation of a KMS emphasize the importance of organizational culture and people. Davenport and Prusak

Figure 1. KM life cycle (Nissen & Espino, 2000)

AUTHORS	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6
Nissen (1999)	Capture	Organize	Formalize	Distribute	Apply	
Despres and Chauvel (1999)	Create	Map/ Bundle	Store	Share/ Transfer	Reuse	Evolve
Davenport and Prusak (1999)	Generate		Codify	Transfer		
Nissen and Espino (2000)	Create	Organize	Formalize	Distribute	Apply	Evolve

(1999) claim that employees need to share part of the responsibility to have a successful KMS implementation.

An organization may need to create dedicated roles, such as chief knowledge officer or knowledge workers, to execute a KM project. Organizational culture can be demonstrated and nurtured by values, norms, and practices (De Long & Fahey, 2000). These three elements together can influence an individual's behavior, thereby affecting the ways employees create, share, and use knowledge. Organizational culture affects an employee's perceived value about the necessity of a KM project, the importance of different KM projects, and the knowledge transfer across organizational layers.

Building a trusting infrastructure to share knowledge is one of the key drivers of KMS projects (Ruppel & Harrington, 2001). Some scholars (Culnan & Markus, 1987; Leavitt & Whisler, 1958) have proposed theories to help address the role of IT in an organization and its implications for organizational change.

Structuration Theory and its Implications on KMS Implementation

Giddens' (1984) structuration theory seeks to resolve the contradictions of agency and structure theories that emphasize human action and structuralism, respectively. He used a duality to explain the reciprocal relationship of human interaction and social structure. Humans interact with each other, thereby changing the social structure. The newly formed social structure will change again as humans continue to interact with one another.

Both human interaction and social structure are comprised of three distinct dimensions - Signification, Domination, and Legitimation. Each dimension is moderated by three modalities, as shown in Figure 2. First, human communication takes place when human actors draw upon stocks of knowledge to justify their actions. Their actions will produce structures of meaning. Second, human agents use their powers to allocate materials, information, and other resources to produce a structure of domination. Finally, human agents sometimes sanction their actions by norms or standards of morality to reproduce social structures of legitimization. Dimensions of human agents and social structures are inextricably interlinked, moderated by these three modalities.

Applying structuration theory into the field of IT can be tracked back to Barley's (1986) study exploring the impacts of computer tomography (CT) scanners on the interactions between technicians and radiologists, and institutionalized traditions. He compared the differences in responses to the introduction of the identical CT scanners in two different community hospitals in Massachusetts. Many IS studies began to utilize

Figure 2. Analytic dimensions of duality of structure (Giddens, 1984)

Structure	Signification	Domination	Legitimation
Modality	Interpretative Schema	materials, information, and other resources	Norm
Interaction	Communication	Power	Sanction

the theory to explain the relationship between information technology and organizational structure. Lyytinen and Ngwenyama (1992) applied structuration theory to the research of computer supported cooperative work (CSCW). They found that it is equally important to consider the organizational structure as it is to consider the situations of managers because they interact with each other during the implementation of a CSCW system. Poole and DeSanctis (1994) proposed using an adaptive version of structuration theory to study group decision support systems (GDSSs). Their adaptive structuration theory asserted that organizational backgrounds can result in different outcomes of GDSS implementations. Orlikowski (1996) utilized structuration theory to identify a five-stage metamorphosis process of a Customer Support Department in an organization through its adoption of an incident tracking support system. This study indicated that many organizational changes are emergent, unpredictable, and sometimes unavoidable when adopting a new IS. Different motives of end users, and their perceptions of the system over a period of time, can result in constant changes to the organizational structure because organizational structures are constantly evolving.

Orlikowski (2000) adopted structuration theory to study the motives and usage behavior of IBM's Lotus Notes system by employees and found that in the process of using the system, employees will create rules and resources that direct their usage behavior. She found that the rules and resources are influenced by human agency factors, such as norms, facilities, and assumptions of knowledge and the situated use of technology. This study concluded that technology alone is insufficient to explain the usage behaviors of employees.

Chen at al. (2007) argue that projects get embedded in multiple systemic contexts through the constitution of structural properties - tasks, times, and teams - that guide project activity. They suggest that project constitution and embedding are inseparable systemic processes. This perspective on constitution and embedding implies a practical theoretical understanding of the use of structuration theory when looking at knowledge management implementation.

In summary, we believe that structuration theory provides a framework to help explain the dynamic interaction process between IT and organizational factors during a KMS implementation. More importantly, the human factor, when introducing a KMS, can be assessed and further resolved via this theory.

ReseArch Methodology

AMC's knowledge management implementation was chosen from numerous candidate companies to study because it met three major criteria. It had:

- A high willingness to cooperate and was interested in the research topic,
- Introduced the KMS two years earlier and already had a Champion Team, and
- A dedicated team to promote a KMS project implementation.

Research Design

A single-case design with embedded units was employed to investigate the KMS program at AMC. The case study design was used for the following reasons:

1. It allowed KMS implementation to be examined in the real life context of the relationship between management and users (Yin 1994); and
2. It provided the ability to answer "how" and "why" questions (Eisenhardt, 1989) for the KMS implementation process.

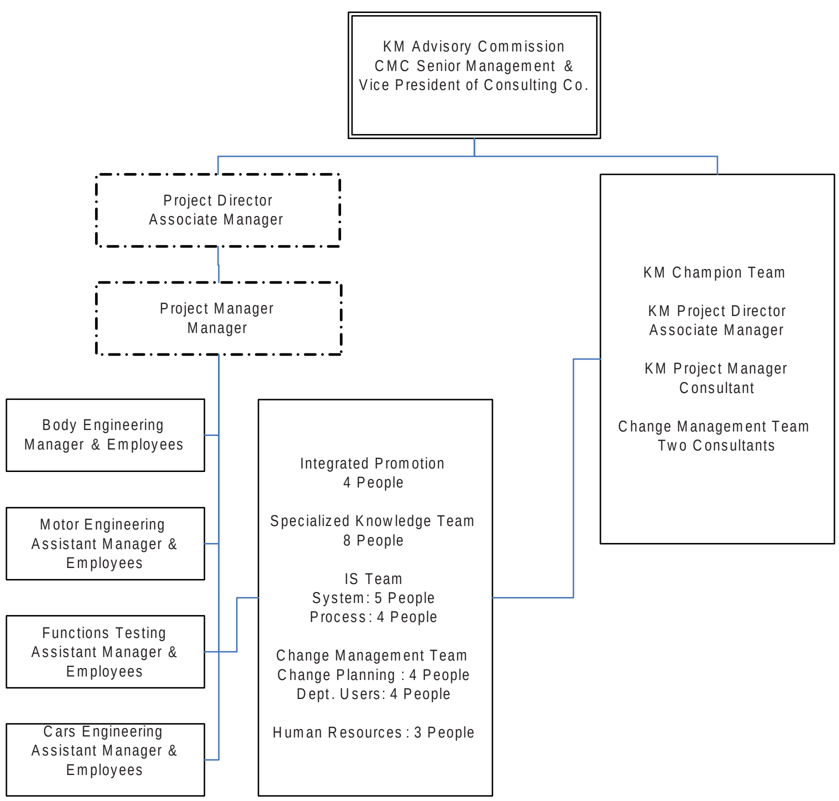
To meet this goal, a protocol to collect qualitative and quantitative data was followed. This study primarily used interviews and questionnaires to help describe, understand, and explain the adaptation processes of the social ecosystem after introducing the two-year KMS program.

AMC wanted to better understand their KMS implementation and its impacts. Its KMS was adopted and used by employees in the company. The IS department and a dedicated project team led the KMS implementation efforts. AMC had adopted the KMS approximately two years prior to this study. Thirty-two people were initial users of the KMS (Figure 3). A KMS Champion Team, comprised of six managers and consultants, was formed to lead the program and was led by AMC's General Manager. AMC's KMS experiences provided the opportunity to examine the relationship between users and managers after KMS implementation.

data collection

Data were collected through focused interviews with key individuals at management and end-user levels. Participants were identified by AMC's executive management based on the degree of their participation in the KMS project. Focused interviews ranged from 30 minutes to one hour were held throughout the study. Three participants were interviewed for the study. A questionnaire was also developed to collect data to corroborate questions asked of interviews participants. Employing both the focused interviews and questionnaires allowed the study to collect both qualitative and quantitative data

Figure 3. Organizational Chart of KM Champion Team



from multiple sources. This multiple data collection method improved the reliability of the findings (Benbasat & Zmud, 1999; Eisenhardt, 1989; Yin, 1994).

data Analysis

The main unit of study was the relationship between management and users of a KMS. The embedded units analyzed within the relationship were nine components of Giddens' (1976) duality structure framework: (1) signification, (2) domination, (3) legitimization, (4) interpretative schema, (5) facility, (6) norm, (7) communication, (8) power, and (9) sanction. The components of structuration theory were used to guide the analysis. A detailed case study report was written to describe the use of KMS in the relationships context between management and users at AMC. Data were gathered, coded, and analyzed using qualitative techniques.

Knowledge MAnAgeMent efforts At AMc, 1999-2002

AMC was founded on June 13, 1969. AMC established an international alliance with a major Japanese motor company for technology transfer in 1970. By the year 2002, AMC had raised its capital to US $400 million and was one of the leading companies in the automobile industry in Taiwan. The company produced more than one million trucks from three plants. AMC established a plant in Mainland China in 1998 via an alliance with a local car company at that time, AMC has a wide range of product lines, including sedans, sports utility vehicles, and commercial trucks.

In the year 2000, the Technical Department expressed a strong interest in implementing a KM system. This department was in charge of researching and developing technologies, such as body engineering, powered engines, capability testing, and car engineering. The Technical Department had documented the technology patents and experiences of solving technical problems. These documents were stored in a data storage room using files and folders that could not be efficiently accessed. Most importantly, the technicians sometimes needed to reinvent the wheel when needed files could not be found. One manager summed up the situation as follows:

AMC has been founded for more than thirty years. We had many successful and failed experiences, but did not document and store them effectively. We often needed to reinvent the wheel when encountering similar cases (Manager Y).

To solve the document management problem, the technical department proposed that a KMS be adopted. After a KMS was suggested, senior management began to recognize the importance of implementing a KMS, not only for the benefit of that department, but for the organization as a whole. One compelling reason for the KMS was a very high employee turnover rate. Many job-related working experiences were lost when these individuals left the company. In addition to the internal pressure of adopting a KMS, AMC also wanted to realize its 2005 vision of "Being the Model Auto Plant in the Asia Pacific Region." The KMS initiative was aligned with the strategic direction of AMC.

To achieve the 2005 vision, AMC needs a more effective approach to solve problems and manage things (Manager Y).

After careful consideration, AMC started seeking a company-wide consensus on KMS implementation. A KM Champion Team was established in September, 2000. The General Manager's office was in charge of the project. By January, 2001, the Technical Department had become part of the KM Champion Team.

Case Analysis with Structuration Theory

Structuration theory was adopted to analyze the relationship between management and users during the KMS implementation in AMC. The analysis was organized in three distinct areas: (1) KMS implementation processes, (2) KMS functions, and (3) KMS assessment. Each analysis area is further decomposed into three distinct dimensions to reflect the relationship between human interaction and social structure in the AMC during the KMS implementation process. The following discussion follows the logic behind Giddens' duality of structure (Figure 1) to explain those three dimensions. Figures 4, 5 and 6 were created to illustrate the: (1) users (employees and managers) of the KMS in AMC taking actions to communicate with each other based on the learned knowledge, thereby enhancing shared understanding; (2) users allocating their resources via power to produce a structure of domination; (3) users resisting or welcoming the adoption of KMS to recreate social structures of legitimization. After each area of analysis in these three dimensions, the intricate relationships between users and social structure during the KMS implementation could be further understood.

Analyzing the KMS Implementation Processes

The agent for the actualization of the KMS at AMC was its Champion Team. The team constantly engaged management and users in a cyclic communication process. The interaction process was two-way: upward (from users to management) and downward (from management to users). To garner support from the senior executives at AMC, the Champion Team developed prototypes to help them clearly understand what a KMS would do for AMC; a document detailing the costs and risks associated with the operation and installation, procedures on how the KMS might be experimented with, and a plan showing how the transition to using KMS could be accomplished.

When no one was clear about the KMS, it was hard to convince the senior management about the benefit of knowledge management. A knowledge management project is a long-term investment. Its short-term benefits are not obvious. We created a prototype to help us communicate with the senior management about the benefits and promote the KMS project (Manager X).

Senior executives were better able to recognize the benefits of a KMS through the demonstration of prototypes.

After the demonstration of the prototyping, our senior management changed its perception about the benefits of KMS project. They understood the primary objectives of KM are to share experiences, avoid reinventing the wheel, and waste resources (Manager Y).

The Champion Team utilized e-mails, social activities, and other techniques to communicate with users. These included naming the KMS as "SMART," choosing logos via the voting process, study meetings, and seminars. The concepts and benefits about KMS were established in the minds of management and users. Comments relating to the downward communications process included:

Users who attended meetings and discussion forums had a positive view about the KM and KMS. You could find that users who missed one or few of these meetings due to other important meetings had some misconceptions about KM. There was a significant difference in the understanding between users who attended and us-

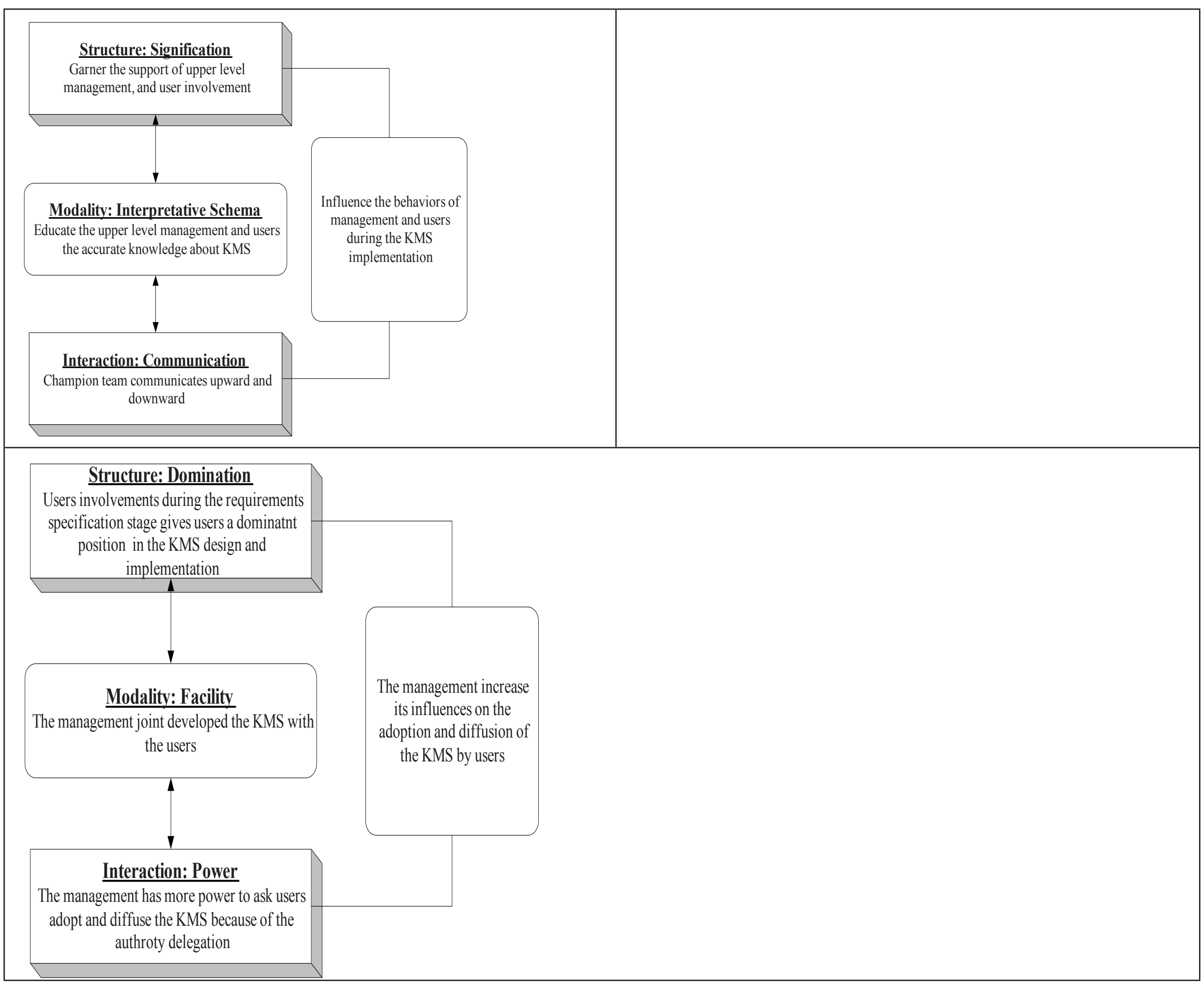
ers who did not attend KM meetings or forums (Manager Y).

The Office of the General Manager insisted users be involved in the KMS development process. Users needed to brainstorm with managers and technicians about the system's interface, features and so forth. We did not want users' critiques after the system was developed. This required a great amount of time and effort to get inputs from the user side. Although we did not have a dedicated position for users to involve themselves into the project, they spent almost as much time as they could as a responsible person for the KMS (Manager Y).

The 'Incubation Center' mentioned in the KM was not autonomously created. A number of formal meetings and informal discussion were behind its creation. First, you saw a small group of people communicating with each other. This small group communicates with a bigger group after they reach a consensus. The communication process was very intensive because the objectives were to make the concept concrete and explicit so it could be properly documented (Manager X).

One of the most important aspects of this downward communications was that it allowed management and users to understand and ap-

Figure 4. Analyzing KMS Implementation via Structuration Theory



preciate the differences of their requirements for the KMS. As such, the requirements gap between management and users was greatly narrowed. Reducing this gap can potentially improve the odds of a successful KMS implementation through the joint development process (Wood & Silver, 1995). The KMS design and implementation experiences at AMC further supported the assertion that the success of system implementation is highly correlated with the support of upper level management (Beath, 1991) and user involvement (Baronas & Louis, 1988). A model depicting the analysis of KM implementation using structuration theory is shown in Figure 4.

AMC's KMS implementation experience followed the evolutionary change paths:

1. **Legitimization:** Champion Team legitimized the pioneer unit as a change agent and intermediary between the technician and users.
2. **Sanction:** KMS drew a lot of attention and pressure from other departments. Their potential sanction or support for the KMS implementation in their departments strengthened the sanction element.
3. **Norm:** To improve the odds of a successful KMS implementation, the pioneer unit needed to work closely with the Champion Team to address external pressures. The cooperation mode gradually became a norm.
4. **Relegitimization:** Early implementation success of KMS further garnered support of the senior executives. This further legitimized the importance of the pioneer unit and reduced the sanction power of other departments.

On the structure dimension, the Champion Team actively involved users through meetings and extensive communications during the requirements specification stage. As a result, users had a significant influence in deciding the functional and nonfunctional requirements of the KMS. From the domination perspective, the users are dominant in the KMS design and implementation process. The involvement resulted in high communication cost. Users' resistance was greatly reduced because they were delegated and authorized in the KMS design and implementation process.

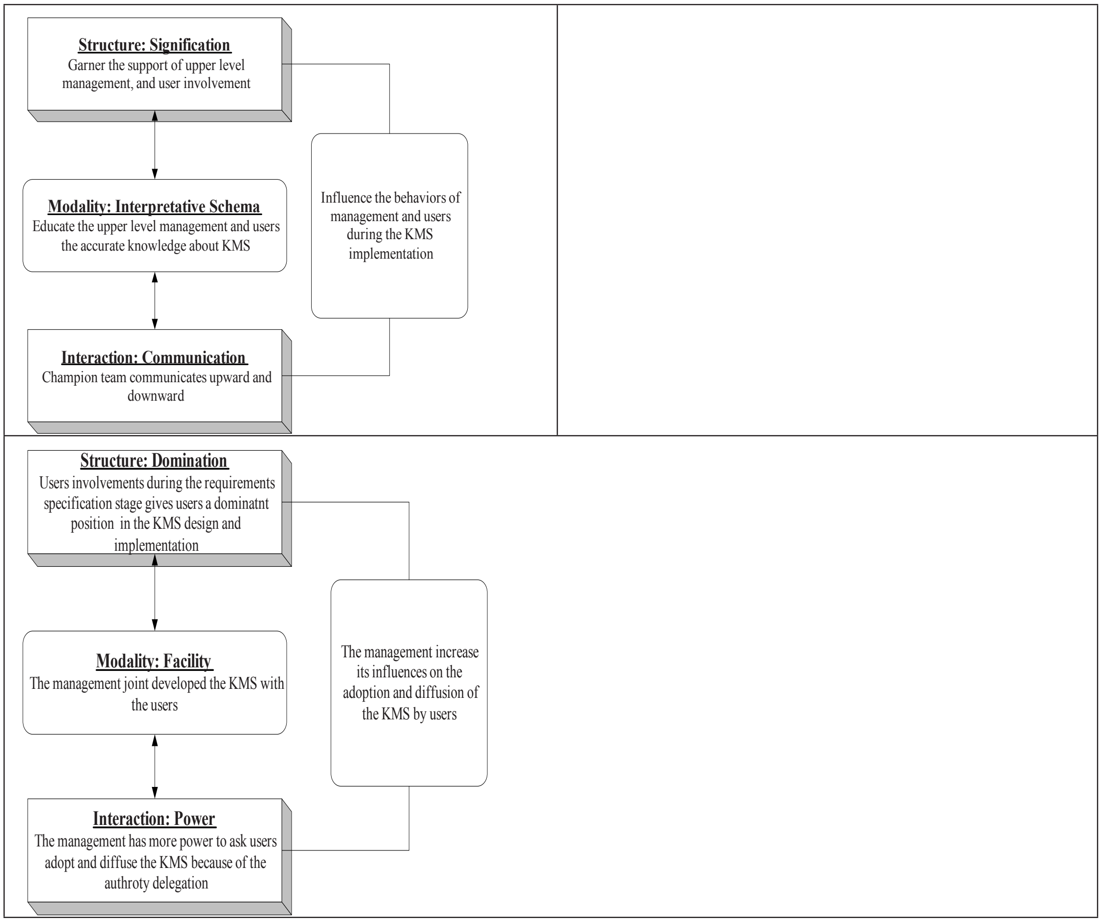
Analyzing the KMS Functions

The KMS was first used by the Technical Department in the September, 2001. The system was rolled out to the other seven departments by January, 2002. The usage behavior and the improvement of the KMS's function were studied from structuration theory.

One of the objectives for the KMS was to improve knowledge sharing among employees. The system's functions, such as the discussion forum, KM database, search engine, and knowledge repository, addressed the knowledge sharing issues. These functions not only opened up channels for users to communicate with each other, but also helped users quickly locate useful documents to assist them in solving problems. Users with needs for different knowledge, such as the chassis and engine departments, formed their own virtual community via the discussion forum to share and consult knowledge with experts of the domain. The virtual communities were open to all employees and their creation helped to eliminate the physical boundaries that existed between departments. Many successful experiences using the KMS allowed management and users to reach a consensus about the importance of different KMS functions.

The consensus further substantiated the use of the KMS functions for communication, knowledge sharing, and generation. These elements improved the recognition of the KMS functions by management and users. A model depicting

Figure 5. Analyzing KM Functions via Structuration Theory



the analysis of KM functions using structuration theory is shown in Figure 5.

The Champion Team gave users authority to recommend documents and reports to be stored in the KMS after the General Manager approved. From the perspective of domination, users could critique each other's shared documents and messages that were previously posted to the discussion forums. As a result of the critiquing process, knowledge approved by the General Manager and stored in the repository of the KMS was of a better quality. The process increased the motivation of users to share with and distribute ideas, documents, and knowledge with other users.

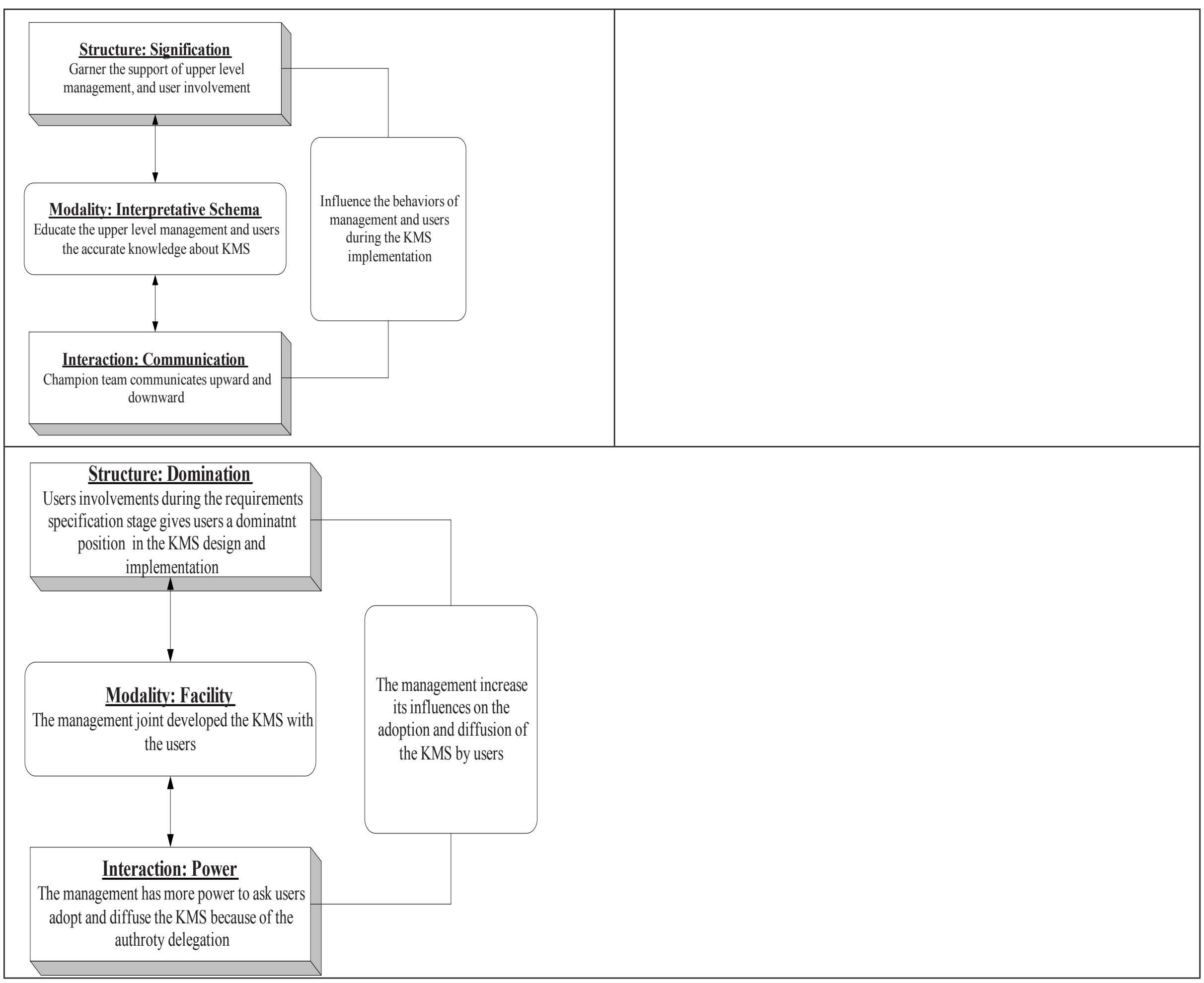
It is a matter of mindset change. One of our assistant managers always shared his knowledge with us. He told us we could take turns sharing our knowledge and growing together. The altruism is important for the success of 'SMART' (User Z).

The Champion Team's aim was to nurture the knowledge-sharing habit for employees by conducting training sessions and running assessments of the system use. However, the actual performance of these endeavors was below expectation. Users often gave priority to their jobs. It is possible that some KM activities were not fully legitimized at AMC and properly integrated into the existing jobs of employees. When an employee's workload increased, the first thing that was dropped was the KM activity. The KM activity needed to be adopted as a normal part of the work system for employees. If so, this norm could have been part of employee assessment and may have helped to improve the sanction power for users who do not comply with KM activities. As the norms become widely accepted, they could have been legitimized and used to further improve the sanction power of management. Unfortunately, managers and users did not believe that this occurred to the fullest extent.

Analyzing the KMS Assessment

After the KMS was deployed in eight departments, the organization's next goal was to increase the quantity of shared documents in the system. Therefore, each department started implementing an assessment program to manage

Figure 6. Analyzing KM Assessment via Structuration Theory



the shared documents. A model depicting the analysis of KM assessment using structuration theory is shown in Figure 6.

Each employee was to decide on the number of documents that they could contribute to the KMS. Along with the employee's workload, an annual objective for the number of documents generated by each employee was created and used as the basis of performance evaluation. This decision was jointly made by management and users. Users did feel pressured to comply with the assessment programs, thereby, increasing the quantity of documents generated because of the participative decision making process. Some of the comments regarding the assessment process included:

It was held against you if you did not adopt 'SMART' and did not use your shared knowledge. Most employees took it personally to promote their shared knowledge and the system use. The Champion Team is the not sole driver for the adoption of 'SMART.' It is every employee (Manager X).

We had a discussion forum where information systems professionals collected problems raised by users. Users posted their questions on the forum to communicate with information systems professionals. After just six months, many questions were accumulated and addressed via the feature (User Z).

The annual goal setting process defining each employee's performance showed the legitimization of knowledge sharing by management and the sanction power of management to manage the KMS. Criteria, such as the quantity and quality of documents generated, were legitimized and used to assess employees' performances. The assessment affects the ways management and users share knowledge. A norm of knowledge-sharing behavior was formed under the influence of the assessment program.

Although the assessment did increase the quantity of documents generated, it seemed to lower the quality of documents. This drop in quality arose because management set high goals for employees and few employees were able to meet them. To meet the expectations of management, users compromised the quantity of their documents over quality. In the long run, the company did not benefit from the unattainable goals set by management. The power structure therefore, between management and users in the decision-making process for the assessment program, influenced the quantity and quality of documents generated. This observation implied that management must take into account the users' workloads when setting the annual goal of the number of documents generated.

In the early adoption stage, we encouraged employees to adopt 'SMART.' The objective was not to increase the quantity of shared knowledge, but to get employees used to sharing knowledge via the system. However, if a manager set a high target of increasing the quantity of shared knowledge, employees would be more likely to divide a comprehensive document into many sub-documents. For instance, a document with three appendices could be divided into four separate documents; one for the document and one for each appendix. It would be hard to read because they are separated and each document was incomplete. After the system was widely adopted, we redirected our focus to educating employees about the quality of shared knowledge. We explained to our employees the strengths and weaknesses of sharing a particular knowledge versus another (Manager Y).

Implications

In the initial phase of adopting the KMS at AMC, managers and users communicated with each other to form a common interpretative schema to justify the significance of the system. The objectives of communication were to (1) narrow the gap of requirements for the KMS between management and users and (2) to help both parties recognize the importance of the project. Gradually, the behavior of management and users towards the KMS were changed. This change in attitude was due to a two-way and constant interaction process. The behavioral changes formed a new communication mode between management and users. Therefore, it is crucial to have management and users reach a consensus in the early introduction phase for a KMS implementation to succeed.

Practical Implications

First, management needs to create open channels of communications about the requirements of the KMS throughout the implementation processes. Knowledge tacitness and complexity contribute to knowledge-sharing difficulties (Heiman and Nickerson, 2004). An effective communication channel can ease knowledge-sharing difficulties and improve the perceived values of both parties for the system. Higher perceived value can foster positive communication behavior. For instance, a full-duplex communication mode was developed between management and users during the system implementation. The Champion Team demonstrated the KMS using a prototype to garner the resource commitment of the senior management. Water cooler activities (voting for name and logo of the system, seminars, and training sessions) were used to increase the user involvement. Effective communication is indispensible and critical to the success of knowledge transfer (Schwartz, 2007).

Next, management and users change their dominance roles through the development process according to the changes of their power structure. The concept of building a power structure in the corporation to maintain proper control of employees should give away to the concept of integrating the power structure into the exercise of power by all employees (Drucker, 1980). The managerial transition can help release the collective knowledge of employees and improve a firm's competitiveness. Dominance or hierarchical status of knowledgeable individuals can inhibit the organizational learning process because it can undermine the value of potential knowledge co-producers who are charged with the system implementation, but in a lower hierarchical level. A KMS project manager can gradually promote an open, learning culture by de-emphasizing hierarchy and status over time (Tempest, 2003). Therefore, senior management needs to understand their power structure in relation to users throughout the life cycle of KMS.

Management needs to delegate more power to users in the initial adoption phase and orchestrate sources to support users. At AMC, management gradually delegated its authority to users and the Champion Team throughout the progress of the program. Management eventually signed up for the program after realizing the usefulness and importance of the "SMART" KMS. Management's legitimization of the knowledge sharing activities via the system is a clear argument for the adoption of a KMS.

Third, senior management needs to demonstrate their support of the KMS project to convince users to be involved in the system development process. Management needs to be aware of the dynamics of their sanction power in relation to users. Sanction power is of vital importance for the success of a KMS implementation because inappropriate exercise of it can instill the fear of losing knowledge owner's unique value and lowering his/her willingness to share knowledge. These symptoms can result in the interpersonal distrust in general and distrust in the knowledge sharing (Renzl, 2008). The loss of trust between employees and management can lead to adversarial relationships and increase the rate of KM project failure. If possible, management needs to institutionalize the sanction power, such as the assessment program to evaluate an employee's knowledge-sharing activities at AMC, to nurture a knowledge-sharing corporate culture. Once the organizational culture or norm is nurtured, management and users can systematically regulate their behavior to accommodate each other.

Theoretical Implications

Structuration theory asserts that the formation of a society and/or organization is the result of the interaction among people and structure. The interaction process never stops evolving until the society or organization accomplishes or stops pursuing its vision and goals. Projects are important drivers for the continuity of the evolving process and are often embedded in the constitution of various structural properties, such as tasks, teams, corporate culture, and times (Manning, 2008).

When these structural properties interact with each other, their interaction pattern is uncontrollable, and the interaction result may be predictable or unpredictable. Therefore, it is more important to investigate the process, rather than the results of KMS implementation when applying structuration theory. The study has attained its prescribed goal of explaining, describing, and understanding the relationship of different actors during a two-year KMS implementation project at AMC. Although this study did not reach a clear conclusion on this point, it provided another perspective to analyze potential problems that occurred during the KMS implementation. One study that attempts to understand the role of power in managing information systems from Structuration Theory, Critical Theory and Phenomenology could fail to clearly identify the hidden and strategic nature of power (Silva, 2007). Power as discovered in this study played an important role in the KMS program and needed to be carefully exercised. The coupling of power and other structural properties investigated in this study shows the degree of managerial complexity in leading to a KMS project success and the epistemological challenge of studying this phenomenon. Future research may want to replicate the study to investigate other KMS programs in different organizations. These endeavors will advance our knowledge in understanding the human-to-human interaction on the implementation of KMS. Most importantly, as numerous studies investigate in this avenue, a more sophisticated framework can be developed to provide a macroscopic picture of this unique phenomenon.

I IMIt At Io n s

Although the single case study provides evidence confirming the study's proposition, it would produce a more compelling study and add confidence to the findings if multiple case studies were used (Hakim, 1987; Miles & Huberman, 1994). The literal replication is important to make our findings more convincing with a higher explanative power in different settings (Yin, 1994). Readers will also have a better knowledge in judging the applicability of structuration theory in the context of KMS.

Culture may also play a part in the results of this study. The company chosen for analysis was a Taiwanese company. The Chinese and oriental cultures are "group" oriented. We encourage similar analyses of KMS implementation in companies that are in "individual" cultures, such as the United States and Europe. Although we do not believe that culture had an impact on the results, it might have slightly influenced the actions of both management and users.

conclusion

The power structure between management and users was constantly changed through the KMS implementation. Both parties orchestrated different facilities or tools to maintain their dominate positions in the implementation processes. At the start of the implementation, management seemed to be dominant since they were the primary ones defining the requirements for the KMS. It is important to ensure that the creation of a KMS can meet the requirements of users if they are to adopt and operate the system. If management forcibly creates a dominate position in the start of the implementation, users are more likely not to cooperate and provide accurate input as the implementation continues. Users will also have a higher degree of resistance to adopt the system if they are not part of the implementation of the KMS from the beginning or if they feel management has not allowed them sufficient input. If the KMS is designed to meet the requirements of the users, management can have more power to convince users to adopt the system. Management can also institute some incentive policies to improve the implementation of the KMS and knowledge sharing among users. The power structure seemed to reverse during the implementation progresses since the users provided most of the input into the KMS. Our findings corroborate the IS literature that user involvement can increase the odds of successfully implementing a KMS (Baronas & Louis, 1988).

Management also needs to convince users of the importance of adopting the system by demonstrating their support via words and actions. During the introduction phase, users have a higher sanction power. However, once users are convinced and the system is successfully developed, management has a higher sanction power over users that do not use the KMS. In both phases, management and users have to adjust their behaviors to the pressure of sanction power from another party. Steadily, a norm is formed to strengthen the relationship between management and users throughout the KMS implementation. This norm helps legitimize the tasks of implementing the system. Past literature asserts that the support of senior management is an important factor for success of system implementation. This study further asserts that the support needs to be demonstrated to convince users to get involved in the KMS implementation process. A norm or organizational culture to implement the KMS needs to be formed to create sanction power between management and users. Therefore, the success of the KMS implementation depends on if the organization culture or norm can be formed. If senior management are people who only and never use the system to share knowledge with users, users will not be convinced of the importance of sharing knowledge via the system. As a result, the system will eventually be aborted. On the contrary, if managers are people of action and often post messages and reply to other people's messages on the discussion forums of the KMS, users will feel compelled to share knowledge.

In summary, different stages of KMS implementation resulted in a series of interactions between management and users, using three elements: communication, power structure, and sanction power. The relationship between management and users was dynamic and reciprocal. During a KMS implementation, management and users monitored each other's behavior and chose the best approach to interact with each other. Decisions made by management and users caused intentional and unintentional results. The other two areas of analysis on KMS function and assessment conducted in this study further confirm the presence of the social constructions.

"SMART" was a successful two-year KMS program at AMC in Taiwan. Its success primarily resulted from an enforcing duality structure between users and management. The duality structure depended on a clear vision and agenda. Promulgated by the Champion Team, the KMS program began its journey through four evolutionary phases in the following order: legitimization, sanction, norm, and relegitimization. This evolution gradually turned "SMART" into a vastly more complex KMS, where users and management began to socialize and share their work and ideas.

To achieve the objectives, the Champion Team had to resolve three major issues. The first was how to garner the support of management to commit to the two-year project when they only had a fuzzy picture of potential outcomes. Prototyping proved beneficial to achieve this objective. The second issue was how to narrow the different viewpoints about the program across different departments. The copetition mode was used to involve users of different departments to share opinions on the name and features of the KMS via e-mails and other communication-mediated media. The third issue was to institutionalize a norm, to which management and users abide. This created an enforcing force or pressure for different stakeholders to use the KMS.

Their experiences provide five recommendations for implementing a KMS: (1) have a champion or Champion Team, (2) obtain the support of top management in the early phase of the project life cycle, (3) increase user involvement via creating a friendly environment, (4) open physical and virtual communication channels between users and management, and (5) reconcile their difference by creating a norm to force both parties to adapt to using the project.

AMC has a conservative organizational culture because of the nature of the auto industry and the culture of the Taiwanese people. Management and users in other industries may behave differently throughout the KMS implementation process because of different organizational culture. Therefore, it may be important to investigate companies in different industries and different cultures throughout the world. Knowledge management is a dialectic transformation process, composed of human actors and social systems. Human actors and social systems vary with organizations. Research questions on how to construct a healthy interaction between the constituents of KMS and its corporate environment needs to be asked and studied on the micro-level for different organizations (Becker-Ritterspach, 2006). Future research interested in following this direction can not only minimize the epistemological challenge of studying KM phenomenon, but also largely improve the success rate of KMS projects.

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Append Ix I Quest Ionn AIre

Interview Questions for Manager X

- Please demonstrate the use of the KMS, and explain its platform and important features (screenshot of the main page).
- Please explain the timeline to introduce the KMS.
- Please explain the implementation process of the KMS.
- Please explain the efforts and dollar amounts spent in the implementing the KMS.
- How effective were the activities, including Web site postings on the Intranet, monthly newsletter, posters, and plans, to promote the use of KMS in its initial stage?
- What occasions did you use to communicate with users face-to-face in the early implementation stage?
- How did you resolve the complaints of users about the KMS in the early implementation stage?
- What did those early adopters think about the KMS? Why did they decide to use the system?
- What did those late adopters think about the KMS? Why did they decide to use the system?
- What new changes had been made to the managerial systems of your company during the early stage of KMS implementation? (e.g., reward systems, operational procedures, and regulations)
- What additional workloads were employees subject to at the early stage of KMS implementation (e.g., benefits and troubles)?
- How did employees respond to those additional workloads resulted from the KMS implementation?
- What actions were taken by the company to motivate more employees to use the system?
- What have you learned from your face-to-face interactions with employees?
- What have you learned from addressing the complaints of users about the KMS?
- How have the early adopters been using the KMS? How did those employees interact with you?
- How have those late adopters been using the KMS? How did you motivate them to use the KMS?
- What new systems have been created as a result of the KMS implementation?
- How has the corporate culture changed as a result of the use of the KMS?
- How effective are the current knowledge sharing activities?

Interviewing Questions for Manager Y and Ms. Z

- Please briefly talk about the KMS in your company.
- What were the motives for the KMS implementation in your company?
- What was the timeline and implementation stage for the KMS?
- What specific approaches did your company use to promote the use of the KMS? (formal/informal)
- How active was the participation of employees in the use of the KMS? (you and other employees)
- What new policies or regulations have been institutionalized? (mandatory and voluntary)

continued on following page

Append Ix I cont Inued

- How has the KMS changed the ways or methods of work?
- What changes have been made to the KMS adoption by employees as a result of promotion activities?
- How has the degree of participation by employees changed during the implementation?
- Has the company made any new changes to accommodate the use of the KMS?
- Have any new changes being made to the jobs or ways to work as a result of implementing the KMS?
- What are the major benefits and shortcomings to individuals and company as a result of implementing the KMS?
- Is there room for further improvement?
- How were problems resolved as a result of using the KMS?
- How do you use the KMS when you have new ideas or suggestions?
- How do you like having your experience and knowledge stored in the KMS?

Chapter X
Toward a Consensus Knowledge Management Success Definition

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Abstr Act

This chapter explores knowledge management, KM, and knowledge management system, KMS, success. The inspiration for this chapter is the KM Success and Measurement minitrack held at the Hawaii International Conference on System Sciences in January of 2007 and 2008. KM and KMS success are issues needing to be explored. The Knowledge Management Foundations workshop held at the Hawaii International Conference on System Sciences (HICSS-39) in January 2006 discussed this issue and reached agreement that it is important for the credibility of the KM discipline that we be able to define KM success. Additionally, from the perspective of KM academics and practitioners, identifying the factors, constructs, and variables that define KM success is crucial to understanding how these initiatives and systems should be designed and implemented. This chapter presents results of a survey looking at how KM practitioners, researchers, KM students, and others interested in KM view what constitutes KM success. The chapter presents some background on KM success and then a series of perspectives on KM/KMS success. These perspectives were derived by looking at responses to questions asking academics and practitioners how they defined KM/KMS success. The chapter concludes by presenting the results of an exploratory survey on KM/KMS success beliefs and attitudes.

Background on KM Success

Jennex summarized various definitions of KM to propose that KM success be defined as reusing knowledge to improve organizational effectiveness by providing the appropriate knowledge to those that need it when it is needed (Jennex, 2005). KM is expected to have a positive impact on the organization that improves organizational effectiveness. DeLone and McLean use the terms success and effectiveness interchangeably and one of the perspectives proposed in this chapter does the same for KM (DeLone and McLean, 1992 and 2003).

Jennex and Olfman (2005) summarized and synthesized the literature on KM/KMS critical success factors, CSFs, into a ordered set of 12 KM CSFs. CSFs were ordered based on the number of studies identifying the CSF. The following CSFs were identified from 17 studies looking at 78 KM projects:

- A Knowledge Strategy that identifies users, sources, processes, storage strategy, knowledge and links to knowledge for the KMS.
- Motivation and Commitment of users including incentives and training
- Integrated Technical Infrastructure including networks, databases/repositories, computers, software, KMS experts
- An organizational culture and structure that supports learning and the sharing and use of knowledge
- A common enterprise wide knowledge structure that is clearly articulated and easily understood
- Senior Management support including allocation of resources, leadership, and providing training
- Learning Organization
- There is a clear goal and purpose for the KMS
- Measures are established to assess the impacts of the KMS and the use of knowledge as well as verifying that the right knowledge is being captured
- The search, retrieval, and visualization functions of the KMS support easy knowledge use
- Work processes are designed that incorporate knowledge capture and use
- Security/protection of knowledge

However, these CSFs do not define KM/KMS success; they just say what is needed to be successful. Without a definition of KM/KMS success it is difficult to measure actual success.
Measuring KM/KMS success is important

- To provide a basis for company valuation,
- To stimulate management to focus on what is important, and
- To justify investments in KM activities (Jennex and Olfman, 2005)(Turban and Aronson, 2001).

Besides these reasons from an organizational perspective, the measurement of KM and KMS success is important for building and implementing efficient KM initiatives and systems from the perspective of KM academics and practitioners (Jennex and Olfman, 2005).

Perspectives on KM/KMS Success

The KM workshop at the 2006 HICSS found that there were several perspectives on KM success. This section briefly summarizes these perspectives.

KM Success and Effectiveness

One perspective on KM success is that KM success and KM effectiveness are interchangeable and imply the same construct or variable. This is based on the view that effectiveness is a manifestation of success.

An example would be increasing decision making effectiveness to generate a positive impact on the organization resulting in successful KM. This perspective uses both process and outcome measures.

KM and KMs success as Interchangeable

Another perspective is that KM and KMS success are interchangeable. KMS success can be defined as making KMS components more effective by improving search speed, accuracy, etc. As an example, a KMS that enhances search and retrieval functions enhances decision making effectiveness by improving the ability of the decision maker to find and retrieve appropriate knowledge in a more timely manner. The implication is that by increasing KMS effectiveness, KMS success is enhanced and decision making capability is enhanced leading to positive impacts on the organization. This is how KM success is defined and it is concluded that enhancing KMS effectiveness makes the KMS more successful as well as being a reflection of KM success. The Jennex and Olfman KM Success Model (Jennex and Olfman, 2006), based on the DeLone and McLean (1992, 2003) IS Success Model, combines KM and KMS success and utilizes this perspective.

KM and KMs success as separate

As opposed to the previous section, this perspective views KM and KMS success as separate measures. It is based on a narrow system view that allows for KMS success that does not translate into KM success. KMS are often seen as a sub-function of KM comprising technical and organizational instruments to implement KM. Thus, KMS success addresses implementation and operation factors in terms of system or process metrics whereas KM success is an assessment of the value that these systems and processes provide to an organization. KM focuses therefore more on the outcome, while KMS focus more on the process. These perspectives are introduced in the following sections.

KM success as a process Measure

This perspective views KM success as a process measure. KM success can be described in terms of the efficient achievement of well defined organizational and process goals by means of the systematic employment of both organizational instruments and information and communication technologies for a targeted creation and utilization of knowledge as well as for making knowledge available. KM is a support function to improve knowledge-intensive business processes. An example would be supporting the technology forecasting process in an IT consulting firm by technical components of a KMS (Henselewski, Smolnik, and Riempp, 2006). Complementary, the effective implementation of knowledge processes (i.e. acquisition, creation, sharing, and codification) is seen as a part of KM success. This perspective focuses therefore on measuring how much KM contributes to improving the effectiveness of business and knowledge processes.

KM success as an outcome Measure

In contrast, KM success can be viewed as an outcome measure. KM success is therefore seen as a measure of the various outcomes of knowledge process capabilities existing within an organization as a result of undertaken KM initiatives. Typical outcomes in terms of organizational performance are the enhancement of:

- Product and service quality
- Productivity
- Innovative ability and activity

- Competitive capacity and position in the market
- Proximity to customers and customer satisfaction
- Employee satisfaction
- Communication and knowledge sharing
- Knowledge transparency and retention

KM success as combined process and outcome Measures

The last perspective views KM success as a combination of process and outcome measures. Respective descriptions of KM success focus on improved process effectiveness as well as on achieving actionable outcomes. The first and third perspectives contain examples for this combined approach.

Methodology

This was exploratory research with the goal of guiding the KM community towards a consensus definition of KM success. To achieve this, base data was obtained through an exploratory survey. The exploratory survey was generated through an expert panel approach. The 30 members of the editorial review board of the International Journal of Knowledge Management were asked to provide their definitions of KM success. Thirteen responses were received. These responses were used to generate an exploratory survey on KM success. The exploratory survey used 5 point Likert scale items to solicit agreement on various perspectives and proposed KM success definitions. The perspectives were generated by analyzing the responses of the expert board. These responses were found to be grouped two ways. The first grouping of responses looked at the measures used to determine KM success. Three groupings were observed: process based measures, outcome based measures, and combined process and outcome based measures. The second grouping of responses was in two groupings: those that combined KM and KMS success measures and those that viewed KM and KMS success as separate measures. A final observation was that many proposed definitions used success and effectiveness interchangeably.

The exploratory survey also collected data on the KM expertise and focus of the respondent. Also, the survey had text boxes that allowed for free form input on additional KM success factors or measures, KM success definitions, and thoughts on differences between KM and KMS success.

The exploratory survey was administered using a web form with data collected and stored automatically. Survey respondents were solicited via broadcast emails to the ISWorld and DSI email list servers, to lists of KM researchers maintained by the authors, and to the editorial review board and list of authors for the International Journal of Knowledge Management. An initial request was sent followed by a second request approximately one week later.

One hundred and three usable survey responses were received. Thirteen were from KM practitioners, 70 were from KM researchers, 6 were from KM students, and 14 were from others including academics interested in KM but not active KM researchers. Likert items were analyzed using means and standard deviations as no hypotheses have been proposed and need testing.

The results of the exploratory survey were used to generate a second survey. This survey presented a composite definition of KM success and a set of measures for each of the indicated dimensions. A 7 point Likert scale was used to solicit agreement on the composite definition and each set of measures. Additionally, as in the exploratory survey items were provided for collecting data on KM expertise and respondent focus. Also, each set of measures had boxes where respondents could indicate measures they would add or remove from each set of measures.

The second survey was also administered using a web form with respondents solicited in the same manner as the exploratory survey. One hundred and ninety-four usable survey responses were received. Sixteen were from KM practitioners, 114 were from KM researchers, 23 from KM students, and 41 were from others including academics interested in KM but not active KM researchers. Likert items were analyzed using means and standard deviations as no hypotheses have been proposed and need testing.

r esul ts

There was little consensus on KM success perspective or definition from the first survey while we did find agreement on a definition of KM success and measures of success in the second survey. The results of the first survey are summarized in tables 1-3 while the results of the second survey are presented in Table 4.

Table 1 presents opinions with respect to the perspectives on KM success. The only perspec-

Table 1. Opinions on KM success perspectives, mean (std dev) (5 point Likert Scale)

Definition	Overall	Research	Practice	Other	Student
Success = Effectiveness	3.1 (1.4)	3 (1.4)	3.3 (1.3)	3.2 (1.5)	3.7 (0.5)
KM = KMS Success	2.6 (1.5)	2.5 (1.4)	3.2 (1.6)	3.4 (1.5)	2.2 (1)
KM = KMS Measures	2.6 (1.4)	2.4 (1.4)	3.2 (1.6)	3 (1.4)	2.4 (0.9)
KM Success = Process	2 (1)	1.9 (0.9)	2.2 (1.1)	1.9 (0.8)	3 (1.3)
KM Success = Outcomes	2 (1)	2 (1)	2.2 (1.4)	1.7 (0.8)	2.3 (1)
KM Success = Process & Outcomes	**4** (0.9)	3.9 (1)	3.8 (1)	**4.3** (0.6)	**4.2** (0.8)

Overall n = 103, researcher n = 70, practitioner n=13, academics n=14, and student n=6, Values are rounded to 2 significant digits

Table 2. Opinions on KM and KMS success definition components, mean (std dev) (5 point Likert Scale)

Overall	Research	Practice	Other	Student
"Subjective measure of various outcomes of KM processes capabilities" should be included in a definition of KM success				
4.1 (0.8)	**4** (0.9)	**4.3** (0.8)	**4.2** (0.9)	**4.5** (0.8)
"Achieving direct returns from learning and projection" should be included in a definition of KM success				
3.8 (1)	3.7 (1)	3.6 (1)	**4** (1)	**4.3** (0.5)
"Success of KMS should be measured in terms of pure usage statistics" should be included in a definition of KM success				
2.5 (1.2)	2.5 (1.2)	2.2 (1.1)	2.6 (1.2)	2.8 (1.2)
"Success of KMS should be measured in terms of firm performance" should be included in a definition of KM success				
3.7 (1)	3.6 (1.1)	**4.1** (1)	3.5 (0.8)	**4** (0.9)
"Providing the appropriate knowledge when needed" should be included in a definition of KM success				
4.2 (0.9)	**4.2** (0.9)	**4.3** (0.9)	**4.4** (0.6)	**4.3** (0.5)

Overall n = 103, researcher n = 70, practitioner n=13, academics n=14, and student n=6, Values are rounded to 2 significant digits tive that tends to have any consensus agreement is that KM success is a combination of process and outcome measures and is NOT just process or just outcomes. We are undecided if success and effectiveness are equivalent measures and tend to be undecided to slightly against the idea that KM and KMS success are equivalent.

Table 2 summarizes opinions on five suggested components of KM and KMS success definitions. There appears to be consensus on using organization specific subjective measures derived for KM process capabilities. Examples of these capabilities include knowledge reuse, quality, relevance, effectiveness of acquisition, search, and application of knowledge, etc. There also appears to be consensus that any KM success definition should include providing the appropriate knowledge when needed. Additionally, there is consensus that use is not a good measure of KMS success. It is interesting to note that practitioners and students support the use of firm performance measures as indicators of KM success while there is less support for these measures from researchers and academics. It is also interesting to note that academics and students tend to support the use of measures reflecting direct returns from organizational and individual learning and application of knowledge while researchers and practitioners are less favorable to them.

Table 3 summarizes opinions on five suggested definitions of KM and KMS success. There appears to be little consensus on these definitions other than a general neutrality on KM success as the flow of knowledge and KMS success as improving effectiveness of the KMS components.

However, there are some interesting observations. KM success as the ability to leverage knowledge resources to achieve actionable outcomes is overall supported with the strongest support coming from practitioners. This is interesting but not surprising as practitioners tend to favor definitions and measures that are objective, readily measurable, and have an obvious impact on the organization.

Table 3. Opinions on KM and KMS success definitions; mean (std dev) (5 point Likert Scale)

Overall	Research	Practice	Other	Students
KMS success can be defined as making KMS components more effective by improving search speed, accuracy, etc.				
3 (1.2)	2.8 (1.1)	3.6 (1.2)	3.1 (1.1)	3.2 (1)
KM success is the ability to leverage knowledge resources to achieve actionable outcomes.				
4 (1)	**4** (1)	**4.3** (0.9)	3.9 (0.9)	3.7 (1)
KM success is reusing knowledge to improve organizational effectiveness by providing the appropriate knowledge to those that need it when it is needed.				
3.9 (1)	3.8 (1.1)	**4.4** (0.91)	**4.1** (0.7)	3.8 (0.4)
KM success is knowledge – tacit and explicit alike – circulates freely throughout the organization, with no debilitating clumping, clotting, or hemorrhaging.				
3 (1.2)	2.8 (1.2)	3.2 (1.5)	3.4 (0.8)	2.7 (1)
KM success is the efficient achievement of well defined organizational and process goals by means of the systematic employment of both organizational instruments and information and communication technologies for a targeted creation and utilization of knowledge as well as for making knowledge available.				
3.7 (1.2)	3.5 (1.3)	**4.2** (1.1)	3.8 (0.9)	3.8 (1.2)

Overall n = 103, researcher n = 70, practitioner n=13, academics n=14, and student n=6, Values are rounded to 2 significant digits

This is also why practitioners favor KM success as reusing knowledge to improve organizational effectiveness and KM success as the efficient achievement of well defined organizational goals for targeted creation and utilization of knowledge.

Table 4 summarizes opinions from the second survey on a proposed success definition generated from the first survey and sets of measures for the dimensions listed in the proposed definition. There appears to be some level of consensus on the proposed definition and measures. However, we do not consider it strong consensus given that the mean response is between agree and somewhat agree. Still, this is considered a strong beginning to establishing a common definition and set of success measures.

dIscuss Ion

This was exploratory research so few conclusions can be drawn. However, using two surveys has allowed us to reach some consensus on a KM success definition and set of success measures. The consensus KM success definition is:

KM success is a multidimensional concept. It is defined by capturing the right knowledge, getting the right knowledge to the right user, and using this knowledge to improve organizational and/or individual performance. KM success is measured using the dimensions of impact on business processes, strategy, leadership, efficiency and effectiveness of KM processes, efficiency and effectiveness of the KM system, organizational culture, and knowledge content.

Table 4. Opinions on KM and KMS success definition and sets of measures, mean (std dev) (7 point Likert Scale)

Overall	Research	Practice	Other	Student
KM success is a multidimensional concept. It is defined by capturing the right knowledge, getting the right knowledge to the right user, and using this knowledge to improve organizational and/or individual performance. KM success is measured using the dimensions of impact on business processes, strategy, leadership, efficiency and effectiveness of KM processes, efficiency and effectiveness of the KM system, organizational culture, and knowledge content.				
5.4 (1.4)	5.3 (1.5)	6.1 (1.4)	5.6 (1.4)	5.5 (1.2)
Impact on business process measures.				
5.5 (1.3)	5.3 (1.4)	5.8 (1.4)	5.7 (1.2)	5.7 (1.0)
Strategy measures				
5.3 (1.4)	5.1 (1.6)	6.1 (0.6)	5.3 (1.4)	5.7 (1.0)
Leadership measures				
5.2 (1.5)	5.1 (1.5)	5.3 (1.5)	5.3 (1.3)	5.4 (1.6)
KM process effectiveness and efficiency measures				
5.7 (1.3)	5.5 (1.4)	6.2 (0.8)	5.8 (1.3)	5.7 (1.4)
KM system effectiveness and efficiency measures				
5.6 (1.3)	5.5 (1.4)	6.0 (0.7)	5.8 (1.2)	5.4 (1.3)
Learning culture measures				
5.6 (1.2)	5.5 (1.4)	6.0 (0.8)	5.7 (1.1)	5.6 (1.2)
Knowledge content measures				
5.4 (1.4)	5.2 (1.5)	6.0 (1.0)	5.7 (1.2)	5.5 (1.3)

Overall n = 194, researcher n = 114, practitioner n=16, others n=41, and student n=23, Values are rounded to 2 significant digits

Also, there are a few points of consensus that can be identified from the initial survey:

- KM success and KMS success may not be the same thing.
- Usage is not a good measure of KM or KMS success.

Additionally, it is possible that there is a different focus on KM success between practitioners and researchers. Researchers do not seem to have a clear idea of KM success while practitioners appear focused on KM success as being tied to its impact on organizational performance and effectiveness. This can't be stated conclusively, the number of practitioner responses are too low (n=13) making this supposition. However, it isn't unexpected that practitioners would have a focus on organizational impact as a measure of KM and KMS success. Given that KM is an action discipline; researchers should accept this focus and incorporate it into their investigations.

There are some limitations to this research. It is quite possible that the reason little consensus has been observed is because KM and KMS success are complex constructs that are multi dimensional. It may be that KM and KMS success includes outcome measures, quality of knowledge, how well the KM processes function, organizational culture measures, usability measures, and strategy measures. This is consistent with the DeLone and McLean model of Information Systems success (DeLone and McLean, 1992 and 2003) and there is much empirical evidence to support the correctness of this model. This model is also the basis of the Jennex and Olfman KM success model (Jennex and Olfman, 2006). It is quite likely that the exploratory survey used for this research, while generated using an expert panel, probably did not capture the multidimensional nature of the provided KM success definitions and therefore made it difficult for respondents to find statements they fully agreed with. This limitation was considered when generating the second survey and it appears that this has improved consensus with the KM success definition generated from the first survey.

c onclus lon

It is difficult to reach any conclusions with this research; no hypotheses were proposed or tested. This is okay as the purpose of this chapter is to propose a definition of KMS success. Before doing this it is important to identify areas of consensus and areas of disagreement. The following points are areas of agreement:

- KM and KMS success are likely different definitions (note that at least one of the authors greatly disagrees with this point).
- Use is a poor measure of KM and KMS success.
- KM success is likely a multidimensional construct that will include process and outcome measures.
- A base definition of KM success is: KM success is reusing knowledge to improve organizational effectiveness by providing the appropriate knowledge to those that need it when it is needed.

Additionally, a base definition of KM success can be established:

KM success is a multidimensional concept. It is defined by capturing the right knowledge, getting the right knowledge to the right user, and using this knowledge to improve organizational and/or individual performance. KM success is measured using the dimensions of impact on business processes, strategy, leadership, efficiency and effectiveness of KM processes, efficiency and effectiveness of the KM system, organizational culture, and knowledge content.

Some areas of disagreement are in further need of discussion:

- KM success and effectiveness are likely the same and will be able to use the same measures.
- KM and KMS success are essentially the same (in deference to the authors and consistent with a Churchman view of a KMS and DeLone and McLean (DeLone and McLean, 1992 and 2003)).
- The role of learning and firm performance in KM success.
- The role of outcome measures such as speed, accuracy, amount of knowledge stored and used, etc. in KM and KMS success.

It is expected that it will take a great deal of research before consensus is reached on what KM and KMS success is. It is concluded that these findings from an exploratory survey are a good starting point for this discussion.

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Chapter XI
An Evaluation of Factors that Influence the Success of Knowledge Management Practices in U.S. Federal Agencies

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Abstr Act

This research chapter investigates the status of knowledge management (KM) practices implemented across federal agencies of the U.S. government. It analyzes the extent to which this status is influenced by the size of the agency, whether or not the agency type is a cabinet-level department or independent agency, the longevity of KM practices implemented in the agency, whether or not the agency has adopted a written KM policy or strategy, and whether the primary responsibility for KM practices in the agency is directed by a chief knowledge officer (CKO) or KM unit versus other functional locations in the agency. The research also tests for possible KM practitioner bias, since the survey was directed to members of the Knowledge Management Working Group (KMWG) of the Federal Chief Information Officers (CIO) Council who are KM practitioners in federal agencies.

Introduction

The implementation of KM practices has been underway in both the public and private sectors for many years. For the federal government this transition was well underway prior to the devastating events of September 11th, 2001 (9/11). However those events increased the awareness of the value and importance of the government's stewardship of its knowledge. In fact, the 9/11 terrorist attack on the World Trade Center in New York City is considered by many to have been a "wake-up call" for federal agencies to make both policy and process changes in order to prevent future attacks.

KM programs concentrate on managing and distributing what the government knows within and between agencies for the purpose of taking collaborative action. The basic tenet of KM is that the right knowledge needs to be made available to the right people at the right time for the purpose of taking concerted action.

The most important role of the federal government is inarguably to protect its citizens from harm, and specifically from terrorist threats. As a result of 9/11, President George W. Bush, upon a recommendation of the 9/11 Commission, (National Commission on Terrorist Attacks Upon the United States, created in November 2002) began to rectify the gap in sharing knowledge and coordinating action by creating the Department of Homeland Security (DHS). Twenty-two different agencies with a total of 180,000 employees were reorganized into a single agency for the purpose of preventing terrorist attacks and protecting citizens and infrastructure from threats and hazards. The intentional sharing of knowledge on the part of federal agencies is the new paradigm, albeit one in transition. The major objective is to ensure that the government knows what it needs to know, when it needs to know it.

Deployment of KM programs in U.S. federal agencies is hampered by two distinct conditions:

1. Long-established hierarchical "command-and-control" management styles and bureaucratic organizational structures make it challenging for agencies to share knowledge through either intra-agency collaboration, and much less through cross-agency or inter-agency collaboration.
2. Agency information technology (IT) systems are a mixture of legacy systems cobbled together with newer systems and technologies, making interoperability a technically difficult impediment both within and between different agencies.

The management of the government's knowledge is also made difficult by the vast amount of data and information contained in its repositories. In addition, the government's knowledge is comprised of the working knowledge in the minds of approximately 1,800,000 federal employees (Office of Personal Management, 2004) To manage this bewildering resource of both explicit and tacit knowledge and harness its capabilities is enormously demanding. Much of the knowledge in government organizations, and certainly within a constituency base, is tacit in nature, that is, knowledge that cannot be easily articulated and thus exists in people's hands and minds, and only manifests itself through their actions (Koh, Ryan, & Prybutok, 2005; Stenmark, 2001)

A further problem is that the management of knowledge can be executed in many forms, but it is most useful to agencies when these forms are developed to fit specific agency objectives. This immediate utility is what gives knowledge its value to each agency. However, these unique uses and designs are what make it difficult to share knowledge across agencies. Recently much research has been pursued in the area of KM, in which KM initiatives were internally focused, and principally aimed at collaboration and knowledge sharing among employees (Almashari, Zairi, & Alathari, 2002; Henderson

& Venkatraman, 1993; Koh et al., 2005; Lai & Chu, 2003; Liebowitz, 2003-2004).

Unfortunately, there has been mixed comprehensive research into the value proposition of applying KM practices to achieve improvements in productivity either within a single federal agency, or through the transfer of knowledge between agencies to serve common customers.

The focus of this chapter and our research has been to answer the following question:

What factors influence the success of KM practices within the U.S. federal government?

To answer this question, a survey of KM practitioners in federal agencies, members of the KMWG of the Federal CIO Council, was conducted. The survey identified the status of KM programs in federal agencies and examined the extent to which this status was influenced by the size of the agency, whether or not the agency type was a cabinet-level department or independent agency, the longevity of established KM practices in the agency, whether or not the agency had adopted an effective KM policy or strategy, and whether the primary responsibility for KM practices was directed by a CKO or KM unit versus another type of functional unit in the agency.

The question of the "success" of KM practices is answered by the fact that we now have benchmark data on the KM Practices established in individual U.S. federal agencies, resulting from credible sources from the responses of the KM practitioners in these agencies themselves. This survey has obtained the first baseline data on this subject.

Research Background

One of the most inhibiting and intransigent barriers contributing to the lack of knowledge transfer within and across federal agencies is the lingering presence and influence of the historical culture of organizational bureaucracy that is built into federal organizations. It is a hierarchical approach to management, more appropriate for the Industrial Age, in contrast to the practical and intentional establishment of collaborative working relationships between employees from different operational entities more suitable to the Knowledge Age of the 21st century. Employees must be prepared to work across the independent silos of agency operations to bring their collective knowledge to bear on the most demanding issues facing the government, in times of normalcy as well as in emergencies.

In many European countries, the central government establishes KM planning and implementation for the whole country through a central administration, and this acts as an effective mandate for KM within and between governmental bodies in the country. Many of these countries are members of the Organization for Economic Cooperation and Development (OECD). The OECD promotes KM, and for that reason a separate discussion of the OECD's role is included in this chapter.

In the United States, there is no comparable, centrally administered mandate for the adoption of KM programs in U.S. federal agencies. The Office of Management and Budget (OMB) reporting to the President, mandates agency commitment to adopt an e-government approach to provide electronic services to the U.S. public, in response to the President's Management Agenda (PMA) adopted in 2002. The PMA contains the principles for the President's vision for government reform: to citizen-centered, not bureaucracy-centered, results-oriented and market-based agency organizations. There is no concomitant mandate for the intentional transfer of knowledge through the implementation of KM programs within and between agencies.

The General Accountability Office (GAO), an independent nonpartisan agency reporting to congressional policy makers and the public under the leadership of the U.S. Comptroller General (who holds the position for a period of 15 years) with the authority to improve the performance and ensure the accountability of federal government programs. While the GAO promotes KM, and embraces it internally, it does not mandate KM. However, the specific use of KM for its transformational effect on organizations has received longstanding support (GAO, 2004). One of the stated goals of the GAO's strategic plan is to transform the federal government's role and how it does business to meet 21st century challenges. The GAO considers transformation as the key to achieving a new model of management for government organizations.

In 2005, the GAO designated a new "high risk" watch area for federal agencies—that of establishing appropriate and effective information-sharing mechanisms, citing the need for securing the homeland in a government-wide effort involving multiple federal agencies. (GAO, 2005).

In December 2005, the 9/11 Commission remonstrated that "The failure to share information among and within agencies cost us dearly on September 11th," and concluded "No single step is more important to strengthen our intelligence than to improve information sharing" (9/11 Commission, 2005).

public sector governance

Traditionally, public administrations are bureaucratic organizations: an operational definition that gives a better understanding of the difficulties of bringing about change. The office organization is a collective order, a legitimate domination based on a set of procedures, a professional organization based on process. The production of services in a bureaucratic organization follows the concepts of specialization and sequencing of tasks. The advantage to employees for this segmented, bureaucratic work style is that there was no requirement for employees to collaborate with others (Dupuy, 2000). From the other side of the equation, to receive services, the public had no choice but to follow the sequential steps imposed by the organization's operational procedures. This is the antithesis of today's customer service orientation between the government as provider and the public as customer.

Sistare (2004) describes the concept of achieving government transformation and reorganization for the 21st century through means of a "virtual reorganization." This has become increasingly possible, due to the growth of the Internet.

There are four possible paths to achieve the virtual reorganization of federal agencies in lieu of a physical reorganization: (1) virtual reorganization through e-government (firstgov.gov); (2) virtual reorganization through coordinating councils (Council of Chief Information Officers); (3) reorganization by commission (the 9/11 Commission); and (4) reorganization via legislative authorization (the forming of DHS, Sistare, 2004).

An effective implementation of KM to achieve electronic government requires that knowledge be managed horizontally across agencies. Citizens are not cognizant about where or how the government information they require is created, or whether the information they seek needs to be aggregated by federal agencies to provide the ultimate service. To effectively meet these objectives requires that knowledge be integrated between independent segments of common service functions across government. Even though the federal government is organized vertically, with each department and agency serving the public directly, much of what federal agencies do to effectively distribute "what it knows" to improve public services is achieved by sharing knowledge through horizontal partnerships. Government agencies are vertical bureaucracies (federal, state, and local) that are inherently knowledge-intensive (Barquin, Bennet, & Remez, 2001). KM requires leveraging the collective knowledge of agencies to fulfill the mission of the overall federal enterprise (Barquin et al., 2001).

KM practices and the o e c d

Headquartered in Paris, the OECD provides a forum where the governments of 30 industrialized countries, with democratic governments, work together to solve the common economic, social, and governance challenges of the member countries. KM forms the central core of OECD focus.

In January 2002, the OECD launched the first international survey of KM practices for ministries/departments or agencies of central government in OECD member countries, based on previous pilot surveys (OECD, 2003a). A comparison of seven functional sectors of central governments was obtained through a survey of 20 participating members. These functions were the ministries of Economy/Trade /Industry, Education, Finance/Budget, Foreign Affairs, Health/Social Affairs, Home Affairs/Interior, and State Reform/Civil Service/Public Administration. The United States, a member of the OECD, submitted responses to the survey in all except the Finance/Budget sector.

The broad conclusions of the OECD KM Practices Survey were that within the central government in OECD countries, activities are knowledge intensive, staff is highly educated, a critical mass of knowledge exists in these public organizations, and central governments must have superior mechanisms with which to share knowledge across government organizations. The OECD survey was designed to review the actual KM practices implemented, as well as a self-assessed perception of the results of these practices.

One of the significant results of the survey was that there is a need to think about KM from a "whole of government" perspective rather than from the perspective of individual organizations within central government (OECD, 2003b). This is a key difference from the perspective of how KM programs are implemented in the U.S. federal government. While they may be adopted within individual departments or agencies, they are not directed for adoption for the federal government as a whole.

r eseAr ch desIgn And Met hodol ogy

The research methodology was designed to investigate the factors affecting success in U.S. federal agency's adoption of KM practices in cabinet-level departments and independent agencies reporting to the President. The Bureaus and Program Offices of the large cabinet-level departments are comprised of approximately 130 organizations.

r esearch g oal

The central research goal was to examine the influence of five key factors in the success of KM practices within the federal government.

r esearch hypothesis

Five research hypotheses were developed to address this research goal.

HS: *Small federal agencies have higher KM practices index scores than large agencies.*

HI: *Independent agencies have higher KM practices index scores than cabinet agencies.*

HL: *Agencies where KM has been in place for more than 4 years have higher KM practices index scores than agencies where KM has been in place for less than or equal to 4 years.*

HP: *Agencies with a commitment to an effective written KM policy or strategy have higher KM practices index scores than agencies with no effective written KM policy or strategy.*

HR: *Agencies where the KM responsibility is assigned to a KM unit have higher KM practices index scores than agencies where the KM responsibility is assigned to a different department.*

Each of these hypotheses has an associated null hypothesis.

The dependent variable for this study is an index score of KM practices in federal agencies. The independent variables are the size of the agency, whether or not the agency type is a cabinet-level department or independent agency, the longevity of KM practices, whether or not there is a commitment to adopt a KM policy or strategy, and whether the primary responsibility for KM practices is directed by a CKO or KM unit versus other functional locations in the agency.

The KM practices survey questions for this research are drawn from both the Statistics Canada KM Practices Survey conducted in 2001, and from the First International KM Practices Survey conducted by the OECD in 2002. Previous to the KM Practices Survey of U.S. federal agencies, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Korea, Norway, Poland, Portugal, Slovak Republic, Sweden, United Kingdom, and the United States participated in the OECD Knowledge Management Practices Survey. This survey was limited to seven common functional government areas of operation in each country. The KM Practices Survey of U.S. federal agencies was conducted in March 2005.

r esearch population

The survey research targeted the population of the 16 cabinet-level departments and the 10 independent agencies of the federal government listed in Table 1.

Table 1. Survey research population

The 16 U.s. Federal Government Cabinet-Level Departments	
Agriculture	Housing & Urban Development
Commerce	Interior
Defense	Justice
Education	Labor
Energy	State
Environmental Protection Agency	Transportation
Health and Human Services	Treasury
Office of Homeland Security	Veterans Administration
The 10 U.S. Federal Government Independent Agencies	
Agency for International Development	Office of Management and Budget
Army Corps of Engineers	Office of Personnel Management
General Services Administration	Small Business Administration
National Aeronautics and Space Administration	Smithsonian Institute
National Science Foundation	Social Security Administration

Research Instrument

The KM practices research instrument was used to determine the extent of KM practices implemented in the 26 federal departments and agencies and the type of practices most frequently employed. It consisted of 45 questions in three sections: 27 questions about specific KM practices; 11 questions regarding the perception of effective results from the use of KM practices; and 6 mixed questions.

Validation and Reliability

The survey instrument was based on the previous KM practices surveys conducted by Statistics Canada, Denmark, France, Germany, and the OECD. Our Web-based online survey was tested, and feedback was received from a survey special interest group (SIG) of members of the KMWG interested in taking the survey in order to provide feedback prior to the survey distribution. Feedback from these members indicated a concern for the time required to take the survey, and adjustments were made.

Research Procedures

Procedures recommended by Statistics Canada were followed in the administration of the research instrument. In addition, the recommendation of the central government office in Germany that piloted a KM practices survey to utilize a Likert scale was followed. The Canadian survey used a predictive scale that asked whether the respondent had implemented the KM practices within the past 24 months, or whether they were considering an implementation within the next 24 months. In January 2005, in a review of the survey prior to its distribution, Statistics Canada advised the use of a four-ratio Likert scale instead of a five-ratio scale.

DATA COLLECTION AND ANALYSIS

The survey was distributed in the first week of March 2005. It remained open for 6 weeks and was closed in April 2005. The online survey was a blind survey, ensuring that no individual names were attributable to the information collected from each agency. The survey was distributed by a survey company via an e-mail code to 326 KM practitioners, employees of U.S. federal agencies, and members of the KMWG of the Federal CIO Council.

After 6 weeks, the total count of survey responses received from 26 different agencies was 125, or 38% of the members of the KMWG. Of the 125 responses, 119 were included in the analysis, with 6 removed because of incomplete or missing data.

Validation of the Survey Instrument

The reliability of our survey tool was assessed after the initial review of the data analysis of the descriptive statistics concerning the respondent profiles and prior to considering the validation of the research hypotheses. An analysis of the normal distribution of the variables was performed before examining the possible variance analyses. A descriptive analysis was conducted in order to verify the kurtosis and skewness values of the various factors. It is generally accepted that variables obtaining an absolute value lower than two are acceptable (George & Mallery, 2005). In order to assess the discriminant and convergent validity, various factor analyses were conducted using the principal component method with a Varimax rotation and a Kaiser normalization. Only factors obtaining an eigenvalue greater than one were extracted.

The Cronbach's alpha test was used to test the internal reliability of the KM practices construct as well as its five dimensions. The overall alpha value for the KM practices is α=0.941, which reflects an excellent level of reliability**.** All the alpha values are greater than 0.7, which denote an acceptable level of internal reliability of the KM practices construct.

data Analysis

The KM Index Score for each agency was evaluated under five dimensions, as a result of the component factor analysis of the 27 KM practice questions. Each dimension was rated separately, and is described in Table 2.

In order to increase the validity and the reliability of our analysis it was decided to include only the agencies where more than one respondent responded to the survey (frequency ≥2).

1. **Agency size influence.** Hypothesis HS tests the difference between the KM practices index score (dependent variable) associated with the size of the federal department or agency (independent variable). HS: *Small federal agencies have higher KM practices index scores than large agencies*. Table 3 shows the size of each agency responding to the survey. While not a federal agency, The World Bank was included in the survey as a public sector organization with a long and close affiliation with the KMWG.

The KM practices index score variable was measured on an interval/ratio scale of values ranging from (5-20). Since most agencies were large sized, we used the median value of the agency size (45,431) in order to differentiate small versus large agencies. Agencies having a size lower than or equal to 45,431 employees were categorized as "small" and the others as "large." An independent-sample, one-tailed t test was used to analyze the differences of means between the two groups (small and large). Table 4 provides the descriptive statistics of the two groups studied.

The probability associated with the Levene's test for equality of variance is 0.012 (Table 5, row 1). Because this is less than .05, we can be reasonably certain that the variance of the KM index score differs across the two groups. Data from the second row of Table 5 are used (equal variance not assumed).

Applying the two-step rule, p=0.001 (one tailed) (lower than the pre-set α of .05) and directionality of the difference in sample means is consistent with HS (Small 13.12 > 11.21 Large). Thus, H0 is rejected and HS is accepted. We can be reasonably certain that small agencies have higher KM practices index scores than large agencies.

Table 2. The KM index score dimensions

Index dimensions	Description
Knowledge engagement	Agency implementation of KM practices through KM policy, strategy as responsibility of a CKO or KM unit; including formal and informal training in KM practices
Knowledge exchange	Agency value system conducive to promote knowledge sharing; improve workforce retention; monetary or nonmonetary incentives; capture of best practices and lessons learned; SME locators; portal for shared documents; submit best practices
Knowledge acquisition	Partnerships/alliances to aquire knowledge; captures external knowledge; develop communities of practice (CoPs); transfer knowledge to less-experienced workers
KM responsibility	Responsibility of managers/executives; responsibility of nonmanagement workers
KM training and mentoring	Formal and informal mentoring; funding for work-related courses; funding for KM study

Table 3. Agency size

Agency		Frequency	Percent	Size	Cabinet Independent
Department of Veterans Affairs	VA	4	3%	236,495	Cabinet
Department of the Army	US Army	9	7%	230,496	Cabinet
Department of the Navy (incl. US Marine Corps)	US Navy	13	10%	174,350	Cabinet
Department of the Air Force	USAF	3	2%	154,999	Cabinet
Department of the Treasury	TREAS	6	5%	122,521	Cabinet
Department of Agriculture	USDA	8	6%	101,472	Cabinet
Department of Defense Civilian	DOD	13	10%	98,663	Cabinet
Department of Health & Human Services	HHS	2	2%	63,514	Cabinet
Department of Transportation	DOT	9	7%	55,611	Cabinet
Army Corps of Engineers	USACE	5	4%	35,250	Independent
Environmental Protection Agency	EPA	2	2%	18,452	Independent
Department of Energy	DOE	11	9%	14,990	Cabinet
General Services Administration	GSA	5	4%	12,472	Independent
The World Bank	WB	2	2%	9,300	Special
Government Printing Office	GPO	2	2%	2,395	Independent
United States Agency for International Development	USAID	7	6%	2,317	Independent
Pension Benefit Guaranty Corporation	PBGC	10	8%	780	Special

Table 4. Descriptive statistics of the two groups studied

	Size_S_L	N	Mean	Std. Deviation	Std. Error Mean
KM Index Score	Small	33	**13.1192**	2.03984	.35509
	Large	53	11.2106	3.37009	.46292

Table 5. Comparison between the KM index score of small and large agencies

		Levene's Test for Equality of Variances		t-test Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error difference	95% Confidence Interval of Difference	
									Lower	Upper
KMIndexScore	Equal variances assumed	6.632	.012	2.932	84	.004	1.90861	.65089	.61425	3.20297
	Equal variances not assumed			3.271	83.961	.002	1.90861	.58342	.74840	3.06882

Table 6. Descriptive statistics of the two groups studied

	Agency type	N	Mean	Std. Deviation	Std. Error Mean
KMIndexScore	Cabinet	75	11.3290	3.21994	.37181
	Independent	32	**12.6541**	3.00754	.53166

Table 7. Comparison between the KM index score of cabinet-level and independent agencies

		Levene's Test for Equality of Variances		t-test Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error difference	95% Confidence Interval of Difference	
									Lower	Upper
KMIndexScore	Equal variances assumed	.286	.594	-1.987	105	.050	-1.32516	.66696	-2.64761	-.00271
	Equal variances not assumed			-2.043	62.476	.045	-1.32516	.62877	-2.62184	-.02848

2. **Cabinet agencies versus independent agencies' influence.** Hypothesis HI tests the difference between the KM practices index score (dependent variable) associated with cabinet-level and independent agencies (independent variable). HI: *Independent agencies have higher KM practices index scores than cabinet agencies.*

The KM practices index score variable was measured on an interval/ratio scale of values ranging from (5-20). An independent-sample, one-tailed t test was used to analyze the differences of means between the two groups (cabinet and independent). Table 6 provides descriptive statistics of the two groups studied.

The probability associated with the Levene's test for equality of variance is 0.594 (Table 7, row 1). Because this is more than .05, there is no reasonable certainty that the variance of the KM index score differs across the two groups. Data from the first row of Table 7 will be used (equal variances assumed).

Applying the two-step rule, p=0.025 (one tailed) (lower than the pre-set α of .05) and directionality of the difference in sample means is consistent with HI (Independent 12.65 > 11.33 Cabinet). Thus, H0 is rejected and HI is accepted. It is reasonably certain that independent agencies have higher KM practices index scores than cabinet-level agencies.

3. **KM longevity influence.** Hypothesis HL tests the difference between the KM practices index scores (dependent variable) associated with the longevity of the KM practices (how long the KM practices have been in place in the organization) (independent variable). HL: *Agencies where KM has been in place for more than 4 years have higher KM practices index scores than agencies where KM has been in place for less than or equal to 4 years.*

Table 8 illustrates that in our survey population, 62.2% or more that half of the agencies have had KM practices implemented for a period of 2 to 4 years or less.

The KM practices index score variable was measured on an interval/ratio scale of values

Table 8. Longevity of agency KM initiatives

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 2 years	38	31.9	31.9	31.9
	2-4 years	36	30.3	30.3	62.2
	5-9 years	15	12.6	12.6	74.8
	> 10 years	8	6.7	6.7	81.5
	Don't know!	22	18.5	18.5	100.0
	Total	119	100.0	100.0	

Table 9. Descriptive statistics of the different groups studied

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
< 2 years	33	**11.1827**	2.54444	.44293	10.2805	12.0849	5.00	16.75
2-4 years	32	**12.1618**	3.04531	.53834	11.0638	13.2597	5.00	17.32
5-9 years	14	13.7454	3.08852	.82544	11.9622	15.5287	9.05	18.63
> 10 years	8	13.3135	2.72521	.96351	11.0352	15.5919	9.40	18.88
Total	87	12.1511	2.94919	.31619	11.5226	12.7797	5.00	18.88

Table 10. Test of homogeneity of variances

Levene Statistic	df1	df2	Sig.
.743	3	83	**.529**

ranging from (5-20). The longevity variable is a discrete categorical variable (Less than 2 years, 2-4 years, 5-9 years, more than 10 years). A one-way Analysis of Variance (ANOVA) test was performed to analyze the differences of means between the various groups. Table 9 provides descriptive statistics of the various groups studied.

The probability associated with the Levene's test for equality of variance is 0.743 (Table 10). Because this is more than .05, we cannot be reasonably certain that the variance of the KM index score differs across the different groups (equal variances assumed).

The results of the ANOVA test can be found in Table 11. The significance value p=0.028 is lower than the pre-set α of .05, which indicates that we can be reasonably certain that significant differences exist in KM index scores among the various groups studied.

In order to test our hypothesis we made a more precise comparison between the groups "<2 years," "2-4 years," and the other groups.

A pairwise multiple comparison test was performed and the result of the contrast test is displayed in Table 12. The significance value p=0.012 is lower than the pre-set α of .05. Thus, H0 is rejected and HL is accepted. We can be

Table 11. Result of ANOVA test

ANOVA

KMIndexScore

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	77.348	3	25.783	3.191	**.028**
Within Groups	670.659	83	8.080		
Total	748.006	86			

Table 12. Contrast test results

Contrast Tests

	Contrast		Value of Contrast	Std. Error	t	df	Sig. (2-tailed)
KMIndexScore	Assume equal variances	1	-3.7145	**1.44380**	-2.573	83	.012
	Does not assume equal	1	-3.7145	1.44765	-2.566	26.987	.016

Table 13. Descriptive statistics of the two groups studied

Group Statistics

	KM policy in place	N	Mean	Std. Deviation	Std. Error Mean
KMIndexScore	KM policy or strategy	38	**14.2423**	2.37113	.38465
	No KM policy or strategy	69	10.3391	2.72698	.32829

Table 14. Comparison between The KM index score of agencies with or without a KM policy or strategy

Independent Sample t-Test

		Levene's Test for Equality of Variances		t-test Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error difference	95% Confidence Interval of Difference	
									Lower	Upper
KMIndexScore	Equal variances assumed	.248	.620	7.411	105	.000	3.90320	.52667	2.85891	4.94749
	Equal variances not assumed			7.718	85.773	.000	3.90320	.50570	2.89787	4.90852

reasonably certain that agencies where KM has been in place for more than 4 years have higher KM practices index scores than agencies where KM has been in place for less than or equal to 4 years.

4. **KM policy influence.** Hypothesis HP tests the difference between the KM practices index score (dependent variable) associated with agencies that have adopted an effective written KM policy or strategy and the agencies with no written KM policy or strategy (independent variable). HP: *Agencies with an effective written KM policy or strategy have higher KM practices index scores than agencies with no effective written KM policy or strategy*

The KM practices index score variable was measured on an interval/ratio scale of values ranging from (5-20). An independent-sample, one-tailed *t* test was used to analyze the differences of means between the two groups (KM policy and no KM policy). Table 13 provides descriptive statistics of the two groups studied.

The probability associated with the Levene's test for equality of variance is 0.620 (Table 14, row 1). Because this is more than .05, we cannot be reasonably certain that the variance of the KM index score differs across the two groups. Data from the first row of Table 13 will be used (equal variances assumed).

Applying the two-step rule, $p<0.000$ (one tailed) (lower than the pre-set α of .05) and directionality of the difference in sample means is consistent with HP (Policy 14.24 > 10.34 No policy). Thus, H0 is rejected and HP is accepted. We can be reasonably certain that agencies which have adopted an effective written KM policy or strategy have higher KM practices index scores than agencies with no effective written KM policy or strategy.

5. **KM responsibility influence.** Hypothesis HR tests the difference between the KM practices index scores (dependent variable) and the functional area with primary KM responsibility (independent variable). HR: *Agencies where the KM responsibility is assigned to a KM unit have higher KM practices index scores than agencies where KM responsibility is assigned to a different department.*

Table 15. Descriptive statistics of the different groups studied

Descriptives

KMIndexScore

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min.	Max.
HR	8	12.1220	2.38630	.84368	10.1270	14.1170	9.60	16.33
IT	17	12.6078	2.72768	.66156	11.2054	14.0103	9.23	18.88
KM Unit	22	12.8744	2.86626	.61109	11.6035	14.1452	6.25	16.98
Library	2	8.8708	2.33934	1.65417	-12.1473	29.8890	7.22	10.53
Executive	11	12.9644	2.92186	.88097	11.0015	14.9273	7.63	18.63
Grass-roots	26	10.4692	3.23647	.63472	9.1619	11.7764	5.00	17.32
Total	86	11.9430	3.06369	.33037	11.2861	12.5998	5.00	18.88

The KM practices index score variable was measured on an interval/ratio scale of values ranging from (5-20). The functional area responsibility variable is a discrete categorical variable (Human Resources, Information Technology, KM Unit, Library Services, Executive Management, Grass-roots effort). A one way ANOVA test was performed to analyze the differences of means between the various groups. Table 15 provides descriptive statistics of the various groups studied.

The probability associated with the Levene's test for equality of variance is 0.907 (Table 16). Because this is more than .05, we cannot be reasonably certain that the variance of the KM index score differs across the different groups (equal variances assumed).

The results of the ANOVA test can be found in Table 17. The significance value p=0.028 is lower than the pre-set α of .05, which indicates that we can be reasonably certain that significant differences exist in KM index scores between the various groups studied.

In order to test our hypothesis, it was necessary to make a more precise comparison between the group "KM Unit" and the other groups. The result of the contrast test is displayed in Table 18. The significance value p=0.038 (one-tailed) is lower than the pre-set α of .05. Thus, H0 is rejected and HR is accepted. We can be reasonably certain that agencies where the KM responsibility is assigned to a KM unit have higher KM practices index scores than agencies where the KM responsibility is assigned to a different department.

concl uslon

The conclusions of the study were that the size of the agency does influence the advance of KM practices within the federal agencies that were

Table 16. Test of homogeneity of variances

KMIndexScore

Test of Homogeneity of Variances			
Levene	df1	df2	Sig.
.308	5	80	.907

Table 17. Results of ANOVA test

KMIndexScore

ANOVA					
	Sum of Squares	df	Mean square	F	Sig.
Between Groups	113.681	5	22.736	2.659	**.028**
Within Groups	684.144	80	8.552		
Total	797.825	85			

Table 18. Contrast test results

	Contrast	Value of	Std. Error	t	df	Sig. (2-tailed)
KMIndexScore	Assume equal variances 1	-7.3375	4.08316	-1.797	80	**.076**
	Does not assume equal 1	-7.3375	3.79480	-1.934	17.591	.069

the subject of this study. We can be reasonably certain that small agencies have higher KM practices, as measured by the KM index score, than large agencies. There was no previous expectation that agency size would have an effect on the level of the implementation of KM practices in the research population.

The study also found that whether or not the agency is a cabinet-level department or an independent agency does influence the advance of KM practices within the agency. Independent agencies have higher KM practices index scores than cabinet-level departments. There was no expectation that the type of agency, either cabinet-level or independent agency, would have an effect on the level of their implementation of KM practices. The research gives no indication for this conclusion. This is a new finding that could be explored further.

The research data were also analyzed to determine whether agencies where KM practices were in place for more than 4 years had higher KM practices index scores than agencies where KM practices had been in place for less than 4 years. The study found that the longevity of KM practices does influence the advance of KM practices within agencies. Agencies where KM has been in place for more than 4 years have a higher KM practices index score than agencies where KM practices have been in place for less than 4 years. This conclusion would appear to bear out the fact that KM implementation matures and continues to expand over time. This is an encouraging finding.

The study also found that whether or not there is a commitment to an effective written KM policy or strategy does influence the advance of KM practices in the agencies included in the study. Agencies with an effective written KM policy or strategy have higher KM practices index scores than agencies without an effective written KM policy or strategy. As in most management disciplines, policy, planning, and strategy set the tone for the agency's commitment to become knowledge-centric organizations. This indicates the value that can benefit an organization whose management is committed to setting a policy for the implementation of a KM program.

The study found that the location of primary responsibility for KM practices—that is, whether responsibility is assigned to a KM unit versus a different department—does influence the advance of KM practices within the agency. Agencies where the KM responsibility is assigned to a KM unit have a higher KM practices index score than agencies where KM responsibility is assigned to a different department or unit. We can conclude that when a KM unit is created and assigned the responsibility for the implementation of a KM program throughout an agency, the visibility of this commitment results in a broader number of KM practices.

The study also tested the difference between the KM practices index scores associated with survey respondents who have a KM job title and respondents who have a job title not related to KM. The aim was to determine whether or not respondents with a KM job title provided higher KM practices index scores than respondents with a different job title. The study found that we cannot be reasonably certain that respondents with a KM job title provided higher KM practices index scores than respondents with a different job title. Therefore, we can be reasonably certain that responses from KM practitioners relative to their agency's implementation of KM practices are not biased.

The significance of this research into the implementation of KM practices in U.S. federal agencies has provided us with a first benchmark view into the demographic characteristics of the 26 agencies that have successfully implemented KM programs.

Additional information about the nature of the KM practices implemented were also significant—which practices were implemented most frequently across the responding agencies; the results and benefits from the implementation as indicated by the KM practitioners themselves; and the methods of measurement applied across agencies. Unfortunately, we were unable to present this information within the context of this chapter.

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Chapter XII
Interdepartmental Knowledge Transfer Success During Information Technology Projects

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Abstr Act

This article reports on a study that investigates the knowledge transfer between an information systems/technology (IS/IT) department and non-IT departments during IT projects. More specifically, we look into the link between the knowledge management capabilities of the IT department and the effectiveness and efficiency of the knowledge transfer to a client department. Knowledge management (KM) capabilities are defined by Gold, Malhotra, and Segars (2001) as the combination of knowledge infrastructure capabilities (structural, technical, and cultural) and knowledge processes capabilities (acquisition, conversion, application, and protection). Data collected through a Web-based survey result in 127 usable questionnaires completed by managers in large Canadian organizations. Data analysis performed using partial least squares (PLS) indicates that knowledge infrastructure capabilities are related to the knowledge transfer *success, and more specifically to its effectiveness whereas knowledge processes capabilities are only related to the efficiency of such transfer. Implications of our results for research and practice are also discussed.*

Introduct Ion

Knowledge transfer (k-transfer) is a process through which one entity is affected by the knowledge of another (Argote, Ingram, Levine, & Moreland, 2000). K-transfer, a key element of KM research, has been shown to play a critical role in increasing a company's productivity and helping it gain a competitive advantage (Argote & Ingram, 2000; Szulanski, 2000). From a market perspective, the transfer of knowledge between two groups establishes a provider-receiver relationship. As might be inferred from Lin, Geng, and Whinston (2005) interdepartmental transfer of knowledge allows for mutual benefits and represents the knowledge market within a firm.

Although the issue of intra-firm k-transfer has been addressed already (Gruenfeld, Martorana, & Fan, 2000; Gupta & Govindarajan, 2000; Hansen, 1999; O'Dell, 1998), there is a lack of research in interdepartmental k-transfer, in particular during IT projects. This research gap is especially significant since most IT projects are cross functional and interdepartmental (Hoopes, 2001, Sharda, Franckwick, Deosthali & Delahoussaye, 1998). The present research attempts to narrow this gap by empirically investigating interdepartmental k-transfer success during IT projects. The most obvious knowledge asset of the IT department lies in the conception, development, and exploitation of IT applications that support the business processes, characteristically examples of tacit knowledge (Edvinsson & Malone, 1997). However, the IT-related managerial skills constitute knowledge that must be transferred to the client department (as explicit knowledge) during any project if IT is to contribute to creating and sustaining a competitive advantage (Mata, Fuerst, & Barney, 1995). This emphasizes the importance of investigating further how KM capabilities can be fostered to successfully conduct an IT project that suits the needs of another business unit.

A capability is the "firm's capacity to deploy its assets" (Maritan, 2001, p. 514). KM capabilities characterize a firm's ability to build upon its current knowledge to scan for and recognize the value of new information, assimilate it, and apply it in order to create new knowledge (Gold et al., 2001). More specifically, KM capabilities are developed through the processes of combining and exchanging knowledge to foster the creation of new ideas and resources. They are enabled by the presence of the knowledge infrastructure capabilities, which are leveraged by the critical knowledge processes capabilities (Gold et al., 2001).

The present research aims at answering the following research question: *Are KM capabilities of an IT department related to the success of knowledge transfer to non-IT department during an IT project?* Although different authors point out that various aspects of such capabilities are essential to achieving k-transfer success (Nonaka & Takeuchi, 1995; O'Dell, 1998), none of them have actually empirically tested interdepartmental knowledge transfer. Given that IT projects are knowledge intensive, it seems appropriate to assume that some form of deliberate management of knowledge should be present in both the development and the implementation processes of such projects.

This paper is structured as follows: first, the theoretical background is reviewed. Next, the research objectives, variables, hypotheses, and model are presented. The third section describes the methodology used for this research project. The data analysis is followed by a discussion of the results. The last section addresses the limitations and contributions of this study for practice and research and identifies future research avenues.

Theoretical Background

Resource-Based View

Organizations can gain a sustained competitive advantage when they are capable of exploiting their valuable, rare, difficult to transfer, and not easily replicated internal resources and capabilities (Barney, 1995; Grant, 1991; Von Krogh & Grand, 2002). A resource corresponds to the input used during a production process (e.g., employee, skill, equipment), whereas a capability is the capacity for a set of resources to perform some task or activity that will be the main source of the competitive advantage (Grant, 1991). A key organizational capability is the ability to effectively manage the firm's resources. For example, when an organization uses its technology to distinguish itself from its competitors, such technology is much more than just a set of IT functionalities; it becomes the firm's IT capability (Henderson & Venkatraman, 1999).

It is recognized that a critical element for organizations to stay competitive lies in their ability to successfully manage and internally transfer their resources and capabilities, and more particularly their knowledge, which constitutes organizations' most fundamental resource (Grant, 1996). New knowledge is valuable when it can be successfully leveraged in existing operations (Spanos & Prastacos, 2004). The resource-base view is therefore quite useful in investigating the link between KM capabilities and the success of knowledge transfer during an IT project.

Knowledge

There is no universal definition of knowledge management (KM) since there is no agreement as to what constitutes knowledge in the first place. For this reason, it's best to think of KM in the broadest context. Succinctly put, KM is the process through which organizations generate value from their intellectual and knowledge-based assets. (Levinson, 2005, p. 20)

Furthermore, there are many types of knowledge and these may be defined from specific perspectives. For example, from an epistemological perspective we would classify knowledge as logical, semantic, systemic, or empirical. In the field of education, Frick (2004) identifies six types of knowledge of education where knowledge is scientific, praxiological, or philosophical under either situational or theoretical circumstances. From an organizational perspective, knowledge may be tacit or explicit.

As per Edvinsson and Malone (1997) tacit knowledge is the implicit knowledge used by workers to perform their work. It is personal, often difficult to articulate and is embedded in a person's actions or experiences. These authors include within tacit knowledge both technical level know-how (skills and crafts) as well as a cultural/cognitive level dimension (beliefs, ideals, perceptions, or values.)

Explicit knowledge is knowledge that has been formally codified using a system of symbols (words and numbers) for diffusion in the form of data for example, product specifications, computer applications, or manuals. Further, it is considered to be objective and unambiguously expressed (Chua, 2001).

This chapter uses the tacit-explicit framework of knowledge. We assume that one member of the firm has articulated a need that the IT department would respond to. Our work examines how the provider (IT department) using its expertise (tacit knowledge) responds to the need from the customer department (tacit knowledge converted into explicit knowledge). Specifically, the IT department represents tacit knowledge that must become explicit for the customer department.

Knowledge, particularly tacit knowledge, is one resource that is difficult to replicate and hence is key in achieving advantage over other firms (Lubit, 2001, Spanos and Prastacos, 2004). Zack (1999) defines knowledge as "that which we come to believe and value on the basis of information (messages) through experience, communication, or inference" (p. 278). This definition reflects two components of knowledge, that is, an object and a process (Alavi & Leider, 2001). Knowledge as an object corresponds to what is known whereas knowledge as a process implies applying expertise or simply using it.

As per Zack (1999), three types of knowledge exist and are present in IT projects: (1) declarative (know-what), (2) procedural (know-how), and (3) causal (know-why). Specifically, declarative knowledge facilitates effective communication whereby, for example, the customer department describes concepts and elements required. Procedural knowledge, embedded in organizational routines and processes, represents knowing and using the interaction of elements in the system to produce results where, for example, different methodologies and processes convert customer requirements into end-products. Finally, causal knowledge represents an understanding of fundamental principles and is used to formulate goals and strategies. The latter implies that even though the actors in a request for a product or service do not have sufficient knowledge of each other, particularly awareness of the other's tacit knowledge, or do not share a common technical language, they may still need to effectuate a knowledge transfer, that is, make the knowledge explicit.

Knowledge c apabilities

Although Gold et al. (2001) do not explicitly define KM capabilities, we view the construct as a department's ability to manage knowledge in order to improve performance or gain competitive advantage. This definition is similar to one provided by Croteau and Li (2003) who describe KM capabilities as "the ability of an organization to capture, manage, and deliver time-authenticated customer, product, and service information in order to improve customer response and provide faster decision-making based on reliable information" (p. 23). However, the context of their study was customer relationship management (CRM) and is reflected in their definition.

Gold et al. (2001) investigated KM capabilities from an infrastructure capabilities perspective and a process capabilities perspective. First, *k-infrastructure capabilities* refer to the support made available to maximize the social capital that can be found through the network relationships within a social unit. This concept can be broken further into three main components: technological, structural, and cultural capabilities. The *technological* k-infrastructure refers to technology-enabled ties that exist within a firm. These ties consist of the existence of common representation schemes for capturing knowledge, as well as collaboration, knowledge discovery, knowledge mapping, knowledge application, and opportunity generation technologies. The *structural* k-infrastructure refers to the presence of norms and trust mechanisms. Furthermore, the presence of a flexible structure that encourages interactions among departments and incentive systems that reward k-sharing are the major elements of this construct. IT groups and line groups (customer departments) should be provided with opportunities to socially interact and communicate about their work, thus fostering trust and influence as determinants of shared knowledge (Nelson & Cooprider, 1996). *Cultural* k-infrastructure refers to shared contexts. It pertains to the value attributed to knowledge sharing in the corporate vision and practice as well as the support given by senior management to knowledge practices. Effectively managing knowledge across boundaries requires that the actors not only share their knowledge, but that they also assess each other's knowledge (Carlile, 2004).

Second, Gold et al. (2001) define the organization's *knowledge process capabilities* in terms of the capacity to perform four fundamental k-processes: acquisition, conversion, application, and protection. The term *acquisition* refers to the process of seeking and acquiring new knowledge, or creating new knowledge out of existing knowledge in the course of cooperation between individuals or business partners. *Conversion* processes consist of converting knowledge into a useful form. To achieve this, the following key processes must be present: knowledge organization and structure, knowledge integration, and tacit-to-explicit knowledge conversion. They define *application* processes as those oriented toward the use of knowledge. For knowledge to be used, it must be accessible. Knowledge from past mistakes and experiences must be stored for later retrieval and use. Processes for the *protection* of knowledge from inappropriate use or theft must exist in any company that wishes to preserve or generate its competitive advantage. These must include procedures that limit the access to critical knowledge as well as protection policies that are openly communicated to all employees.

Knowledge t ransfer

KM deals with many knowledge processes including k-transfer. According to Wiig (1997), k-transfer had been studied for many years before KM was even termed as a concept (for example, technology and cognitive skills transfer). He indicates that within the past 20 years, an extensive interest has appeared on the topic. Yet, tacit knowledge transfer, content and process, is poorly understood (Foos, Schum, & Rothenberg, 2006). Goh (2005) points out, “it is much harder to grasp what is in peoples’ heads and the real difficulty is figure out how to document, share, and manage it correctly” (p. 11). Conversely, the resource-based view of the firm underlines the importance of transferability of the company’s resources and capabilities as vital in gaining a competitive advantage (Barney, 1986). The transferability is especially important within the firm (Grant, 1996) and organizations that capitalize on knowledge-based assets and drive the most value from them will be the industry winners (Goh, 2005).

The process of k-transfer goes beyond the simple communication process through which knowledge is transmitted. Communication by itself is not sufficient for knowledge sharing; mutual trust and influence must be present for knowledge-sharing success (Nelson & Cooprider, 1996). Trust, early involvement, and due diligence influence the extent of meeting technology transfer expectations (Foos et al., 2006). Moreover, shared knowledge must be successfully absorbed by the receiver (Lane & Lubatkin, 1998). Stated otherwise, it implies the creation of the capabilities of using the knowledge in the client department and hence create value (Argote & Ingram, 2000).

While some would classify absorption as a firm-level mechanism (Rivera, Dussauge, & Mitchell, 2001), it is an integral part of any transfer process (Szulanski, 2000) and involves knowledge utilization (Verkasolo & Lappalainen, 1998). This includes dyadic transfer within a firm whereby “the value of knowledge provided by the sender is realized when the receiver has assimilated the product and put the information to use” (Lin et al., 2005, p. 199) (see also, Darr & Kurtzberg, 2000). This reflects Davenport and Prusak’s (1998) definition: “the transfer of knowledge then involves both the transmission of information to a recipient and absorption and transformation by that person or group” (p. 110). This definition also captures the fact that a k-transfer is a two-way process. It can be broken down into two subprocesses: knowledge distribution from the sender’s point of view and knowledge acquisition from the receiver’s point of view (Bolino, 2002; Huber, 1991; Schulz, 2000). Consequently, a critical success factor to IT projects success lies in the ability to enhance the knowledge base of the recipient (Ayas, 1996). This implies that the ability to affect a k-transfer, where the IT department transfers its knowledge to its client, is vital (Karlsen & Gottschalk, 2003). Specifically, the use of protocols to convert tacit to explicit knowledge may assure an efficient and effective transfer (Herschel, Nemati, & Steiger, 2001). Accordingly, based on the aforementioned and particularly Argote and Ingram (2000) and Ko, Kirsch, and King (2005), we define interdepartmental k-transfer as the process by which a source department within an organization communicates knowledge to a recipient department which absorbs and applies the knowledge.

Knowledge transfer success

A lack of appropriate k-infrastructure can seriously affect a department's ability to successfully transfer knowledge, as well as receive and absorb outside knowledge for its own use (O'Dell & Grayson, 1999). Using proper technology as a transfer medium facilitates the transfer process and its effectiveness (Goh, 2002; Rasmus, 2001). The appropriate technological infrastructure plays an especially critical role in managing codified knowledge by supporting key enabling processes: knowledge search, capture, storage, and presentation (Zack, 1999). A departmental structure that inhibits cross-functional interaction impedes knowledge transfer success (O'Dell, 1998), rendering the implementation of technology solutions problematic (Barki & Hartwick, 2001). K-transfer success also depends in part on the type of organizational culture that the recipient unit possesses (Kostova, 1999). Indeed, the social aspect of KM cannot be overemphasized (Thomas, Kellogg, & Erickson, 2001). A departmental culture that values high participation, interaction, and involvement within the group as well as with other groups will positively influence k-transfer success (DeLong & Fahey, 2000; McDermott & O'Dell, 2001).

Certain key processes allow an entity to successfully absorb knowledge. Without such absorption, a transfer cannot be called successful (Bresman, Birkinshaw, & Nobel, 1999). Part of the acquisition process is the ability to obtain knowledge from an external source. If this process is not present, the transfer will hardly be successful (Byrd, Cossick, & Zmud, 1992). Within the system development context, the customer requirements have to be translated into design specifications. For this task, appropriate knowledge conversion processes must be present. Processes are needed for making the knowledge accessible for effective team member collaboration (Calabrese, 1999) as well as for keeping knowledge up-to-date. Verkasolo and Lappalainen (1998) point out that the efficiency of the k-transfer process depends on the presence and efficiency of subprocesses such as k-acquisition, documentation, transmission, reception, and perception. Thus, the lack of appropriate processes to manage knowledge will impede k-transfer success.

Borrowing from Faraj and Sproull (2000) who assessed the knowledge team performance by its effectiveness and efficiency, we believe that the success of the k-transfer from the IT department toward a non-IT department should also be investigated using the dimensions of effectiveness and efficiency. K-transfer success is defined as the achievement of a desired or intended goal in a process where knowledge is transmitted by one department and is absorbed and applied by a second one (Argote & Ingram, 2000; Darr & Kurtzberg, 2000; Kostova, 1999; Szulanski, 2000). When the knowledge transferred relates to organizational practices, the effectiveness of k-transfer can be judged based on the value attached to the knowledge by the recipient unit. A successful knowledge transfer process is one that is both effective (Argote et al., 2000; Goh, 2002) and efficient (Verkasolo & Lappalainen, 1998), that is, the knowledge is properly transmitted and used (effectiveness), using minimal resources (efficiency).

r ese Arch Model

This research investigates the relationship between an IT department's KM capabilities and the success of knowledge transfer during an IT project. More specifically, our study aims at answering the following question as shown in Figures 1a and 1b:

Are KM capabilities of an IT department related to the success of knowledge transfer to non-IT department during an IT project?

Our unit of measure is the IT department that, using its members' expertise, prepares a response to a customer department need. Thus, we measure the IT department manager's perception of its KM capabilities and the success of k-transfer to client departments. We also measure the perception of the customer department regarding k-transfer success. We hypothesize that an IT department that is KM-capable that is, has technological, structural, and cultural capabilities as described in this research, will be successful in k-transfers.

Our models are an adaptation of the Gold et al. (2001) model. Based on past literature, positive relationships between the independent and dependent variables are expected. The general research model (Figure 1a) addresses the link between the two types of knowledge capabilities and the knowledge transfer success, whereas the detailed research model (Figure 1b) addresses the four possible links between the two types of knowledge capabilities and both the effectiveness and the efficiency of the knowledge transfer success.

Knowledge Infrastructure and Knowledge t ransfer s uccess

Our first hypothesis implies that without the proper technological, cultural, and structural infrastructures, k-transfer will not be successful.

H1: K-infrastructure capabilities are positively related to the k-transfer success.

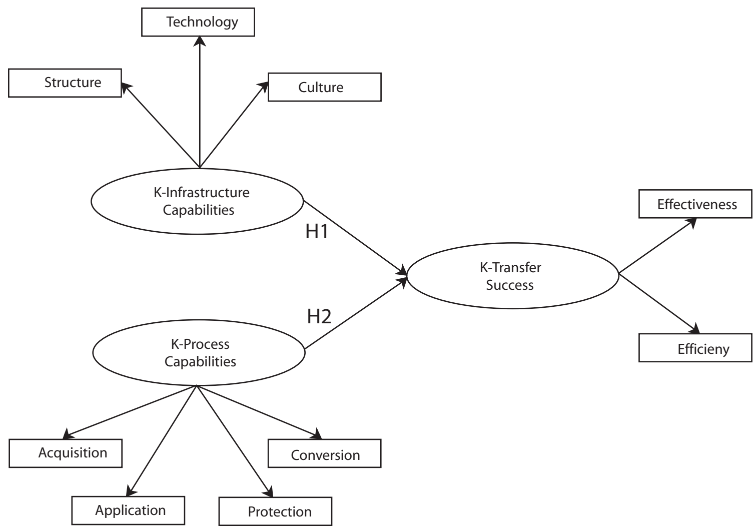
This hypothesis can be further broken down into two parts. Technology, structure, and culture are all enablers of effective and efficient k-transfer (Goh, 2002). First, with regards to effectiveness, the use of appropriate technologies will facilitate k-transfer. A structure that encourages horizontal communication and cross-functional teams, while providing a reward system that recognizes knowledge sharing, will further enhance the effectiveness of k-transfer. Culture is one of the most important elements for effective k-transfer in IT projects (Karlsen & Gottschalk, 2004). A strong, cooperative and collaborative culture will create the necessary trust for k-transfer to take place. Second, the efficiency of k-transfer can be greatly affected by the cultural values of the recipient unit. If the recipient is resistant to change or lacks motivation to collaborate, the transfer process is likely to be problematic. The term "fertile" organizational context can be used to describe one that has the appropriate values, incentive systems, and support for efficient k-transfer (Szulanski, 2000). Standardized IT infrastructure has already been successfully linked to efficiency of operations and processes (Ross, 2003), whereas technology and culture were positively related to both efficiency and effectiveness of k-transfer (Syed-Ikhsan & Rowland, 2004).

H1a: K-infrastructure capabilities are positively related to the effectiveness of k-transfer.
H1b: K-infrastructure capabilities are positively related to the efficiency of k-transfer.

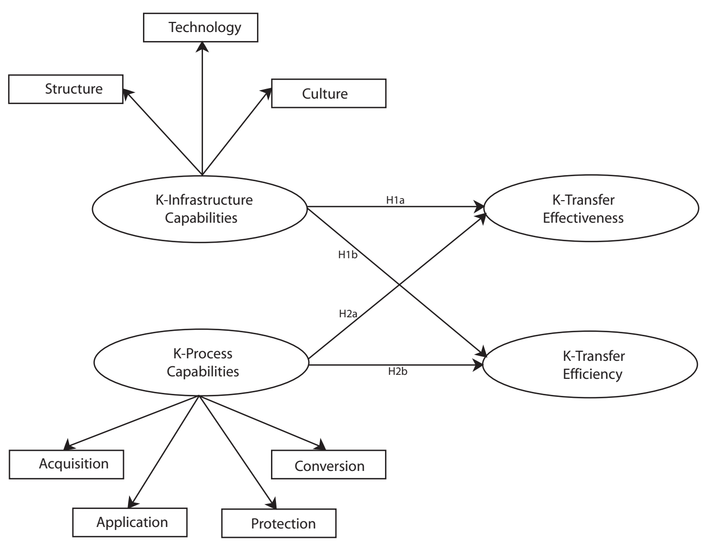
Knowledge processes and Knowledge t ransfer s uccess

Just as k-transfer cannot be successful without a proper infrastructure, neither can it be successful without certain basic KM processes. k-transfer is but one of many essential business processes

Figure 1.



a. General research model



b. Detailed research model

which are closely interlinked. It is not enough to transfer knowledge; its active management will ensure its effective use. It must be kept up-to-date, converted into appropriate formats, distributed to those concerned, protected, applied to related problems, and organized for efficient retrieval. These processes support K-transfer and without them we cannot expect the transfer to be successful. Thus, our second hypothesis:

H2: K-process capabilities are positively related to the k-transfer success.

An organization cannot accomplish certain critical processes if it does not possess the necessary capabilities. The success of k-transfer should increase if the transfer is strongly supported by k-process capabilities. Processes have direct bearing on operational efficiency and organizational effectiveness (Kallio, Saarinen, & Tinnila, 2002). Knowledge is an important organizational resource and a company can utilize it only with the presence of proper knowledge processes (Davenport, Jarvenpaa, & Beers, 1996). Thus, we posit:

H2a: K-process capabilities are positively related to the effectiveness of k-transfer.
H2b: K-process capabilities are positively related to the efficiency of k-transfer.

Measurement

The k-infrastructure capabilities and k-process capabilities constructs replicate the Gold et al. (2001) model but in a different context, that is in IT projects. The authors originally tested organizational KM capabilities with relation to organizational effectiveness. This research will test KM capabilities on a departmental level of analysis and in a context of knowledge transfer success. K-transfer success is to be tested as a new construct in this research. In our model, the k-infrastructure capabilities construct is a second order factor (latent construct) composed of three first-order factors: technological, structural, and cultural infrastructures. The k-process capabilities construct is also a second-order factor composed of four first order factors: acquisition, conversion, application, and protection processes.

The purpose of k-transfer is to allow the receiver to generate value with the new knowledge that it was not able to generate before (Bozeman & Rogers, 2001). The dependent variable, k-transfer success is a second-order factor defined by effectiveness and efficiency. First, a k-transfer process is effective if knowledge sent corresponds to knowledge received. An effective process is one that considers customer requirements and whose end product corresponds to original expectations and satisfies the user. User satisfaction with the system is one of the criteria by which the success of k-transfer is judged (Garrity & Sanders, 1998) because it allows an evaluation of whether the receiver of knowledge (1) received the right knowledge, (2) correctly interpreted it, and (3) correctly applied it (DeLone & McLean, 1992). Second, the k-transfer process is efficient if it is timely and does not create problems in the client department. An efficient process is one that respects its schedule (Verkasolo & Lappalainen, 1998) and involves a minimal number of problems in its duration (Szulanski, 2000). A first proxy to measure the efficiency of k-transfer is the time requirements of the process (Jacob & Ebrahimpur, 2001). A second proxy for the efficiency of k-transfer is its stickiness (Szulanski, 2000). Stickiness refers to the difficulties experienced during the transfer process and is often communication related.

In this research, the k-infrastructure capabilities and k-process capabilities constructs are operationalized based on Gold et al. (2001) whereas the k-transfer efficiency is operationalized based on Franz and Robey (1986); Doll and Torkzadeh (1988), and Kostova (1999). For k-transfer effectiveness, the items from by Szulanski (2000) and Verkasolo and Lappalainen (1998) are used.

Data Collection

Interdepartmental IT projects were selected because they present an opportunity to study a cross-functional k-transfer process. Since effective communication and understanding may be relatively difficult to achieve in such contexts, there is a need to establish what elements of KM capabilities will increase k-transfer success. IT projects are also transactional, that is, projects requiring two parties—one acting as supplier, the other as customer of the end product. As discussed earlier, such a view is appropriate for the study of k-transfer.

A pre-test was conducted with four IT practitioners and resulted mainly in editorial corrections to the instrument. An introductory message providing the links to the online survey was sent by e-mails to the 2,425 IT managers in our sample. To identify them, we relied on the list of 3,281 companies in the Canadian Capabilities Directory. Although not all firms in the directory listed e-mail addresses, 2,425 firms met our criteria, that is, to ensure (sizeable) IT departments, we used medium-sized firms or larger (50 employees or more). Our survey contained two Web links: one with questions appropriate to providers, that is, IT managers, the other for the customer department managers, that is, those department managers who received an IT solution within the last year from the IT department. We requested the firm contact, the IT manager, to forward the link to part of the questionnaire (the items for the dependent variable and satisfaction) to at least one customer department for which the project had been completed. Both IT and non-IT managers were asked to base their answers on a "typical" project that was implemented during the last year. To this end, the IT managers were asked to complete the full questionnaire, which allows us to measure their departments' capabilities and their perception of k-transfer success. Respondents from the customer department were asked to complete only the part of the questionnaire pertaining to their perception of k-transfer success. Two weeks after the initial mailing, 51 usable responses had been received. A reminder was sent which was followed by 76 complete surveys.

Analysis and Results

A total of 127 usable questionnaires, representing a good cross-section of the population, were received. Although the majority of the respondents came from the heavily populated province of Ontario, there were respondents from 8 out of the 10 Canadian provinces. While 30% of the respondents were from the manufacturing industry, the balance was spread evenly among service industries, such as communications and media, finance, insurance and real estate, construction, and wholesale. Regarding firm size, 19% of the sample had less than 100 employees, 37% between 101 and 500 employees, and 44% were large enterprises.

As suggested by Armstrong and Overton (1977), nonresponse bias was assessed by performing t-tests between the initial and the latest waves of respondents. More specifically, the 21 IT managers and 30 customer department managers who had completed the survey in the first week were considered early respondents. The 30 IT managers and 46 customer department managers who completed the survey after the reminder was sent were considered late respondents. The t-tests between early and late respondents were not significant on any variable under study.

The research model was analyzed using PLS, a second-generation multivariate technique permitting the validation of the psychometric properties of the scales used, as well as the strength and direction of the relationships among variables (Cassel, Hackl, & Westlund, 1999). Performing structural equation modeling with PLS requires two major steps: (1) assessment of the measurement model by investigating both convergent and discriminant validity and (2) assessment of the

Table 1. K-Infrastructure capabilities discriminant validity (CFA)

	Technological	Cultural	Structural
Technological (ρ=0.88)	0.46		
Cultural (ρ=0.91)	0.44	0.45	
Structural (ρ=0.85)	0.35	0.46	0.45

Table 2. K-Process capabilities discriminant validity (CFA)

	Acquisition	Conversion	Application	Protection
Acquisition (ρ=0.94)	0.62			
Conversion (ρ=0.96)	0.53	0.67		
Application (ρ=0.90)	0.54	0.38	0.52	
Protection (ρ=0.94)	0.27	0.26	0.16	0.66

Table 3. Loadings and shared loadings for k-infrastructure capabilities[3]

	Scanning	Facilitate	Sharing	Standard	Learning	Collaborate	Rewards
TI11	0.83	0.33	0.27	0.44	0.33	0.35	0.19
TI12	0.87	0.35	0.34	0.46	0.33	0.56	0.32
SI09	0.80	0.13	0.10	0.32	0.28	0.09	0.23
SI10	0.88	0.40	0.37	0.36	0.44	0.46	0.31
SI2	0.37	0.72	0.09	0.24	0.15	0.45	0.18
SI3	0.32	0.84	0.43	0.34	0.51	0.42	0.45
SI4	0.25	0.82	0.36	0.15	0.47	0.40	0.34
SI7	0.22	0.72	0.32	0.08	0.19	0.27	0.28
SI11	0.19	0.67	0.34	0.11	0.24	0.40	0.04
CI7	0.14	0.33	0.76	-0.09	0.41	0.25	0.18
CI8	0.30	0.29	0.84	0.07	0.35	0.37	0.01
CI11	0.25	0.36	0.83	0.07	0.31	0.50	0.29
CI12	0.33	0.32	0.70	0.31	0.27	0.38	0.26
TI1	0.49	0.32	0.16	0.90	0.30	0.32	0.40
TI2	0.20	0.13	0.03	0.84	0.09	0.30	0.20
TI3	0.50	0.16	0.07	0.79	0.04	0.10	0.21
CI4	0.47	0.34	0.30	0.35	0.88	0.31	0.29
CI5	0.16	0.46	0.46	-0.03	0.72	0.19	0.34
CI6	0.36	0.28	0.32	0.09	0.87	0.23	0.26
TI4	0.34	0.40	0.32	0.26	0.27	0.88	0.18
TI5	0.49	0.34	0.39	0.34	0.39	0.86	0.16
TI6	0.27	0.57	0.52	0.12	0.08	0.78	0.20
SI5	0.33	0.29	0.27	0.26	0.35	0.19	0.95
SI6	0.26	0.38	0.18	0.36	0.32	0.22	0.95

Table 4. Loadings and shared loadings for k-process capabilities [4]

	Acquisition	Conversion	Protection	Application
ACP2	0.81	0.62	0.50	0.62
ACP3	0.80	0.39	0.31	0.52
ACP5	0.83	0.62	0.37	0.52
ACP6	0.77	0.52	0.17	0.54
ACP8	0.85	0.53	0.45	0.63
ACP9	0.77	0.44	0.45	0.59
CP1	0.50	0.83	0.53	0.26
CP4	0.58	0.84	0.31	0.48
CP5	0.61	0.91	0.54	0.46
CP9	0.62	0.76	0.27	0.58
AP1	0.50	0.88	0.49	0.28
AP2	0.53	0.86	0.38	0.48
AP3	0.44	0.76	0.41	0.29
AP4	0.61	0.82	0.35	0.50
ACP1	0.43	0.81	0.51	0.21
PP1	0.33	0.38	0.89	0.26
PP2	0.42	0.42	0.83	0.34
PP3	0.41	0.44	0.96	0.29
PP4	0.45	0.45	0.92	0.26
PP5	0.41	0.52	0.88	0.19
PP7	0.46	0.51	0.83	0.29
AP7	0.55	0.29	0.22	0.91
AP8	0.57	0.35	0.22	0.89
AP11	0.65	0.41	0.39	0.86
CP7	0.68	0.61	0.22	0.78

Table 5. Loadings and shared loadings for k-transfer success [5]

	Effectiveness	Efficiency
KS1	0.77	0.56
KS2	0.86	0.58
KS3	0.76	0.50
KS4	0.61	0.85
KS5	0.32	0.57
KS6	0.53	0.80
KS7	0.48	0.65

Table 6. K-Infrastructure capabilities discriminant validity (EFA)

	Scanning (ρ=0.91)	Facilitate (ρ=0.87)	Sharing (ρ=0.86)	Standard (ρ=0.88)	Learning (ρ=0.87)	Collaborate (ρ=0.88)	Rewards (ρ=0.95)
Scanning	0.72						
Facilitate	0.13	0.57					
Sharing	0.11	0.17	0.62				
Standard	0.22	0.06	0.01	0.71			
Learning	0.17	0.18	0.18	0.03	0.68		
Collaborate	0.19	0.26	0.23	0.08	0.09	0.71	
Rewards	0.10	0.13	0.05	0.11	0.12	0.05	0.90

Table 7. K-Process capabilities discriminant validity (EFA)

	Acquisition (ρ=0.92)	Conversion (ρ=0.95)	Application (ρ=0.92)	Protection (ρ=0.96)
Acquisition	0.65			
Conversion	0.42	0.69		
Application	0.50	0.22	0.74	
Protection	0.22	0.26	0.10	0.79

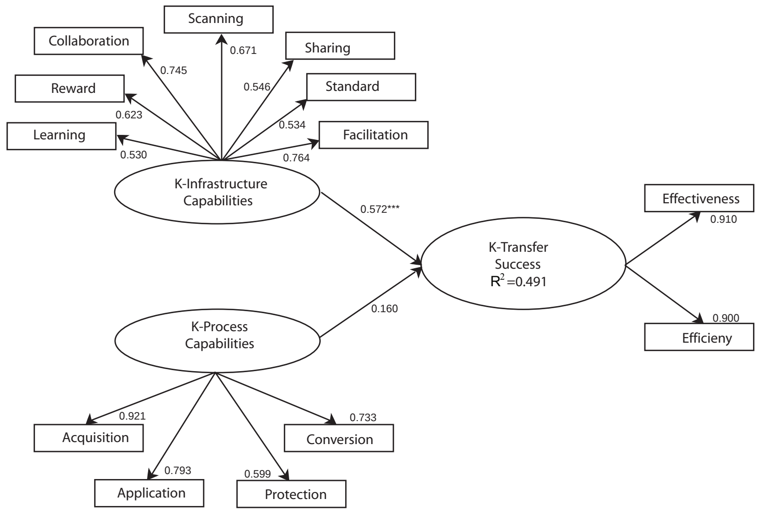
Table 8. K-Transfer success discriminant validity (CFA)

	Effectiveness (ρ=0.79)	Efficiency (ρ=0.71)
Effectiveness	0.66	
Efficiency	0.45	0.53

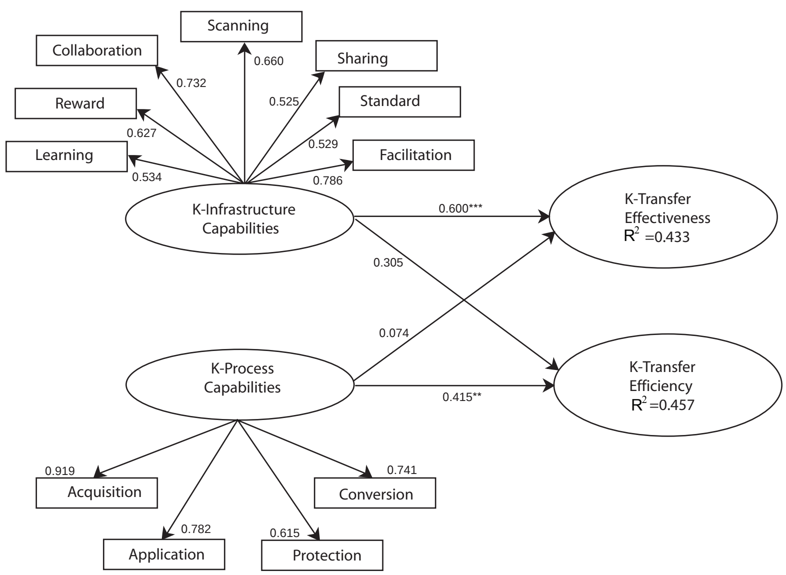
Table 9. Descriptive data of the final model assessment

	Min	Max	Median	Mean	Std. Dev.
Technological Scanning	1	7	5.00	4.82	1.22
Facilitation Mechanism	4	7	5.40	5.33	0.79
Culture of Sharing	4	7	6.00	5.84	0.81
Establishment of Standards	1	7	4.67	4.70	1.16
Culture of Learning	3	7	6.33	6.13	0.78
Collaboration Technology	2	7	5.00	4.96	1.20
Systems of Rewards	1	7	3.50	3.65	1.82
Acquisition	2	7	5.17	4.94	1.19
Conversion	2	7	5.78	5.52	0.96
Application	1	7	5.33	5.02	1.23
Protection	2	7	6.00	5.55	1.38
Effectiveness	4	7	6.00	5.73	0.80
Efficiency	3	7	5.50	5.46	0.76

Figure 2.



a. Tested general model



b. Tested detailed model

structural model, which reveals the item loadings and path coefficients measures (Hulland, 1999; Thompson, Higgins, & Howell, 1991). The computer program used for this analysis was PLS Graph 2.91 developed by Chin and Frye (1995).

The measurement model assessment began by using confirmatory factor analysis (CFA). It is first achieved by keeping constructs with reliability values higher than 0.70 (Hulland, 1999; Nunnally, 1967). The ρ coefficient (rho[1]) is used to verify this criterion. All k-process, k-infrastructure, and k-transfer success rho values were above 0.70, ranging from 0.79 to 0.96 (see Tables 1, 2, and 8). Convergent validity is then evaluated by calculating the average variance extracted (AVE[2]), which should be higher than 0.50 (Fornell & Larcker, 1981). Results as indicated in Table 1 shows that this threshold was not met for the k-infrastructure capabilities construct. The last assessment step to be conducted is the discriminant validity used to verify if each construct is unique. AVE should have a higher value than the shared variance between each construct (Compeau, Higgins, & Huff, 1999). This criterion was not met for both the k-process capabilities and the k-infrastructure capabilities constructs (see Table 1 and Table 2).

Because the discriminant validity of certain constructs was not confirmed, an exploratory factorial analysis (EFA) was conducted for k-infrastructure and k-process constructs respectively. Using SPSS, the factorial analysis produced seven factors with a total of 21 items for k-infrastructure capabilities and four factors with 25 items for the k-process capabilities. All the necessary steps to assess the new model were followed and produced satisfactory results. Loadings and shared loadings are indicated in Tables 3 to 5. Note that both ρ values and AVE values are now above minimum thresholds as indicated in Tables 6 to 8.

Following the model assessment, the final descriptive data for each construct are provided in Table 9.

PLS graph was used to assess the structural model (Figures 2a and 2b). The analysis was twofold. First, the general model was assessed to test for Hypotheses 1 and 2. Then, a separate model was analyzed in order to test Hypotheses 1a, 1b, 2a, and 2b. The path coefficients were calculated using the PLS Jack-Knife procedure (Wildt, Lambert, & Durand, 1982). All the independent and dependent variables were assessed as second-order factors in the general model.

As depicted in Figure 2a, hypothesis 1 tested for a positive relationship between k-infrastructure capabilities and k-transfer success. This relationship was confirmed (path Coefficient = 0.572, $p<0.001$). Hypothesis 2 tested for a positive relationship between k-process capabilities and k-transfer success. This relationship was not confirmed (path Coefficient = 0.160). Almost 50% of the k-transfer success is explained by the contribution of the k-infrastructure capabilities ($R^2 = 0.491$).

The second analysis was performed to test the sub-hypotheses (Figure 2b). K-infrastructure and k-process constructs were tested in a direct relationship with k-transfer efficiency and effectiveness. Efficiency and effectiveness were assessed as first-order factors while k-infrastructure and k-process capabilities were tested as second-order factors.

Hypothesis 1a tested for a positive relationship between k-infrastructure capabilities and k-transfer effectiveness. This relationship was confirmed (path coefficient = 0.600, $p<0.001$). Hypothesis 1b tested for a positive relationship between k-infrastructure capabilities and k-transfer efficiency. This relationship was not confirmed. Hypotheses 2a tested for a positive relationship between k-process capabilities and k-transfer effectiveness. This relationship was not confirmed. The last subhypothesis (2b) was confirmed with a positive relationship between k-process capabilities and k-transfer efficiency (path coefficient = 0.415, $p<0.01$).

dIscuss Ion

The overall results indicate that even if only the k-infrastructure capabilities lead to k-transfer success, it still explains close to 50% of variance of the dependent variable. This reflects the position of Sambarmuthy, Bharadway, and Grover (2003) and Ross (2003) who indicate that firms need proper, well integrated, and standardized technological infrastructure to grow and reach some organizational flexibility and agility. Without the necessary technological resources, it is therefore difficult for firms to help employees to successfully exchange some of their knowledge about a specific project.

Our results also suggest that both aspects of KM capabilities play an important role in ensuring the success of k-transfer, namely its efficiency and effectiveness. The tests for our subhypotheses have shown that KM capabilities have a significant impact on the particular aspects of k-transfer. Specifically, k-process capabilities contribute to k-transfer efficiency and k-infrastructure capabilities contributes to k-transfer effectiveness. A k-transfer is said to be efficient if it is timely and involves a minimal number of problems. This can only be achieved if the processes, upon which k-transfer depends, function smoothly. We can say that if an IT department has such processes in place, it is in a better position to efficiently deliver IT solutions to its clients. Whether these solutions will correspond to the original client demands (effectiveness), will be largely determined by the presence of k-infrastructure elements within the IT department. Namely, whether its culture and structure promote sharing and collaboration, and whether it has technology that enables collaboration and new opportunity generation.

Interestingly, k-infrastructure capabilities did not prove to significantly contribute to k-transfer efficiency. Infrastructure elements can be viewed as a set of tools and enablers for k-transfer (Goh, 2002). They do not however guarantee its efficiency. Our survey verified the presence of infrastructure elements, but not the extent and modes of their application. Similarly, k-process capabilities did not prove significant with respect to k-transfer effectiveness. This was an unexpected result. Certainly, processes have an important bearing on improving efficiency (Kallio et al., 2002). We can speculate that in cases where firms did have k-processes capabilities in place and were not able to achieve k-transfer effectiveness, these processes may have been either improperly implemented or badly managed.

In interpreting our results, some limitations have to be kept in mind. For one, the response rate is low due to the following reasons. First, because we used an online survey, concern for spam and e-mail security may have contributed to the low response rate. Second, Canadian law restricts corporate lists from public provision and therefore we used the *Canadian Capabilities Directory,* a registry of voluntary association. This informal structure behind the directory may also have contributed to the low response rate. Third, the questionnaire and the Canadian Capabilities Directory existed solely in English, a fact that surely limited response from Canada's second largest province, French-speaking Quebec. Moreover, we asked the respondents to consider an inter-departmental project that had been completed within the last year. This obviously limits the number of eligible respondents.

Fifty-four IT managers and managers from 73 of their customer departments provided the 127 usable responses. Because the IT department respondent was asked to direct the appropriate part of the questionnaire to the customer departments, there is the possibility of a bias in favor of satisfied customer departments. If this is the case, the "selected" customer departments would however have been perceived as "satisfied" by the IT respondent. Our survey did not include a control check in this regard.

Contributions and Research Avenues

The main academic contribution of this research is that it is one of the few that has empirically measured the success of k-transfer. Although several models were proposed for measuring k-transfer success, to our knowledge we are the first to design an instrument that combines proposed measurements of efficiency and effectiveness into one construct, *interdepartmental* k-transfer success. The statistical results have shown it to be both valid and reliable. We also have learned that measuring k-transfer success only would not have provided us with enough information on the impact of k-process capabilities. Indeed, the general research model showed a nonsignificant link between these two constructs whereas the detailed research model indicated that the k-process capabilities are positively related to the efficiency aspect of k-transfer success but not to its effectiveness.

The model assessment of KM capabilities showed that each construct had to be revisited, more specifically the k-infrastructure capabilities construct. Because the technology, culture, and structure subconstructs were redistributed as seven new subconstructs, our results suggest that these new components are more precise and better indicators of a department's k-infrastructure capabilities than the original components (e.g. technology, culture, and structure) (See Table 3). Each of the new subconstructs, except technological scanning, was related to only one of the original scales. This is another contribution of this research since our revised k-infrastructure capabilities construct is more detailed and provides practitioners with even more specific guidelines than did the original construct. As such, IT managers' attention is directed at specific technological, cultural, and structural components of their k-infrastructure capabilities. Focussing on each of them instead of on the whole picture should help them to identify weaknesses and problems much more easily and quickly. This identification will enable them to rely on the appropriate actions and mechanisms to improve their capabilities which will, in turn, lead to more effective k-transfer during their IT projects.

In addition, our results show that both aspects of KM capabilities are needed to make k-transfer effective and efficient. More specifically, managers should keep in mind that k-infrastructure capabilities must be put in place and used properly if they want to increase the effectiveness of k-transfer. On the other hand, if the main objective is to enhance the efficiency of k-transfer, managers must put more efforts on developing strong k-process capabilities related to the acquisition, conversion, application, and protection of knowledge.

Replications of our study are needed to further our understanding of the mechanisms and key factors involved in successful k-transfer within organizations. Larger samples would allow for more flexible analyses and further assessment of the reliability and validity of our model. They would also allow for the examination of the effect of departmental subcultures within organizations, which potentially play a role in success of k-transfers. It would be interesting to investigate whether different processes and infrastructure elements would play a more or less critical role in k-transfer success.

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endnotes

[1] $\rho = (\Sigma|\lambda_i|)^2 / (\Sigma|\lambda_{i|})^2 + \Sigma(1-\lambda_i^2)$ where λ_i is the loading for factor i.

[2] AVE = $\Sigma\lambda i2 / (\Sigma\lambda_i^2 + \Sigma(1-\lambda_i^2))$ where λ_i is the loading for factor i.

[3] Note that each indicator was labelled as follows: TI—technological infrastructure, SI—Structural infrastructure, and CI—Cultural infrastructure. The legend for the new constructs of k-infrastructure capabilities is the following:

Scanning	Technological Scanning
Facilitate	Facilitation Mechanism
Sharing	Culture of Sharing
Standard	Establishment of Standards
Learning	Culture of Learning
Collaborate	Collaboration Technology
Rewards	Systems of Rewards

4 Note that each indicator was labelled as follows: CP—Conversion process, PP—Protection process, AP—Application process, and ACP—Acquisition process.

5 Note that each indicator was labelled as follows: KS – Knowledge success.

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Chapter XIII
Improving KMS Acceptance:
The Role of Organizational and Individuals' Influence

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Abstr Act

The purpose of this chapter is to contribute to the improvement of the acceptance of information systems (IS) devoted to the codification and sharing of knowledge (a type of knowledge management systems [KMS]). A research model was developed through a multi-staged, multi-method research process and its test supports the hypotheses that the acceptance of KMS is determined, in addition to the classical constructs of the technology acceptance model (TAM), by a few organizational factors, and by the influence exerted on the user by individuals close to her/him.

Introduct Ion

The topics of knowledge management (KM) and KMS are among the most popular topics in the IS field with recent years yielding a number of reviews of the literature and taxonomies of KMS (Alavi & Leidner, 2001; Argote, McEvily, & Reagans, 2003; Jennex, 2006; Jennex & Olfman, 2004; Liao, 2003; Maier, 2002; Malhotra, 2004; Muscatello, 2003; Sambamurthy & Subramani, 2005; Wickramasinghe, 2003). Far from sharing a common viewpoint regarding to what extent and under which hypotheses KMS represent an actual support to organizational processes, researchers and practitioners in the KMS field recognize a number of issues that need to be studied. From the academic standpoint, Argote et al. (2003) and Sambamurthy Subramani (2005) have identified a set of emergent issues for the future of research on KM and KMS. They emphasize social relations in understanding knowledge creation, retention and transfer (Argote et al., 2003) and the role of IT to facilitate the efficient and effective development of communities of practice (CoP) (Sambamurthy & Subramani, 2005). They also point out the need to shift the interests of academia from single to multiple relations dealing with the KM process. The complementary practitioner view has been effectively synthesized by Smith and McKeen (2003) who have collected opinions and expectations of chief knowledge officers (CKO). CKOs are confident that the development of KMS has come to a turning point, where investments in implementation of new KM tools and methodologies should be replaced by initiatives aiming at measuring and maximizing the return on the investments (both in the organizational structure and in information and communication technologies [ICT]) that companies made in the past (Folkens & Spiliopoulou, 2004; Smith & McKeen, 2003).

Such indications suggest concentrating the efforts of research towards the achievement of a better and eventually a more complete understanding of the factors that influence the effectiveness and efficiency of a KMS. To this end, adopting a widely accepted definition of KM is a prerequisite. In this work we use the Alavi and Leidner (2001) KM definition which envisions KM as a process and the KMS as the specific IS which supports the organizational KM processes of creation, storage, diffusion, and application of knowledge. This definition fits our study for two reasons. First, it is compatible with those provided in relevant publications about KMS (Grover & Davenport, 2001; Hansen, 2002; Lai, Ong, Yang, & Tang, 2005; Money & Turner, 2005; Ong, Lai, Wang, & Wang, 2005; Schultze & Leidner, 2002; Xu & Quaddus, 2004, 2005). Second, it can be used to classify KMS applications according to their main purpose: (1) to code and share knowledge, (2) to create corporate knowledge directories, and (3) to create knowledge networks (Alavi & Leidner, 2001).

This chapter refers to the first category of KMS, therefore its general aim is to contribute to the improvement of the effectiveness of those KMS devoted to the codification and sharing of knowledge. In order to do so, a multi-staged, multi-method research has been carried out, combining a theoretical analysis with an empirical investigation, structured in a preliminary qualitative and a subsequent quantitative research that allowed to design and test a research model.

t he c onceptual f ramework of the s tudy

The aforementioned general objective of studying the effectiveness of a KMS can be translated to the objective of studying the acceptance of a KMS. The IS literature is rich in works on IS acceptance (Legris, Ingham, & Collerette, 2003; Money & Turner, 2005; Van der Heijden, 2004; Venkatesh, Morris, Davis, & Davis, 2003), which has often used the concept of IS usage (Money & Turner, 2005; Venkatesh et al., 2003) measured using either self-reported or objective data.

Money and Turner (2005) consider user acceptance and usage crucial to determining KMS success and acceptance, but not amount of KMS use. Additionally, Jennex (2005) further proposes that KMS success is not based on the amount of system use but more importantly on the intention to use the KMS as a measure of KMS success.

A further assessment is performed by Jennex and Olfman (2005), as they review the fitness of different success models in the context of KM and they conclude highlighting the multi-dimensionality of IS success, as proposed by DeLone and McLean (1992).

Our focus nevertheless remains on the acceptance of the KMS, and therefore we investigate the KMS usage and not the KMS success.

An important contribution to this subject is represented by a research on the role of computer-aided systems for the organizational learning (Goodman & Darr, 1998). In that study, IS usage is defined as a process with two stages: (1) the *nourishment* (data entry and updating) of the IS, carried out through the formalization of solutions and best practices and the contribution of such formalization into the IS; (2) the *utilization* (in its narrow sense) of the IS, that is, the consultation of the IS and the application of the solutions provided by the system. The present work is based on this approach and focuses it on KMS and the first stage of IS usage: contribution, while the aforementioned study of Money and Turner (2005) focuses only on utilization, the second stage.

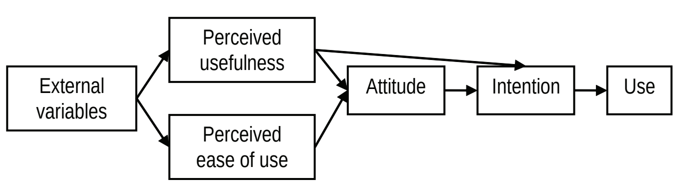
The concept of IS usage (and, thus, of KMS usage) is widely accepted, through TAM, as a condition for system acceptance; however, identifying the determinants of such acceptance is a more challenging task. Not surprisingly, the quest for the determinants of IS usage can be found in the IS literature since its early days and has been the subject of many researches (Adams, Nelson, & Todd, 1992; Davis, 1989; Fishbein & Ajzen, 1975; Khalil & Elkordy, 2005; Money & Turner, 2005; Moon & Kim, 2001; Moore & Benbasat, 1991; Taylor & Todd, 1995; Van der Heijden, 2003; Venkatesh et al., 2003).

Determinants of IS Usage: Beyond the Technology Acceptance Model

Among the different research models developed in the attempt to understand IS usage, the most well known is the TAM. TAM, whose roots lie in the Fishbein and Ajzen's (1975) theory of reasoned action (TRA), was developed by Davis (1989), who aimed at minimizing the number of factors used to explain IS usage while preserving the generality of the model (Figure 1). This approach has been proving effective in a number of different organizational contexts and for studying different types of computer-based systems (Legris et al., 2003), including also some research specifically on KMS (Lai et al., 2005; Money & Turner, 2005; Ong et al., 2005; Xu & Quaddus, 2004, 2005).

It is questionable whether the application of a model—although it has proven to be general—can be extended to any type of IS. This general issue appears even more critical considering the differences between KMS (specifically, those

Figure 1. The technology acceptance model (TAM) in its original formalization (Davis, 1989)



KMS under investigation in this study) and other IS. Money and Turner (2005) suggest TAM can serve as a basis for future investigation of KMS user acceptance while cautioning that other factors associated with the complex sociocultural organizational implications of KMS must be explored.

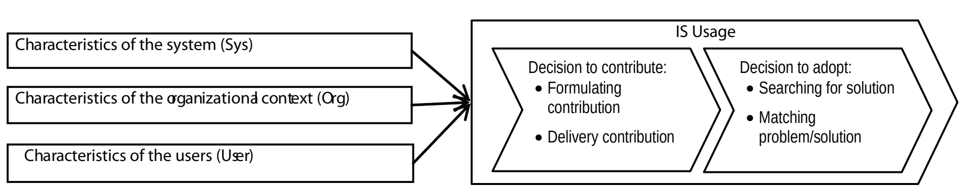
A central aspect of a KMS (and especially of a KMS of the first type with respect to Alavi & Leidner, 2001), is the voluntariness of usage of the system, combined with the presence of network effects within the organization. As an example, systems like ERPs support transactions and/or managerial activities: once in place they become the exclusive tool for the activities of a user. Thus, the question is *how* this tool should be used, and not *if* it should be used. On the contrary, the contribution to a KMS does not necessarily substitute a corresponding activity performed without the support of IT: this allows an individual to avoid KMS usage, and it is evident that the solution of making the contribution mandatory would critically affect the relevance of the contents of the contribution. On the other hand, if the amount of high quality contributions available through the KMS reaches a critical mass, then the cost/benefit ratio of each contribution becomes a strong incentive to KMS usage.

These concerns led us to question the assumption that TAM was the appropriate model for this study. An alternative was Thompson, Higgins, and Howell's (1991) model for IS utilization in volitional contexts, which has been adapted and applied in KMS contexts by Jennex and Olfman (1998, 2006). Alternatively, other authors used the TAM in volitional contexts, in IS (Venkatesh, 2000; Taylor & Todd, 1995) and specifically in KMS contexts (Money & Turner, 2005). We choose to base our model on the TAM and its extensions in voluntary contexts.

The research that extended the TAM including voluntariness to contribute as a moderating variable (Moore & Benbasat, 1991; Venkatesh & Davis, 2000; Venkatesh et al., 2003) still appears too generic to represent the characteristics of a KMS as mentioned previously. Thus, the conceptual framework of this study is based on a literature review that went beyond the various versions of TAM in the attempt to identify a complete set of factors influencing IS usage. Although the works published in this field in the past two decades are very heterogeneous in the approaches and in the specific subject of the research, it is possible to group the factors into three sets (Figure 2).

- Factors related to the **characteristics of the system**. These factors mainly derive from the various works based on the TAM where the model has been adapted by widening the set of determinants of IS usage related to the characteristics of the system itself. However, even those works aspiring to completeness (Agarwal, Krudys, & Tanniru, 1997; Moore & Benbasat, 1991; Tornatsky & Klein, 1982; Venkatesh et al., 2003) failed in achieving a common standpoint on a large set of factors and converged only on the two factors representing the core of the original TAM: the *perceived usefulness* and the *ease of use*.

Figure 2. The conceptual framework of the research. Adapted from (Goodman & Darr, 1998).



- Factors related to the **characteristics of the organizational context** where the system is used. It is commonly accepted that the same technology adopted in two different contexts can generate effects significantly different. ICT proves this general rule: the characteristics of the organizational context and the work environment, play a determinant role in the usage of an IS (Goodhue & Thompson, 1995; Janz & Prasarnphanich, 2003; Markus, 1994; Tyre & Orlikowski, 1994; Venkatesh et al., 2003).
- Factors related to the **characteristics of the users** of the system. The third set of determinants of IS usage deals with factors that specifically characterize the users of the system. The comportamentist approach adapted to the IS field aims at explaining users behaviors essentially through the characteristics (cognitive and affective) of the individual. In particular, the TAM, following this approach, suggests the users' *attitudes toward usage* and users' *behavioral intentions* as factors relevant to explain IS usage (Taylor & Todd, 1995; Venkatesh et al., 2003).

t he Qualitative s tudy

The three sets of characteristics (each described by a large set of factors) and their relationship with IS usage represented the conceptual framework of our study. A qualitative exploratory study was carried out in accordance with Miles and Huberman (1994) to validate and refine the framework with regards to its specific context of application (i.e., the KMS) and to its specific factors, influencing the KMS acceptance. Semi-structured interviews were carried out on a set of CKO in large French companies. We developed a guide for the interviews using five sections: characteristics of the respondent, description of the KMS of the organization, objectives planned and results achieved by the KMS, description of the use of the KMS, and factors perceived as obstacles and enablers to KMS usage. The selection of the CKOs was based on the analysis of the French professional press and conference proceedings regarding KM. Thirteen interviews were carried out within 12 organizations. Transcripts of seven interviews were generated and analyzed according to the method of the analysis of contents (Bardin, 1977; Berelson, 1952). The others interviews were not transcribed because the CKOs did not allow us to record them.

The qualitative study supports the overall structure of the conceptual framework. CKOs reported that the contribution to a KMS is significantly influenced by factors belonging to all three sets of factors. However, interviews identified a limited number of factors that were indicated as more relevant and became the constructs of the research model described in the next paragraph.

t he r esearch Model

The qualitative study supports that TAM, in its most general representation, can be applied to the context of the *contribution to a KMS* as a specific case of *IS usage*. In other words, among all the factors in the conceptual framework, those belonging also to the TAM were indicated as particularly relevant. This result is consistent with previous research that extends KMS' acceptance and usage to the domain of applicability of TAM (Money & Turner 2005).

However, the interviews highlighted the importance of contribution for measuring success and acceptance of KMS, rather than the intention as suggested by Jennex (2005). Moreover the qualitative study indicates that to fully understand KMS contribution it is necessary to explicate the set of factors that in TAM (as shown in Figure 1) generically fall under the name of *external variables*.

More precisely, it was pointed out that, with respect to the conceptual framework, the research model should include two macro-constructs: (1)

Figure 3. Definitions of the constructs of the research model.

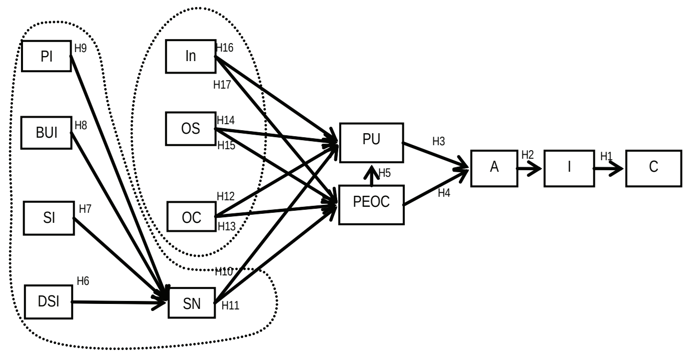
Set of the construct	Name of the construct in this study	Abbr.	Definition of the construct adapted to this study	Source	Name of the construct in the original paper
User	Intention	I	The strength of individual's intention to contribute	Adapted by (Fishbein and Ajzen 1975; Taylor and Todd 1995b)	Behavioral intentions
User	Socio- demographic variables	SD	Factors objectively describing an individual: function, education, hierarchical level, gender, age, years in the same position, years in the same enterprise.	(Adams, Nelson et al. 1992; Straub 1994; Compeau and Higgins 1995; Fraser, Marcella et al. 2000; Jarvenpaa and Staples 2000)	Socio- demographic variables
User	Attitude towards contributing	A	An individual's positive or negative feeling about contributing	Adaptyed by (Fishbein and Ajzen 1975; Taylor and Todd 1995b)	Attitude toward behavior
Sys	Perceived ease of contributing	PEOC	The degree to which an individual believes that contributing to the KMS would be free of effort	Adapted by (Davis 1989; Taylor and Todd 1995b)	Perceived ease of use
Sys	Perceived usefulness of contributing	PU	The degree to which an individual believes that contributing to the KMS would enhance performance	Adapted by (Davis 1989; Taylor and Todd 1995b)	Perceived usefulness
Org	Subjective norms to contributing	SN	The individual's perception that referent people want the individual to contribute	Adapted by (Ajzen 1991)	Subjective norms
Org	Direct superior's influence	DSI	Individual normative belief concerning that the direct superior wants the individual to contribute	Adapted by (Taylor and Todd 1995b)	Referent group
Org	Business unit director's influence	BUI	Individual normative belief concerning that the business unit director wants the individual to contribute	Adapted by (Taylor and Todd 1995b)	Referent group
Org	Peers' influence	PI	Individual normative belief concerning that peers want the individual to contribute	Adapted by (Taylor and Todd 1995b)	Referent group
Org	Subordinates' influence	SI	Individual normative belief concerning that the subordinates want the individual to contribute	Adapted by (Taylor and Todd 1995b)	Referent group

continued on following page

Figure 3. continued

Org	Organizational culture	OC	The collective programming of the mind which distinguishes the members of one organization from another	(Hofstede 1991; Gold, Malhotra et al. 2001)	Organizational culture
Org	Organizational structure	OS	Infrastructure capability intended to foster contributing	Adapted by (Gold, Malhotra et al. 2001)	Organizational structure
Org	Incentives	In	Expectations of change in image or status or expectations of rewards, such as promotions, raises, or praise to contributing	Adapted by (Goodman and Darr 1998; Compeau and Higgins 1999)	Incentives
IS Contributing		C	Individual who has discovered a solution to a problem shares this with others by formulating this solution and delivering it through the KMS	Adapted by (Goodman and Darr 1998; Barillot 1998)	Contributing

Figure 4. The research model emerged by the qualitative study



a subset of factors describing the characteristics of the organizational context and (2) a subset of factors (related to characteristics of the user) that describe the influence on the user's willingness to contribute from individuals close to her/him (Figure 3 and Figure 4).

Intention (I). Intention, as a measure of the strength of one's intention to perform a specific behavior (Davis, 1989), is considered a factor directly influencing IS usage, (Compeau & Higgins, 1995; Taylor & Todd, 1995; Thompson et al., 1991). The present study aims at validating the presence of such causal link in the specific case of KMS usage, which, for KMS, is questioned by Jennex (2005) and by Money and Turner (2005). In this KMS context, this variable is declined as the individual's intention to contribute to the KMS. Therefore, the following hypothesis is proposed:

H1: Intention positively influences Contributing

Attitude (A). Attitude has originally proposed by Davis (1989) in the TAM as moderating variable between the perceptions of usefulness and of ease of use and intention to use. In the following years, the IS literature has underlined the importance of attitude with respect to the behavior of contribution (Compeau, Higgins, & Huff, 1999; Davis, 1989; Limayem & Chabchoub, 1999; Thompson, Higgins, & Howell, 1994). In particular, this factor showed to be very important whenever IS usage takes place on a voluntary basis, which is the case for KMS (Fishbein & Ajzen, 1975). In KMS context of this study, attitude regards specifically the individual's positive feelings about contributing, which could positively impact the intention to contribute. Therefore, the following hypothesis is proposed:

H2: Attitude positively influences Intention

Perceived Usefulness (PU). Fishbein and Ajzen (1975) claimed that adopting a behavior is an indirect consequence of the beliefs related to the consequences of such behavior and of the evaluation of those consequences. IS-focused theoretical and empirical studies support the hypothesis that individuals use ICT whenever they perceive that ICT usage will bring them benefits (Adams et al., 1992; Agarwal et al., 1997; Bandura, 1986; Compeau et al., 1999; Moore & Benbasat, 1991; Thompson et al., 1991; Venkatesh et al., 2003). The focus on contribution to the KMS, instead of general use of an IS, imposes the specification of this variable. The adoption of the general variable, perceived usefulness of the use of the IS would lose the focus uniquely on contribution to the KMS. In this research context, perceived usefulness is therefore defined as the degree to which the KMS user believes that contributing to the KMS would enhance performance. Therefore, the following hypothesis is proposed:

H3: Perceived Usefulness positively influences Attitude

Perceived Ease of Contributing (PEOC). Since 1989, Davis proposed the perceived ease of use as a determinant of the usage of IS. Recent studies confirmed this assumption (Adams et al., 1992; Lai et al., 2005; Moore & Benbasat, 1991; Ong et al., 2005; Venkatesh et al., 2003; Venkatesh & Smith, 1999; Xu & Quaddus, 2004, 2005), although none of them had contribution to the KMS as subject of their investigation. The present research model aims at validating this assumption specified both in terms of context of application (KMS instead of IS) and in terms of activity (contribution instead of usage). This focus on contribution to the KMS leads to changing the research model from using the construct of perceived ease of use to using perceived ease of contributing, which is the degree to which the KMS user believes that contributing to the KMS would be free of effort. Therefore perceived ease of contributing represents the adaptation of perceived ease of use to the context under analysis. The following hypotheses are therefore proposed:

H4: Perceived Ease Of Contributing positively influences Attitude

and

H5: Perceived Ease Of Contributing positively influences Perceived Usefulness

Subjective norms (SN) and referent individuals: *direct superior* (DSI), *subordinates* (SI), *Business unit director* (BUI), *peers* (PI). Subjective norms and referent individuals (or *referent groups*, that is, the groups that could influence the users of a system) are included in many different theoretical models on ICT usage (Compeau & Higgins, 1995; Davis, 1989; Fishbein & Ajzen, 1975; Lai et al., 2005; Moore & Benbasat, 1991; Ong et al., 2005; Thompson et al., 1991; Venkatesh et al., 2003; Xu & Quaddus, 2004, 2005). The referent groups affect the individual behavior by means of the subjective norms that reflect one individual's willingness to adopt a behavior as a consequence of someone else's opinion (Ajzen, 1991). Taylor & Todd (1995) suggest decomposing referent groups to take into account the different opinions of individuals the user is in relation with. In fact, such influence could even turn out to be null as a result of the composition of opposing pressures exerted on the user. Considering the context of a KMS and the social nature of KM, whose users might belong to any hierarchical level, the research model takes into consideration four referent groups: *Direct Superior* (DSI), *Subordinates* (SI), *Business Unit director* (BUI), *Peers* (PI). These actors are supposed to influence, through the *Subjective Norms* (SN), the *Perceived Usefulness* (PU) and *Perceived Ease of Contributing* (PEOC) of the system. Consistent with the study of Money and Turner (2005), these relationships are formalized in the following hypotheses:

H6: Direct Superiors, DSI, positively influences Social Norms, SN;
H7: Subordinates, SI, positively influences Social Norms, SN;
H8: Business Unit Director, BUI, positively influences Social Norms, SN;
H9: Peers, PI, positively influences Social Norms, SN;
H10: Social Norms, SN, positively influences Perceived Usefulness, PU;
H11: Social Norms, SN, positively influences Perceived Ease of Contributing, PEOC

Organizational Culture (OC)

The organizational culture produces a system of rules or norms that drive the individuals' behaviors (Hofstede, 1991; Janz & Prasarnphanich, 2003; Schein, 1996). Specifically, a knowledge-sharing OC, that is, an organizational culture in favor of knowledge sharing, enables the usage of a KMS, because it exerts a positive influence on the perception of the ease of use and on the usefulness of the system (Comeau-Kirschner, 2000; Davenport & Prusak, 1998; Gold, Malhotra, & Segars, 2001; Goodman & Darr, 1998; Nakra, 2000; Venkatesh et al., 2003; Xu & Quaddus, 2004, 2005). The following hypotheses are thus proposed:

H12: Knowledge-sharing Organizational Culture, OC, positively influences Perceived Usefulness, PU;
H13: Knowledge-sharing Organizational Culture, OC, positively influences Perceived Ease of Contributing, PEOC.

Organizational Structure (OS)

The organizational structure can enable or inhibit the usage of an IS (Compeau & Higgins, 1995; Gold et al., 2001; Venkatesh et al., 2003; Xu & Quaddus, 2004, 2005). In particular, the usage of a KMS is affected by the possibility to transfer knowledge across organizational units and/or hierarchical levels, or by the presence of an employees' assessment system also based on the evaluation of the knowledge created by each individual. This study proposes that an organizational structure supporting knowledge sharing improves the contribution to a KMS, through the *Perceived Usefulness* and the *Perceived Ease of Contributing*. Consequent hypotheses are proposed:

H14: Organizational Structure, OS positively influences Perceived Usability, PU;
H15: Organizational Structure, OS, positively influences Perceived Ease Of Contributing, PEOC.

Incentives (In)

Within the factors related to the organizational environment, it has been shown that the presence and the type of incentives towards the IS usage influence the PU and the PEOU of the system (Compeau & Higgins, 1995; Gold et al., 2001; Janz & Prasarnphanich, 2003; Venkatesh et al., 2003). Given the importance of voluntariness in the use of a KMS, this study pursues providing these evidences in the specific context of contribution to a KMS. In the context of KMS, only Aladwani (2002) and Kankanhalli, Tan, and Wei (2005) have validated this hypothesis, while others have found none or negative effect (Bock, 2002; Bock & Lee, 2005). The following hypotheses are proposed:

H16: Incentives, IN, positively influences Perceived Usefulness, PU;
H17: Incentives, IN, positively influences Perceived Ease of Contributing, PEOC.

r esearch Method

To examine the hypothesized model a field study technique was employed. The research site and instrument development are described next.

r esearch s ite

The field research took place in two different organizations: one of the world's largest providers of consulting, technology, and outsourcing services, and one of the world's largest steel producers.

The consulting company employs approximately 52,700 people worldwide and generates more than 7 billion euros of global revenues. The survey was conducted at the Italian subsidiary of the company, which has six office locations, employs 1,300 professionals, and generates 115 million euros of revenue. As in any other typical consulting company, the consultants spend most of their time at their customer's sites. The mobile nature of their work makes them dependent on ICT to perform their tasks (Sussman & Siegal, 2003). In particular, they have access to the intranet enterprise portal, which includes a KMS, directly from their notebooks.

The steel producer has approximately 94,000 employees in over 60 countries and generates 30 billion euros of global revenues. The survey was conducted in the research and development (R&D) division, which has its offices in four locations (two in France, one in the U.S., and one in Singapore), and includes 490 engineers. This distribution of the personnel over four sites drives the need for sharing information through IT solutions. In fact, the employees have access to an intranet portal, specifically developed for the R&D division, by the internal IS department.

The two KMS, the one of the consulting provider and the one of the steel producer, are both Web-based applications supporting all the three categories of functionalities defined by Alavi and Leidner (2001). Coding and sharing best practices and problems' solutions require voluntary contributions by the employees. The submitted contributions are immediately stored in a knowledge base and shared worldwide and every employee could access this information simply interrogating the KMS search engine. Employees typically submit reports and documentation concerning projects they have worked on and typically extract contributions concerning projects which are similar to the one they are working on, in order to find out solutions and best practices.

The Italian subsidiary of the consulting provider, and the R&D division of the steel producer agreed to take part in the survey as a means of increasing system use by showing employees the advantages they could obtain from its adoption.

Instrument development, data collection And descriptive statistics

The literature review led to the identification and categorization of the existing measures suitable to the research model. For each construct the existing scales were identified and then adjusted. For the construct *contributing* two measures were used: a two-item, 5-point Likert scale and an open question asking the average number of contributions per week to the KMS. All the other constructs were defined using 5-point Likert scales (Figure 5 and Appendix A).

Before administering the questionnaire, it was reviewed by the CKOs of the Italian subsidiary of the consulting provider and of the R&D division of the steel producer, who suggested adjustments to the terminology in order to fit the organizational contexts. The final version of the questionnaire was published on a Web server accessible by all employees and was promoted through several means.

In the Italian subsidiary of the consulting provider, the CKO sent an e-mail to all the employees; placards were put up on the walls outside the staff rooms; and consultants present in the main subsidiary were directly invited to participate. Finally, the CKO solicited with a phone call those employees with the highest access rate to the KMS.

In the R&D division of the steel producer, the CKO sent an e-mail to all the employees of this division worldwide. A few weeks later, a follow up e-mail was sent to all the employees.

At the end of this process, the questionnaire was filled in by 103 consultants of the consulting company (response rate of 8%) and 97 engineers of the steel producer (response rate 20%). They were 69% men and 31% woman and 68% of them ranged from 20 to 39 years old. The 47% of respondents have worked in the company from 1 to 5 years and 82% is titled with at least a university degree.

Figure 5. KMS context constructs

Construct	Source	N. of items	Scale ranges
Intentions	Taylor and Todd 1995b	2	From strongly agree to strongly disagree
Perceived ease of contributing	Taylor and Todd 1995b	3	From strongly agree to strongly disagree
Perceived usefulness of contributing	Taylor and Todd 1995b	7	From strongly agree to strongly disagree
Subjective norms	Taylor and Todd 1995b	2	From strongly agree to strongly disagree
Direct superiors' influence	Taylor and Todd 1995b	2	from strongly agree to strongly disagree
Peers' influence	Taylor and Todd 1995b	2	from strongly agree to strongly disagree
Subordinates' influ-ence	Taylor and Todd 1995b	2	from strongly agree to strongly disagree
Business Unit director's influence	Taylor and Todd 1995b	2	from strongly agree to strongly disagree
Attitude towards contributing	Taylor and Todd 1995b	4	from good to bad, wise to foolish, positive to negative and pleasant to unpleasant
Organizational culture	Gold, Malhotra et al. 2001	13	from strongly agree to strongly disagree
Organizational structure	Gold, Malhotra et al. 2001	12	from strongly agree to strongly disagree
Incentives	Goodman and Darr 1998 Compeau and Higgins 1999	5	from strongly agree to strongly disagree
Contributing	Barillot 1998	2	from abundantly to scarcely and /frequently to rarely

Data Analysis

Data analysis was carried out using principal component factor analysis (PCA) and Cronbach's α to test the discriminant validity and reliability of constructs and scales, and then multiple linear stepwise regressions were used to test the model. The next sections describe the two stages of the analysis.

In order to achieve the convergent and discriminant validity of the constructs, PCA and Cronbach's α reliability test were used. A separate PCA was run for each construct in order to verify the structure validity of each scale (Appendix B), then Cronbach's α was computed to test their reliability (Figure 6).

The scales tested resulted acceptable, as shown in Figure 6 (ranging from 0,67 to 0,89). The constructs *peers' influence*, and *direct superior's influence* were dropped from the research model and so they were the corresponding hypotheses (H9 e H6).

Data analysis was carried out through multiple linear stepwise regression, that builds the model by adding one variable at a time to the model and—at each step—testing for removal the variables already entered. The results of the application of multiple regression applied to the 17 hypotheses are summarized in Figure 7 (and

Figure 6. Reliability test

Constructs	Item	Reliability (α)	Reliability when items are dropped
Contributing	2 items	.89	-
Intention	2 items	.77	-
Perceived Ease of Contributing	3 items	.83	-
Perceived usefulness	7 items	.87	-
Organizational culture	13 items	.83	-
Business Unit director's influence	2 items	.67	
Direct superior's influence	2 items	.52	All Dropped
Peer's influence	2 items	.63	All Dropped
Subordinated's influence	2 items	.72	
Subjective norms	2 items	.76	-
Organizational structure	11 items	.79	
Incentives	5 items	.78	-
Attitude towards contributing	4 items	.80	-

Figure 7. Summary of findings

Macro constructs	No	Independent variable	Dependent variable	Adjusted R2	F	Sig
Individuals' influence	H7	Subordinates' Influence	Subjective Norms	0,42	19,42	0,000
	H8	Business Unit director's Influence	Subjective Norms	0,40	113,99	0,000
	H11	Subjective Norms	Perceived Ease of Contributing	0,08	14,98	0,000
	H10	Subjective Norms	Perceived usefulness	0,22	47,68	0,000
Organizational characteristics	H13	Organizational culture	Perceived Ease of Contributing	0,08	5,04	0,026
	H15	Organizational structure	Perceived Ease of Contributing	0,16	4,00	0,047
	H17	Incentives	Perceived Ease of Contributing	0,23	5,67	0,018
	H12	Organizational culture	Perceived usefulness	0,13	25,22	0,000
	H14	Organizational structure	Perceived usefulness	0,13	4,48	0,036
	H16	Incentives	Perceived usefulness	0,29	68,16	0,000
	H5	Perceived Ease of Contributing	Perceived usefulness	0,20	5,58	0,019
	H4	Perceived Ease of Contributing	Attitude	0,29	4,70	0,032
	H3	Perceived usefulness	Attitude	0,57	4,90	0,029
	H2	Attitude towards Contributing	Intention	0,32	4,15	0,043
	H1	Intention	Contributing	0,36	13,82	0,000

reported in detail in Appendix C). With respect to the research model represented in Figure 2, we can highlight three main outcomes of the analysis:

- The research model as a whole (i.e., the TAM applied to the context of this study) is supported. Twelve out of the 14 values computed were high (adjusted R^2 ranges from 22 to 57), and significant (four of F statistics are well above the 30,00).
- The macro-construct describing the characteristics of the organization is supported. It should be noted that the relationships between the variables of this group and *Perceived Ease of Contributing* (R^2 values range from 0,08 to 0,23) are systematically weaker than the relationships with *Perceived Usefulness* (R^2 values range from 0,13 to 0,29).
- The macro-construct describing the influence of individuals is supported. In particular, the relationships between each referent group and *Subjective Norms* is supported with R^2 values among the highest in the model (from 0,40 for *Business Unit director's influence* to 0,42 for *Subordinates' influence*).

dIscuss Ion

The outcomes of data analysis can now be discussed in the light of the purposes of this study, that is, the achievement of a better understanding of the determinants of contribution to a KMS.

A first result is the support for TAM in the context of KMS. Earlier in this chapter, when presenting the conceptual framework of the study, the KMS' unique properties of voluntariness of usage and of associated network effects were pointed out. In line with the results achieved by Jennex and Olfman (2006), our study shows that such properties do not substantially affect TAM, and therefore it is correct to extend to the KMS the domain of applicability of this model. With respect to previous research where TAM was applied in the context of other types of IS, our study shows a lower explicative power of *Perceived Usefulness* and *Perceived Ease of Contributing* (Venkatesh et al., 2003). Nevertheless, the validity of TAM tested in this research implies that the specific characteristics of KMS are not strong enough to undermine the significance of the relationship between the perceived characteristics of the system (i.e., *Perceived Usefulness* and *Perceived Ease Of Contributing*) and Attitude and, as a consequence, the influence on IS contribution.

With respect to the dependent variable, it is relevant to recall that our model (Goodman & Darr, 1998) breaks up IS usage into two stages: IS contribution and IS utilization. Our research model included only the first, *Contributing*, thus the aforementioned validation of the TAM for KMS is focused on this aspect of the usage of the systems. It is necessary to develop the research further to include the second, *utilization*, before conclusion on TAM validation can be reached. The specific character of KMS, and especially network effects, may affect IS acceptance when referring to utilization, to the exploitation of the knowledge "archived" in the system, besides than just to the "loading" of knowledge into the system.

At the practitioner level, it is possible to highlight eventual implications considering the different points of view of two of the critical players dealing with IS usage: the developer of the KMS and the CKO.

The successful application of TAM in the context of KMS suggests that to develop the *characteristics of the system,* KMS developers do not need to design and use peculiar methodologies or techniques. In theory, considering the intrinsic complexity of a KMS and the heterogeneity of users' technical skills, one may believe that KMS' developers should focus on improving the features that could strengthen the system accessibility or usability (such as the software user interface). The results of this empirical study (more precisely:

the significance of the construct *Perceived Ease of Contributing* to explain KMS' contribution) provide a rather different indication: improving the accessibility or the usability of the system, as well as users' technical skills, has only a limited influence on the contribution to the KMS. Accordingly, organizations should address their efforts towards improvements at the organizational and individual level. These findings are coherent with the practitioners' standpoint about the future of KMS (Smith & McKeen, 2003) and provide guidelines for the future development of KMS.

Similarly, our study suggests that CKOs willingness to increase contribution to the KMS would not obtain substantial improvements by struggling to use methodologies and tools specific for KMS'. Since *Attitude, Intention,* and *Perceived Usefulness* can explain KMS contribution only to a little extent, the traditional methodologies to improve these three characteristics of the users would not prove effective. Instead, CKOs could design initiatives to influence the external variables identified by the study, that is, enhancing the employees' assessment and reward system, by explicitly including the monitoring and evaluation of the knowledge created by individuals (H14-H15-H16-H17). Initiatives aiming at developing a favorable attitude towards knowledge sharing, such as recurrent events aiming at promoting the results achieved by sharing knowledge, are also suggested (H12-H13).

This research, in line with recent works on KMS' success, extends the number of constructs in the TAM beyond the traditional four, and pursues investigating the external variables able to explain the TAM in the context of KMS. Our study basically supports findings from Thompson et al. (1991) adapted by Jennex and Olfman (2006), who pointed out that a specific set of referent individuals play a determinant role in influencing the contribution of a user to a KMS. More precisely, and in contrast with Thomson et al. (1991), our data show that peers and direct superiors do not belong to this "influencing" set, while the business unit director and the subordinates (the latter not considered in Thompson et al.'s (1991) study) proved to be very effective in determining the subjective norms that guide users' perception about the usefulness and the ease of use of the KMS (H6-H8-H10-H11). As a consequence, the CKO should put her/his efforts in enhancing the commitment of these individuals, and, even more important, in enabling this commitment to become of public domain within the organization. As an example, according to this conclusion, simple communication instruments (such as a notice board to post the names of the "best contributors of the month") should prove more effective than improvements in the usability of the software.

Finally, we should discuss the lower explicative power of the TAM in our study with respect to previous applications of TAM in other contexts. A possible explanation might lie in the characteristics of the research process and/or the research sample. As a further development, the quantitative study could be repeated on larger samples, the model could be tested in different types of organizations and the set of external variables could be modified to take into account some of those considered in the early stages of the research but then excluded by the quantitative study. However, just in order to avoid biases related to the sample we designed a multi-stage, multi-method research process, where the external variables were identified through a broad literature review, then refined through a rigorous qualitative study before being statistically tested. In the light of this observation, the lower explicative power of the TAM, could be ascribed also to the specificity of this category of IS. Voluntariness and network effects may not lead to a different model of the main few variables determining IS contribution, but can reduce the explicative power of such variables with respect to the many other influencing contributions.

c onclus Ion

The purpose of this study was to determine the factors affecting the acceptance of a KMS, and, more specifically, factors affecting the contribution to a KMS, in the attempt to provide guidelines for increasing the effectiveness of a KMS. Therefore, the aim of this research was beyond the mere application of the well-known TAM to this type of IS (although a similar application was not found in the IS literature), on the contrary, the objective of this work was to design a more comprehensive research model regarding the successful acceptance of a KMS. Nevertheless, the qualitative study carried out through direct interviews to CKOs led to the definition of a research model that in fact corresponds to the TAM, but with a relevant extension that consists in a set of organizational and individual factors influencing the contribution to a KMS. The test of the research model through the method of multiple regressions supports the model as a whole.

Results of the data analysis indicate that improvement initiatives at the organizational level have the potential to significantly increase the contribution on KMS and, consequently, the successful acceptance of the KMS. The main ones are: the definition of the organizational structure, the development of an appropriate reward system, the implementation of an easy interaction with the KMS, and the accurate management of both the communication and the collaboration between the users and the individuals in the organization with whom they interact.

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Append Ix A. Instru Ment

Constructs and questions	Scales
Intentions	
I intend to contribute to the KMS soon	from strongly agree to strongly disagree
I intend to contribute to the KMS frequently	from strongly agree to strongly disagree
Perceived ease of Contributing	
It is difficult to learn how to contribute to the KMS	from strongly agree to strongly disagree
The instructions for contributing to the KMS are hard to follow	from strongly agree to strongly disagree
It is easy to contribute to the KMS	from strongly agree to strongly disagree
Perceived usefulness	
To contribute to the KMS does not benefit me	from strongly agree to strongly disagree
The advantages that I obtain, by the contribution to the KMS outweigh the disadvantages	from strongly agree to strongly disagree
To contribute to the KMS is advantageus to me	from strongly agree to strongly disagree
To contribute to the KMS is useful in my job	from strongly agree to strongly disagree
To contribute to the KMS does not benefit my organization	from strongly agree to strongly disagree
To contribute to the KMS is advantageous to my organization	from strongly agree to strongly disagree
In my organization, the KMS contribution advantages outweigh the KMS contribution disadvantages	from strongly agree to strongly disagree
Subjective norms	
People, who I consider important, think that I should contribute to the KMS	from strongly agree to strongly disagree
People, who influence my behavior, think that I should contribute to the KMS	from strongly agree to strongly disagree
Direct superiors' influence	
My chief would think that I should contribute to the KMS	from strongly agree to strongly disagree
I will have to contribute to the KMS because my chief requires it	from strongly agree to strongly disagree
Subordinates' influence	
My subordinates would think that I should contribute to the KMS	from strongly agree to strongly disagree
I will have to contribute to the KMS because my subordinates require it	from strongly agree to strongly disagree
Peers' influence	
My colleagues would think that I should contribute to the KMS	from strongly agree to strongly disagree
I will have to contribute to the KMS because my colleagues require it	from strongly agree to strongly disagree
Business Unit director's influence	
I will have to contribute to the KMS because the senior management of my business unit requires it	from strongly agree to strongly disagree
Senior management of my business unit would thinks that I should contribute to the KMS	from strongly agree to strongly disagree
Attitude towards contribution	
Contributing to the KMS is	from good to bad
The idea of contributing to the KMS is	wise to foolish
To contribute to the KMS is	pleasant to unpleasant
The idea of contributing to the KMS is	positive to negative
Organizational culture	
In my organization, the benefits of sharing knowledge outweigh the costs	from strongly agree to strongly disagree
In my organization, employees are encouraged to ask others for assistance when needed	from strongly agree to strongly disagree
In my organization, high levels of participation are expected in capturing and transferring knowledge	from strongly agree to strongly disagree
In my organization, overall organizational objectives are clearly stated	from strongly agree to strongly disagree
In my organization, employees understand the importance of knowledge for the organizational success	from strongly agree to strongly disagree
In my organization, on-the-job training and learning are valued	from strongly agree to strongly disagree
In my organization, overall organizational vision is clearly stated	from strongly agree to strongly disagree
In my organization, employees are valued for their individual experience	from strongly agree to strongly disagree
In my organization, employees are encouraged to interact with other workgroups	from strongly agree to strongly disagree
In my organization, employees are encouraged to discuss their work with people in other workgroups	from strongly agree to strongly disagree
My organization shares its knowledge with other organizations (e.g. partners, trade groups)	from strongly agree to strongly disagree
In my organization, senior management clearly supports the role of knowlegde in our firm's success	from strongly agree to strongly disagree
In my organization, employees are encouraged to explore and experiment	from strongly agree to strongly disagree
Organizational structure	
My organization's structure promotes collective rather than individualistic behavior	from strongly agree to strongly disagree
My organization's employees are readily accessible	from strongly agree to strongly disagree
My organization encourages employees to go where they need for knowledge regardless of structure	from strongly agree to strongly disagree
My organization's structure facilitate the transfer of the new knowledge across structural boundaries	from strongly agree to strongly disagree
My organization has a large number of strategic alliances with other firms	from strongly agree to strongly disagree
My organization bases our performance on their knowledge creation	from strongly agree to strongly disagree
My organization designs processes to facilitate knowledge exchange across functional boundaries	from strongly agree to strongly disagree
My organization has a standardized reward system for sharing knowledge	from strongly agree to strongly disagree
My organization's structure facilitates the creation of new knowledge	from strongly agree to strongly disagree
My organization's structure facilitates the discovery of new knowledge	from strongly agree to strongly disagree
My organization's managers frequently examine knowledge for errors/mistakes	from strongly agree to strongly disagree
My organization's structure of departments and divisions inhibits interaction and sharing of knowledge	from strongly agree to strongly disagree
Incentives	
In my organization, contributing to the KMS is highly rewarded	from strongly agree to strongly disagree
My organization appraises employees basing on their contribution to KMS	from strongly agree to strongly disagree
My organization does not reward the contributions to the KMS	from strongly agree to strongly disagree
My organization has a standardized reward system linked to the contribution to the KMS	from strongly agree to strongly disagree
In my organization, contributing to the KMS is highly rewarded	from strongly agree to strongly disagree
Contributing	
I think I contribute to the KMS	from frequently to rarely
What is your KMS contribution frequency?	from abundantly to scarcely

Append Ix b. f Act or AnAl yses

	Component
	1
CON2	,953
CON3	,953

	Component
	1
INT1	,903
INT2	,903

	Component
	1
INSUP2	,822
INSUP1	,822

	Component
	1
FAC1	,919
FAC2	,841
FAC3	,823

	Component
	1
INCOL2	,855
INCOL1	,855

	Component
	1
INSUP4	,837
INSUP3	,837

	Component
	1
INSUP6	,868
INSUP5	,868

	Component
	1
SUBNORM1	,898
SUBNORM2	,898

	Component
	1
INSUB	,886
INSUB2	,886

	Component
	1
INCIT4	,797
INCIT1	,772
INCIT3	,760
INCIT5	,746
INCIT2	,579

	Component
	1
ATT1	,791
ATT2	,857
ATT3	,816
ATT4	,683

	Component		
	1	2	3
CULT1	,453	,175	,153
CULT2	,605	,237	,113
CULT3	,750	,259	,015
CULT4	,746	,095	,127
CULT5	,769	-,010	,146
CULT6	,205	,742	,139
CULT7	,540	,456	,157
CULT8	,603	,457	,297
CULT9	,290	,140	,861
CULT10	,192	,072	,867
CULT11	,588	,262	,351
CULT12	,214	,593	-,307
CULT13	,105	,678	,301

	Component	
	1	2
STRUC3	,827	,118
STRUC2	,746	,132
STRUC8	,727	,226
STRUC4	,706	,378
STRUC5	,611	,128
STRUC1	,517	,058
STRUC12	,516	,286
STRUC9	,339	-152
STRUC11	,090	,759
STRUC7	,120	,684
STRUC6	,111	,599

	Component
	1
CPCNI1	,787
CPCNI2	,830
CPCNI3	,840
CPCNI4	,770
CPCNO1	,532
CPCNO2	,754
CPCNO3	,697

Append Ix c. Model suMMAr y extended

	Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Predictors	
						R Square Change	F Change	df1	df2	Sig. F Change		
H1	1	0,562585926	0,316502924	0,312505865	0,876408868	0,316502924	79,1839526	1	171	7,9312E-16	a	Predictors: (Constant), INT2
	2	0,606530239	0,367878931	0,360442213	0,845302514	0,051376007	13,81684877	1	170	0,000273266	b	Predictors: (Constant), INT2, INT1
H2	1	0,482213161	0,232529532	0,227878196	0,910446412	0,232529532	49,99198593	1	165	4,15613E-11	a	Predictors: (Constant), ATT4
	2	0,558720432	0,312168521	0,303780332	0,864539069	0,079638989	18,98836354	1	164	2,31235E-05	b	Predictors: (Constant), ATT4, ATT2
	3	0,573791186	0,329236325	0,316890981	0,85636023	0,017067804	4,147588908	1	163	0,043312046	c	Predictors: (Constant), ATT4, ATT2, ATT3
H3	1	0,637973068	0,407009636	0,400767632	0,528546075	0,407009636	65,2049641	1	95	2,09217E-12	a	Predictors: (Constant), CPCNI4
	2	0,73058675	0,533756999	0,523836935	0,471154206	0,126747363	25,5537393	1	94	2,11594E-06	b	Predictors: (Constant), CPCNI4, CPCNO2
	3	0,752862802	0,566802399	0,552828283	0,456585782	0,033045401	7,094273487	1	93	0,009114381	c	Predictors: (Constant), CPCNI4, CPCNO2, CPCNI2
	4	0,767267437	0,58869932	0,570816681	0,44730797	0,02189692	4,897917184	1	92	0,02936243	d	Predictors: (Constant), CPCNI4, CPCNO2, CPCNI2, CPCNO1
H4	1	0,52364941	0,274208704	0,269836468	0,582458791	0,274208704	62,71588708	1	166	3,25816E-13	a	Predictors: (Constant), FAC1
	2	0,542522806	0,294330995	0,285777432	0,57606557	0,020122291	4,70500757	1	165	0,031506135	b	Predictors: (Constant), FAC1, FAC3
H5	1	0,402934346	0,162356087	0,157310039	0,829883662	0,162356087	32,17490157	1	166	6,13026E-08	a	Predictors: (Constant), FAC3
	2	0,435253945	0,189445996	0,179621099	0,818823966	0,027089909	5,514543163	1	165	0,020044363	b	Predictors: (Constant), FAC3, FAC1
	3	0,464895142	0,216127493	0,201788362	0,807685586	0,026681497	5,582241232	1	164	0,019316031	c	Predictors: (Constant), FAC3, FAC1, FAC2
H7	1	0,597760296	0,357317371	0,353249759	0,74212843	0,357317371	87,84451623	1	158	7,11823E-17	a	Predictors: (Constant), INSUB
	2	0,654258917	0,428054731	0,420768804	0,702322759	0,070737359	19,41753177	1	157	1,9375E-05	b	Predictors: (Constant), INSUB, INSUB2
H8	1	0,636924388	0,405672675	0,402113829	0,727833522	0,405672675	113,9899412	1	167	1,29808E-20	a	Predictors: (Constant), INSUP5
H10	1	0,475738382	0,226327008	0,221580548	0,803045163	0,226327008	47,68332696	1	163	1,06332E-10	a	Predictors: (Constant), SUBNORM2
H11	1	0,290162879	0,084194496	0,078576058	0,902367378	0,084194496	14,98539032	1	163	0,00015649	a	Predictors: (Constant), SUBNORM2
H12	1	0,373101539	0,139204759	0,13368684	0,849845545	0,139204759	25,22776765	1	156	1,3786E-06	a	Predictors: (Constant), CULT2

Append Ix c. cont Inued

H13	1	0,205824904	0,042363891	0,036225198	0,927450188	0,042363891	6,901125534	1	156	0,00947352	a	Predictors: (Constant), CULT2
	2	0,265414334	0,070444769	0,058450507	0,916693996	0,028080877	4,682385574	1	155	0,032004915	b	Predictors: (Constant), CULT2, CULT3
	3	0,316115718	0,099929147	0,0823953	0,904962587	0,029484379	5,044707692	1	154	0,026123963	c	Predictors: (Constant), CULT2, CULT3, CULT12
H14	1	0,294547324	0,086758126	0,080941299	0,87462069	0,086758126	14,91502544	1	157	0,000164065	a	Predictors: (Constant), STRUC12
	2	0,343868913	0,118245829	0,106941289	0,86216051	0,031487703	5,570806342	1	156	0,019499221	b	Predictors: (Constant), STRUC12, STRUC11
	3	0,378191686	0,143028951	0,126442415	0,852695342	0,024783122	4,482513015	1	155	0,035839553	c	Predictors: (Constant), STRUC12, STRUC11, STRUC9
H15	1	0,328602301	0,107979472	0,102297813	0,899093935	0,107979472	19,0049182	1	157	2,34875E-05	a	Predictors: (Constant), STRUC11
	2	0,392885055	0,154358667	0,143517111	0,878209786	0,046379194	8,555819147	1	156	0,003958177	b	Predictors: (Constant), STRUC11, STRUC7
	3	0,419098165	0,175643272	0,15968798	0,869879737	0,021284605	4,002046331	1	155	0,047191303	c	Predictors: (Constant), STRUC11, STRUC7, STRUC9
H16	1	0,541841162	0,293591845	0,289284478	0,771156311	0,293591845	68,16040025	1	164	4,74753E-14	a	Predictors: (Constant), INCIT2
H17	1	0,456707183	0,208581451	0,203755728	0,860450219	0,208581451	43,22284079	1	164	6,22455E-10	a	Predictors: (Constant), INCIT5
	2	0,484972498	0,235198323	0,225814254	0,84844789	0,026616873	5,672778143	1	163	0,018383107	b	Predictors: (Constant), INCIT5, INCIT1

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Chapter XIV
IS Support for Knowledge Management and Firm Performance:
An Empirical Study

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Abstr Act

While a great deal has been written about how information systems (IS) can be deployed to facilitate knowledge management for performance improvements, there is little empirical evidence suggesting such IS deployment can actually improve a firm's bottom-line performance. This study attempted to assess the impacts of IS support for two key knowledge management activities (knowledge generation and knowledge transfer) on labor productivity and profitability with both survey and archival data. The potential moderating effects of firm-specific, complementary organizational resources on the performance impacts of the IS support were also examined and tested. The results showed that IS support for knowledge generation and IS support for knowledge transfer both had direct positive effects on labor productivity. Coupled with firm-specific, complementary organizational resources, both types of IS support exerted positive effects on profitability.

Introduct Ion

With the widespread recognition of knowledge as a key source of sustainable competitive advantage (Nonaka & Takeuchi, 1995; Quinn et al., 1996; Spender & Grant, 1996), how to manage organizational knowledge to achieve and maintain competitive advantage and superior economic performance becomes a critical issue facing many firms. In the field of information systems (IS) management, the past decade has witnessed a proliferation of research on IS roles in knowledge management (see Alavi & Leidner (2001) for a review of this body of research). While much of the extant literature has identified various ways IS can be deployed to support knowledge management and IS support for knowledge management is often assumed to improve organizational effectiveness, efficiency and competitiveness (Alavi & Leidner, 2001; Gold et al., 2001; Alavi & Tiwana, 2003; Shin, 2004), it remains unclear whether such IS support would actually result in positive economic returns, due to scant empirical evidence linking IS support for knowledge management directly to the bottom-line performance of firms. Without large-scale empirical research assessing the bottom-line performance impacts of IS support for knowledge management, firms and their managers interested in investing in IS support for knowledge management to improve their competitive position and performance have little evidence on which to base their IS investment and deployment decisions.

Furthermore, although IS have traditionally been viewed as one of the key enabling tools for knowledge management (Davenport & Prusak, 1998; Alavi & Leidner, 2001), researchers have increasingly entertained the notion that IS alone would not influence firm performance, but have to be complemented by other firm-specific organizational resources (e.g., organizational culture and structure) in order to confer knowledge-based competitive advantage (Roberts, 2000; Davenport et al., 2001; Lubit, 2001; Karlsen & Gottschalk, 2004). The presence of these firm-specific, complementary organizational resources not only enables a firm to reap the economic benefits from using IS to support knowledge management, but also helps the firm better defend its advantage resulting from such IS support (Clemons & Row, 1991; Grant, 1996a; Bharadwaj, 2000). Unfortunately, discerning the moderating effects of such complementary organizational resources on the performance impacts of IS support for knowledge management has received scant attention in the existing literature.

The purposes of this study were two folds. First, it provided an empirical assessment of the performance impacts of IS support for knowledge management by testing the relationships between IS support for two key knowledge management activities (knowledge generation and knowledge transfer) and firm performance. Second, the study examined and tested the potential moderating effects of certain unique organizational resources that complement the IS support for knowledge generation and knowledge transfer (i.e., firm-specific resources a firm needs in order to effectively develop and deploy IS to facilitate knowledge generation and knowledge transfer) on the above-mentioned relationships.

The remainder of this chapter is structured as follows. The next section (1) reviews the strategic roles of knowledge and two key knowledge management activities: knowledge generation and knowledge transfer, (2) examines the competitive value of IS support for knowledge management from the resource-based perspective, (3) offers a synthesis of the extant literature on IS support for knowledge generation and IS support for knowledge transfer, along with their performance implications, and (4) explores the potential moderating effects of firm-specific, complementary organizational resources on the relationships between the IS support and firm performance. Together, this discussion provides the conceptual foundation for the development of the research hypotheses. The third section presents the research methodology, including the sample and data collection procedure, the operationalization and measurement of the variables of interest, and the results. The last section of the chapter discusses the implications of the research findings, the limitations of the study, and some suggestions for future research and practice.

Theoretical Background and Hypotheses

Strategic Roles of Knowledge and Knowledge Management

It is widely recognized today that knowledge assets represent one of the most important sources of sustainable competitive advantage (Nonaka & Takeuchi, 1995; Quinn et al., 1996; Spender & Grant, 1996). Knowledge not only increasingly adds value to products and services (Davis & Botkin, 1994), but also plays a vital role in transforming resources and capabilities into dynamic core competencies, which arguably form the basis of durable competitive advantage (Prahalad & Hamel, 1990; Leonard-Barton, 1995; Grant, 1996a). Knowledge also exhibits positive-sum, increasing-return qualities, that is, it expands and increases in value when it is used and shared (Prahalad & Hamel, 1990; Miller & Shamsie, 1996). Moreover, because knowledge-based resources tend to be tacit, socially complex, embedded in firm-specific routines and processes, and nontradeable in strategic factor markets, the knowledge-based advantage is difficult to imitate and thus sustainable (Polanyi, 1967; Barney, 1986a; Nonaka, 1994).

Given the strategic significance of knowledge, how to manage a firm's knowledge assets to create sustainable competitive advantage becomes a critical strategic issue (Nonaka, 1994; Grant, 1996a; 1996b; Teece, 2000). Since organizational knowledge resources are inimitable and hard to purchase, they must be developed and utilized inside the firm (Teece, 2000). Hence, the challenge of knowledge management is how to generate and leverage collective knowledge in the firm to create value that leads to competitive advantage (von Krogh, 1998; Hult, 2003). Constant generation of new knowledge is critical to the firm's success, not only because knowledge has economic value, but also because internally developed knowledge is firm-specific and hard to imitate, as noted above. Knowledge transfer is as vital as knowledge generation in that the former affects the firm's ability to utilize its valuable and unique knowledge for competitive advantage (Spender, 1994; Darr et al., 1995; Argote & Ingram, 2000). That is because sharing and exchanging knowledge enables more employees to gain new knowledge acquired or developed elsewhere in the firm, hence increasing the value of the knowledge (Huber, 1991) and maximizing its performance impact (Garvin, 1993; Nonaka, 1994). In the long run, firms that create and share knowledge more efficiently, speedily and effectively than their competitors are more likely to develop knowledge integration capability for competitive advantage (Kogut & Zander, 1992; Grant, 1996a; Matusik & Hill, 1998; Alavi & Leidner, 2001).

The Resource-Based View of IS Support for Knowledge Management

Despite extensive research on how IS can be used to facilitate knowledge management (Davenport & Prusak, 1998; Alavi & Leidner, 2001; Gold et al., 2001; Marwick, 2001), whether and how IS support for knowledge management contributes to competitive advantage and superior firm performance is not well understood. Here, the increasingly popular resource-based approach to analyzing the strategic contributions of IS can shed some light on this issue. According to the resource-based view of competitive advantage in the strategic management literature, firms with unique resources and capabilities that are difficult to imitate or substitute can gain and maintain competitive advantage and superior performance (Barney, 1991). While early resource-based analysis of the strategic roles of IS views IS as commodity-like resources that are unlikely to have any direct impact on firm performance (Clemons, 1986; Mata et al., 1995), more recent research indicates that, despite lacking characteristics that are unique or difficult to imitate, IS may play an indirect (supporting or enabling) role in influencing firm performance (Powell & Dent-Micaleff, 1997; Bharadwaj, 2000). Drawing on the concept of complementary assets (resources whose presence enhances the values of other resources) (Teece, 1986), researchers who examine the supporting role of IS argue that IS can contribute to competitive advantage when they are used to create and leverage distinctive organizational competencies (rent-yielding and firm-specific resources and capabilities) that are hard to imitate or substitute (Clemons & Row, 1991; Lado & Zhang, 1998; Bharadwaj, 2000; Ravichandran & Lertwongsatien, 2005). Viewed from this perspective, firms which deploy their IS to support knowledge management are in a better position to develop and utilize valuable and distinctive organizational knowledge for competitive advantage and superior performance (Lado & Zhang, 1998; Alavi & Leidner, 2001).

Information vs. Knowledge in Is support for Knowledge Management

Before dealing with IS support for knowledge management and its performance impacts, it is necessary to discuss the differences and relationships between information and knowledge because of their implications for how IS should be deployed to support knowledge management (Keane & Mason, 2006). In the field of knowledge management, knowledge is conventionally viewed as conceptually different from information (Keane & Mason, 2006). For instance, Kogut and Zander (1992) define information as facts, numbers or symbols and knowledge as skills or expertise. While drawing a distinction between information and knowledge, many knowledge management researchers recognize the two constructs are closely related to each other. Sveiby (1997) argued that information becomes knowledge when it is interpreted. Baker et al. (1997) noted that knowledge is created when information is applied in a particular context. Alavi and Leidner (2001) considered knowledge as personalized information (i.e., information possessed in the mind of individuals). In view of the close relationships between information and knowledge, it is argued that IS support for knowledge generation and knowledge transfer should facilitate information generation and sharing as well as knowledge generation and sharing in order to be effective (Alavi & Leidner, 2001; Keane & Mason, 2006). Accordingly, IS support for information generation and sharing was considered as part of IS support for knowledge generation and transfer in this study.

Is support for Knowledge generation and firm performance

With their communication and storage capabilities, IS enhance a firm's ability to collect and accumulate critical internal information the firm needs in order to generate useful knowledge. The electronic communication capabilities of IS allows the firm to overcome time, geographical and organizational barriers in gathering data and information (Hammer & Mangurian, 1987; Stroud, 1998). The ongoing increases in storage capacities of IS and such IS features as automatic capturing, on-line access and user-friendly interface greatly expand the firm's capacity to retain more data with completeness and precision and facilitate information access and retrieval (Huber, 1991). Furthermore, the hypertext and hypermedia technologies enable firms to capture and retain information in rich contexts (Stein & Zwass, 1995).

In addition to utilizing the communication and storage capabilities of IS to collect critical information and data, a firm can use expert systems (ES) and case-based reasoning systems to capture and accumulate valuable and scarce expertise and skills specific to the firm (Beerel, 1993). Lado and Zhang (1998) argued that firm-specific ES that capture highly complex knowledge can be a source of sustainable competitive advantage. The ES literature is replete with evidence of firms reaping economic benefits from using ES (Leonard-Barton & Sviokla, 1988, Yamasaki & Manoochehri, 1990; Grupe & Owrang, 1995). ES and case-based reasoning systems can also be employed to extract valuable knowledge from existing data. The popular and academic literatures on data mining have shown how some firms benefit from developing and using these systems to derive critical customer and market knowledge (e.g., insights about customer needs and market trends) from their databases or data warehouses (Trybula, 1997; Chopoorian et al., 2001).

IS can also be deployed to improve a firm's ability to gather valuable information from external sources in a timely, accurate and efficient manner. It is evident in the literature on inter-organizational systems (IOS) that one key benefit of using IOS, which typically link firms through electronic data interchange (EDI), is easy and quick acquisition of critical information from their trading partners (Scott, 2000). Executive information systems (EIS) are another tool for collecting important information from external sources. With online access to various external databases, EIS allow managers to search and retrieve a large amount of external information about its suppliers, customers, competitors, financial organizations, stockholders, regulatory bodies, and interest groups, etc. in a timely manner (Young & Watson, 1995). Moreover, with the advent of the Internet, today firms can use Web-based network systems (e.g., extranets) to gather information about their customers and market trends (Boudreau et al., 1998; Stroud 1998).

There is considerable empirical evidence showing that IS support for external information gathering has led to improvements in organizational performance. Several field studies of EDI-based IOS have reported faster response to market changes and significant operational efficiencies (e.g., better tracking of inventory levels, orders and quality performance) accruing from improved information exchange between firms (Mukhopadhyay et al., 1995; Scott, 2000). Moreover, EIS research has indicated that IS support for environmental scanning has led to improved productivity, more successful new product introduction, and improved decision making in terms of quicker identification of potential problems and opportunities (Sayeed & Brightman, 1994; Ahituv et al., 1998).

Hypothesis 1: *IS support for knowledge generation is positively related to firm performance.*

Is support for Knowledge transfer and firm performance

It is evident in the literature that a variety of IS are capable of increasing organizational communication, hence promoting knowledge transfer within a firm (Alavi & Leidner, 2001). Early analysis of electronic communication systems indicates that such systems increase the speed and spread of communication channels and support asynchronous communication (Keen, 1988; Adam et al., 1993). Adam et al. (1993), for example, found that the use of email systems expanding the scope (breadth and capacity) of organizational communication. Recent studies of email usage in the knowledge management context indicate that email systems may enable firms to develop knowledge from email-supported knowledge flow (Kock, 2000; Bontis et al., 2003; Lichtenstein, 2004). In a case study, Lichtenstein (2004) documented how the employees in a university utilized email conversations to incrementally and iteratively build new knowledge. The employees used email to crystallize the knowledge under construction by repeatedly submitting it to a range of key stakeholders for comment until a consensus is reached regarding the outcome. Besides email systems, other groupware systems (e.g., electronic meeting systems) can be used to increase interpersonal interactions and hence sharing of information and knowledge (Marvick, 2001; Dalkir, 2005). For example, real-time, on-line meetings provide a virtual space where participants can share certain kinds of experience through listening to presentations, conducting discussions and exchanging documents relevant to a certain task (Marvick, 2001). As Nonaka (1994) noted, shared experiences are critical to the formation and sharing of tacit knowledge.

Organizational communication can be further enhanced by video conferencing systems, Web-based intranets, and systems with sophisticated search technologies. Video conferencing systems connect people from different geographical locations in virtual face-to-face meetings, allowing information and knowledge to reach more people in rich media (Dewett & Jones, 2001; O'Callaghan & Andreu, 2006). Intranets can be used to broaden communication reach across global boundaries and reduce costs and time in preparing and transferring information and knowledge in rich content (Boudreau et al., 1998; Bidgoli, 1999; Marvick, 2001). Intranets also facilitate contact between individuals that seek knowledge and those who possess it by supporting electronic bulletin boards, discussion groups, and corporate directories (Andreu & Ciborra, 1997; Alavi & Leidner, 2001; Stenmark, 2001). Moreover, more advanced communication systems with sophisticated search technologies (e.g., semantic network and adaptive pattern recognition processing) foster company-wide exchange of best practices by interconnecting people and facilitating the process of matching solutions to problems (Goodman & Darr; 1998; Alavi & Leidner, 2001; Sambamurthy et al., 2003).

Aside from promoting person-to-person communication, IS can contribute to knowledge transfer by providing timely access to information and knowledge in computerized repositories and portals (Collins, 2003; Firestone, 2003; Dalkir, 2005). Goodman and Darr (1996) showed that companies such as Office Equipment and Tandem Computer improved their operations through utilizing their electronic libraries to facilitate organization-wide exchange of the best practices. Alavi and Tiwana (2003) illustrated how firms like PepsiCo use intranet-based corporate portals to promote exchange of information and knowledge. A portal developed by a division (Frito-Lay) of PepsiCo enabled their employees around the world to contribute to and access a diverse array of information and knowledge (e.g., sales information, market trends and news, sales tips, best practices and market insights) in a timely manner. As a result of using the portal, Frito-Lay doubled its growth rate within a few months. Besides centralized repositories, a firm can promote information and knowledge sharing with a peer-to-peer (P2P) sharing network. As a decentralized network, the P2P sharing network allows users to have their own local knowledge repositories and to share information and knowledge through file sharing, video conferencing and audio communication (Parameswaran, 2001). One advantage of using multiple knowledge repositories is that information and knowledge can be produced in many different formats for different users by people at different functional levels (Kwok & Gao, 2004).

It is increasingly recognized that organizational improvements accrue from using IS to promote faster, more accurate, more complete and better-coordinated knowledge flows across key business functions such as marketing, engineering, manufacturing and distribution (Joshi 1998; Andersen & Segars, 2001). Such IS-enhanced knowledge transfer allows instant connection, tapping, combination and recombination of expertise from different functional activities to create new skills and insights for rapid and flexible product and service delivery (Venkatraman, 1994; Lei et al., 1996). Research on IS support for cross-functional sharing and integration of knowledge in both manufacturing and service firms have documented such operational benefits as increased sales or market shares, reduced lead times, increased flexibility, and improved productivity and profitability (Goodman & Darr, 1998; Andersen & Segars, 2001).

Firms can also derive strategic benefits from using IS to support knowledge transfer across business units. Clemons and Row (1991) note that IS-enabled sharing and integration of a firm's critical skills and expertise among similar products or markets allow the firm to develop a new knowledge base for competitive advantage. Boynton et al. (1993) reported a system (dubbed as the CS90) designed by Westpac (a South Pacific financial service conglomerate) to consolidate its expertise in new financial product developments from a range of related product lines into a set of highly flexible software modules. By facilitating the rapid and efficient combinations of knowledge from different sources, the system enabled Westpac to handle a greater variety and range of customer and marketplace needs at low cost and fast speed.

Hypothesis 2: *IS support for knowledge transfer is positively related to firm performance.*

Moderating Effects of Firm-Specific, c omplementary o rganizational r esources

While IS may improve a firm's competitive position and performance through their support for knowledge generation and knowledge transfer, one may argue that such IS support is subject to easy imitation because many IS lack characteristics that are unique or difficult to copy (Mata et al., 1995). However, drawing on the notion of complementary assets in the resource-based theory (Teece, 1986), IS and strategy researchers have argued that firms with certain firm-specific, hard-to-copy resources that complement their IS are in a better position to defend their IS-derived advantage than those that lack such resources (Clemons & Row, 1991; Powell & Dent-Micallef, 1997; Bharadwaj, 2000; Wade & Hulland, 2004; Ravichandran & Lertwongsatien, 2005). According to this line of reasoning, though the necessary software and hardware used by a firm's IS can be easily imitated, it is more difficult for the competitors to copy the intangible resources needed for the successful implementation and exploitation of the IS. This argument has received some empirical support in the literature (Kettinger et al., 1994; Powell & Dent-Micallef, 1997). Powell and Dent-Micallef (1997), for example, found that IS combined with other intangible organizational resources (e.g., flexible organizational culture) yielded competitive advantage.

It is well recognized in the knowledge management literature that organizational culture and structure are instrumental in influencing a firm's ability to derive economic benefits from its IS support for knowledge generation and knowledge transfer. Davenport et al. (2001) argued that firms may not be able to turn data and information into useful knowledge and organizational results from their IS without a supportive organizational culture. Research on barriers to effective knowledge transfer has produced consistent evidence which shows that people lack motivation and incentives to share information and knowledge without a supportive organizational culture (Von Krogh, 1998; Ba et al., 2001; Cohen & Prusak, 2001; Karlsen & Gottschalk, 2004). This is the case even when IS provide a supportive technological environment for knowledge transfer (O'Dell & Grayson, 1998; Gold et al., 2001; Lubit, 2001; Sundaresan & Zhang, 2004).

There is also a growing body of research demonstrating the importance of organizational structure for effective knowledge generation and transfer. Creed and Miles (1996) noted that hierarchical organizational structure presents a constraint on knowledge generation and knowledge sharing by limiting communication among employees and managers. Lee and Choi (2003) found a centralized organizational structure hindered socialization (the process of creating tacit knowledge through shared experience) (Nonaka, 1994). Recent empirical research has produced evidence that supports the positive influence of the alignment between IS and organizational structure on knowledge generation and knowledge transfer (Davenport et al., 2001; Kim & Lee, 2005; Zhang et al., 2006).

Aside from affecting the effectiveness of IS support for knowledge generation and knowledge transfer, firm-specific organizational culture and structure make it difficult for the competition to imitate the IS they complement because organizational culture and structure tend to be intangible and costly to duplicate. In his analysis of the imperfect imitability of organizational cultures, Barney (1986b, 1991) noted that even though firms lacking certain attributes of a valuable organizational culture may understand how these attributes contribute to competitive performance, systematic efforts to create those attributes typically require simultaneous manipulation of complex social relationships, hence making imitation costly. Other researchers also argued that duplicating effective organizational structures is difficult in that they are often context-bound (i.e., they must be properly matched with the particular organizational situations) and require synergistic integration of different organizational elements (e.g., processes, systems and capabilities) (Miller & Whitney, 1999; Galbraith, 2000; 2001).

Besides organizational culture and structure, a firm's competitive scopes (geographic, segment, vertical, and industry) can affect its ability to reap the benefits from IS support for knowledge generation and knowledge transfer. Recent studies relating IS to geographical scope and product scope suggest that geographical diversification and product variety complement IS in influencing firm performance (Peffers & Tuunainen, 2001; Gao & Hitt, 2004). These findings can be explained by the argument that firms with broader geographical presences and product breadths are in a better position to generate and exchange more expertise among more locations and product lines than their rivals with narrow geographical and product coverage (Feeny & Ives, 1990; Sambamurthy et al., 2003). Firms can also combine the scale advantage from their unique vertical integration and related diversification with IS to develop and transfer critical skills and expertise from multiple markets for competitive advantage (Clemons & Row, 1991; Liu et al., 2006). For instance, a firm performing more vertically related activities can deploy IS to share its unique information and knowledge between its upstream and downstream businesses, thus creating an advantageous position over its less vertically integrated competitors (Feeny & Ives, 1990). In a classic case, Otis (once an independent firm of elevator manufacturing and service) installed a remote diagnostic system in the elevators it produced to capture and pass critical information on elevator reliability to the company's information system (OTISLINE) (Neumann, 1994). The reliability information was then combined with engineering information to provide service technicians with advice on what caused an elevator breakdown. This knowledge, along with other critical information created by OTISLINE, enabled Otis to obtain competitive advantage over other elevator service providers.

To the extent a firm's competitive scope is rare and costly to imitate, its complementarity with IS support for knowledge generation and knowledge transfer may generate durable competitive benefits. The strategic management literature indicates that firm-specific competitive scopes tend to be difficult to duplicate. For example, Barney (2002) argued that related diversification based on rare and costly-to-imitate economies of scope (e.g., core competencies) is more unique and immune from direct imitation than one based on common and less costly-to- imitate economies of scope (e.g., shared activities and risk reduction). He also posited that vertical integration managed with superior governance skills (e.g., ability to analyze uncertain and complex economic transactions) are often rare and costly to imitate.

Hypothesis 3: *The interaction between IS support for knowledge generation and firm-specific, complementary organizational resources is positively related to firm performance.*

Hypothesis 4: The interaction between IS support for knowledge transfer and firm-specific, complementary organizational resources is positively related to firm performance.

Methods

sample and data collection

The data for this study came from two sources. The data tapping the independent and moderating variables were gathered via a mail survey in 1998, and the data about the control and performance variables were obtained from the Research Insight (formerly known as Compustat) database. The target respondents of the survey were senior IS executives in large (Fortune and Forbes) firms in the U.S. Most of the respondents held the positions of either vice presidents of IS or chief information officers (CIO). The senior IS executive was chosen as the single informant in this study because of his or her familiarity with both IS and strategic management issues. Prior research has reported increasing involvement of senior IS executives in strategic planning and control activities of firms (Applegate & Elam, 1992; Earl & Feeny, 1994). Applegate and Elam (1992), for example, found a growing number of CIO reporting directly to CEO and nearly half of the CIO surveyed were members of the senior management/strategic policy committee. Furthermore, two recent studies found the information offered by key IS executives consistent with the insights obtained from other senior and mid-level members of management (Palmer & Markus, 2000; Senn, 2002). Consequently, IS researchers have increasingly relied on senior IS executives as single informants in gathering data about strategic IS issues (Karimi et al., 1996; Palmer & Markus, 2000).

The contact information of the senior IS executives was obtained from the Directory of Top Computer Executives compiled by Applied Computer Research Inc. From this source, a sample of 879 firms that had financial data in the Research Insight database was identified. Before being mailed to the target respondents, the survey instrument was pre-tested and refined for content validity and item clarity with CIO from five Fortune companies headquartered in a mid-western state. One hundred and one questionnaires were undelivered or returned because the IS executives were no longer with the companies. Twenty-nine firms declined to participate in the study in writing, on the phone, or through e-mail. To boost the response rate, two follow-up mailings and one reminder letter were initiated after the first mailing. Of the 778 firms that received the questionnaires, a total of 164 responses were received, out of which 11 responses were unusable because the respondents didn't fill out the whole questionnaire. The effective response rate was thus 20% (153 responses). Such a response rate is comparable to those reported in similar studies using senior IS executives in large firms (Powell & Dent-Micallef, 1997; Byrd & Turner, 2001; Kearns & Lederer, 2003).

To test for potential non-response bias, the respondent firms were compared to their non-respondent counterparts with respect to sales and number of employees. T-test results showed no significant differences between the two groups. Another non-response bias check was conducted by comparing the early respondents with the late respondents (Armstrong & Overton, 1977). T-tests of the mean differences for the three explanatory variables failed to reveal any significant differences. Together, these checks supported the absence of non-response bias in the data set.

Measures

Independent variables. Based on the review of the related literature, six items were developed to measure IS support for knowledge generation and another six items to measure IS support for knowledge transfer. In each item, the respondents were asked to indicate the extent to which their

IS had provided a particular type of support during the previous three years on a five-point, Likert-type scale with anchors ranging from "Very great extent" (=5) to "No extent" (=1). To help the respondents draw the difference between information and knowledge, the definitions of the two concepts were provided in the questionnaire. To assess the construct validity of the two scales, a principal components factor analysis with varimax rotation was performed on the twelve items. The results from the factor analysis (Table 1) revealed two factors explaining about 51% of the total variance and corresponding with IS support for knowledge generation and IS support for knowledge transfer, respectively.

Moderating variable. In keeping with the related research (Feeny & Ives, 1990; Clemons & Row, 1991; O'Dell & Grayson, 1998), firm-specific, complementary organizational resources were defined as a set of unique organizational resources that complemented IS used to support knowledge generation and/or knowledge transfer. These resources include: unique organizational culture, unique organizational structure, unique geographical area, unique product breadth, unique vertical integration, and unique range of related industries. The respondents were asked to indicate the extent to which the use and implementation of their IS required each of these unique resources on a five-point, Likert-type scale with anchors ranging from "Very great extent" (=5) to "No extent" (=1). To help the respondents determine whether a complementary resource in question was unique, the term 'unique' was clarified as 'controlled by only a small number of competing firms' (Barney, 1991) in the questionnaire. A separate factor analysis of this six-item scale (Table 2) found a single factor explaining about 50% of the total variance, thus confirming the unidimensionality of the scale.

Dependent variables. Both profitability and labor productivity were used to assess the performance impacts of the IS support in this study. A popular profitability ratio, return on sales (ROS), was chosen to measure profitability. ROS has frequently been used in other studies of the strategic impacts of IS investments (Tam, 1998; Li & Ye, 1999). While other profitability measures such as return on assets (ROA) and return on equity (ROE) have also been used in prior research (Li & Ye, 1999), ROS was chosen over ROA and ROE mainly because ROS is not only closely related to ROA and ROE, but also less susceptible to variation in accounting procedures (Price & Mueller, 1986; Li & Ye, 1999). Labor productivity represents an intermediate measure of firm performance. In view of the potential time lag in gauging IS impacts on firm performance (Brynjolfsson, 1993), IS researchers have recommended the use of labor productivity to capture potential IS impacts (Barua et al., 1995). A conventional measure of labor productivity (sales to employees) was adopted. To smooth annual fluctuations and average out short-term effects, a three-year average (covering the years of 1997, 1998 and 1999) was used for both dependent variables.

Control variables. Since the firms participating in this study came from a variety of industries, it was necessary to control, to some degree, the different industry conditions under which the firms operated. To control for the industry effects, SIC codes were first used to classify the firms into four groups: 1) manufacturing, 2) transportation and public utilities, 3) wholesale and retail trade, and 4) service. Where a firm operated in more than one industry, the firm's SIC code was determined by identifying the industry from which the firm received the largest percentage of sales and the corresponding SIC code. Three dummy variables (each with values of 0 or 1) were created for the second (transportation and public utilities), the third (wholesale and retail trade) and the fourth (service) groups of firms. For each dummy variable, a firm was assigned a value of 1 if it belonged to a group.

Table 1. Factor analysis of IS support

Item Description	IS Support for Knowledge Generation	IS Support for Knowledge Transfer
To what extent have your company's IS provided each of the following support during the past three years?		
1. Facilitate fast and easy collection of critical information from outside the company	.823	
2. Facilitate fast and easy collection of critical information from within the company	.594	
3. Reduce the cost of collecting critical information from within the company	.662	
4. Reduce the cost of collecting critical information from outside the company	.803	
5. Capture unique employee expertise	.624	
6. Generate useful information from existing databases	.495	
7. Transfer expertise or skills across different business units		.685
8. Transfer expertise or skills among different lines of business		.695
9. Provide timely access to internal information in decision making situations 10. Provide timely access to internal knowledge in decision making situations 11. Increase communication linkages among employees 12. Increase sharing of information throughout the company		.619 .566 .702 .724
Eigen Value	3.05	3.02
% of common variance explained	25.45	25.18
Cronbach Alpha	.80	.79

The fourth control variable was firm size, which has frequently been used in previous studies involving firm performance as a dependent variable (Kivijarvi & Saarinen, 1995; Tam, 1998). A conventional measure (natural logarithm of the number of full-time employees) was used to represent firm size. Another control variable used in the study was technological resources. A firm's technological resources may influence its ability to develop IS for sustainable competitive advantage (Kettinger et al., 1994). While a preferable measure of technological resources is R&D intensity, the Research Insight data for R&D intensity were missing for many firms in the sample. An alternative measure (investment intensity operationalized as invested capital to sales) was then adopted to measure technological resources (Kettinger et al., 1994). The next control variable controlled for organizational slack, which is indicative of a firm's ability to generate cash flow for reinvestment (Chakravarthy, 1986). Organizational slack needs to be controlled due to its potential influence on a firm's financial performance as well as the firm's ability to invest in and develop IS (Li & Ye, 1999). In keeping with Bourgeois (1981), the current ratio (current assets

Table 2. Factor analysis of firm-specific, Complementary Organizational Resources

Item Description	Loadings
To which extent have the use and implementation of your company's IS required each of the following organizational resources?	
1. Unique geographical area	.653
2. Unique breadth of products or buyers	.715
3. Unique vertical integration	.703
4. Unique range of related industries	.640
5. Unique organizational culture	.758
6. Unique organizational structure	.752
Eigen Value	2.98
% of common variance explained	49.69
Cronbach's Alpha	.80

to current liabilities) was employed to measure organizational slack.

Analyses

To test the hypothesized main effects and moderating effects, two sets of hierarchical regression analyses were performed, using ROS and sales to employees as the dependent variables. In the first step of each set of the analyses, the six control variables were entered as a set into the regression model. In the second step, the two independent variables and the moderating variables were added to the equation. In the third step, the two interaction terms were added to the model. To avoid potential multicollinearity among the independent and moderating variables, the factor scores calculated from the factor analysis of the twelve IS support items were used in the regression analyses and the moderating variable was mean-centered before being used in the regression analyses.

r esults

Table 3 displays the results of the hierarchical regression analyses. Hypothesis 1 suggests a positive relationship between IS support for knowledge generation and firm performance. Models 2 and 5 show that IS support for knowledge generation was significantly related to sales to employees ($b = .17$, $p < .05$) in the expected direction, but not to ROS. These results thus provided partial support for Hypothesis 1. Hypothesis 2 proposes a positive relationship between IS support for knowledge transfer and firm performance. As in the case of testing Hypothesis 1, IS support for knowledge transfer was significantly and positively related to sales to employees only ($b = .21$, $p < .01$). Hypothesis 2 was then partially supported.

Hypothesis 3 predicts that the interaction between IS support for knowledge generation and firm-specific, complementary organizational resources is positively related to firm performance. In Models 3 and 6, the interaction term between IS support for knowledge generation and firm-specific, complementary organizational resources was significant in predicting ROS in the

Table 3. Regression results[a]

Variables		ROS			Sales/Employees	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Industry dummy 1	-.09	-.10	-.12	-.03	-.05	-.04
Industry dummy 2	-.13+	-.14+	-.11	.25**	.23**	.22**
Industry dummy 3	.20*	.20*	.20*	-.04	-.04	-.04
Firm size (log of employees)	.10	.08	.08	-.36***	-.36***	-.36***
Current assets to current liabilities	-.03	-.02	-.03	.04	.04	.03
Invested capital/sales	-.44***	-.44***	-.46***	-.06	-.06	-.08
IS support for knowledge generation		.02	.07		.17*	.16*
IS support for knowledge transfer		.01	.03		.21**	.21**
Firm-specific, complementary organizational resources		.10	.05		-.11	-.11
IS support for knowledge generation X firm-specific, complementary organizational resources			.14*			-.06
IS support for knowledge transfer X firm-specific, complementary organizational resources			.16*			.06
R^2	.33	.34	.39	.17	.24	.24
ΔR^2		.01	.05		.07	.00
F	12.13***	8.32***	8.13***	4.97***	4.88***	4.07***
ΔF		.80	5.14**		4.10**	.52

[a] *N = 153. Standardized regression coefficients are shown.*

[+]*p < .10, *p < .05, **p < .01, ***p < .001* expected direction ($b = .14$, $p < .05$). However, the same interaction term was not significant in predicting sales to employees. Hence, these moderation results provided only partial support for Hypothesis 3. Finally, Hypothesis 4 states that the interaction between IS support for knowledge transfer and firm-specific, complementary organizational resources is positively related to firm performance. The interaction term was significant in predicting only ROS ($b = .16$, $p < .05$) in the expected direction, thus offering partial support for Hypothesis 4.

dIscuss Ion

o verview and Implications of the f indings

This study was conducted to assess the performance impacts of IS support for two key knowledge management activities. The results showed that some firms enjoyed gains in labor productivity from deploying IS to support knowledge generation and knowledge transfer. Some firms even increased profitability from such IS support by bundling their IS with certain firm-specific organizational resources. Contrary to the growing skepticism towards the performance impacts of IS support for knowledge management (Ciborrra & Patriota, 1998; Lubit, 2001; Husted & Michailova, 2002; Butler, 2003), these findings suggest that IS may represent more than a strategic necessity for knowledge management and that IS support for key knowledge management activities may actually lead to competitive advantage and superior economic performance. One key contribution from this research is that it provided some initial evidence in support of the strategic value of IS-based knowledge management.

While generally confirming the competitive values of IS support for knowledge generation and IS support for knowledge transfer, the study revealed that the profitability impacts of the IS support depended on the presence of certain firm-specific, complementary organizational resources. Absence such resources, both IS support only improved labor productivity. This finding has an important managerial implication for how to achieve competitive advantage from IS-based knowledge management. That is, it is not sufficient for firms to simply invest in and deploy IS to facilitate knowledge generation and knowledge transfer if they expect profitability gains from such IS investment and deployment. Firms also need to consciously develop and mobilize other organizational resources that not only facilitate the implementation and exploitation of IS for knowledge management, but also make the IS less susceptible to imitation by their competitors.

In a broader sense, since IS and unique, complementary organizational resources both represent knowledge management enablers or facilitators, the interactive effect between IS support for knowledge management and firm-specific, complementary organizational resources on profitability points to the importance of evaluating how different enablers of knowledge management interact in helping a firm gain and maintain competitive advantage. Whereas the existing literature has identified a number of knowledge management enablers and examined their additive effects on firm performance (Lee & Choi, 2003; Kim & Lee, 2005), there have been few attempts to explore and assess the performance impacts of their interactive effects. As implied by the resource-based theory and the evidence from this and other related studies (Goodman & Darr, 1998; Davenport et al., 2001), the competitive contributions of different enablers of knowledge management may lie in their interactions. Therefore, future research needs to devote more attention to the exploration and assessment of the interactive effects among different knowledge management enablers on firm performance.

For researchers interested in organizational resources that complement IS support for knowledge management, while prior research tends to focus on organizational culture and structure (Powell & Dent-Micallef, 1997; Goodman & Darr, 1998; Davenport et al., 2001; Sundaresan & Zhang, 2004), the findings from this study suggest that the competitive scopes of a company, to the extent they are firm-specific and complementary to IS support for knowledge generation and knowledge transfer, can be just as important in providing competitive advantage for IS-based knowledge management. It is possible that other firm-specific and intangible organizational resources such as organizational trust (Powell & Dent-Micallef, 1997; Lee & Choi, 2003), absorptive capacity (Gupta & Govindarajan, 2000), and T-shaped skills (Leonard-Barton, 1995) may also complement IS support for knowledge management, and the potential moderating effects of these complementary organizational resources warrant investigation in future research.

l imitations of the s tudy

The findings from this study need to be interpreted within its limitations. The first limitation is that the response rate (20%) for the survey used in the study, while comparable to those of similar studies, is relatively low and may thus limit the generalizability of the study results. Obtaining higher response rates for sensitive information concerning the strategic use of IS continues to be a challenge for researchers. The second limitation of the study is its reliance on perceptual data collected from single informants in measuring the independent and moderating variables. Data collected in such a manner may be subject to the respondents' cognitive biases and distortions. While the use of objective measures for the performance and control variables reduced potential biases and inaccuracies in measuring those variables and lowered the 'common method variance', additional research is needed to develop better (more objective and fine-grained) measurements of IS support for the two knowledge management activities and firm-specific, complementary resources and incorporate perceptions and opinions by non-IS managers and employees.

Another limitation is that, while a number of industry and organizational factors were controlled in the study, there might be other potential performance determinants whose effects were not taken into account due to the lack of data and the small sample size. The exclusion of these variables might have resulted in either overestimating or underestimating the main or interactive effects of IS support for knowledge generation and IS support for knowledge transfer (Berry & Feldman, 1985). Whenever possible, future research needs to include or control other environmental and organizational attributes related to firm performance in order to provide a more accurate assessment of the performance impacts of IS support for knowledge management.

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Chapter XV
Chinese Culture and Virtual Knowledge Sharing in a Multinational Corporation

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Abstr Act

The goal of this study was to explore how national (Chinese) culture influences knowledge sharing in virtual communities of practice at a large U.S.-based multinational organization. The study involved qualitative interviews with the company's employees in China, and managers who are involved in managing knowledge-sharing initiatives. The study findings suggest that the influence of the national culture could be less pronounced in online knowledge sharing than what the literature has suggested. Although Chinese employees' tendency to draw sharp distinctions between in-groups and out-groups, as well as the modesty requirements were barriers to knowledge sharing online, the issue of saving face was less important than expected, and attention paid to power and hierarchy seemed to be less critical than what the literature indicated. A surprising finding was that despite widely assumed collectivistic nature *of the Chinese culture, the high degree of competitiveness among employees and job security concerns seemed to override the collectivistic tendencies and resulted in knowledge hoarding. The reasons for these unexpected findings could be associated with differences between face-to-face and online knowledge sharing environments, the influence of the company's organizational culture, and the recent rapid changes of the overall Chinese cultural patterns.*

Introduction

Recent research on organizational learning and knowledge management shows that knowledge sharing, communication, and learning in organizations are profoundly influenced by employees' cultural values (Hambrick, Davison, Snell & Snow, 1998; Hofstede, 2001; Hutchings & Michailova, 2004; Jennex, 2005, 2006; Kohlbacher & Krähe, 2007; Peltokorpi, 2006; Pfeffer & Sutton, 2000). Studies of cognitive strategies and methods of learning and knowledge generation suggest that cognitive styles differ by national cultures (Korac-Kakabadze & Kouzmin, 1999). Bhagat, Kedia, Harveston, and Triandis (2002) have explained how national cultural tendencies toward individualism and collectivism strongly influence ways of thinking, including processing, interpreting, and using information and knowledge. People in collectivistic cultures are less likely than those in individualistic cultures to emphasize the significance of information that is written and codified, and more likely to disregard such information. Other dimensions of national culture, such as uncertainty avoidance, and power distance, also influence knowledge flows between individuals (Ford & Chan, 2003; Hofstede, 2001). There have been studies on the impact of national culture on knowledge sharing in general (Bhagat, Kedia, Harveston & Triandis, 2002; Ford & Chan, 2003; Glisband & Holden, 2003; Guptal & Govindarajan, 2000; Hutchings & Michailova, 2004). However, research on knowledge sharing through computer-mediated communication (CMC) in organizational settings, such as knowledge sharing through online communities of practice (CoPs), is scarce. At the same time, there are multiple examples of successful use of online CoPs by well-known industry leaders such as Hewlett Packard, British Petroleum, Chevron, Ford, IBM, and Shell (Ardichvili, Page & Wentling, 2003). Although there are some studies about online knowledge sharing (Bansler & Havn, 2003; Ardichivili et al., 2003), very few of these studies have addressed the role that national culture plays in knowledge sharing through CMC (Ardichvili, Maurer, Li, Wentling & Stuedemann, 2006).

Therefore, there is a gap in current research on how national culture impacts knowledge sharing through CMC. To address this gap, this study focuses on knowledge sharing through online CoPs in Corporation Alpha's China offices (to maintain confidentiality, we will be using this pseudo-name for the Fortune 100 multinational company we have studied), and attempts to answer the following research question: How do Chinese cultural values affect the knowledge sharing behavior of Chinese employees in Alpha's China offices?

Theoretical Framework

This section will present key ideas/literature related to the theoretical discourse applied in this article in the following areas: CoPs, knowledge sharing, and national (Chinese) cultural values.

Communities of Practice (CoPs)

Lave and Wenger (1991) established the notion of "community of practice" in their book on situated learning as a process of "legitimate peripheral participation." Wenger and Snyder (2000) defined communities of practice as groups of people informally bound together by shared expertise and passion for a joint enterprise. CoPs can be either physical or online/virtual. With the advanced development of information and communication technologies (ICTs), the increasing wide reach of the Internet, and thus the lack of physical constraints, online or global CoPs become possible and also important since these communities can help their members find others who share the same interests and concerns no matter where they are located physically. CoPs can fill the "structural holes" in networks (Burt, 1992) and help members take advantage of the "strength of weak ties" (Granovetter, 1973) to get richer information and solve problems faster. These online communities are especially valuable for multinational companies that are faced with the challenge of disseminating organizational knowledge which resides in individuals and teams spread around the world when the opportunities for face-to-face interactions are rather limited. Thus, distributed virtual CoPs enabled by the modern ICTs are becoming an increasingly popular way of knowledge sharing among geographically dispersed employees (Wenger, McDermott & Snyder, 2002).

Knowledge Sharing and National Cultural Values

Literature on knowledge transfer between units of multinational corporations as well as within joint ventures discusses various factors in international knowledge sharing such as organizational culture and incentive systems (Gupta & Govindarajan, 2000; Inkpen & Dinur, 1998; Kogut & Zander, 1993; Simonin, 1999). However, only very few recent studies have explicitly concentrated on the discussion of national cultural factors that influence knowledge transfer (Chow, Deng & Ho, 2000; Ford & Chan, 2003; Holden, 2001, 2002; Huang, 2005; Hutchins & Michailova, 2004). Bhagat et al. (2002) have made a significant contribution to this body of literature by proposing a quite powerful theoretical framework for understanding the significance of four transacting cultural patterns, defined in terms of the dimensions of individualism-collectivism and verticalness-horizontalness, for their potential in moderating the effectiveness of cross-border transfer of organizational knowledge.

Culture is the way in which a group of people solves problems and reconciles dilemmas. Culture presents itself at different levels (Trompenaars, 1998). At the highest level is the culture of a country or of a regional society, which can be called national culture. On the next level, the way in which attitudes are expressed within a specific organization is described as corporate or organizational culture (Schein, 2004). Finally, within organizations, people within certain functions will tend to share certain professional and ethical orientations, which are called professional culture (Trompenaars, 1998). Hofstede (2001) describes five main dimensions of cultures (particularly at the country level): individualism-collectivism, power distance, uncertainty avoidance, masculinity-femininity, and long-term-short-term orientation. These are the five classic dimensions that have been widely used in empirical studies (Hwang, Francesco & Kessler, 2003).

In order to examine the effect of Chinese cultural values on knowledge sharing behaviors of Chinese employees, this article will focus on several of the most salient attributes of Chinese culture. These attributes have been identified on the basis of the literature review and the data gathered from a focus group (discussed below).

Individualism/In-group/out-group distinction

Individualism describes the tendency of people to place personal goals ahead of the goals of a larger social group, such as the organization. On the other hand, individuals in collectivistic cultures tend to give priority to the goals of the larger collective or group they belong to (Hofstede, 2001), which often results in actions of individuals which serve the community or society (Trompenaars, 1998). A further distinction between individualism and collectivism can be made on the basis of the definition of self (Triandis, 1995). Members of individualistic cultures see themselves as independent of others, whereas collectivists see themselves as interdependent with other members, in many cases with members of a specific in-group. Collectivists tend to make a sharper differentiation between in-group and out-group members. Cross-cultural literature suggests that members of collectivist cultures tend to be open and willing to share their knowledge with members of their in-group (Chow et al., 2000), but could be strongly distrustful of out-group members. Indeed, Chow et al. (2000), by comparing factors influencing knowledge sharing behaviors between U.S. and Chinese managers, have found that Chinese participants were much more reluctant to share knowledge with an out-group member than Americans were. Hutchings and Michailova (2004), discussing the impact of group membership on knowledge sharing, indicate, "In China one's membership of in-groups affects all daily activities" and one's membership of in-groups "is the source of identity, protection, and loyalty" (p. 87).

High-Low Context

Hall (1976) points out that "a high-context communication or message is one in which most of the information is either in the physical context or internalized in the person while very little is in the coded, explicit, transmitted part of the message. A low-context communication is just the opposite, i.e., the mass of the information is vested in the explicit code" (p. 79). China has been categorized as a high-context culture, in which people tend to rely more on the context of nonverbal actions and the environmental settings to convey meaning, and therefore tend to prefer communication media with high media-richness, such as face-to-face communication or phone calls. This corresponds to what Bhagat et al. (2002) described. According to Bhagat et al., members of collectivistic and individualistic cultures are characterized by distinctively different ways of processing information and constructing knowledge. For instance, in individualistic cultures (e.g., the United States), individuals tend to see each piece of information independent of its context, emphasize information in written and codified form, and are more likely to accept such information. On the other hand, members of collectivistic cultures (e.g., China) look for contextual cues in information and tend to disregard written information (Bhagat et al., 2002).

Concerns About Face and Modesty

With regard to factors influencing knowledge seeking behavior, the literature points towards an attribute very important for Chinese, namely face (Chen, 2001; Chow et al., 2000; Hwang et al., 2003). Face is the image that people strive to maintain before others in pursuit of recognition and inclusion (Hallahan, Lee & Herzog, 1997, cited in Hwang et al., 2003). Researchers have noted that although the concern for face is encountered in numerous cultures around the world, it is a particularly high concern in a collectivistic culture like the Chinese (Redding & Wong, 1986, cited in Chow et al., 2000) and this concern can limit collectivists' willingness to share some types of knowledge (Chow et al., 2000). According to Hwang et al. (2003), research on face has shown that face is not a single construct but is delineated along two facets, "Lian" and "Mianzi". Lian was described as the confidence in the integrity of one's moral character, while Mianzi represents prestige and honor that accrues to a person as a result of successes and/or ostentatious behavior before others. Hwang et al. (2003) have found that the extent to which individuals try to gain face (Mianzigain) or avoid to loose face (Mianziloss) influences knowledge seeking behavior. In a study with undergraduate business students, they have found that individualism is positively related to Mianzigain, and that consequently individualists, in this case American students, were most likely to ask questions in class. This is because asking questions is a way to gain prestige and recognition (Mianzigain), and not just to gain knowledge. Surprisingly, the researchers did not find support for the hypothesis that collectivism is positively related with the fear of Mianziloss. However, this relationship was found to exist in the American individualistic sample. Nonetheless, Hwang et al. (2003) were able to confirm that, in general, individuals concerned with losing Mianzi will be less likely to ask questions in class in order to avoid Mianziloss. They also found evidence that individuals who want to gain face will be more likely to use formal communication channels to show their knowledge and ability, while those who worry about losing face will prefer informal communication channels, such as students asking the professor questions outside the classroom.

With regard to factors influencing knowledge sharing (giving) behavior, the literature points out modesty, namely, the public under-representation of one's good traits and abilities (Bansler & Havn, 2003; Kurman, 2003). Bansler and Havn conducted a longitudinal study of online sharing of best practices among middle managers inside a large European pharmaceutical company, and found that one reason why many managers did not want to contribute to the company's Intranet-based knowledge database was that they wanted to avoid giving the impression of bragging. Their findings suggested that letting other people know how knowledgeable one is was not considered good etiquette in that organization, and posting something online was seen as a form of boasting and an inappropriate self-compliment. Research has suggested that modesty issues tend to be prevailing in collectivistic cultures, like the Chinese culture (Kurman, 2003). Kurman specifically examined the relationship between modesty requirements and low self-enhancement in collectivistic cultures. Kurman (2003) found support for the notion that cultural restrictions, such as the requirement of displaying modesty, are mainly responsible for low self-enhancement found in certain collectivist cultures. Therefore, it is reasonable to assume that modesty not only explains low self-enhancement, but also accounts to some extent for Chinese employees' reluctance to actively participate in online community discussions.

power distance

Power distance is "the extent to which the less powerful members of organizations and institutions accept and expect that power is distributed unequally" (Hofstede, 2001, p.xix). Hofstede's (2001) power distance (PD) dimension is similar to Triandis' (1995) distinction between vertical and horizontal culture. People in vertical cultures tend not to value equality. Instead, they tend to see themselves as different from others in social status. In fact, differences in status are expected and accepted, which is an important attribute of high PD cultures. On the other hand, in horizontal cultures, people ideally are all equal, and power distance is low, which implies that differences in status are less pronounced. Bhagat et al. (2002) argue that the distinction between horizontal and vertical cultures is useful in explaining cross-border knowledge transfer, because information in vertical cultures usually flows from the top to the bottom, whereas information in horizontal cultures flows in both directions. Ford and Chan (2003) studied knowledge sharing in a multicultural setting and found that knowledge flows for the Japanese (in vertical culture) tended to be more top-down, whereas knowledge flows for North American employees/managers (in horizontal culture) tended to be more diverse (top-down, lateral, and bottom-up). Similarly, Hofstede (2001) suggests that in high PD cultures information is usually constrained by hierarchy, which might lead to an exclusion of lower-level employees from certain types of information, and thus create an obstacle for knowledge sharing within CoP members with different status.

Assumptions about the Impact of Chinese Cultural Values on Knowledge Sharing

Since this was an exploratory study, no specific hypotheses were formulated. However, the above literature review helped to form several assumptions about the main factors that might influence Chinese in terms of knowledge sharing via online CoPs.

Individualism/In-g roup/o ut-g roup d istinction

Being members of a collectivistic culture, Chinese employees would tend to focus on the needs of various collectivities they belong to, which is why they might be more willing to share what they know with other members of the same collectivities. At the same time, a potential barrier to knowledge sharing in such a culture could be a sharper distinction made between in-group and out-group members. That is to say, Chinese members would be more willing to share knowledge with someone considered to be part of an in-group while they might stay away from sharing knowledge with someone considered to be part of an out-group (even though these employees could be members of the same larger organization they both belong to).

h igh and l ow c ontext c ommunication s tyles

Situated in a high-context culture, Chinese employees tend to rely more on the context of nonverbal actions and the environmental settings to convey meaning, and therefore tend to prefer communication channels with high media-richness, such as face-to-face communication or phone calls. This can be a barrier for their participation in online communities since Chinese people may think that using media with high richness such as face-to-face communication or phone calls (as opposed to using media with low richness such as online systems) is more polite and more conducive to establishing trust.

f ear of l osing f ace (Asking Questions) and Modesty (Answering Questions)

In Chinese culture such values as the desire to save face and modesty would constitute a significant barrier to active participation in online knowledge sharing communities. Posting questions online could be threatening to people who are concerned with saving their own face. According to one of the participants, "In an open forum like this, there is always a threat of ridicule." At the same time, responding to questions and making suggestions online could also pose threat to other people's face. Again quoting one of the participants, "What if the posted question was rather trivial, and the ease with which an answer was found hints at the inquirer's incompetence?" Finally, in cultures that put a significant weight on modesty, community members are likely to avoid being too active in online or other open-forum discussions out of fear of appearing too immodest and boastful.

It needs to be pointed out that the above considerations could be affected by the generation gap. Older people may be more sensitive about face; younger people, especially those who are more exposed to global influences, could have higher tolerance for "face-threatening" situations.

Power Distance and Importance of Status

Since active participation in online knowledge sharing presumes that individual employees will feel free to post questions and respond to postings without checking with their supervisors first, such behavior could be seriously limited in Chinese culture, which is described by Triandis (1995) as a vertical culture.

Research Setting and Methodology

The Participating Organization

This research was conducted in a large multinational business organization, Corporation Alpha. It operates in more than 20 countries. As a Fortune 100 corporation, Corporation Alpha's competitive advantage depends heavily on the utilization of professional knowledge of its employees. In the mid-1990s, Alpha started to use CoPs to help its worldwide employees share knowledge. Most of the communities are initiated by employees who share some common interests, instead of by management interventions. Alpha's communities are supported by an Internet-based knowledge sharing system. As an infrastructure for community functioning, this knowledge sharing system allows users to post/answer questions and connect to numerous other online communities. A typical community includes a community manager, one or more "delegates," a number of "experts," and "subscribers". Typically, managers are selected by the team and are usually senior, experienced members who have earned the team's respect though a strong history of contributing to the company. "Delegates" are associate managers who can run the community in the managers' absence or take on certain parts of the community management duties. "Experts" are people recognized for their skills and knowledge in certain areas. They actively participate in the community by posting knowledge entries, assisting managers in reviewing new postings, and answering questions posted to the community in general. Finally, any member of the organization, who is interested in a CoPs subject, can become a "subscriber" to that community. Alpha is characterized by a rather egalitarian and open culture. The overseas subsidiary in China (Alpha China) seems to have significantly assimilated this cultural attribute, that is to say, Alpha China shares organizational culture with its parent company. Its culture is substantially different from the organizational cultures of most traditional state-owned companies in China. The analysis reported in this article, focusing on data collected in Alpha China offices, is part of a larger project with three countries involved, namely China, Russia, and Brazil (results of the larger study presented in Ardichvili et al., 2006).

Research Methods

This research is based on a qualitative design. The data were gathered by means of one focus group, four face-to-face interviews, and ten telephone interviews.

The focus group was conducted with four Chinese students from University of Illinois, Urbana-Champaign and one visiting scholar from China on November 8, 2003. All of the five participants were native Chinese and by the time of the focus group they have spent only several months in U.S. Therefore, the probability that Western cultural influences could override the Chinese culture assumptions was minimal. Most of the focus group participants were working in business or government organizations prior to coming to the United States. The focus group lasted one and a half hours. The moderator led the discussion which was generally guided by a list of prepared questions. These questions were asked to identify Chinese cultural values that might influence online knowledge sharing behavior. Here are two examples. To identify the cultural factors that might prevent Chinese from asking questions online, the following question was asked: "Do you feel comfortable posting questions online? Please explain reasons for your answer." To test if there was in-group/out-group distinction in terms of sharing knowledge or not, the following question was asked: "Let's assume that you read a question, posted by someone else, and you feel that you know the answer. Will you post your answer?" Along with the literature review, the data from this focus group helped to clarify some of the salient factors determining Chinese employees' attitudes towards knowledge sharing. These data were then used to refine the questionnaire that was used in interviews (discussed below).

Four face-to-face interviews were conducted with managers located in Alpha's headquarters. Three of these managers were North Americans, and one was Chinese. All of the interviewees had experience working with Chinese employees and/or in China. These interviews were semi-structured, guided by a list of questions such as, "What are your opinions about the reasons (especially cultural reasons) why Chinese employees do not use the knowledge sharing system actively?" and "Based on your observation, how do Chinese employees communicate with each other? What communication media do they prefer? " Each interview lasted about one hour.

Next, ten telephone interviews were conducted. Interviewees included six Chinese employees of Alpha working in overseas offices located in China, and four Chinese employees working for Alpha's dealers. Both Alpha employees and dealership employees had experience with virtual CoPs. The interviewees were identified through the online participation records provided by Alpha or through referral by the four managers as mentioned above. Each interview lasted about one and a half hours and was followed up by e-mails and/or additional phone calls with clarification questions. In interviews, the participants were asked a number of open-ended questions, which were intended to generate rich descriptions of knowledge sharing and problem-solving situations and strategies.

The principal researcher on this study coded and analyzed the data collected by the above methods independently using the qualitative data presentation and analysis methods proposed by Miles and Haberman (1994), including development of summary sheets for each interview, coding of individual interview data, and coding of the overall data set. The second researcher provided rating reliability checks by independently coding and analyzing samples of interview transcripts.

The study authors acknowledge a major limitation inherent to the study design. The qualitative nature of this study decreases the generalizability of the findings. Since the data is specific to the participating organization, the findings and recommendations will only be valid for the study participants. However, as recommended by Lincoln and Guba (1985), the authors have made an attempt to provide rich and thick descriptions of their findings and the context of the study, in order to allow the reader to judge whether the findings of this study can be applied to other contexts and situations as well.

Key fI nd Ings

The data from this study indicate that overall the influence of the national culture was less pronounced than what the literature review suggested. Although Chinese employees' tendency to draw sharp distinction between in-group and out-group members and the modesty requirements were barriers to open knowledge exchanges online, the issue of saving face was less important than expected, and attention paid to power and hierarchy seemed to be less critical than suggested by the literature. A surprising finding was that, although the Chinese culture is assumed to be collectivistic, in this particular sample the high degree of competitiveness among employees and job security concerns were among the main reasons for not sharing knowledge through the online sharing system.

Next, the main findings will be discussed one by one in line with the four assumptions made earlier: individualism/collectivism and in-group/out-group distinction, high and low context (type of communication style), fear of losing face (asking questions) and modesty (answering questions), and power distance and importance of status.

Individualism and c ollectivism and In-g roup/o ut-g roup d istinction

The data from this study show that, contrary to generally assumed collectivistic orientation of the Chinese, employees of Alpha did not display strong collectivistic tendencies. As one participant observed, "Maybe the traditional Chinese culture was this way; it is not true for today's China, especially in big cities." While our initial assumption was that, being from a collectivistic culture, Chinese employees of Alpha would share their knowledge openly with other members of the organization, the study data indicate that Chinese employees tended to abstain from sharing knowledge with others. At the same time, consistent with the in-group/out-group distinction suggested by the literature, the data show that there is a strong in-group orientation, and distrust of outsiders among Alpha's Chinese employees. Various comments made by study participants suggest this. For example, "Chinese do not like sharing, maybe because of politics. This is related to culture. For example, if I see an e-mail from someone I do not know, I may not help." "Chinese take 'Guanxi' seriously. If there is a request for help from friends, they are very warm-hearted and will really make an effort to help; but if the help is needed by strangers or someone who is not close to them, they may ignore."

Among the reasons for not sharing knowledge is the fierce competition in today's China. Because of high competitiveness, employees worry about their job security and prefer to hoard knowledge. A widely accepted proverb is "knowledge is power"; therefore, when people acquire new knowledge, they believe that it is the key to their success and are likely to guard it instead of sharing it. This finding was rather surprising, since it contradicts one of the assumptions about collectivist societies, namely, that there is less competition, at least within in-groups. Concerns about job security were especially prevalent among younger and lower-level professionals. The following quotes illustrate these findings:

- *"As the Chinese economy is opening up and growing fast, the competition in Mainland China is getting fiercer. Competition among colleagues is already very high."*
- *"If we are in the same line of work, we are enemies. People are selfish in this sense."*
- *"In China there are too many people for 'one cake' and so the competition is high. Everybody is busy with his own work. Helping others is regarded as extra work. At all levels, people have their struggles. The pressure is high. There is no much tranquility in heart."*
- *"Employees are careful about what they say, considering the competition and evaluation."*
- *"Many people do not want to share the expertise they get through many years of hard working. The reason for this situation is competition. If you can solve problems others cannot solve, you will be valued and get self-respect. They know sharing is good for all but they do not share because they think they get less than what they need to contribute. This is a comparison of personal benefit and cost."*

One participant explained that asking a question would mean admitting that he does not know something, and admitting this would affect a person's job security. By an estimate, provided by one respondent, about 40% of employees of this particular organization may have this concern, "They do not want their supervisors to know that they do not know something." Therefore, employees prefer to ask someone they are familiar with, for example, their peers, people with whom they have started to work at the company together. This suggests that the in-group orientation has, indeed, a powerful influence on the knowledge-sharing patterns.

high and low context communication styles

As one participant observed, "China is more of a people society and we value face-to-face communication." When asked about their general preference for ideal communication channels, respondents provided answers that suggest the following order: first face-to-face meetings, followed by phone calls, and then by e-mails as the last choice. "If you use face-to-face communication, there is some additional stuff." "Phone calls are easier. If using phone call is enough, people prefer phone calls. Only when it is very necessary, will people use e-mails, for example to send an agenda. Chinese people prefer 'personal' communication, by calls, at least there is voice. If you deal with something by e-mail, people will suspect that this is something serious." "People do not like 'cold' e-mails, but like 'warm' phone calls. They can express their warm regards to build good relationships with each other." These findings support Hall's (1976) distinction between high- and low-context cultures. In high-context cultures, such as China, individuals tend to prefer communication channels with high media richness.

At the same time, when asked about communication methods actually used at the Alpha China offices, employees provided the following order of preference: e-mails as the most preferred mode of communication, followed by phone calls, and then by face-to-face communication. Alpha China employees prefer e-mail for several reasons:

- In many cases, face-to-face communication and phone calls are not realistic because of the high cost of traveling and expensive long distance phone calls.
- Much communication is global, and the time difference between different regions of the world is an issue.
- Global communication through knowledge sharing system happens in English, but there is a language barrier. The Chinese are especially concerned about their ability to clearly express their ideas, making sure that they will be understood. Therefore, they prefer to use e-mail, since this gives them more time to organize sentences, think through the wording, and so forth.
- Some employees point out that they prefer e-mails because e-mails provide "black and white" trail of evidence. Therefore, they especially prefer to use e-mails when dealing with persons they do not know well.

fear of losing face (Asking Questions) and Modesty (Answering Questions)

Interestingly, contrary to the initial expectation, the issue of face was not as important for Chinese participants in this study. Most employees feel rather comfortable about asking questions and contributing to discussions in public, as long as these interactions contribute to improved job performance. The majority of the interviewees shared an opinion, expressed by one participant, "There is no problem for me to post a question on the knowledge sharing system. I feel very comfortable to do so." Even those who have some concerns about losing face indicate, "I'd better ask colleagues and do a good job. It is worse to lose face in front of clients." Another employee stated that, "I once heard that Chinese were very sensitive to 'face'. But regardless of culture, nobody likes to be embarrassed in public. Maybe this is a little bigger deal in China, but not a very big deal. Anybody wants to be treated with courtesy and respect." At the same time, in line with our expectations, "face" was more of a concern for older people.

Although our assumptions regarding the role of face were not supported strongly, the assumption regarding the role of modesty was confirmed; modesty considerations seemed to affect online participation and knowledge sharing at this particular organization's Chinese offices a great deal. It was pointed out repeatedly in interviews that in the Chinese culture it is not acceptable to speak a lot in public and to stand out. Several participants cited a Chinese proverb to explain this point, "Making many people aware of a trivial matter is exaggerating." Influenced by the value expressed in this proverb, Chinese employees prefer to solve minor problems by themselves, without seeking help from others. One interviewee illustrated this by saying, "I think most of us worry too much about our questions, wondering if we are doing a good job. Maybe the question is not so silly, but as a Chinese proverb goes: 'we must think three times before we do it,' Chinese people will think three times (meaning 'think very carefully') before posting questions."

A related issue is the lack of confidence in language skills. In China, even when Chinese employees had quite strong language skills, they were worried that what they posted online was not perfectly worded. As a consequence, they were spending too much time trying to improve their writing, or were abandoning these attempts altogether.

Power Distance and Importance of Status

Although our assumption was that Chinese employees would pay significant attention to power and hierarchy, the data from this study seem to contradict this assumption. Participants indicated less power distance by mentioning that "In online communities of practice, everybody is equal."

When selecting and appointing online community managers and experts in China, seniority, rank, or age were not the major factors. As one participant put it, "In the end, whether you are qualified to be an expert depends on how good you are professionally." Especially in younger people's eyes, qualification rests on professional knowledge and does not have much to do with status and positions. In fact, several participants agreed that "managers in high positions are not very good in terms of professional knowledge, since they are too occupied with administrative tasks." However, such attitude to hierarchy and rank could be an artifact of organizational culture; the US headquarters of Alpha is characterized by an egalitarian and open culture, and Alpha China seems to have significantly assimilated this cultural attribute.

dIscuss Ion

Since this study investigated knowledge sharing patterns in an online environment, one plausible explanation for lower than expected impact of several national cultural values could be that these differences are less pronounced online than they are in face-to-face interactions. For instance, since the organizational status of other community members is unknown, employees might be less hesitant to post a comment or an answer to someone else's question on the discussion board. Indeed, there are already some studies showing that electronically facilitated communication may make national cultural differences less salient (Jarvenpaa & Leidner, 1999; Matsumoto, 2002; Singh & Baack, 2004). Given the scarcity of empirical studies specifically addressing the impact of national culture characteristics on online knowledge sharing, there is a definite need to further examine this relationship.

At the same time, more research is needed to identify the influence of organizational culture factors in this context as well as the link between the organizational and national culture. As the findings in this study have shown, the impact of national cultural characteristics was in some cases less pronounced than initially expected, which could be attributed to the fact that the organizational culture was in some instances stronger in shaping individuals' knowledge sharing patterns. Previous research has indicated that knowledge sharing can be affected by the interaction of national culture and other contextual factors, such as organizational culture (Chow, Deng & Ho, 2000; Huang, 2005). As part of an international company, Alpha China shares organizational culture with its parent company. "I do not notice a big difference except language. If I go to our office in Beijing, I work just like how I work in US. The Alpha culture there is consistent with the culture here." Study participants have also pointed out that Alpha China's culture was substantially different from the organizational cultures of pre-reform state-owned enterprises (SOE) in China, which were typically characterized as centrally-planed, closed and bureaucratic (Ralston, Terpstra-Tong, Terpstra, Wang, and Egri, 2006). They perceived themselves as quite open in their communication and information sharing compared to employees of some Chinese SOEs.

The results of our study also suggest a need to investigate the national culture change. National cultures are rather stable over time, but the products of scientific discovery are the major force of cultural change (Hofstede, 2001), such as the Internet, which is rapidly integrated into our everyday life (Haythornthwaite & Wellman, 2003). Japan is a prominent example of a national culture which has been significantly changed by technological advances of the last four to five decades (Matsumoto, 2002). China offers another example of national cultural change. Although China is usually described as a collectivistic society (Hofstede, 2001), some recent studies have reported that there is growing individualism there (Hu & Grove, 1999; Lau, 1992; Ralston, Gustafson, Terpstra & Holt, 1995). For example, Lau's (1992) research found that Chinese put a strong emphasis on individualistic values even though they showed some traces of collectivistic concerns, and that these Chinese were no less individualistic than Americans. Ralston et al. (1995) conducted a longitudinal study of the work values among young Chinese managers in Shanghai over two and a half years' period and observed that there was an obvious evolution of their work values, one of the main changes being growing individualism. Hu and Grove (1999) also observed the increasing individualism in China, especially among younger Chinese as China is playing a more and more important role in the global market.

One of the surprising finding from this study was that there is fierce competition even among in-group members in China. At the same time, there were indications that sharing knowledge with some in-groups is still possible. Thus, some respondents indicated that they would share with their peers, people with whom they have started work at the company at the same time. This indicates that, although the same individual may be a member of several different in-groups, he or she may be willing to share knowledge with some of these in-groups, and not with others. Therefore, instead of assuming willingness to share with in-groups in general, researchers need to investigate specific composition of in-groups in organizations under investigation, and determine differences in knowledge-sharing patterns within different in-groups.

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Chapter XVI
Selecting the Right Knowledge Management Tools:
Software Trends and Key Evaluation Criteria

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Abstr Act

In this chapter, we update earlier research on the state of the art Knowledge Management (KM) tools and present key evaluation criteria that can be used by organizations to select the applications that best meet their specific KM needs. We briefly describe tools currently available in the software industry to support different aspects of knowledge management and offer a framework for understanding how these tools are clustered based on the functionality they support.

Background: Knowledge Management (KM) Tools Requirements

Information systems have continued to evolve and change their role to better respond to the needs of organizations. Until recently, organizations have used information technology to support information management (Ruiz-Mercader, Merono-Cerdan, & Sabater-Sanchez, 2006), (Schultze & Leidner, 2002). Therefore, organizational systems have been information-bound and information centric. Today, we have a better understanding that for information to be effectively used by individuals, information systems need to be more people-centric and support specific individual needs. KM places people at the center. The key difference between information and knowledge management is the role played by the individual actors (Davenport, Jarvenpaa, & Beers, 1996); (Adamides & Karacapilidis, 2006); (Frank & Gardoni, 2005). While information management focuses on the information infrastructure (Janev & Vranes, 2005); (Ruiz-Mercader et al., 2006); knowledge management focuses on people and their role in the organization.

Within the above premises, knowledge management tools will focus on facilitating individual learning, use and contextualization of organizational knowledge embedded in people and documents (Alavi & Leidner, 2001). This leads to at least four key functional requirements for KM tools: 1) facilitate information contextualization; 2) intelligently transfer information; 3) facilitate social interactions and networking; 4) present a customized human-computer interface that meets user needs. We have discussed these functional requirements in earlier research (Balmisse, Meingan D., & Passerini, 2007).

KM Tools Classification

KM applications need to be designed to sustain knowledge management implementations within organizations. This includes the process of managing existing knowledge and supporting the creation of new knowledge. This process is embedded and thrives on information that is transferred from individuals to groups with a continuous transformation of information into knowledge through contextualization and knowledge-discovery. Figure 1 presents roles and actors linked to knowledge management tools in enterprises, and highlights their functions.

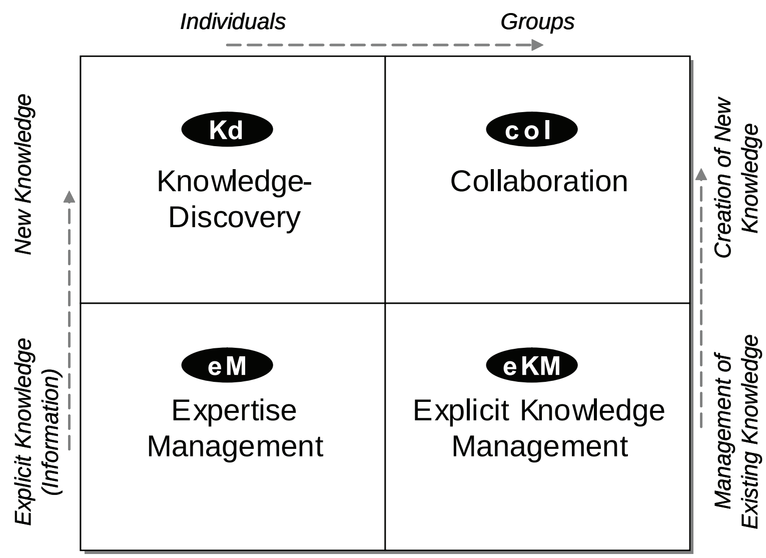
KM tools support the management of existing knowledge and new knowledge creation by individuals and groups by focusing on:

Management of explicit knowledge [EKM] with a specific focus on the compilation, organization, replenishment, and use of the knowledge base. Compilation and capture of knowledge include facilitating the creation and publication of information in shared areas. Organization requires structuring information based on specific taxonomies and ontology that facilitate document mapping. Replenishment and use (and re-use) can be supported by providing users with tools to add comments on how the information was used and contribute to future uses.

Knowledge discovery [KD] through the uncovering of unexploited information stored in large databases. This include text analysis and mining; knowledge extraction and automatic classification and visualization of patterns; and use of semantic mapping to link documents.

Expertise management [EM] tools to link people and facilitate knowledge exchanges within the enterprise. These tools go well beyond smoothing the progress of finding the right resources (as in employees' directories) because

Figure 1. KM Tools Framework



they dynamically ease contacts, follow ups and communication.

Collaboration tools [COL] for the production of knowledge, coordination and communication. The knowledge production activities provide a static view of the results of team interactions and lessons learned after the exchange. The collaboration activities are more dynamic and support the definition of actors and roles, activities and tasks throughout the duration of a project. Lastly, communication areas facilitate direct exchanges among users and, therefore, are important new knowledge creation areas.

A number of tools are currently available to support the functionalities and processes described. Some tools are highly specialized while others try to offer comprehensive solutions to the enterprise. The tools are clustered based on the framework presented in Figure 2, which groups software by knowledge management function (expertise, discovery, collaboration) and type of users (individual or groups). The applications are listed in Table 1.

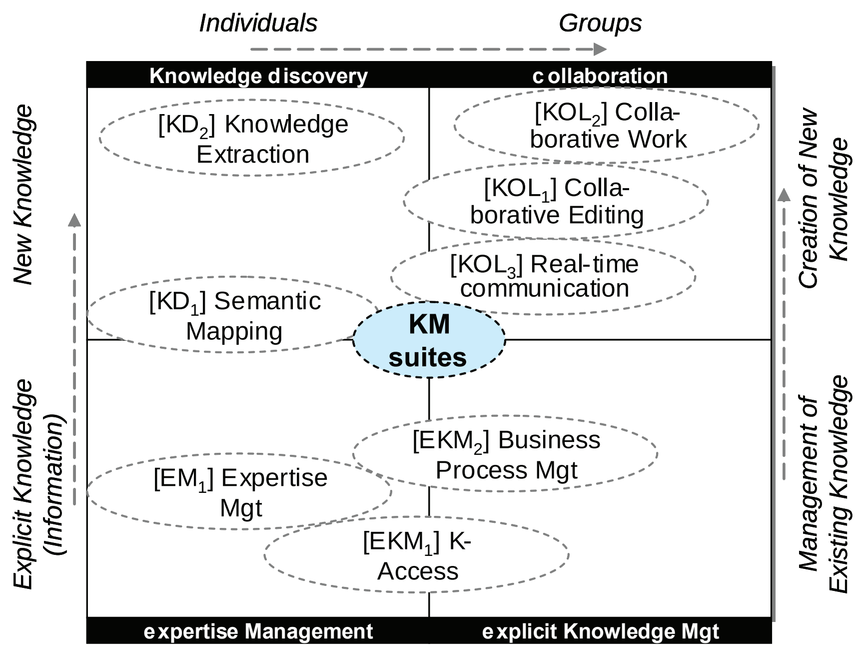
t ools to Access Knowledge [e KM$_1$]

These tools provide access to explicit knowledge that can be shared and transferred through the enterprise information systems. They use powerful indexing systems, including systems to classify expertise based on both content and collaboration dynamics and networks within the enterprise.

t ools for s emantic Mapping [Kd $_1$]

Semantic mapping is emerging as a fundamental instrument to make sense out of the vast amount of data and information available in increasingly large repositories (Davies & Duke, 2005). Semantic mapping tools are meant to quickly support presentation of information, analysis and decision-making. The extent of interaction with the knowledge map varies by tools, with some tools being mostly static visualizations and others allowing continuous and dynamic interactivity by changing the data views. For example, KartooKM provides many different views from centric mapping, to clustering, topographical maps, interactive trees, closeness and social networks maps,

Figure 2. KM Tools Clusters



circular maps and animated charts. Ontology tools are also part of this category as they enable users to organize information and knowledge by groups and schemata that represent the organizational knowledge base (Parpola, 2005).

Tools for Knowledge Extraction [KD$_2$]

Tools for knowledge extraction support structured queries and replies. They help mining text by interpreting relationships among different elements and documents. Therefore, they help the knowledge seeker in identifying the exact document and the other documents related to his/her queries, resulting in structured and more articulated answers. Some sophisticated data and text analysis tools also support the identification of relationships among concepts, using sound and rigorous statistical association rules (e.g., SPSS).

Tools for Expertise Localization [EM$_1$]

These tools enable quickly locating the knowledge-holders in the enterprise and facilitating collaboration and knowledge exchanges (Huysman & Wulf, 2006). Therefore, they are focused on going beyond simple directories by enabling users to easily capture and organize the results of their project interactions (Coakes, Bradburn, & Blake, 2005) by quickly locating project expertise and enabling re-use.

Tools for Collaborative Editing and Publishing [COL$_1$]

Tools like DocuShare enable collaborative editing of documents and the management of the entire document publication cycle. They include systems for document management within the enterprise, as well as more flexible systems such as Wikis and Blog creation tools.

t ools for c ollaborative w ork [col $_2$]

These tools enable teams to globally share dedicated spaces for managing the project lifecycle; editing and publishing materials; conducting live discussions and interactions; and maintaining a repository of materials associated with every step of the collaborative exchange (Frank & Gardoni, 2005). For example, using MS SharePoint servers, teams can quickly create password-managed and secure project areas and follow the lifecycle of documents creation and exchanges.

t ools for r eal t ime c ommunication [col $_3$]

These tools overlap with some of the functionalities of the previous category. However, they are specifically focused on live communication exchanges, whiteboarding and file sharing.

t ools for b usiness process Management [e KM$_2$]

These tools can be split into applications for process modeling and tools for workflow management. Process modeling tools focus on designing and optimizing processes (Gronau, Muller, & Korf, 2005). They formalize and define the elements of the process, assign actors to roles, and identify data sources and flows within the processes.

g lobal Knowledge Management s olutions

Applications in this category refer to software suites dedicated to KM. For example, portal packages provide collaboration modules; content management; access to repositories and information; process management; text mining and business intelligence.

g uIdel Ines And c r Iter IA t o s elect KM t ools

Given the large number of solutions available in the market and listed in Table 1, organizations need to clearly understand guidelines and criteria for selecting the tools that are most appropriate to meeting their specific environmental and business needs. Using due diligence in the selection of the KM solution is one of the key aspect of the project success. KM brings substantial organizational change within the enterprise. This change will be harder to manage if it is not supported by a thorough alignment between business needs and the technological solution. In this section, general guidelines to select KM applications are discussed. Then, based on the framework presented in Figure 2, criteria for the selection of functional solutions that can address specific organizational issues are also presented.

g eneral s election g uidelines

1. *Conduct an evaluation of the real needs of the enterprise* (Acur & Englyst, 2006). Firms should specify the objectives of the tools to increase their ability to select which applications can solve specific problems. Implementing a KM initiative without a clear understanding of the environmental resources will lower effectiveness. In the latter scenario, the tool configuration (and its standard functionality) will drive the implementation of KM in the organization, thus lowering any competitive differential.
2. *Move beyond vendors' marketing*. Several vendors promise to solve every organizational problem while lacking a clear understanding of the enterprise. Vendors often gain access to the decision makers and entice them with a "one-does-it-all" solution without any knowledge of the infrastructure, culture, people and processes of the enterprise (Kwan & Cheung, 2006). These

Table 1. Knowledge Management Software List

Vendors	Applications	Web Link
Tools for knowledge access		
Autonomy Verity	Idol K2	www.autonomy.com
Coveo	Coveo Enterprise Search	www.coveo.com
Endeca	Endeca for Intranet and Knowledge Management	www.endeca.com
Exalead	Exalead Corporate	www.exalead.com
Fast (Microsoft)	Fast ESP	www.fastsearch.com
IBM	OmniFind Enterprise Edition	www.ibm.com
Lingway	Lingway Custom Search	www.lingway.com
Oracle	Oracle Secure Enterprise Search	www.oracle.com
PolySpot	PolySpot Enterprise Search	www.polyspot.com
Tools for semantic mapping		
i2	i2 TextChart	www.i2.co.uk
Inxight (Business Objects)	SmartDiscovery VizServer	www.inxight.com
Kartoo	KartooKM	www.kartoo.net
Pikko	Arak	www.pikko-software.com
Tom Sawyer Software	TomSayer Visualization	www.tomsawyer.com
Visual Analytics	VisuaLinks	www.visualanalytics.com
Ontologies		
Mondeca	ITM	www.mondeca.com
Ontopia	Knowledge suite	www.ontopia.net
Sandpiper Software	Visual Ontology Modeler	www.sandsoft.com
SchemaLogic	Enterprise suite	www.schemalogic.com
Tools for knowledge extraction		
ClearForest	ClearForest Text Analysis Suite	www.clearforest.com
Inxight (Business Objectifs)	Inxight SmartDiscovery	www.inxight.com
Lingway	Lingway KM	www.lingway.com
Temis	Luxid	www.temis.com
Relationship discovery		
Lockheed Martin	AeroText	www.aerotext.com
SPSS	LexiQuest Mine	www.spss.com
Tools for expertise localization		
IBM	Lotus Connections	www.ibm.com
Tacit	Illumio	www.tacit.com
Tools for collaborative editing		
Alfresco	Alfresco ECM	www.alfresco.com
Atlassian	Confluence	www.atlassian.com
Interwoven	WorkSite	www.interwoven.com
Nuxeo (Open Source)	Nuxeo	www.nuxeo.org

continued on following page

Table 1. continued

Xerox	DocuShare	http://docushare.xerox.com/
Tools for collaborative work		
EMC – Documentum	eRoom	http://software.emc.com/
IBM / Lotus	QuickR	www.lotus.com
SiteScape	SiteScape Forum	www.sitescape.com
Tomoye	Tomoye Ecco	www.tomoye.com
Tools for real time collaboration		
Adobe	Acrobat Connect Professional	www.adobe.com
Marratech	Marratech e-Meeting Portal	www.marratech.com
Microsoft	Live Meeting	www.microsoft.com
Skype Technologies	Skype	www.skype.com
WebEx	Meeting Center	www.webex.com
Tools for business process management		
Boc	Adonis	www.boc-eu.com
IDS Sheer	Aris	www.ids-scheer.com
Mega	Mega Process	www.mega.com
Workflows		
IBM	Business Process Manager	www.ibm.com
TIBCO	iProcess Suite	www.tibco.com
W4	W4BPMEngine	www.w4global.com
Global Solutions and Suites		
Knowings	Collaborative.ECM	www.knowings.com
Microsoft	SharePoint Server 2007	www.microsoft.com
Oracle	Collaboration Suite	www.oracle.com
Portals		
BEA	AquaLogic User Interaction	www.bea.com
IBM	IBM Enterprise Accelerator	www.ibm.com
OpenText	LiveLink	www.opentext.com
Vignette	Vignette Suite	www.vignette.com

vendors are less likely to provide solutions aligned with the organizational eco-system (Alavi, 2000), at least without extensive and expensive customizations.

3. *Understand the "paradigm" and perspectives behind the tools.* This includes identifying the core value proposition of the KM solution. It may require defining the market entry strategy that vendors utilized when the product was first launched (what was the focus area?). Tools may have been launched as niche modules to penetrate specific areas, and then may have evolved into global solutionss. For example, Open Text Livelink ECM is a tool designed for document management. Therefore, its focus is on classifying information into structured repositories. Its group and communication

capabilities are secondary (and dependent from) its main goal.

4. *Limit the weight of financial criteria.* While costs are clearly important drivers of any selection, particularly for small and medium-sized enterprises, financial considerations should be weighted together with technical, security, ergonomics, administrative and functional feasibility considerations, briefly explained in the next paragraphs.
5. *Maintain a practical view.* No single tool can answer all organizational needs. Modular implementations, paired with change management, may be the better approach than holistic and riskier global information systems projects (Corso, Martini, Pellegrini, Massa, & Testa, 2006), (Janev & Vranes, 2005).
6. *Focus on interoperability.* The rapid evolution of technology, storage capabilities, software and hardware alters our understanding of which tools will still be available and supported in tomorrow's competitive environment. The more interoperable and open standards, the easier to migrate the information and knowledge to other, yet undiscovered, platforms.
7. *Interface and ergonomics integration.* The user interface should support customization based on individual actors and roles. To encourage re-use, employees should enjoy personalization options based on their organizational access rights, as well as their selections.
8. *Guarantee information security.* Information and knowledge shared through KM systems may vary from strategic level know-how to sensitive organizational processes and intellectual property. Security levels, access rights and security operational controls will constitute another important selection guideline.

Additional specific criteria need to be applied to the diverse applications, based on their functional specialization (Xu & Quaddus, 2005). Table 2 summarizes functional attention areas that support comparisons among different KM solutions. Table 3 shows a basic and actionable evaluation scorecard that can be assembled and customized for implementing the suggested comparative evaluations.

c onclus Ion

A due diligence process in the selection of the most suitable technical solution is an obvious premise to the success of knowledge management projects in organizations. However, the long-term success of any KM application highly depends on its continuous alignment with users, who will ultimately re-use the tool if it adds value to their activities. Notable models propose various measurements and drivers for the identification of KM success and impacts (Jennex, 2005) in organizations. We refer to these models for a complete review of the topic. In this paper, we provided a summary overview of the market and drivers of KM solutions and highlighted specific selection guidelines. Technical, organizational and individual factors contribute to knowledge creation. From the technical standpoint, the KM tools need to demonstrate that they are beneficial to the organization, at least based on usage statistics. From the organizational standpoint, the tools must be supplemented with workplace changes that promote knowledge sharing and dissemination through the new platforms. Organizational changes could include, for example, rewarding peer ranking and document usage as practiced by companies like Infosys (Chatterjee & Watson, 2005; Kochikar & Suresh, 2004; Mehta & Mehta, 2005). Lastly, individuals must feel secure that participation and utilization of the tools is not focused on personnel reduction but

Table 2. KM Solutions Comparison Criteria

Function	Criteria	Explanation
Management of explicit knowledge	⇨ K-Capturing and publishing ⇨ Validation ⇨ Searching ⇨ Distribution	Management of explicit knowledge is based on the platform ability to capture the right information and to add value through information organization and publication in the repository. The added value may be embedded in the process of validation of the document sources; sophisticated and intelligent search capabilities, and ample tools for information dissemination.
Knowledge discovery	⇨ Extraction ⇨ Classification ⇨ Mapping	Knowledge discovery is supported by tools for automatic knowledge extraction as well as automatic and dynamic organization of the content / relationships through visualization tools and semantic maps.
Expertise management	⇨ Profiling ⇨ Expert searching ⇨ Identification	Expert identification is a crucial activity that connects knowledge sellers and buyers (Davenport & Prusak, 1998). Directories should be updated and dynamically re-allocate queries to different experts. They should be based on a real-time collection of social interactions and load analyses.
Collaboration	⇨ Asynchronous interactions ⇨ Instant messaging ⇨ Web conferencing ⇨ Team coordination and collaboration	Collaboration tools must support both real-time and off-line asynchronous interactions to accommodate users' scheduling. Coordination in asynchronous environments involves off-line capture of missed messages, traces of interactions, and the historical view of collaboration outcomes.
Knowledge organization	⇨ By Structure ⇨ By Owner ⇨ By Content	Requires identifying the taxonomies that best fit the organization. Content-based organization may be critically important in service industries; while a process-based organization may be critical in vertical industries. Ideally, tools should support multiple views, including a quick identification of information owners.
Interface and ergonomics	⇨ User email and calendaring integration ⇨ Personalization ⇨ Off-line access ⇨ User-based interface ⇨ Help	The effectiveness of KM tools is enhanced by integration with daily work tasks, employees' ability to access and contribute to exchanges through remote synchronization, and continuous support and help resources to guide interface customization.
Administration and maintenance	⇨ Users management ⇨ Groups management ⇨ Languages support ⇨ Usage trends reporting ⇨ Sub-roles and delegation	A powerful KM application provides multiple users management levels; integrates language translation tools; provides periodic feedback on system use. For example, it can point users to most accessed resources and experts, raising attention to important organizational needs.
Security	⇨ Platform security ⇨ Authentication ⇨ Digital rights management ⇨ Confidentiality and data integrity ⇨ Data safeguarding	Security management includes network intrusion detection; validation; implementation of network separation strategies when connecting different groups (internal and external) to sensitive data. Access management and increased wireless security standards are also required to support delivery on multiple hardware platforms (PDAs, Smart phones).
Technical constraints	⇨ Architecture ⇨ Ownership ⇨ User interface mgt. ⇨ Open systems interoperability and integration	The dynamism and instability of the KM vendor market environment favors the selection of highly interoperable and scalable systems that can be quickly integrated with other solutions.
Vendor characteristics	⇨ Sales agreement ⇨ Stability and trust ⇨ References ⇨ Processes ⇨ Support ⇨ Proximity and reaction time	These criteria are typical of any information systems solution selection. They are even more useful in the diversified and segmented KM software market described herein. Proximity, financial and long-term stability of the vendors represent key decision factors.
Costs	⇨ Purchase licenses and materials ⇨ Integration costs ⇨ Customization and configurations ⇨ Maintenance ⇨ Support and training	As in other information systems solutions, maintenance costs; license agreements; warranties; integration and customization solutions are globally more important than the one-time license acquisition price.

Table 3. Sample comparison scorecard

Functional Criteria	Wgt %	Tool_ 1	Tool_ 2	Tool_ 3	Tool_ 4
Management of explicit knowledge	⇨				
Knowledge discovery	⇨				
Expertise management	⇨				
Collaboration	⇨				
Knowledge organization	⇨				
Interface and ergonomics	⇨				
Administration and maintenance	⇨				
Security	⇨				
Technical constraints	⇨				
Vendor characteristics	⇨				
Costs	⇨				

on personal development, and long-term leadership and growth.

It is the mix of the above factors - coupled with a clear understanding of the market, the tools and the drivers for the selection of applications aligned with business needs described in this paper - which may ultimately support successful KM initiatives.

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Chapter XVII
Knowledge Patterns and Knowledge Refactorings for Increasing the Quality of Knowledge

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Abstr Act

Knowledge management is a relatively young discipline. It has accumulated a valuable body-of-knowledge on how to structure and represent knowledge, or how to design socio-technical knowledge management systems. A wide variety of approaches and systems exist that are often not interoperable, and hence, prevent an easy exchange of the gathered knowledge. Industry standards, which have been accepted and are in widespread use are missing, as well as general concepts to describe common, recurring patterns of how to describe, structure, interrelate, group, or manage knowledge elements. In this chapter, we *introduce the concepts "knowledge pattern" and "knowledge anti-pattern" to describe best and worst practices in knowledge management, "knowledge refactoring" to improve or change knowledge anti-patterns, and "quality of knowledge" to describe desirable characteristics of knowledge in knowledge management systems. The concepts are transferred from software engineering to the field of knowledge management based on our experience from several knowledge management projects.*

Introduct Ion

The ability to learn from knowledge gained in past projects to determine success factors and reasons for failure is a key factor for organizational learning. Consequently, knowledge management (KM) as well as learning management (LM) are important for any quality improvement initiative to succeed. Researchers and practitioners have defined and installed a multitude of models, theories, and systems comprised of valuable and recurring knowledge that is waiting to be reused in KM systems. However, the quality of the knowledge gained, the technical KM system used, or the social KM method applied is neither easy to evaluate, nor is it easy to improve. This is partly due to the fact that there exists no universal KM system that is suitable for all kinds of organizations. In practice, each system has to be adapted and tailored to the individual needs of an organization. Examples of aspects influencing the design of KM systems include the improvement and learning strategies applied, the physical structure of the organization (e.g., different sites and locations), and the organization's logical structure (e.g., departments, projects, and working groups). Defining a KM initiative and implementing a KM system in an organization remains a time consuming and often error-prone endeavor. As a result, knowledge on how to avoid errors or shorten the time for implementation is in high demand.

Such knowledge on KM systems has been documented in the form of success factors (Mathi, 2004) (Thomas, 2006) (Morisio et al., 2002), success models (Jennex & Olfman, 2004, 2006), success measures (Jen & Yu, 2006), reference architectures for KM systems (Davenport & Probst, 2000; Mertins, 2003), or worst practices (Fahey & Prusak, 1998). They typically preserve knowledge about a whole KM system or initiative. But (complete) reuse of existing solutions is neither common nor do standard schema libraries or COTS collections for creating a KM system exist. Hence, support for a consistent set of KM systems, which would allow for easy integration of existing knowledge into an organization's specific system, or for sharing and exchanging knowledge with other organizations, is still missing. Especially such easy exchange and wide-spread use would help to detect flaws and misbelieves in the existing body of knowledge, and thereby would help to significantly increase the quality of knowledge. Even commonly accepted best practices on how to structure knowledge, how to design an interface for a KM system, or how to start a storytelling session are hard to find. Unlike in other disciplines, general concepts or rule of thumbs documenting recurring patterns of how to describe, structure, interrelate, group, or manage knowledge are still missing.

During the mid-1990s, the concept of "design patterns" was developed in software engineering to describe best practices regarding the design of software systems in a structured way. Design patterns are used to represent knowledge that is based on experiences captured in several real-world projects and is widely accepted. This semi-formal representation is often used for describing and presenting the gained knowledge.

In this chapter, we transfer the concepts of quality, patterns, and refactoring from software engineering to the field of KM and introduce the concepts of *knowledge patterns* and *knowledge* *refactorings* in the context of *knowledge quality*. We describe an approach for structuring knowledge in knowledge management systems in the form of so-called *knowledge patterns*. These patterns and anti-patterns can be used to develop KM systems and improve the quality of the systems themselves as well as that of the knowledge within (i.e., the *quality of knowledge*). Furthermore, we transfer the concepts of software refactoring and software quality in order to describe the effect of knowledge patterns as well as countermeasures (i.e., *knowledge refactorings*) for removing knowledge anti-patterns. To illustrate the concept of knowledge patterns, we provide examples that are based on our observations from developing and operating several knowledge management (KM) systems (i.e., these do not represent empirically validated findings). Knowledge patterns state lessons learned and best practices for the structuring of knowledge, the design of KM systems, and the development of underlying ontologies. They should be kept in mind when building high-quality knowledge and KM systems. Furthermore, patterns in KM represent a way of structuring knowledge as well as a form of language that helps knowledge engineers to communicate about knowledge and KM systems. With this chapter, we also want to stimulate discussions about the meaning of quality in the context of KM, how knowledge should or should not be described in a KM system, and what is needed to generate a fruitful socio-technical KM system.

Relevant background information concerning KM, best practices in KM, software engineering, and software patterns are presented in the next section. Section 3 describes several desirable quality aspects of knowledge in KM systems that are affected by patterns. The core of this chapter —the knowledge patterns and anti-patterns— are described in Section 4, followed by sections on how these patterns might be implemented (c.f. Section 5), and examples of where some of the patterns have been used in current knowledge bases (c.f. Section 6). Finally, we conclude and give an outlook on future work in Section 7.

bAcKground

The relevant background for knowledge patterns is comprised of knowledge and learning management, software engineering and reuse, KM in software engineering, as well as patterns in software engineering. The following sections will focus on these fields and their relations to patterns in general.

Knowledge and Learning Management

KM and learning management (LM) both serve the same purpose: facilitating learning and competence development of individuals, in projects, and in organizations – but, they follow two different perspectives. KM is related to an organizational perspective, because it addresses the lack of sharing knowledge among members of the organizations by encouraging individuals to make their knowledge explicit by creating knowledge elements, which can be stored in knowledge bases for later reuse or for participating in communities of practice. Learning management emphasizes an individual perspective, as it focuses on the individual acquisition of new knowledge and the socio-technical means to support this internalization process. The high potential for synergies between Knowledge- and Learning Management seems obvious given the many interrelations and dependencies of these two fields. An interview-based study demonstrated that perceived connections between both are not operationalized (Efimova & Swaak, 2002). Even a few years later, many barriers regarding their integration still exist (Ras et al., 2005).

Knowledge as the fourth factor of production (Senge, 1995) is one of the most important assets for any kind of organization, and for all areas of science. While *experiences* describe events in one specific context that can only be reused carefully, *knowledge* is usually applicable in previously unknown contexts with a fair amount of certainty. *Experience knowledge* can be described as knowledge that has been gained by acting. It may either result from unprocessed and unreflected events in specific situations or from conscious reflection and interpretation about the undergoing things. Experience knowledge is knowledge that can let us act practiced and automatically, or that helps us to judge about, to select, and to apply an appropriate problem solving strategy, method, technique, or tool. Unfortunately, a small number of experts who have acquired knowledge through their experiences in day-to-day work hold major parts of the knowledge in an organization. Surprisingly, this is equally true for researchers in KM. Experience gained about knowledge itself and KM systems, either technical, social, or socio-technical ones, are typically recorded in the form of models or process models only. Fine-grained knowledge about the structuring, interconnection, or classification of knowledge is rarely documented, and common and recurring patterns are hardly available – while best practices about the whole KM systems and initiatives are often shared (Davenport & Probst, 2000; Mertins, 2003).

While the concept of knowledge patterns is still new in KM, there are similar concepts such as success factors (Mathi, 2004) (Thomas, 2006) (Morisio et al., 2002), success models (Jennex & Olfman, 2004, 2006), success measures (Jen & Yu, 2006), reference architectures for KM systems (Davenport & Probst, 2000; Mertins, 2003), worst practices (Fahey & Prusak, 1998), barriers (Eberle, 2003), facilitators (Damodaran & Olphert, 2000), and incentives (Feurstein et al., 2001) that are often described in an unstructured and informal way. Barriers, facilitators, or incentives represent types of patterns that describe common and recurring incidents, practices, or behavioral structures in KM. There are many different types of barriers such as knowledge barriers in general (Riege, 2005), barriers in knowledge transfer (Sun & Scott, 2005) and distribution (Bick et al., 2003), barriers based on culture (Lippert et al., 2003), as well as barriers based on roles and activities (Awazu, 2004). Nevertheless, a concept for documenting commonly recurring patterns on how to describe, structure, interrelate, group, or manage knowledge components is still missing.

The expectations on Learning Management and e-Learning content in particular are high (cf. SCORM 2004 2nd Edition Overview page 1-22, http://www.adlnet.org/scorm/index.cfm): Systems should provide access to instructional components from diverse locations, instruction should be adaptable to individuals and organizational needs, delivering instruction must be affordable, and the system should address the criteria durability, interoperability, and reusability. Only best practices exist related to the development of learning management systems and learning content since they strongly depend on the learning context of the individual, group, or organization who want to learn – no general patterns or anti-patterns are available. Nevertheless, numerous initiatives like AICC (the Aviation Industry CBT Committee), ADL (Advanced Distributed Learning), IEEE LTSC (the Learning Technology Standards Committee of the IEEE) and IMS Global Learning Consortium have made efforts to establish standards as a first step to guide the development of patterns. For several years, a number of initiatives have agreed to cooperate in the field of standards and specifications. Several of these specifications have been incorporated and in some cases been adapted by ADL to define the SCORM reference model. SCORM describes that technical framework by providing a harmonized set of guidelines, specifications, and standards based on the work of several distinct e-Learning specifications and standards bodies. These specifications have one aspect in common: by separating the content from the structure and layout, they enable the author to develop different variants of learning material very efficiently, while relying on the same set of learning objects.

Many commercial as well as open source-based learning management systems have implemented the concepts provided by these specifications and standards in order to fulfill the requirements listed previously. The concepts are still not available as a comprehensive set of patterns. Nevertheless, the development of patterns and anti-patterns for knowledge management should also refer to learning management concepts, since they provide relevant aspects about content structuring, linking, and navigation. Knowledge transfer – as a phase of KM – is related to learning and competence development, and therefore its success depends on knowledge structures that stimulate learning processes.

Software Engineering

The discipline of *Software Engineering (SE)* was born in 1968 at the NATO conference in Garmisch-Partenkirchen, Germany (Simons et al., 2003), where the term "software crisis" was coined to describe the increasing lack of quality in software systems that were continuously growing in size. Today, quality is still of utmost importance in the development of software products.

At the same conference, the systematic reuse of software components was motivated by Dough McIllroy (McIllroy, 1968) to improve the quality of large software systems by reusing small, high-quality components. The reuse of existing knowledge and experience is one of the fundamental parts in many sciences. Engineers often use existing components and apply established processes to construct complex systems. Without the reuse of well proven components, methods, or tools, we would have to rebuild and relearn them again and again.

In software reuse, several named barriers were described by Judicibus and classified into the two classes, "individual factors" and "collective factors" (Judicibus, 1996). Individual factors are:

- **Artist's Syndrome:** Developers consider themselves more like artists than like engineers; they want to build something "beautiful" and avoid the reuse of external and "ugly" software. Typically, developers would more likely develop a function from scratch than reuse an existing component that does not fulfill the given requirements 100%.
- **Standards' Phobia:** Standards are needed in software reuse to build upon standardized components. But developers have to build components based on the project requirements and the reuse standard and often neglect the additional effort.
- **Egghead's Syndrome:** Developers and esp. experts do not want to share their expertise and abandon their power. Building reusable components would enable other, less experienced developers to reuse this knowledge.
- **Feudal Lord's Syndrome:** Typically, managers think and are judged by the numbers – the more personnel or budget the more important a manager has to be. Building reusable components will mostly generate a benefit for other departments and relatively decrease one's own status. Furthermore, reuse would lead to smaller teams, cheaper projects, and therefore fewer personnel and a lower budget.

In contrast to these individual factors, the collective factors group together cultural and social barriers:

- **Not Invented Here Syndrome:** Companies or departments often see the products of others as inferior to what they themselves have or could create. The motivation to (re-)use them is non-existent to negative.
- **The Technology Syndrome:** The first impression of a new technology often decides about how it will be seen in the company. New technologies typically need time to

be tailored and understood in order to be efficient and effective.

- **The Revenue Mania:** Departments are often judged solely by their income. The more revenue a department makes right now, the better. Building reusable components for future usage is often not recognized as a long-term investment and only decreases the short-term income.

Another social barrier was described in (Favaro, 1991): New approaches and technologies like software reuse are often introduced with high expectations that lead to an initial euphoria followed by disillusion. This barrier could be named *manic depression*.

Knowledge Management in Software Engineering

Since the NATO conference on software engineering, the two fields software reuse and Experience Management (EM) have increasingly been gaining importance. The roots of EM lie in Experimental Software Engineering ("Experience Factory"), in Artificial Intelligence ("Case-Based Reasoning"), and in KM. EM is comprised of the dimensions methodology, technical realization, organization, and management. It includes technologies, methods, and tools for identifying, collecting, documenting, packaging, storing, generalizing, reusing, adapting, and evaluating experience as well as for the development, improvement, and execution of all knowledge-related processes.

KM Systems in the area of Software Engineering (SE) deal with the processes and products as described in the Software Engineering Body of Knowledge (SWEBOK, 2004). They should be able to handle work products, reusable parts thereof, and organization-specific experience achieved with or through applying those processes.

KM systems for EM (esp. in SE) are usually instantiations of the Experience Factory (EF) concept. The EF is an infrastructure designed to support EM (i.e., the reuse of products, processes, and experiences from projects) in software organizations (Basili et al., 1994). It supports the collection, pre-processing, and dissemination of experiences and represents the physical or at least logical separation of the project and experience organization as shown in Figure 1. This separation is meant to relieve the project teams of the burden to find, adapt, and reuse knowledge from previous projects as well as to support them in collecting, analyzing, and packaging valuable new experiences that might be reused in later projects.

Typically, such experience and/or (external) knowledge is stored and documented in the form of FAQs, lessons learned, war stories, or identified best practices (e.g., (Harrison, 2004), (Nicholls, 2004)). Examples for possible products to be stored in a KM system for SE are requirements, designs, patterns, source code, test cases, or other documentation about products and processes. Additionally, knowledge about the development and measurement of products and processes is stored in these systems. In (Briand et al., 1994), three kinds of documentations were considered for software maintenance projects:

- **Product related**, describing the system itself (i.e., software requirement specification, software design specification, and software product specification);
- **Process related**, used to conduct software development and maintenance (i.e., software development plan, quality assurance plan, test plan and configuration management plan);
- **Support related**, helping to operate the system (i.e., user manual, operator manual, software maintenance manual, firmware support manual).

In the "knowledge dust to pearls" approach (Basili, Costa et al., 2001), the experiences gained in day-to-day work (i.e., the knowledge dust) is "analyzed, synthesized, and transformed into knowledge pearls, which represent more sophisticated, refined, and valuable knowledge items that take a longer time to produce". Similar to this approach, in the context of quality improvement, the raw defect data (i.e., experiences) found by testing, usage, or maintenance is collected, and if enough data is available and a pattern is apparent, it is generalized into a general pattern or anti-pattern description.

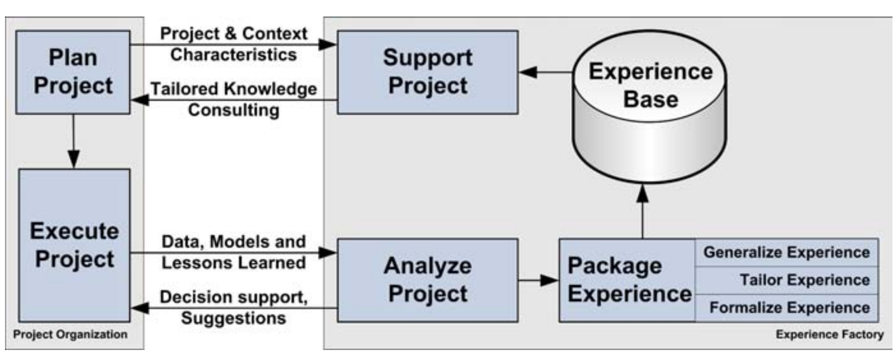
Almost all KM system implementations in SE make use of metadata (i.e., data about data) for describing and capturing the content (e.g., (Prieto-Díaz & Freeman, 1987), (Prieto-Díaz, 1993), (Lindvall et al., 2001)). Probably the most widespread and best known example for commonly used metadata are the file system attributes. For each file, these attributes provide additional information such as creation data, date of last modification, or owner information. Such metadata can simply be described as attribute-value pairs, for example, (creation_date, 9/25/2005), or (owner, system admin).

One of the first and probably best documented KM system in SE is the EF at NASA Software Engineering Laboratory (SEL) (Basili & Rombach, 1988), (Rombach & Ulery, 1989), (McGarry & Pajerski, 1990), (Basili et al., 1992), (Basili et al., 1995). Since then, many different implementations have been reported in North America (Basili, Lindvall et al., 2001), (Kamel et al., 2001), (Mendonca et al., 2001), as well as in Europe (Markkula, 1999), (Halvorsen & Nguyen, 1999), (Schneider & Schwinn, 2001), or Australia (Koennecker et al., 2000), (Scott & Jeffrey, 2003). One of the most recent initiatives in the U.S. is the Department of Defense Best Practices Clearinghouse (Dangle et al., 2005), which can be compared to the German VSEK (Feldmann & Pizka, 2003) or European ESERNET (Jedlitschka & Ciolkowski, 2004) systems.

KM Systems in Software Engineering

To illustrate the concept of knowledge patterns and refactorings in the following sections, we provide examples that are based on our observations from developing and operating several knowledge management (KM) systems. The EF was the underlying model for developing several experience and knowledge bases in projects such as RISE (Decker et al., 2005), ESERNET (Jedlitschka & Ciolkowski, 2004), SFB-EB (Feldmann, 1999), VSEK (Feldmann & Pizka, 2003), the U.S. Department of Defense Best Practices Clearinghouse (BPCh) (Feldmann et al., 2007), or the Software Organization Platform (SOP) (Ras & Rech, 2007).

Figure 1. The Experience Factory (EF)



The RISE (Reuse in Software Engineering) project was conducted during 2004 and 2005. With heavy industrial cooperation (about 50%), research focused on supporting reuse of SE knowledge by SMEs of the software industry (Decker et al., 2005). RISE aimed at integrating lightweight experience management with agile software development. The objectives targeted by RISE were to improve the communication between employees, to strengthen and accelerate the transfer of knowledge via a socio-technical system, to improve the retrieval of knowledge and orientation in a body of knowledge, and to optimize the amount and accelerate the time to access relevant knowledge. A further objective was to improve the quality of knowledge by assisting software engineers in creating optimized artifacts (i.e., with optimized content and structure) based on didactical principles.

ESERNET (Jedlitschka & Ciolkowski, 2004) was a thematic network project conducted between 2001 and 2003 as part of the European Union's 5th Framework Programme under contract number IST-2000-28754 (cf. http://www.esernet.org). It had the objective to gradually change the mentality of software engineers and their organizations towards systematic empirical studies, for the purpose of long-term learning. The overall goal was to collect, systematize, and disseminate relevant and valid insights by building a SE knowledge base for several European countries with different cultural backgrounds. Knowledge collected in the project serves as a empirically validated base for assessing, understanding, changing, innovating, and using software technologies. The task of collecting this knowledge required a joint effort between academia, technology providers, software developers, and possible endusers.

In the context of the SFB 501 project, a long-term strategic research activity of the DFG (German Research Foundation), we created an experience base for software artefacts (Feldmann, 1999) to support the reliable and low-cost customization of complex domain-specific software systems. The PLEASERS (Product Line Approach for SE Repository Schemata) library with building blocks for the development of EM schemata (i.e., patterns of knowledge base structures) is based on this project (Feldmann & Carbon, 2003).

Germany's VSEK portal (previously known as ViSEK, see http://www.vsek.de) is a portal implemented to offer up-to-date SE knowledge in order to support SMEs in their daily work (Feldmann & Pizka, 2003). The German Federal Ministry of Education and Research (BMBF) funded the ViSEK project based on the idea that experience gained from research and practice should be packaged and easily made available to all companies. Therefore, an on-line SE repository was developed and installed during the project, which offers access to up-to-date software engineering technologies of selected application domains.

In the U.S., Department of Defense has launched the Best Practices Clearinghouse (BPCh) (see https://bpch.dau.mil). The portal aims to provide the Department of Defense workforce, as well as government contractors, with a centralized repository of validated, actionable practice information that have been approved, and deemed useful. BPCh offers characterization (i.e., metadata) of practices, not the practices themselves, including applicable context descriptions, cost/benefit information, and validity information in form of rated application reports and empirical studies. All content is accessible through full text search, keywords, and perspective based listings according to legal work processes or document structures (e.g., CMMI for Acquisition (CMMI-ACQ), or the DoD Systems Engineering Plan Preparation Guide).

The main ideas for SOP emerged from the RISE. With the emergence of semantic Wikis, the ideas and technologies developed in RISE were integrated into an internal project at Fraunhofer IESE called SOP (see www.sop-world.org). This project resulted in a technology of the same name – the Software Organization Platform (SOP), which is based on a semantic Wiki and shaped to support software organizations. The first industrial applications focused on the requirements engineering phases, where SOP demonstrated its usefulness especially for stakeholder participation in requirements engineering. Thereafter, SOP was adapted for use during the whole software lifecycle and to support software engineers in managing their observations and experiences. SOP supports the documentation of observations and experiences by using specific templates. SOP has been adapted not only to support the documentation of experiences but also to create learning content simply from existing Wiki content and to provide so-called learning spaces for context-aware workplace learning (i.e., SOP): A learning space intends to enhance experience reuse by following a specific learning goal and is created based on information about the current context. The learning space is presented by means of dynamically linked Wiki pages within SOP, which is based on a predefined set of didactical templates for experiential learning. The creation and annotation of learning content is done by means of a metadata editor in the Wiki and by using concepts of a software engineering domain ontology. Hence, SOP is a good example how KM and LM can be integrated into one system.

patterns in software engineering

In the 1990s a new concept was transferred from architecture to computer science that helped to represent typical and reoccurring patterns of good and bad software architectures. These design patterns (Gamma et al., 1994) and anti-patterns (Brown et al., 1998) were the start of the description of many patterns in diverse software phases and products. Today, we have thousands of patterns (Rising, 2000) for topics such as software reuse (Long, 2001), agile software projects (Roock & Havenstein, 2002) or pedagogies (http://www.pedagogicalpatterns.org/) (Monteiro et al., 1999; Fincher & Utting, 2002). Many other patterns are stored in pattern repositories such as the Portland pattern repository (PPR, 2005) or the Hillside pattern library (HPL, 2005) and are continuously expanded by conferences such as PLOP (Pattern Languages of Programming; see http://hillside.net/conferences/).

While there are similar concepts in KM and software reuse such as barriers (Riege, 2005; Sun & Scott, 2005) and incentives (Ravindran & Sarkar, 2000), (Judicibus, 1996), the idea of patterns seems to be underdeveloped in KM.

However, we found the concept of patterns and anti-patterns helpful for documenting our knowledge and the experience we gained with the projects mentioned in Section 2.2.2. Our KM patterns are based on the following definitions as used for SE design patterns:

Def: Design pattern: A design pattern is a general, proven, and beneficial solution to a common, reoccurring problem in software design. Built upon similar experiences, design patterns represent “best-practices” about how to structure or build a software architecture. An example is the façade pattern, which recommends encapsulating a complex subsystem and only allows the connection via a single interface (or “façade”) class. This enables the easy exchange and modification of the subsystem.

While patterns typically state and emphasize a single solution to multiple problems, anti-patterns typically state and emphasize a single problem to multiple solutions. According to (Brown et al., 1998), anti-patterns are defined as:

Def: Anti-pattern: An anti-pattern is a general, proven, and non-beneficial problem (i.e., bad solution) in a software product or process. It strongly classifies the problem that exhibits negative consequences and provides a solution. Built upon similar experiences, anti-patterns represent “worst-practices” about how to structure or build a software architecture. An example is the “lava flow” anti-pattern that warns about developing a software system without stopping sometimes and reengineering the system. The larger and older such a software system gets, the more dead code and solidified (bad) decisions it carries along.

In the following sections, we will set the stage for our KM patterns by exploring quality aspects of knowledge, and we will use these definitions to describe best practices in KM.

QuAl Ity of Knowledge

One fundamental goal of software engineering is the development of high quality, reliable, and safe software at acceptable costs. Attention to software quality is important in software development not only because of its influence on long-term corporate goals, but also because of the increasing pervasiveness of software in everyday life. Software has become an enabling technology that is being used more and more as a product enhancement rather than as a standalone product. Hence, software quality is recognized within the industry as a key factor to guarantee market success.

There are various definitions of *software quality* and various ways of how to achieve it. The standard ISO-9126 (ISO/IEC-9126-1, 2003) as depicted in Figure 2. defines a quality model for software that encompasses:

- **Internal quality factors,** concerned with static aspects that are visible to the developers but not to the user of the software system, such as maintainability or reusability.
- **External quality factors,** concerned with dynamic aspects that are visible only to the developers but not to the user of the software system (e.g., memory requirements when running the system).
- **Quality-in-use factors,** concerned with usability aspects (i.e., about the extent to which the software meets the needs of the users and not the ones of the developers).

In order to quantify a software system according to such a model, metrics are used to measure current quality factors and to develop strategies for improving the software system.

In KM the *quality of knowledge* is likewise important (Marwick, 2001) because what one person documents in a knowledge component (e.g., a Wiki page) might be read by several others and should therefore, have some good "quality-in-use" factors such as understandability (Kari, 1996) and preciseness – similar to requirements and other software artifacts in software engineering . The knowledge even has "external quality" factors that do not represent aspects when the knowledge is "executed" (i.e., dynamic aspects), but rather show how well it helps or solves a problem. Furthermore, the knowledge documented will (hopefully) have a lifetime of several years and will be analyzed, improved, and adapted. Therefore, the knowledge needs high "internal quality" factors to ensure its maintainability or portability (e.g., to another KM system).

However, as no quality model for knowledge (components) exist right now we present some quality characteristics that were transferred from software engineering and database technology. We present this to stimulate further discussions about the meaning of quality in the context of knowledge management. In the following, we describe some characteristics of high-quality knowledge based upon our experience and software quality models. We use the following terms to describe knowledge that was transferred to a knowledge base (i.e., a technical KM system such as a Wiki):

Def: Knowledge Elements are the most basic components that knowledge is stored in and cannot be further divided without destroying the ability to understand them using other knowledge fragments.

Def: Knowledge Components are complete and self-sufficient (i.e., independent of other knowledge elements) descriptions of knowledge (e.g., a SE artifact). A knowledge component consists of at least one or more knowledge elements.

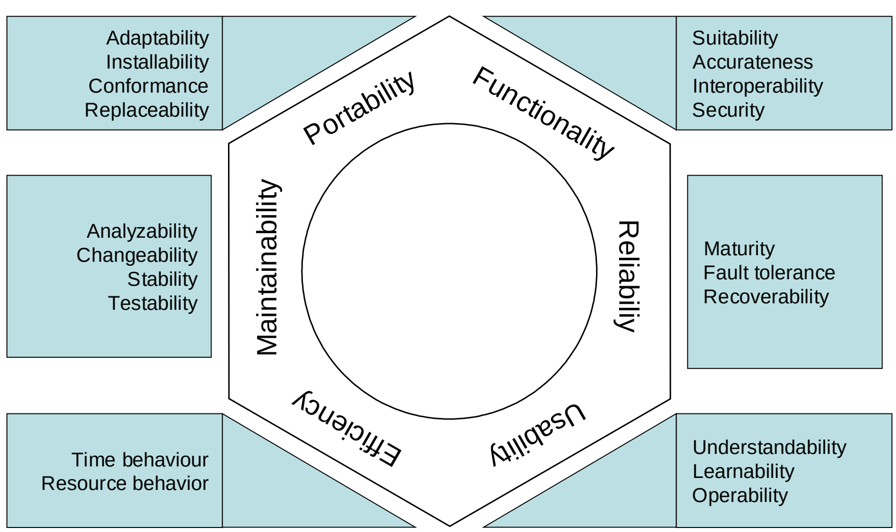
From our point of view, knowledge components and elements should possess at least the following (non-complete) group of characteristics in order to foster high quality content:

- **The AID Properties:** A knowledge element has to be *atomic*, i.e., the element cannot be divided further without destroying the ability to understand it without other knowledge elements. A knowledge component should be *independent* in its use, i.e., the component should be applicable (or reusable) without using other knowledge components. A knowledge component or element should be *durable*, that is, if it is still in the active knowledge base, the content should be valid. While knowledge might change over time as the environment shifts, the knowledge should be valid for the time it is applied or a warning should be attached. The AID properties are based on the ACID characteristics from database design (Haerder & Reuter, 1983).
- **The four C's:** The content of knowledge components in a knowledge base has to be correct, complete, consistent, and concise. *Correct* means that it should not be wrong or ambiguous, *complete* means that all available and relevant information was recorded and no information is missing, *consistent* means that it was recorded in a style similar to other instances of this type of knowledge (e.g., by using templates), and *concise* means that the content is simple, adequate, and precise. The four C's are based on widespread used characteristics of software requirements (Sommerville & Sawyer, 1997).

These characteristics aim at supporting the authors and maintainers of knowledge bases in creating high-quality knowledge components.

In order to characterize the quality of a knowledge component, we transfer the concept of software quality models to KM. This is not to be confused with a *KM system quality model,*

Figure 2. Quality factors (including sub-characteristics based on ISO 9126)



which would state quality factors for the technical software system (or social system) used for KM. A ***knowledge quality model*** groups several quality aspects that should be kept in mind when recoding knowledge as well as maintaining the knowledge base. Similar to software quality models, there are diverse quality models, and each knowledge domain might require a specific quality model emphasizing specific quality aspects.

The core quality factors of software quality models (ISO/IEC-9126-1, 2003) applied to knowledge are:

- **Functionality,** meaning that knowledge components should work in a suitable and accurate way as indicated,
- **Reliability,** meaning that the knowledge components should be mature and valid enough to not cause great damage and be easily undoable,
- **Usability,** meaning that the knowledge component should be easily understandable, learnable, and operable,
- **Efficiency,** meaning that the knowledge component should state the quickest solution with the least resource requirements,
- **Maintainability**, meaning that the knowledge component should be easily changeable (e.g., low coupling or distribution), very stable, and testable (e.g., in thought experiments or fast case studies),
- **Portability,** meaning that the knowledge component should be adaptable to new contexts, conforming to internal (e.g., templates) or external (e.g., IMS Learning Design or SCORM reference model for course materials) standards, and be replaceable in larger knowledge arrangements.

pAtterns And Ant I-pAtterns In Knowledge MAnAge Ment

By transferring the concept of patterns to knowledge management, we therefore define knowledge and knowledge management patterns as follows:

Def: Knowledge Pattern: A knowledge pattern is a general, proven, and beneficial solution to a common, reoccurring problem in knowledge design, i.e., the structuring and composition of the knowledge (e.g., on or via Wiki pages) or the ontology defining metadata and potential relationships between knowledge components.

In general, anti-patterns are the opposite of patterns and represent worst-practices that should not be applied. We define knowledge anti-patterns as follows:

Def: Knowledge Anti-Pattern: A knowledge anti-pattern is a general, proven, and non-beneficial problem (i.e., bad solution) in a knowledge product, system, or process, i.e., the structuring and composition of the knowledge (e.g., on or via Wiki pages) or the ontology defining metadata and potential relationships between knowledge components.

In order to group and delimitate the patterns, we describe them in seven groups ranging from KM System patterns, via content patterns to KM maintenance patterns. For describing our (anti-)patterns, we use the following short template that was derived from more elaborate templates. It consists of the following sections:

- **Name:** What is the (anti-)pattern called?
- **Issue:** What is the issue (e.g., problem) addressed by this (anti-)pattern?
- **Q-Effect:** What "knowledge quality aspects", as described in Section 3, are affected the most by this (anti-) pattern? In this section, we state if there is a positive (+), negative (-), or neutral (0) effect.

- **Solution:** What are the principal solutions underlying this pattern? Multiple alternative solutions might be given to remove an anti-pattern or build a pattern. In this section, we cite "knowledge refactorings", which are described in more detail in Section 5.
- **Causes:** What are the basic causes of this (anti-) pattern?

The full template format to describe these patterns consists of additional information entities such as structure, dynamics, anecdotal evidence, example, or exceptions. The usage of the full template would be outside the scope of this chapter.

Knowledge c ontent patterns and Anti-patterns

These patterns and anti-patterns apply to the content of a knowledge component as well as semantic relations between components. Typically, they are perceived from the viewpoint of the reader or writer. See Exhibit 1.

Exhibit 1.

name	*Knowledge Blob Anti-Pattern*
Issue	The description of an experience or knowledge component gets larger and larger over time, subsumes more and more information and becomes a so-called knowledge blob. The search for an arbitrary knowledge component will often include the knowledge blob. The knowledge blob can be used for different problems, has multiple solutions, or contact data.
Q-effect	Functionality - Reliability 0 Usability - Ef.ciency - Maintainability - Portability -
solution	**c ompact Knowledge:** Summarize and rewrite the knowledge in a shorter form (e.g., on one page). **extract e lements:** Apply divide & conquer to create several mutually exclusive pages with parts of the original page. **extract c ommonalities:** Find elements in other pages with overlapping knowledge and extract this overlapping element from both (or all) pages into a new page.
causes	The KM system makes it easy to find and change (e.g., extend) a knowledge component, the users are not sensitized to create individual experiences, or there is no maintenance or change process established for the knowledge in the KM system.

continued on following page

Exhibit 1. continued

name	*Superfluous Information Anti-Pattern*
Issue	The description of an experience or knowledge component is too long and has information that is either not relevant to the topic, already stored elsewhere, or outdated. The reader has to read more to get little relevant information, which might lead to an abandoned system. Furthermore, the description is longer than one page in the KM system and requires that the user scrolls and has to disrupt his understanding and learning process.
Q-effect	Functionality 0 Reliability 0 Usability - Efficiency -/0 Maintainability -/0 Portability 0
solution	**compact Knowledge:** Summarize and rewrite the knowledge in a shorter form on one page **offer templates:** Find all knowledge components of a specific type and offer a distinct template for every type.
causes	The writer does not really know what to describe in order to produce a simple, short and comprehensive knowledge component. Additionally, this might be caused by missing guidelines how to structure a knowledge component and how to write for one or multiple target groups.

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Exhibit 1. continued

name	***Unnecessary Refinement Anti-Pattern***
Issue	Multiple pages that are used to describe one topic are not reusable for other knowledge descriptions and all have to be read to understand the knowledge component. The reader has to read several pages in order to understand the knowledge; he interrupts his learning mode, and might disrupt or stop the understanding and learning activity completely. Furthermore, a search on the knowledge base might return only a page within this knowledge chain.
Q-effect	Functionality 0 Reliability 0 Usability - Efficiency 0 Maintainability - Portability 0
solution	**compact Knowledge:** Summarize and rewrite the knowledge in a shorter form on one page.
causes	The writer either tries to over-generalize the knowledge (e.g., he thinks that every small piece of knowledge might be used in other knowledge components) or does not really know what to do in order to produce a simple, short and coherent knowledge component.

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Exhibit 1. continued

name	***Duplicated Knowledge Anti-Pattern***
Issue	Multiple versions of the same information reside in different locations in the knowledge base. The change of one piece of information causes changes to be made on several pages of different knowledge components. If not all replications are changed as well, multiple, slightly different versions might exist in the knowledge base.
Q-effect	Functionality 0 Reliability 0 Usability 0 Efficiency 0 Maintainability - Portability 0
solution	**compact Knowledge:** Summarize and rewrite the knowledge in a shorter form on one page. **extract commonalities:** Find elements on other pages with overlapping knowledge and extract this overlapping element from both (or all) pages to a new page.
causes	Writers are not aware of or do not care about similar knowledge. Furthermore, either the knowledge base is not cleaned up from time to time or similar knowledge components are not aggregated.

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Knowledge usage patterns and Anti-patterns

These patterns and anti-patterns apply to the maintenance of knowledge components or elements and are typically perceived from the view of the knowledge maintainer or gardener. See Exhibit 2.

Knowledge ontology patterns and Anti-patterns

These patterns and anti-patterns apply to the ontologies used to structure knowledge components or elements and are typically perceived from the viewpoint of the ontology developer. See Exhibit 3.

Exhibit 2.

name	***Dead Knowledge Anti-Pattern***
Issue	A knowledge component is considered useless, is not (re-)used anymore by the users, and wastes either space in the knowledge base or computational power from the server of the KM system (e.g., in search algorithms).
Q-effect	Functionality -/0 Reliability -/0 Usability - Efficiency 0 Maintainability - Portability -
solution	**f use Knowledge:** Find a similar and “non-dead” knowledge component and integrate the remaining useful information (i.e., combine, compact, or rewrite their descriptions). **f orget Knowledge:** Remove the knowledge from the knowledge base (maybe after an inspection by possibly interested parties).
causes	The knowledge is outdated right from the start, too specific, or too general. This can be caused by incentive systems that “pay” for contributions but do not monitor the quality, or by authors who do not really know what to do in order to produce a simple, short and comprehensive knowledge component.

continued on following page

Exhibit 2. continued

name	***Invisible Knowledge Anti-Pattern***
Issue	Knowledge is not used anymore by the system and is undiscoverable by the users. While it might be useful to the users, it cannot be reused anymore and wastes space or computational power (e.g., in search algorithms).
Q-effect	Functionality 0 Reliability 0 Usability - Efficiency 0 Maintainability - Portability 0
solution	**r eintegrate Knowledge:** Reintegrate the component in the search index or an applicable navigational structure. **f use Knowledge:** Find a similar and "non-dead" knowledge component and fuse them together (i.e., combine, compact, or rewrite their descriptions). **f orget Knowledge:** Remove the knowledge from the knowledge base (maybe after an inspection by possibly interested parties).
causes	The knowledge is not linked anymore and does not show up in any navigational structures or search results. This might be caused by knowledge refactorings, knowledge base gardening activities, or the KM system itself.

Exhibit 3.

name	*Template Pattern*
Issue	Knowledge components of the same specific type (e.g., patterns) that have different structures are harder to understand because, on the one hand, the reader first has to understand how the knowledge is structured (e.g., where is the problem statement?) and, on the other hand, the writer must remember how to describe a complete component (e.g., he should not forget the problem statement).
Q-effect	Functionality + Reliability + Usability + Efficiency 0 Maintainability + Portability 0
solution	**offer templates:** Every type of knowledge should have a uniform representation. Find all knowledge components of a specific type and offer a distinct template for every type. Templates may exist for many different types of knowledge, e.g. template for documenting an experience, observations or didactical templates that support understanding and learning processes.
causes	The writers are free to describe their knowledge and typically use their own structure or write as it seems fit. This might also be caused by different standards used in separate projects (e.g., to describe requirements).

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Exhibit 3. continued

name	***Landmark Pattern***
Issue	Knowledge components that have no linked start page typically confuse the reader. The reader might miss some crucial information from the previous pages if the found page is directly linked in a search result.
Q-effect	Functionality 0 Reliability + Usability + Efficiency 0 Maintainability + Portability +
solution	The knowledge described, especially if it is distributed over multiple pages, should always have at least one starting point that is linked from all subsequent pages. **l ink to start page:** Either link to a specific start page where one should start reading the knowledge, or link to an overview listing all starting points for this knowledge.
causes	The search technique uses all pages and returns a hit list including knowledge elements that are meaningless or at least hard to understand by themselves. Alternatively, entry points to understand knowledge elements are not integrated by the knowledge authors.

continued on following page

Exhibit 3. continued

name	***Overview Pattern***
Issue	Knowledge components that semantically belong together and have no overview page that lists them are harder to find and several of them might get lost in a simple search.
Q-effect	Functionality 0 Reliability 0 Usability + Efficiency 0 Maintainability + Portability 0
solution	**l ist knowledge:** Find all knowledge components related to a specific topic and generate a page for this topic listing all these knowledge components.
causes	The writer is not informed about other, similar knowledge components and does not integrate the new component into existing structures.

continued on following page

Exhibit 3. continued

name	*Ambiguous Relations Anti-Pattern*
Issue	Links between knowledge elements that belong to the same knowledge component are not clearly described and defined. The same holds for the relations between different knowledge components. Authors are confused if there are too many or too similar relations that are to be assigned manually.
Q-effect	Functionality 0 Reliability + Usability + Efficiency 0 Maintainability + Portability +
solution	Named relations help users to navigate thru the KM system content and can also be used to check for a complete documentation (e.g., are refinements and links to process descriptions included?) Define clearly named relations between the knowledge elements (e.g., is_refined_by, part_of_process) and different knowledge components (e.g., use_with, applied_in_project, measured_with). Use predefined relations to define learning-cycles and support systematic learning. **Minimize set of relations:** Minimize the set of relations available. Use same naming for relations with (similar) objectives (e.g., used in/used_by). Fuse relations that are very similar or identical – possibly by introducing a more general relation. **provide Authoring guidelines:** Clearly describe how classes of knowledge have to be structured, which relations and metadata have to be used, and how existing templates may be used. **offer templates:** Wherever possible, offer templates for inserting or editing knowledge in the KM system.
causes	No authoring guidelines, templates, or tool supported authoring environments are offered. Concrete rules for adding and editing the KM system content are missing. As a consequence, each author/editor uses a different naming and refinement structure. The content grows in an uncontrolled and often confusing way. This case can often be found in Wiki-based systems.

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Exhibit 3. continued

name	*Common Metadata Pattern*
Issue	KM systems frequently store different kinds of knowledge elements. The metadata describing each of these knowledge classes typically varies (e.g., "programming_language" makes sense with code components but not with tool descriptions or lessons learned). However, to generate indexes and catalogs, or to easily address all KM system entries in a search algorithm (e.g., retrieve the ten newest entries), a minimal set of common metadata, shared by all entries of the KM system, is needed.
Q-effect	Functionality 0 Reliability 0 Usability + Efficiency 0 Maintainability + Portability +
solution	**create common metadata class:** Common metadata (e.g., entry name, creation date, author) can be applied to all KM system entries (cf., file system attributes). This common set can be enriched by specific attributes for maintenance (e.g., "last_reviewed", "version_number") and access control (e.g., "allowed_user_roles"). This common metadata class is inherited by all other knowledge classes of the KM system and extended for each specific type of knowledge element. **provide Authoring guidelines:** Clearly describe how classes of knowledge have to be structured, which relations and metadata have to be used, and how existing templates may be used. **offer templates:** Wherever possible, offer templates for inserting or editing knowledge in the KM system.
causes	No rules for editing and adding content exist. Common describing metadata (e.g., such as the file system attributes) are often forgotten by authors or used with different names (e.g., name, ID, entry_name, etc.).

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Exhibit 3. continued

name	***Useless Metadata Anti-Pattern***
Issue	The ontology consists of (too) many characteristics that describe useless (or all imaginable) aspects of the knowledge. Furthermore, the metadata does not provide any direct benefit to the users.
Q-effect	Functionality 0 Reliability 0 Usability -/0 Efficiency 0 Maintainability - Portability +
solution	Use only metadata that is required for specific tasks in the usage or maintenance of the knowledge base. **r emove Metadata:** Remove metadata that is not used by a function or by the typical users (readers and maintainers). **f use Metadata:** Find similar metadata and either use only one of them or create a new metadata that represents the essential facts from all of them.
causes	The ontology designers tried to "develop for the future" and for every possible use of the system. The essential goals of the system as stated by the stakeholders are diluted by many other "fancy" ideas.

Knowledge presentation patterns and Anti-patterns

These patterns and anti-patterns apply to the presentation of knowledge components or elements in a KM system and are typically perceived from the viewpoint of the reader or writer. See Exhibit 4.

Knowledge t ransfer patterns and Anti-patterns

These patterns and anti-patterns apply to the transfer (i.e., reading, understanding, and application) of knowledge components or elements and are typically perceived from the viewpoint of the reader or writer. See Exhibit 5.

Exhibit 4.

name	***Sequential Reading Pattern***
Issue	Knowledge components that are not arranged in a sequential order often confuse or distract the reader. When knowledge is not presented in a logical order, the user might not be able to understand and apply it correctly.
Q-effect	Functionality 0 Reliability + Usability + Efficiency 0 Maintainability 0 Portability 0
solution	Knowledge should be presented in a way that allows sequential reading. The actual serialization (i.e., at "runtime" or "read-time") depends on the user's needs. **serialize Knowledge:** Serialize every coherent knowledge block (e.g., component).
causes	Multiple rewrites of the knowledge component were made, but with different activity flows. This caused a non-linear description of possible ways, for example, to solve a problem.

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Exhibit 4. continued

name	*Large Template Anti-Pattern*
Issue	Authors have to fill out many metadata fields manually to describe their knowledge and consequently lose interest in recording their knowledge in the KM system.
Q-effect	Functionality 0 Reliability - Usability - Efficiency 0 Maintainability - Portability -
solution	Elicit as many metadata as possible using automated techniques and reduce the amount of manually requested ones. For example, administrative information (author name, creation / modification date) can be derived from the system or underlying workflow. Furthermore, classification terms, e.g., from SWEBOK (SWEBOK, 2004) can be automatically inferred and suggested by comparing the content or context of the new knowledge component to already existing components. **create template defaults:** Templates used should have meaningful default values. If defaults are not used, this indicates the need for an edited or additional template. **shorten template:** Reduce the size of the template elements.
causes	The KM system is either based on a very large ontology or it offers (too) many features and aims at supporting many application scenarios that require this amount of structured information.

continued on following page

Exhibit 4. continued

name	Unique Presentation Pattern
Issue	Different representations of knowledge components confuse and distract the reader. While every user groups might want a unique way of representation, it should be fixed before the launch of the KM system.
Q-effect	Functionality 0 Reliability 0 Usability + Efficiency 0 Maintainability 0 Portability 0
solution	Every type of knowledge should have a uniform, distinguishable form of presentation (e.g., by using a specific template, color, or a screen design). Nevertheless, it should be identical for all knowledge components of this type. **offer template:** Design and use a template for every type of knowledge (e.g., based on standards).
causes	The writers are free to describe their knowledge and typically use their own structure or write as it seems fit. This might also be caused by different standards used in separate project (e.g., to describe requirements).

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Exhibit 4. continued

name	***Information Flood Anti-Pattern***
Issue	Too many knowledge components (which might even be very similar) are presented to the user, for example, in the form of all knowledge components found by a search.
Q-effect	Functionality 0 Reliability 0 Usability - Efficiency 0 Maintainability - Portability 0
solution	**Aggregate Knowledge:** Find and integrate similar knowledge components into a single, more general knowledge component. **c hunked presentation:** A search should partition the results and present only a small amount (chunks) of knowledge components (e.g., 10). **c luster r esults:** Results from a search should be clustered to identify groups of similar pages. **Refine Classification:** Find subgroups of classes in a classification that has too many components and reclassify the concerned knowledge components.
causes	As a knowledge base grows a large amount of knowledge components are amassed with potentially similar contents. This is typically caused by missing knowledge gardening activities or a large number of separated, but similar projects.

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Exhibit 5.

name	***Context-based Enrichment Pattern***
Issue	Information stored in a knowledge element is often described solely from the point of view of the author. An expert might take contextual knowledge for granted that a novice does not possess.
Q-effect	Functionality: + Reliability: + Usability: + Efficiency: 0 Maintainability: +/- Portability: +/-
solution	**describe context:** Clearly describe what the circumstances of the knowledge are and who (with what level of expertise) created it. **link Knowledge:** Link every concept that is used in the description with a similar concept (or training course) in the knowledge base.
causes	The writer does not really know how to describe knowledge in order to produce a reusable, simple, short and comprehensive knowledge component. Additionally, this might be caused by time constraints, lack of management support, or missing feedback (i.e., ignorance of the problem).

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Exhibit 5. continued

name	*Collaborative Authoring Pattern*
Issue	The KM system does not provide a technical means to collaboratively create knowledge components (e.g., fast editing, locking mechanism, and rollback functions)
Q-effect	Functionality + Reliability 0 Usability + Efficiency + Maintainability 0 Portability 0
solution	**collaborative Knowledge Authoring:** Provide a technical infrastructure so that people can create content in a collaborative manner (e.g., by using the Wiki paradigm).
causes	First, technical problems exist, because the systems simple do not support collaboratively authoring. No rollback mechanisms are available. Hence older versions of knowledge components cannot be recovered. Locking is not implemented, which means that people can edit simultaneously knowledge components. Second, several human-based problems exist that are related to trust, anxiety to share knowledge with others (e.g., *Egghead Syndrome*), and the lack of motivation and time for documenting and sharing knowledge. Other reason can be found in Section 2.2.

continued on following page

Exhibit 5. continued

name	notification Pattern
Issue	In a static knowledge base, the user is not informed about changes to knowledge components he has written, used before, or needs on a daily basis. The user is not informed about updates to his contributions or to knowledge components he is currently using (e.g., in a project).
Q-effect	Functionality + Reliability + Usability + Efficiency 0 Maintainability + Portability 0
solution	**Monitor Knowledge:** Users should be able to monitor pages and be notified if changes are made to a knowledge component (especially if he is the author). **Monitor ontology:** A user should be able to monitor part of the ontology and be notified if changes are made to it (e.g., to reclassify their own pages).
causes	The observation by automated notification helps to keep up to date with a knowledge component especially if the knowledge is currently still used in a project.

KM Systems Organization Patterns and Anti-patterns

These patterns and anti-patterns apply to organizational aspects of the technical infrastructure of knowledge management systems (KMS) such as Wikis and are typically perceived from the viewpoint of a KM system (e.g., Wiki) developer or administrator. See Exhibit 6.

Social KM Patterns and Anti-patterns

These patterns and anti-patterns apply to the social system or purely human-based part of KM systems

Exhibit 6.

Name	*One Group One Area Pattern*
Issue	Often, a KM system or a delimited area therein (e.g., a project area) is used by specific groups with no or small overlaps in interests. This causes the decrease of the percentage of relevant content for each individual group as the system grows.
Q-effect	Functionality 0 Reliability 0 Usability + Efficiency 0 Maintainability + Portability -/0
Solution	For each group in an organization such as a project, there should be a specific area or KMS. Further integration of these areas is done via a centralized search function or inter-system linking. **Separate Concerns:** Delimitate areas of groups with different interests (e.g., using group-specific pages, access rights or individual KMS).
Causes	The authors of different groups describe knowledge in a very similar way and cause collisions between the knowledge spaces. By structuring the KM area or system into smaller and non-related parts, the overlap of knowledge decreases.

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Exhibit 6. continued

name	***VOIC Pattern***
Issue	If a KM system does not separate the subsystems for presentation (View), structure (Ontology), rules (Inference), and knowledge (Content), its maintenance will become hard.
Q-effect	Functionality 0 Reliability + Usability 0 Efficiency 0 Maintainability + Portability + Comment: These quality aspects are meant to describe the quality of the system (e.g., the maintainability of the system) and not the knowledge within!
solution	The VOIC (View, Ontology, Inference, Content) pattern states that the different architectural subsystems should be separated. In general, this is an extension of the MVC pattern including the ontology layer. The separation improves the extension and modification of the individual subsystem (e.g., it is easier to exchange or improve the ontology without looking for changes to be made in the rest of the system). **separate vo Ic:** Identify and separate view, ontology, inference, and content parts in the KM system.
causes	Typically, a KM system is either a proprietary or open source system that is tailored for a single purpose. Due to time or design constraints, information is not explicitly separated, and information (e.g., about the ontology) is hard-wired into the system, which, for example, decreases the adaptation to new ontologies.

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Exhibit 6. continued

name	*Knowledge and Learning Management Integration Pattern*
Issue	In many organizations, knowledge management and learning management systems exist separately from each other. They are not conceptually nor technically integrated. Both systems have the same purpose – knowledge sharing and learning. This results in redundant information in both systems. In addition, content from a KM system can enhance learning process, by offering up-to-data company specific and contextual knowledge, which brings learning closer to the working process. On the other hand, learning content supports the reuse (i.e., understanding and application) of knowledge components in a new context, by offering additional term definitions, explanations, examples, counter examples, etc. Dividing these systems complicates the maintenance of their content and requires more effort since users have to alternate between two systems.
Q-effect	Functionality + Reliability 0 Usability + Efficiency + Maintainability + Portability 0

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Exhibit 6. continued

solution	This pattern refers to the integration of a KM system and a LM system on a technical level as well on the conceptual level. Applying this pattern is complex since it relies on the existing system structures in an organization and on the application of many different refactorings. Nevertheless, it will improve the quality of knowledge since knowledge components are primarily enriched with learning content and learning content gets contextualized by knowledge components. **Integrate technically KM systems and LM systems:** Identify and merge domain ontologies, human resource databases, content databases, and choose on system as host system (i.e., the remaining system that be accessed by the users). **Link Knowledge:** Link every concept that is used in the description with a similar concept (or training course) in the knowledge base. This count for the knowledge components as well as for the learning content and is done with the new ontology of both systems. **Reintegrate Knowledge:** Integrate the knowledge element into existing navigational structures (e.g., in lists of knowledge classes or higher-level knowledge components) or search indices. This is a prerequisite when knowledge components and learning content should be aggregated and presented in the same environment. **Extract Elements:** Find and extract parts of the knowledge component description that semantically belong together and can be extracted into a self-sufficient learning content element. Recursively apply this "divide & conquer" strategy to create several mutually exclusive learning chunks with parts of the original knowledge component. **Fuse Knowledge:** Find a similar knowledge components and extract useful knowledge to be put in already existing learning elements to enhance their quality.
causes	In the past, KM systems and LM system were considered as two different types of systems with different purposes and different technical infrastructures. Today, KM as well as LM have changed and have converged in many aspects. For example, classical web-based trainings have moved to learning content which consists of many reusable learning objects. These learning objects have been collaboratively created for example in communities of practice. However, high integration costs avert organizations to integrate the systems. Another reason is that it is unclear how to transfer content from one system to another including the annotations and underlying ontologies.

and are typically perceived from the viewpoint of a KM system (e.g., a Wiki) developer or administrator. For example, they can be implemented via social rules and supported by architectural styles and patterns. See Exhibit 7.

Knowledge r ef Act or Ing

During the few last years, refactoring has become an important part in agile processes for improving the structure of software systems between development cycles. Especially in agile development, under-engineering usually happens

Exhibit 7.

name	***Coffee Kitchen Pattern***
Issue	Exchange between colleagues does not take place, as there is no place to meet such as a coffee kitchen, smoker's corner, or reading room. The less the employees know each other, the less information is shared between them.
Q-effect	Functionality 0 Reliability 0 Usability + Efficiency + Maintainability 0 Portability +
solution	**Arrange Meeting space:** Provide one or more comfortable places to meet such as a coffee kitchen with chairs or a sofa (i.e., a lounge area).
causes	Either the management does not want people to talk and share information (i.e., waste time), or they gave multiple coffee machines to their employees (e.g., one coffee machine per department or group).

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Exhibit 7. continued

name	*Knowledge Meeting Pattern*
Issue	The content of the (technical and human) knowledge base is not used due to time pressure or doubts about whether the content is helpful. Furthermore, the content affects operational and managerial decisions.
Q-effect	Functionality 0 Reliability + Usability + Efficiency + Maintainability 0 Portability +
solution	Knowledge should be a part of every meeting and the communication between employees should be fostered. **talk About Knowledge:** Present new knowledge and discuss knowledge demands as part of regular meetings (e.g., departmental meetings). **conduct explicit Knowledge Meeting:** Hold explicit meetings about specific topics (e.g., a new technology) with the goal of distributing knowledge and eliciting knowledge gaps.
causes	The people are either not willing to use the KM system and communicate with their colleagues or fear virtual barriers (e.g., feudal lords syndrome). Additionally, this is often caused by stress and time constraints.

when the focus lies on adding more functionality to a system without improving its design along the way. When code works, it is often simpler to engage the next task than clean up the previous work. Additionally, as systems are getting larger, refactoring gets more and more complex and time consuming to do manually. Even if one knows how to refactor software, it is not clear where and under what conditions which refactoring should be used (Fowler & Beck, 1999).

In practice, refactoring is a great challenge, as most software systems are badly implemented and therefore hard to evolve, maintain, and reengineer (e.g., Y2K). This becomes worse if the software has to be optimized in order to meet new requirements, remove defects, or improve qualities like maintainability or reusability.

In order to improve the quality of a knowledge component representing a knowledge anti-pattern, we transferred the concept of software refactoring (Fowler & Beck, 1999) to *knowledge refactoring*. A software refactoring is a formal transformation process that describes how a software component (e.g., a class in an object-oriented system) can be changed in order to improve its quality. It is defined as follows:

Def: Software refactoring: A (software) refactoring is an explicit, replicable, and beneficial activity that transforms the structure or representation of a software component without changing its meaning (i.e., behaviour). The goal of software refactoring is the improvement of the quality (e.g., maintainability; see Section 3) of the software system.

We use the term "knowledge refactoring" defined as follows:

Def: Knowledge refactoring: A (knowledge) refactoring is an explicit, replicable, and beneficial activity that transforms the structure or representation of a knowledge element or component without changing its meaning (i.e., semantics). The goal of knowledge refactoring is the improvement of the quality (e.g., understandability; see Section 3) of the documented knowledge.

For improving the above mentioned anti-patterns, we used the following activities, which we learned and applied in several of our projects, for the refactoring of knowledge components or KM systems. While these could be classified by their executive role (e.g., ontology developer or knowledge author) and the affected product (e.g., templates or knowledge elements), we merely list them in this chapter:

- **Aggregate Knowledge:** Similar to "Fuse Knowledge", but with the difference that one has to find several similar knowledge components, extract the common or general knowledge within, and then create a knowledge component with this generalized knowledge. The original knowledge components are not dismissed or forgotten but remain in the knowledge base as concrete or specific knowledge. For example, the aggregation of multiple similar experiences would lead to a new pattern (e.g., about software testing) or a "rule of thumb".
- **Arrange Meeting Space:** Provide one or more comfortable places to meet such as a coffee kitchen with chairs or a sofa (i.e., a lounge area).
- **Chunk Presentation:** Find and subdivide a search result list into several chunks (e.g., ten links) and present these chunks on a single page.
- **Cluster Results:** Find similar knowledge elements and present them by their commonality. These clusters might be based on the text (i.e., Wiki page content), knowledge type (e.g., requirement documents), or other similarities.
- **Collaborative Knowledge Authoring:** Provide a technical infrastructure so that people can create content in a collaborative manner (e.g., by using the Wiki paradigm).

- **Compact Knowledge**: Summarize and rewrite the knowledge in a shorter form such that it fits the requirements (e.g., that it fits on one page). Find and remove filler words or superfluous sentences that do not change the meaning of the knowledge.
- **Conduct Explicit Knowledge Meetings**: Hold explicit meeting about specific topics (e.g., a new technology, project retrospectives) with the goal of distributing knowledge and eliciting knowledge gaps.
- **Create Common Metadata Class**: Common metadata (e.g., entry name, creation date, author) can be applied to all KM system entries (cf., file system attributes). This common set can be enriched by specific attributes for maintenance (e.g., ”last_reviewed”, “version_number”) and access control (e.g., “allowed_user_roles”). This common metadata class is inherited by all other knowledge classes of the KM system and extended for each specific type of knowledge element.
- **Create Template Defaults**: Templates used should have meaningful default values. If defaults are not used, this indicates the need for a modified or additional template.
- **Describe Context:** Clearly describe what the circumstances of the knowledge are and who (with what level of expertise) created it.
- **Extract Commonalities**: Find parts of two different knowledge components that semantically belong together and extract them into a self-sufficient knowledge element.
- **Extract Elements**: Find and extract parts of the description that semantically belong together and can be extracted into a self-sufficient knowledge element. Recursively apply this “divide & conquer” strategy to create several mutually exclusive knowledge elements with parts of the original knowledge component until all resulting knowledge elements fit the requirements.
- **Forget Knowledge**: Remove the knowledge component from the knowledge base. This might also be realized by marking the knowledge component as dead, removing it from any navigational structures and the search indices, and having it inspected by interested parties or experts.
- **Fuse Knowledge:** Find a similar knowledge component and extract useful knowledge not existent in the other components. Fuse this useful knowledge with the other knowledge components and remove the remaining original knowledge component (i.e., apply “Forget Knowledge”).
- **Fuse Metadata:** Find similar metadata and either use only one of them or create a new metadata that represents the essential facts from all of them.
- **Integrate technically KM Systems and LM Systems**: Identify and merge domain ontologies, human resource databases, content databases, and choose on system as host system (i.e., the remaining system that be accessed by the users).
- **Link Knowledge:** Find and link every concept (i.e., in the form of a word or phrase) in the description of a knowledge element with the respective knowledge component in the knowledge base.
- **Link To Start Page:** Identify one or more starting points for every knowledge component and mark them respectively. Statically or dynamically link every knowledge element (or every page) to one or all starting points.
- **List Knowledge**: Find all knowledge components related to a specific topic and generate a page for this topic listing all these knowledge components.
- **Minimize Set of Relations**: Minimize the set of relations available. Use same naming for relations with (similar) objectives (e.g., used in/used_by). Fuse relations that are very

similar or identical – possibly by introducing a more general relation.

- **Offer Templates**: Find a class of knowledge components that have a common topic, extract common headlines or semantical blocks, and identify the information offer and need of the knowledge users. From this information, synthesize a comprehensive template for this knowledge class.
- **Provide Authoring Guidelines:** Clearly describe how classes of knowledge have to be structured, which relations and metadata have to be used, and how existing templates may be used.
- **Refine Classification:** Find classes with (too) many elements in a classification (e.g., ontology) and refine this concept (i.e., class) by identifying and introducing new meaningful subclasses.
- **Reintegrate Knowledge:** Integrate the knowledge element into existing navigational structures (e.g., in lists of knowledge classes or higher-level knowledge components) or search indices.
- **Remove Metadata:** Remove metadata that is not used by a function or by the typical users (readers and maintainers).
- **Separate Concerns:** Delimitate areas of groups with different interests (e.g., using group-specific pages, access rights or individual KMS).
- **Serialize Knowledge:** Serialize every coherent knowledge block (e.g., component).
- **Shorten Template:** Reduce the size of the template elements.
- **Talk About Knowledge:** Present new knowledge and discuss knowledge demands as part of regular meetings (e.g., department meetings).

In general, there are a lot more refactoring activities that could be used to remove these and other anti-patterns or generate patterns. Be aware that these refactoring activities are difficult to classify because they refer to different levels of knowledge granularity, different system elements and components, and social issues. Some are used to change or transform a knowledge element, while others are used to change the visual representation or KM system.

Use of Knowledge Patterns in Contemporary Knowledge Bases

The patterns mentioned above were also used in the further evolution of knowledge bases we were involved in. As listed in Table 2, many of the patterns described were implemented in these knowledge bases to improve the quality of knowledge. A full dot (●) refers to the complete implementation in the system or at multiple locations, while a half dot (◉) means that it is only partially implemented or only used for a subset of locations (i.e., alternatives exist), and an empty dot (○) indicates the use for almost no location (i.e., only rarely used). A minus (-) means that this pattern was not incorporated into the knowledge base (e.g., typical for social patterns).

SOP is based on a semantic Wiki (see Section 2.2.2 for a short project description). Simple templates are used for creating new Wiki pages. The creation of the so-called learning space is done completely by means of didactical templates. *Special pages* refer to pages of the same category with a specific functionality. They can be used as landmarks. In learning spaces, only overviews are available, which can be accessed from anywhere in a learning space. Metadata can be defined by using the functionality of *categories* in a Wiki. They allow classifying a Wiki page into a specific category. Learning spaces consist of learning components and learning elements. The atomic learning elements possess metadata about their type, author, creation date, keywords, etc. The content in SOP is written by using the Wiki syntax. Hence, the presentation

Table 1. Classification of Knowledge Refactorings

	g ranularity		***Knowledge***			***System***		***Social***
	Knowledge e lement	**Knowledge c omponent**	**c ontent**	**s tructure/ Metadata**	**presentation**	**o ntology**	**Infrastructure**	
Aggregate Knowledge	+	+		+				
Arrange Meeting s pace								+
c hunk presentation		+			+			
c luster r esults	+			+				
c ollaborative Knowledge Authoring	+	+	+					
c ompact Knowledge	+	+	+					
c onduct e xplicit Knowledge Meetings								+
c reate c ommon Metadata c lass				+				
c reate t emplate d efaults				+				
d escribe c ontext	+	+	+					
e xtract c ommonalities		+		+				
e xtract e lements	+		+					
f orget Knowledge	+	+	+	+				
f use Knowledge		+	+	+				
f use Metadata	+	+		+				
Integrate technical KM s ystems and I M s ystems						+	+	
l ink Knowledge		+		+				
l ink t o s tart page				+				
l ist Knowledge	+			+				
Minimize s et of r elations		+		+				
o ffer t emplates		+		+	+			
provide Authoring g uidelines				+				
Refine Classification						+		
r eintegrate Knowledge	+			+				
r emove Metadata	+	+		+				
s eparate c oncerns				+				
s erialize Knowledge		+		+				
s horten t emplate				+				
t alk About Knowledge								+

Table 2. Use of patterns in contemporary knowledge bases

		bpc h (dod)	cc -exp (lese)	sop
o ntology patterns	t emplate pattern	●	●	●
	l andmark pattern	●	-	◯
	o verview pattern	●	○	◯
	c ommon Metadata pattern	●	●	◯
presentation patterns	s equential r eading pattern	-	●	○
	u nique presentation pattern	◯	●	●
t ransfer patterns	c ontext-based e nrichment pattern	◯	●	◯
	Notification Pattern	◯	-	●
	c ollaborative Authoring pattern	◯	○	●
o rganization patterns	o ne g roup o ne Area pattern	-	◯	◯
	vo lc pattern	◯	○	◯
	Knowledge and l earning Mgt. Integration pattern	●	-	◯
s ocial patterns	c offee Kitchen pattern	-	-	-
	Knowledge Meetings pattern	-	-	-

of each page is the same. A "notification" function is part of the standard functionality of the Wiki system and the user will be notified if a page, he watches, has been changed. The user himself decides which pages he watches, resp. wants to get informed about. SOP integrates KM and LM because learning spaces are created by using learning content from a specific repository and knowledge from the Wiki. However, SOP is not able to integrate e-learning content created outside the Wiki. A Wiki perfectly implements the collaborative authoring pattern.

CC-Exp is a web-based repository aiming at providing empirical evidence about the appropriateness of software development techniques, methods, tools (thereafter named technology) in certain contexts. Templates are used for acquiring both information on the technology and information regarding the evidence. Metadata are used for classifying technologies and aspects of the evidence. The two generic user groups of CC-Exp are software managers and researchers. Regarding the presentation of the content to the software managers, CC-Exp provides structured, problem-oriented search facilities. In order to support them in locating relevant technologies and related evidence (if available) within seconds, CC-Exp allows for incrementally reducing the search space. The results are presented in a standardized way by using templates. The context in which the evidence was obtained is explicitly addressed and presented. Sequential reading is supported through the structure of the result templates. Researchers can use CC-Exp to search for hypotheses or evidence and use (parts of) the information to support decision making or research activities.

As described before, the BPCh portal does not focus on describing the best practices themselves, but rather provides information such as application context, cost/benefit information, and validity information. Therefore, the "one group one area pattern", for instance, is not applicable. The public part of the portal (also denoted as the front-end), is complemented by a massive back-end system that enables authorized subject matter experts (including content specialists and providers) to collect, edit, group, summarize, and validate the information displayed by the front-end system. In this back-end part, not visible to the end-user, collaborative authoring and notifications are implemented, using a commercially available web-based collaboration and document management system.

Conclusion and Future Work

Knowledge management or software reuse in learning (software) organizations is often accompanied by poor quality of the knowledge, experiences, or decisions within a KM system as well as poor quality of the KM system itself.

We described an approach to structuring knowledge in knowledge management systems in the form of so-called *knowledge patterns*. These patterns and anti-patterns can be used to develop KM systems and improve the quality of the systems themselves as well as that of the knowledge within (i.e., the *quality of knowledge*). Furthermore, we transferred the concepts of software refactoring and software quality in order to describe the effect of knowledge patterns as well as countermeasures (i.e., *knowledge refactorings*) for removing knowledge anti-patterns.

Our argument is that the use of knowledge patterns to describe how knowledge and KM systems should or should not be structured generates several positive effects. First, researchers and practitioners in the KM field can reuse these patterns to build or reconstruct their knowledge bases. Second, the patterns might be used as a language extension to efficiently and precisely communicate about knowledge and KM systems using these patterns.

While this chapter represents the first step in the formalization of best and worst practices (i.e., knowledge) about knowledge and KM systems, it is not the ultimate set of knowledge patterns. The knowledge patterns in this chapter are based upon experiences made in the development of several KM systems in projects such as RISE, ESERNET, SFB-EB, VSEK, or SOP within the German and European cultural area. However, several of the patterns described might not be applicable or be misleading in a specific context or in other cultural backgrounds. Furthermore, there are many other patterns that could not be described in the context of this chapter. We encourage the readers to write down their own patterns and share them with other users. The authors created an initial website (see http://www.knowledgepatterns.eu) containing all patterns and anti-patterns described in this chapter. Furthermore, the web site offers users the possibility to download our pattern and anti-pattern templates and to submit their own patterns. By means of this website, we hope to create a forum for sharing and exchanging such patterns. Furthermore, we hope that our website will help to make the knowledge stored in the semi-formal patterns become applicable in other contexts. Such applications in a non-SE context might help to increase the experience regarding specific topics (e.g., knowledge structuring) and enable us to further generalize (i.e., de-contextualize) the patterns. Such a generalization approach is described, for instance, in the "knowledge dust to pearls" approach (Basili, Costa et al., 2001).

Hopefully, this chapter will stimulate the discussion about the meaning of quality in the context of knowledge management, about how knowledge should (and should not) be described in a KM system, and what is needed to generate a fruitful socio-technical KM system. If, as we envision, more researchers and practitioners will start documenting experiences regarding knowledge and KM systems in the form of patterns, this might even encourage and foster the development of automatisms and knowledge refactoring tools.

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Chapter XVIII
Knowledge Elicitation and Mapping:
Ontology as an Instrument of Design and Organizational Learning

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Abstr Act

This chapter is concerned with engaging end-users in the design and development of knowledge management systems. The identification, capture and use of contextual knowledge in the design of knowledge management systems (KMS) are key development activities. It is argued that tacit knowledge, while often difficult to capture, can be extremely useful as contextualising knowledge to designers of KM systems. A methodology was developed to combine soft systems methodology, causal cognitive mapping, and brainstorming to provide a set of knowledge requirements. The methodology appears to offer an effective platform for making sense of non-routine yet rigorous knowledge work. The interventions enacted by the consultant and involving project stakeholders and end users facilitates individual, group and organizational learning through a metacognitive process of understanding the relationships and dynamics of shared group knowledge. Engagement with the methodology, in addition to causing tacit knowledge to be made explicit, enables second-order 'deutero learning', or 'learning how to learn'. The combination of activities presented forms a metacognitive process which is both a form of proactive individual and organizational learning and an endeavour which adds to organizational memory. The identification, capture and use of contextual knowledge and their use in engaging end-users in the design of KMS will result in better user-system interaction.

Introduct Ion

This chapter is concerned with engaging end-users in the design and development of knowledge management systems. The identification, capture and use of contextual knowledge in the design of knowledge management systems (KMS) are key development activities and it is suggested that the metacognitive tasks involved in formalising tacit knowledge, when undertaken by stakeholders and end-users, adds to and enhances organizational learning and organizational memory. By linking process modelling, elements of soft systems methodology and cognitive mapping for knowledge elicitation, the stakeholders in the case study improve both the knowledge management system design process and organizational learning. These are important activities which can enhance organizational learning (Tsoukas & Mylonopoulos, 2004b, Snowden, 2002). Metacognition involves thinking about the aspects and processes involved in cognition itself - thinking about one's own thinking, memory and perception etc. Here, we are concerned with stakeholders and end-users reflecting on two types of knowledge: implicit/unconscious knowledge and explicit, conscious, factual knowledge and the process of transforming the former into the latter.

The interface between business activities known as 'knowledge work' and the group of technologies referred to as 'knowledge management systems' is a key area for organizational change and organizational learning. While there continues to be much debate about the relationships between organisational learning and the use of knowledge management systems to augment this process, the **interface** between the knowledge work activities and the technologies used to manage them has to be considered a crucial area (Awad & Ghaziri, 2004; Becerra-Fernandez et al., 2004; Malone et al., 2003) In addition, while there are many formal notations to rigorously capture and document information systems requirements for the purposes of design, a more difficult yet critical area also exists: that of capturing the knowledge processes of creating, finding, sharing and using knowledge to achieve good business outcomes. A key challenge taken up here then, is to construct representations which will assist in the design of appropriate tools and management solutions to support those activities and in doing so involve end-users in a manner which will enhance the development process and eventual outcomes. The activities involved also entail developing processes that can facilitate and augment organizational learning.

This chapter therefore has been concerned with contextual knowledge and organizational learning, more specifically with the identification, capture and use of contextual knowledge in the design of knowledge management (KM) systems. It was proposed that this is an important process which can augment organizational learning through enhancing object learning and making tacit knowledge explicit.

The elicitation and analysis of operational and management knowledge and the design of systems to contain and give access to that knowledge still seem to focus largely upon explicit forms of knowledge. Even design ontologies (Guarino, 1998; Maedche et al, 2003), which appear to offer comprehensive methods for the rigorous capture of shared conceptualisations, generally remain in the comfort zone of knowledge that can be written down. As Robillard (1999) says:

Software engineers have placed a great deal of emphasis on documenting the final representation of the knowledge structure, or the source code, but only recently the rationale, or process, of knowledge crystallisation. (Robillard, 1999, p92).

Using a single case study, this chapter argues that any type of knowledge which is used for effective action should be considered in the search for systems or managerial solutions. Design formalisms, such as UML class diagrams and activity models (Bennett, McRobb and Farmer, 1999), business process modelling notation (Object Management Group, 2006) or entity relationship models (Chen, 1976) are generally used to capture and present business information in a compact, digestible form to support systems analysts and designers in creating business process or IT-based solutions. In this chapter we argue that these formalisms can be used to capture tacit, role-related and relationship knowledge and therefore provide *context* for those other explicit items of knowledge which may be candidates for process improvement, computerisation or Intranet-based tools. This research shows a path to that formalism by linking business process modelling, the soft systems methodology, causal cognitive mapping and brainstorming to elicit knowledge from staff in a government agency.

This methodology seeks to address two common issues. Firstly, there is the well-known difficulty of eliciting knowledge from groups of people who are experts, colleagues or co-stakeholders engaged in a business activity. Secondly, as these inputs are articulated and documented, there is a loss of much contextual knowledge when one moves from the fuzziness of the social world to the hard requirements of software engineering or systems design. Because this contextual knowledge is itself tacit or not amenable for computerisation, it may not be captured and passed on to designers of solutions. When requirements and design considerations are transcribed, they become de-contextualised, alienated from their original situation: meaning is lost, even though the words may appear to be clear. Westrup (1999) claims that because of this, more attention must be paid to the practice of eliciting the knowledge and ensuring that knowledge is not lost (for cognitive, social or political reasons). Or as Winograd (1996) more bluntly states:

"A sealed set of requirements as blueprint for software designer is a disaster waiting to happen" (pxvii).

We propose combining a number of elicitation methods and adopting a philosophical stance based upon the social construction of knowledge (Berger and Luckmann, 1967; Schutz, 1972). Constructivism takes the view that our knowledge of the world is shaped by language, convention and culture and that we create and maintain these constructs through ongoing social interaction and dialogue. It is these constructs that, to a large extent, constitute our reality or "ontology".

The nature of the work is that it is an iterative and dynamic form of learning and development and we situate the research within the tradition of organisational learning and methodological refinement that comes from employing such a process. Vygotsky described this approach, with reference to learning and cognition as "the search for method" (Vygotsky, 1978).

The search for method becomes one of the most important problems of the entire enterprise of understanding the uniquely human forms of psychological activity. In this case, the method is simultaneously prerequisite and product, the tool and the result of the study (Vygotsky, 1978, p251).

The phrase is similarly apposite in this situation. The application of the methodology to a real-world problem situation necessarily refines both the user's view of the problem and the methodology itself.

c Aptur Ing Knowledge

There are many formal notations and methods to rigorously capture and document information for the purposes of business analysis or systems design, acquisition and implementation. But in the messy world of non-routine knowledge work, the interesting elements are often those which evade documentation. There is now a multiplicity of knowledge management solutions (such as yellow pages of expertise, bulletin boards and multi-media) which can assist in managing access to all kinds of knowledge and expertise (Vail, 1999), so there may well be advantages in documenting the existence, if not the content, of those elements in our formalisms. If we don't, we may be in danger of committing the error of looking under the lamp: although the light is brightest there, it is not where the most important gems are hidden. This article therefore concerns itself with the interface between that type of business activity which loosely calls itself "knowledge work" and that group of assorted technologies which can be referred to as "knowledge management systems". The key research challenge taken up here is to construct representations which will assist us to design appropriate tools and management solutions to support the knowledge processes of creating, finding, sharing and using knowledge to achieve good business outcomes. We conduct a case study, mapping organisational knowledge as an "ontology", which represents a conceptualisation of a socially constructed and highly integrated reality experienced by people engaged in organisational activities. We do this in order to capture as much knowledge about that conceptualisation as possible. We contend that this knowledge, whilst sometimes not propositional or itself amenable to computerisation, is useful as contextualising knowledge to designers of systems (in particular knowledge management systems), managers and finally, to users.

background to the r esearch

The context of this research is that of managing knowledge in organisations – not just information, reports or transactional systems – but knowledge in all its gritty and inconvenient particularity (Davenport, 1997; Markus, 2001). The practical challenge is to provide managers with relevant and cost effective tools and methods to enable them to leverage the knowledge assets (to "know what they know") and minimise the cost of not "knowing that they know"(O'Dell & Grayson, 1998; Prusak, 1996).

The general requirement confronting knowledge management is to identify, catalogue and then provide access to organisational knowledge such that it can be easily stored, found, used and enhanced (Boisot, 1998; Davenport & Prusak, 1998; Leonard-Barton, 1995; von Krogh & Roos, 1996). A core task is that of taking inventory of organisational memory and mapping these in some diagrammatic form to provide clarity and gain intellectual mastery over knowledge stocks and how they are related to each other (Hansen, Nohria, & Tierney, 1999 ; Nissen, Kamel, & Sengupta, 2000; Vail, 1999): in essence, to "know what you know". The knowledge management solutions which build upon these maps include such technology as forums, databases, organisational "yellow pages" and knowledge bases (Alavi & Tiwana, 2002). These solutions can be grouped and made available to match the work patterns of knowledge workers in what the Gartner Group calls "Smart Enterprise Suites" (Gartner Report AV-17-7196, 12 November 2002). Knowledge maps can be used to match a business need to an identified knowledge repository via a knowledge management system.

t he Knowledge Map as a business "l ife world"

If they are to be complete and correct conceptualisations of a domain of human activity, knowledge maps should reflect the salient institutional features of the reality of the agents who act within that domain. Knowledge maps should contain the elements that determine the logic of *social action* within a field of endeavour and therefore include all axioms or beliefs which influence decision making and action. The category of "criminal" for example is not only a cognitive category with a semantic set of legal attributes, but is also associated with a set of norms which lead to actionable judgments. A knowledge map must be a reflection of this sociological "life-world" and uncover the judgements, motivations and intentions of the participants. The term "life world" is taken from the influential constructivist sociology of Alfred Schutz (Schutz, 1972) and describes the everyday social context of particular social actions where participants exercise judgment based upon social categories and values. But design formalizations, whether E-R diagrams, data flow diagrams or UML use case models, seem to be based upon a picture theory of meaning (Wittgenstein, 1978), in that they focus upon truth-functional propositions: explicit knowledge stating facts or possible facts. The human meaning of those facts, the often tacit rules and behavioral signals and responses according to which those propositions are wielded within language games is not captured – and yet these are critical to meaning and action. How might it be possible to maintain the formality and rigor of design formalisms, whilst including information about the context in which the propositions make sense?

We contend that the components of "shared conceptualizations" which constitute social and organizational context and are relevant to task performance can be identified through analysis and investigation methods and included *within* a formalism, such that object and context are related by the same representational techniques. This enables a fuller appreciation of meaning to be conveyed to the reader. Complete representations are derived through an analysis of the mental models and shared perceptions of any group concerned with the performance of a particular task. One can derive rules of association, treatment, constraints and relationships of objects within a certain behavioural *frame* (Goffman, 1974), or within a "language game" (Wittgenstein, 1958) and create an "ontology" of the objects which populate the social reality of the protagonists.

The challenge is to understand this context and move from the ill-defined and messy problem domain of the "stream of consciousness" that is lived in the business world to the clean representations required in the solutions domain of information systems or business process redesign (Robillard, 1999). Recent support for the expansion of ontological formalisms to cover socially constructed entities comes from Masolo et al (2004), where the articulation of social roles in ontologies is explored. They argue that extensions are required for "representing collective intentions and mental attitudes of communities of agents that create, maintain and accept descriptions" (Masolo et al., 2004).

Techniques such as business process mapping, cognitive mapping (Rughase, 2002) and the Soft Systems Methodology (Checkland & Scholes, 1990), can be considered to represent the shared view of complex scenarios by groups of stakeholders. In this research, we developed high level and expanded sub-level business process models, which were derived from interviews and document analyses. These business models are simple and intuitive, consisting only of activity and sequence flow notation, but each activity represents a domain of action (Object Management Group, 2006). Soft systems and cognitive mapping techniques were then applied to enrich our understanding of these activities and UML class diagrams were used as the representational form to document the outcomes.

t he problem of Knowledge e licitation

So we define our problem not just as one of gleaning explicit knowledge which is amenable to programming and storage, but as of capturing and representing the life world of a knowledge worker engaged in a particular form of activity. We need an understanding of the gamut of knowledge which drives situated, deliberate action in a specific domain. Ngwenyama and Klein (1994) posit several reasons for the difficulty in transferring and codifying the knowledge of such professionals for transfer. Experts may have reasons for not wanting to divulge their knowledge, such as loss of power and influence (the effect of social theories in use) and may themselves not know what they know.

Their knowledge may not be not easy or possible to articulate (it is tacit). Knowledge engineers do not always have the skills or techniques to elicit tacit knowledge used in problem resolution or solutions design. Ngwenyama and Klein (1994) differentiate explicit foreground knowledge, which are facts, formal heuristics and recognisable norms which are "present-at-hand", and implicit background knowledge, which are beliefs, tacit knowledge, intuition and skills. They state that knowledge elicitation from expert must move beyond the cognitive structures of explicit foreground knowledge and argue that the implications of both types of knowledge for problem solving in work contexts must be investigated. Different knowledge elicitation techniques must be applied to acquiring different types of knowledge.

Linberg (1999) appositely quotes Likert and Likert: " ... people act on the basis of what they perceive the situation to be, whether the perceptions are accurate or grossly inaccurate...". These "theories in use" or "mental models" describe the assumptions and beliefs that actually govern actions and judgements: agents may not be aware of, or be able to articulate these theories (Argyris, 1999). If we are to make sense of actions and decisions, and establish standards for reasoned behaviour in professional contexts, we need to understand and consider both tacit knowledge and theories in use (Ackoff, 1983; Davis et al., 1992). As Kim (1998) says:

The mental models in individuals' heads are where the vast majority of an organization's knowledge (both know-how and know-why) lies.....

Tacit knowledge is expertise and insight which is often not readily available to introspection, and yet is critical to organisational success (Patel, Arocha, & Kaufman, 1999). Paradoxically, tacit knowledge is often not recognised as a form of excellence (Horvath et al., 1999). However, as Schon (1983) says: "the workaday life of the professional depends upon tacit knowing-in-action, which is how professionals deal with situations of uncertainty, instability, uniqueness and value conflict".

So a substantial proportion of business knowledge therefore is complex, wide ranging, not codifiable and elusive – yet essential to task performance. It seems logical to codify the existence, significance and relevance of this knowledge, even if that knowledge is not itself codifiable. Formal design ontologies are a sophisticated method of knowledge representation and embody contextual, functional and relational aspects of information or knowledge categories (Gilchrist, 2003; McGuinness, 2003). The more formal the specification, the greater the ability of technology to sort and mediate the access to the objects within categories (Berners- Lee, 1998; Maedche, Staab, Stojanovic, Studer, & Sure, 2003). The technique of UML class modelling offers a path to such precision and structure.

A cont Ingent Method for el Ic It Ing Knowledge of A ll fe w orld

Making sense of the business and eliciting business knowledge is usually done through some form of business analysis method and business process mapping, which identifies work activities and sequences, and other salient features such as the flows of information, and roles and responsibilities. In our case study, we applied business process mapping and the Soft Systems Methodology (SSM) (Checkland & Scholes, 1990) as our initial elicitation methodology. The reason for this was to facilitate sense making and keep things simple: although procedures existed, the group of policy makers in the case study had never mapped their business processes or analysed their workflow. Using the SSM enabled the conversion of tacit process knowledge to an explicit objectivation which could be shared and mutually agreed. Because we wanted to reveal as much of the knowledge which is required to execute business processes as possible, we introduced *cognitive mapping*. We hoped to derive not only the explicit knowledge prerequisites for work (those pieces of information which constitute the typical grist of information systems), but also derive the tacit knowledge and contextual information within work processes (Ambrosini & Bowman, 2002; Huff & Jenkins, 2002). A cognitive map is a "representation of an individual's personal knowledge, of an individual's own experience" (Rughase, 2002). A causal cognitive map is a type of cognitive map, which uncovers those resources, including tacit routines, which are required for successful achievement of a goal. Causal cognitive maps are particularly useful in tacit knowledge mapping as this enables us to focus on action and elicit knowledge that is context dependent.

Causal cognitive maps are generally developed by asking a series of questions geared towards uncovering what *"causes success in the organization?"* (Ambrosini & Bowman, 2002, p29). After preliminary interviews and document perusal to identify key constructs which support success, a workshop is generally held to explore each construct (Johnson & Johnson, 2002). A series of *"what causes that*?" questions are asked, and these causes are linked to the construct. This is continued, until no further constructs are suggested.

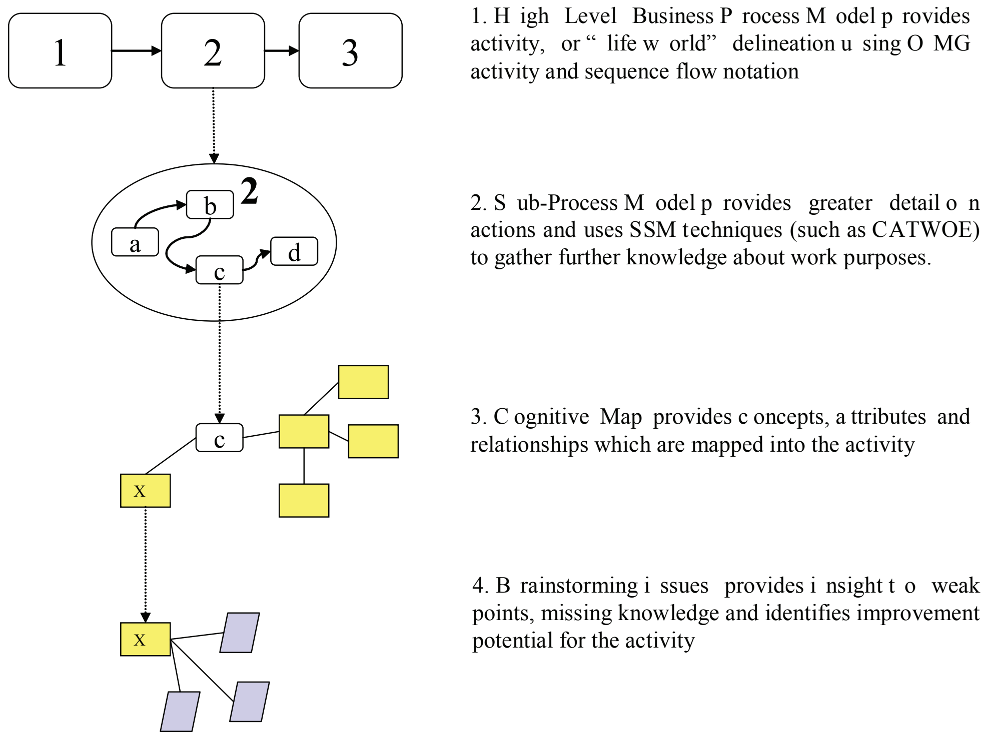
Subsequently to the completion of a cognitive map, workshop participants were asked to reflect upon the elements which had been identified as prerequisites for successful work and to annotate those with any *issues* or *hindrances* to the provision of those resources. This was a kind of brainstorming method and the subsequent density of issues around groups of concepts highlighted deficiencies which required focus and resolution. After the information had been elicited from staff, this was moved into a high-level UML class diagram.

An overview of the Applied Knowledge elicitation

Figure 1 shows how knowledge required to perform work tasks can be elicited in a way that reveals insights into what people do, and more importantly why they do it, within what we call a life-world of participants in a domain of activity. Our persistent use of the term "life-world" is to emphasise that each purposeful activity determines the constructed reality, the cognition and normative reasoning of participants: a policeman enforcing laws, for example, inhabits a different "life world" to a legislator who drafts the regulations.

1. The activities depicted within each top process level shows the generic tasks performed by the organisation and establishes the overall work-context. Each activity stands for a life-world, in that the perspectives, meanings and actions of participants relate to the purpose of that process. Defining this process sets the boundaries and the context for knowledge elicitation, locating the protagonists within a role and a purposeful activity.
2. The second level provides a more detailed set of tasks which need to be performed to achieve the goals of the higher level process. In effect, it is a second-level process model and contains a greater level of detail about work. These tasks serve as more specific catalysts for triggering protagonists to realise what knowledge is required to get things done.
3. The third level identifies knowledge (tacit and explicit) which is used to achieve task objectives. No limits are set to the type of knowledge: it could be level of education, skill, relationship management or even "gut feel". Some of this knowledge can be provided or facilitated by tools such as database applications, workflow systems,

Figure 1. The Knowledge Elicitation Methodology



e-mail, bulletin-boards, skills databases and so on.

4. The fourth level reveals issues and problems in the provision of the required knowledge: these issues, both individually and taken collectively, can be translated into specifications in the acquisition or development of solutions (for example work procedure adaptation or technology).

Methodology

The research project was a commercial project, fully funded by a government client. The tools of information management such as process modelling and data modelling were used extensively within an overall knowledge management discovery context. The project was conducted by one author of this article, currently a university researcher, who has 22 years experience in IT development and strategic consulting. The case study description is therefore a combination of:

- Straightforward reporting of organisational characteristics and information from corporate documentation and workshop outputs,
- Observations of the protagonists who participated in the project and the effect of the

innovations on their ability to contribute data to the requirements gathering process,
- Reflection in action and the use of a reflective journal regarding the innovations in requirements gathering workshops and the usefulness of the information in creating a high level design.

The methodology, in particular the innovations mentioned, was not changed during the execution of the project. This article has been read and verified by the client project manager, who agrees with the representation of the approach and the outcomes.

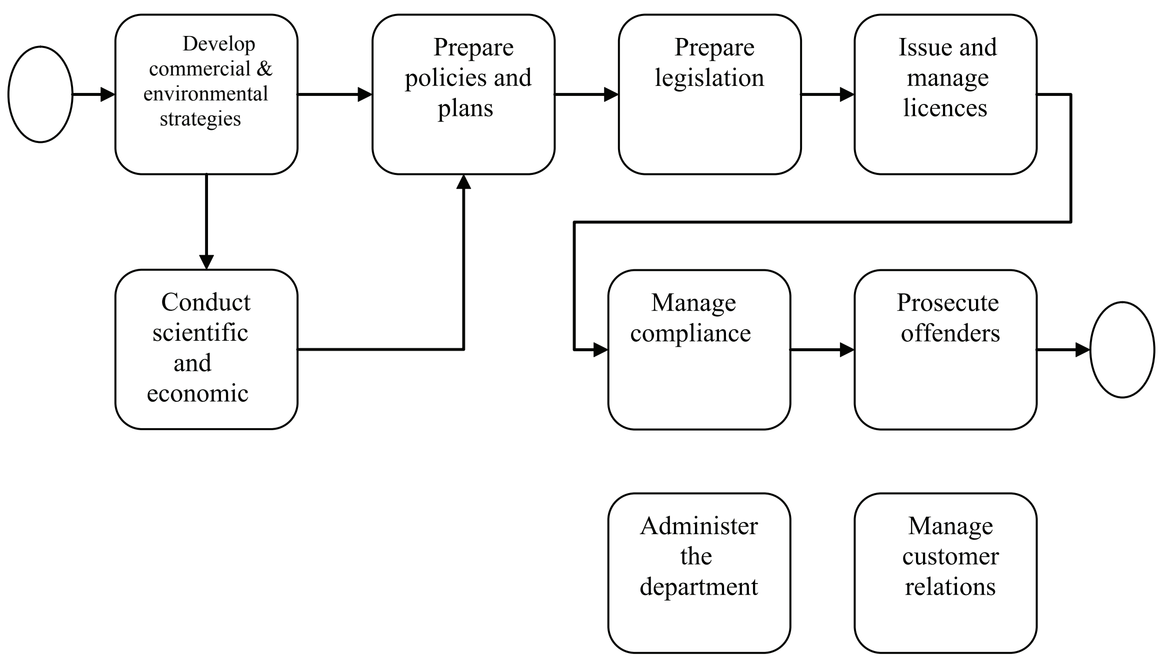
t he c ase s tudy

The context of this research was the analysis of existing knowledge for a small but highly visible public service agency, concerned with the sustainable development and management of natural resources. The intent of the plan was to identify main areas of knowledge, issues in the sharing and acquisition of that knowledge, and propose initiatives for improvement.

The organisation has about 400 employees. The major activities of these employees are to develop strategy and policy for the sustainable use of natural resources, conduct research to ascertain the condition of the environment and ascertain sustainable levels of exploitation, develop plans for the management of those resources and instantiate those in regulations and law, monitor users of the environment to ensure they comply with the regulations and prosecute breaches of the regulations.

The following sections demonstrate how we moved from the messy problem space of the business to the solution space, an enterprise ontology diagram to be used, amongst other things, as a basis for designing an Intranet knowledge portal and improving knowledge management practices. The route from one to the other was by way of business process modelling, SSM and cognitive mapping.

Figure 2. High Level Business Process Model



Understanding the Context and Framing the Life World

The first step was to understand the overall context and nature of the organisation: its mission, key business processes and values. The annual report, a series of strategic departmental plans, which cascaded down from the overall corporate plan, and other reports and publications were used to this end. A workshop was conducted with senior management in which the major knowledge domains, communities of practice and issues in knowledge management were identified. A corporate business process model (Figure 2) was developed, which presented the nine most important business processes and their interactions. For each process, interviews and workshops were conducted to identify the major activities and develop a sub-process business model. The formalism we use here is a rounded box for activity and an arrow for sequence flow (Object Management Group, 2006).

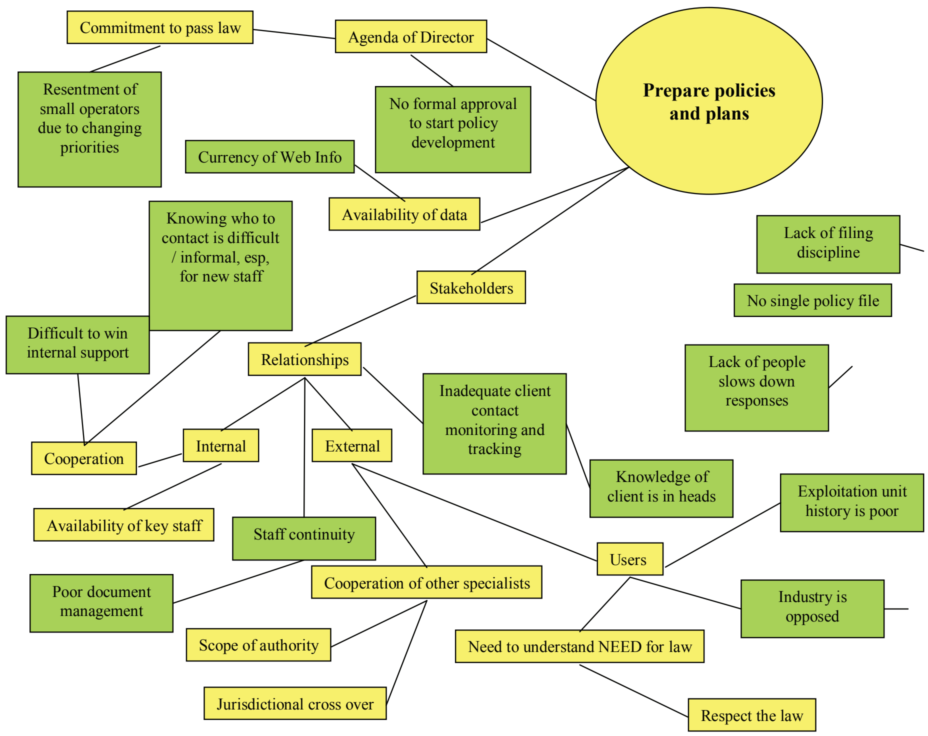
Using Soft Systems Methods to Evoke Context and Catalyse Cognitive Mapping

A soft systems "CATWOE" and cognitive mapping workshops were conducted for each sub-process model. "CATWOE" is an acronym taken from Checkland's Soft Systems Methodology and is used to support the elicitation of information from system participants about customers, actors, transformations, worldview, outputs and environment. Whilst this process does elicit important information, its primary role in this method is to establish the salient components of the work context. For example the business activity "*Prepare Policies And Plans*" establishes the work routine of consulting with stakeholders, gathering research, environmental data and developing an environmental management plan. Having done the CATWOE, and having brought much activity information into their "explicit foreground" memory, participants were asked to identify all things which led to successful completion of the work. These contributors to success could be information, skills, experience, relationships, stakeholders, resources or conditions such as time and space. These were written on *yellow* post-it stickers and stuck on the white board, fanning out from the process, which had been drawn on the middle of the board. As participants made their contributions, the post-its were clustered together in meaningful collections which seemed sensible to the facilitator and participants at the time (see Figure 3 for an extract).

The final step was to identify issues with the process and information on the board through a process of brainstorming. Participants were asked to reflect upon the content of the yellow post-its (the success factors) and consider inhibitors to the availability or usefulness of these on *green* post-its, which they then connected to the appropriate yellow post-it. What was gained from this exercise therefore was a list of resources required to perform the task (giving a clear context) and a list of issues which inhibited good performance. For the purposes of knowledge mapping, this provides us with 1) a domain (the process or sub-process), 2) knowledge objects in the domain (including issues) and 3) their relationship with each other.

An analysis of the clustering of the knowledge elements reveals insights into the lived work reality of the participants which may escape the positivist or object-oriented systems analyst. For example, in cognitive maps for two discrete processes ("Prepare Policies and Plans" and "Manage Compliance") there was a clustering of elements around the concept of "relationships" with stakeholders. This relationship facilitates inbound and outbound information flows, which are to be nurtured if the public are to be seen as genuine partners in the development of policy on the one hand and also providers of operational intelligence to compliance officers (effectively environmental policemen) on the other. Relationships needed to

Figure 3. A subset of results of the Knowledge Elicitation



be long term, consistent, trusting of mutual benefit and so on. So the notion of relationship, whilst not embodying explicit knowledge about any relevant entity in the model, is highlighted as a piece of the knowledge puzzle. To know about the history of a relationship with a stakeholder, and be aware of its nuances, threats and opportunities, is critical to the successful execution of both processes, but unlikely to be ever elicited or written down, particularly in systems analysis sessions.

obtaining an understanding of Knowledge in Action

The transmission of draft policy, proposed legislation and supporting information to the public and other stakeholders is carefully, explicitly and formally managed and recorded, as are the submissions and responses from stakeholders. This is good *information* management. But the formulation of effective law by the public service includes understanding what is physically and realistically enforceable by compliance officers and police. Laws that place unreasonable demands upon compliance officers or which create evidentiary nightmares are not enforceable and so tend to fail. The (usually tacit) knowledge of compliance officers must be applied to test whether a particular draft regulation can be enforced with reasonable effort. On occasions in the past, this knowledge has not been included in the formulation of laws, and as a consequence, complex and impractical regulations have been developed. The workshops were able to capture the requirement, that this type of knowledge, although tacit and not generally linked to the purpose of the law is nevertheless critical to its effective formulation.

Another example of a complex knowledge flow is to gain information from informants relating to breaches of laws by the general public. Obtaining this intelligence requires trust, confidentiality, rapport, empathy and a perception to be held by the potential informant that the law is fair. These are forms of tacit behavioural knowledge and knowledge of a stakeholder's character and needs, built up over long periods, which the organisation as a whole needs to understand if stakeholders in the community are to be treated consistently and appropriately over time. This knowledge should be captured in some form (possibly only as a metadata construct to allow identification of the human repository of the data) to render it less vulnerable to attrition and loss and to maintain its salience when management decisions are made.

In Figure 4, certain types of knowledge are depicted which are critical to the development of laws, policies and plans, but which would not find their way into any information system. These are how to maintain a good relationship with stakeholders, how to create law which is respected by the users of the resource (so they will themselves conform and report others who contravene that law) and what constitutes law which can be readily understood and implemented by compliance officers.

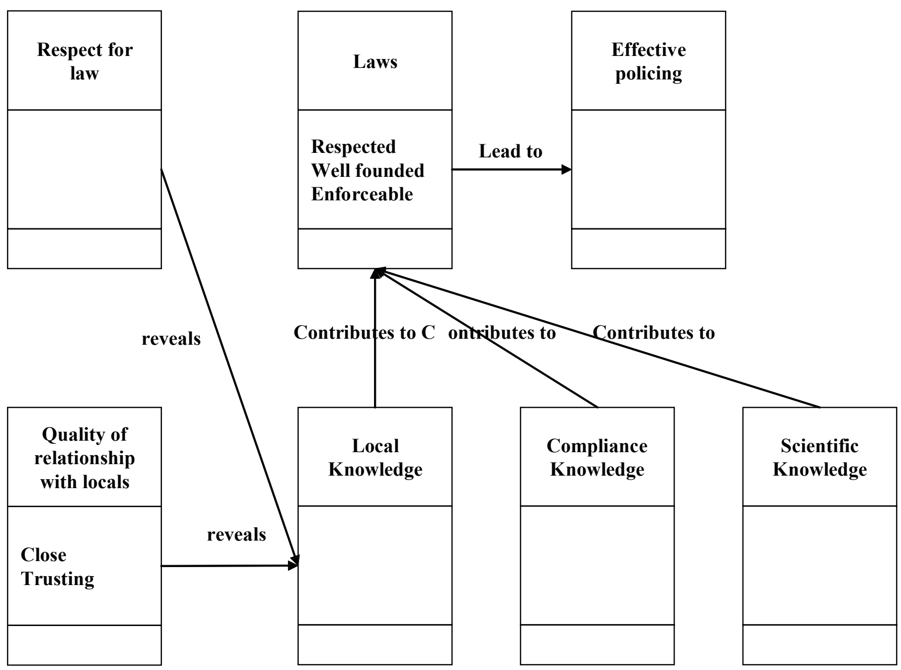
These are sets of knowledge that help determine the effectiveness of the policies and laws which are developed by policy development staff. So therefore they should be included in any design document which purports to represent important knowledge, even if that may not be amenable to codification in a database or document at some future time. In particular, any formalism which claims to represent phenomenological reality should have pointers to the existence and nature of these prerequisite forms of knowledge.

Codifying the Elicited Knowledge into a Map

In previous sections we argued that an ontology, the "knowledge map" which reflects the social reality of the agency officers in this area, should reflect stocks of deep and tacit knowledge and expertise. Potentially then this map can be used to locate and access the knowledge, should it be required in another location in the organisation, or by someone else in the future. The rules for capturing this knowledge must recognise the limits to codification of tacit knowledge. But it must be acknowledged and mapped as it is of major importance. Furthermore, these objects are in a sense "contextualising objects". That is, they give additional information and meaning to the objects with which they are associated. So, for example, in Figure 4 (a subset of the high-level UML class diagram) there is a relationship depicted between "local knowledge" and "quality of relationship and "respect for law", showing that local stakeholders, with a relationship to the Department's personnel, submit information to the Department. Unless this relationship is of a certain standard, with high trust, empathy and physical closeness, little intelligence will be received to assist compliance management. Laws which have the attributes of respect, being well-founded (e.g. in good science) and are realistically enforceable will have an association with effective policing of the law. This is important to managers and the designers of systems intended to capture and assess all such informational inputs.

In the case study project, a UML class diagram was derived from the information elicited in workshops and organisational documentation. This depicts a "life world" related to specific activities. This UML class diagram can be enriched over time with formalisms describing the rules and attributes of the respective classes, such that where appropriate, access and extraction of information can be automated through the intranet or internet. This UML diagram is taken

Figure 4. Extract from an indicative UML class diagram



as the basis for further design work in preparing an Intranet Knowledge Portal to support those personnel developing legislation and policies, and understanding the social logic of the respective work activity systems.

dIscuss Ion

The result of this project was a high level knowledge map for the organisation, developed by the researcher. The substantive component of this research however is the method of knowledge elicitation and the resulting ontology, which contains contextualising social elements and reasoning for organisational action and decisions. The basic ontology provides the foundation for identifying knowledge needs, what might be stored in an information repository, what might be the taxonomic structure for an intranet knowledge portal, and the beginnings of an organisational taxonomy and a detailed set of issues which could be addressed by management decision.

Business process modelling was used to arrive at the taxonomy and the relevant issues. This enabled a clear definition of the context within which the ontology could be developed and was most effective in putting participants in the mindset of the particular business process and triggering them to identify their own background knowledge. Developing a business process model has the advantage of capturing the most important activities in a clear and easy to understand format.

The formulation of each process within the model represented a "root definition" (Checkland & Scholes, 1990). The "CATWOE" was performed to establish some base data about the overall process such as the customers, activities, transformation, worldview outputs and environment of the overall process model. This assisted both the facilitator and the audience in focussing upon the context of the process and making the decisive components in the process present in the mind of participants. Then a key process within the model was taken and formed the basis of the question: "What do you need to achieve success in the activity of "X"". The information collected in the example was consistent, comprehensive and rich. The formulation of question of "what causes success" in terms of the process is useful because it is very direct and reflects an activity which the staff perform and understand well. Above all, it was the staff present in the workshops who developed and identified with the model.

The issues underscored the importance of problematic access to information and are useful for showing where management can apply leverage to improve a situation. For example, staff continuity was highlighted in the process as the most important reason why uniform information and knowledge management solutions were required. When a single staff member develops a new policy, the knowledge is internalised and available on demand through personal memory: no external repository is required. But if that person leaves during policy development, the knowledge is gone. So some consistent form of management of explicit information during the preceding period of policy development must be introduced.

Moving from the data to the ontology modelling is the "design process" and so more of a "black art". This was done by examining the cognitive maps and abstracting or splitting the concepts as appropriate. Other concepts were derived from the documentation, using nouns and concepts as candidate objects for diagramming. This process arrived at an indicative UML class diagram, which is fairly easy to understand and can be used for further refinement. There are several things to be hoped from the diagram, as it raises knowledge objects which would not normally be visible (such as the quality of the relationships and trust) to the level where designer and possibly management attention is focussed. Contextual information becomes available to the designer at the object level within an ontology, even though that information may never be a candidate for codification and it may form the basis for thesaurus / taxonomy and designing the Intranet storage and access paths.

At the beginning of this chapter we noted two particular challenges to knowledge mapping: the elicitation of knowledge and the loss of context in the resulting documentation. We believe that this case study demonstrates that through using a number of tools and techniques, knowledge elicitation can be improved, and that by documenting in a design formalism (in this case UML class diagrams) the tacit mental models and social constructs of stakeholders, we can pass on contextualising information.

Forms of Learning and Memory Enhancement

Although the artefacts produced in this project are intended to support the design of knowledge management solutions, they also become part of ongoing knowledge generation and objectivation within the organization. The ontology and "knowledge map" reflect the social reality of the participants in the agency we have described here. They can provide key resources for the organizational memory and, via the use of effective knowledge management techniques, enhance organizational learning via the metacognitive process involved in making tacit knowledge explicit.

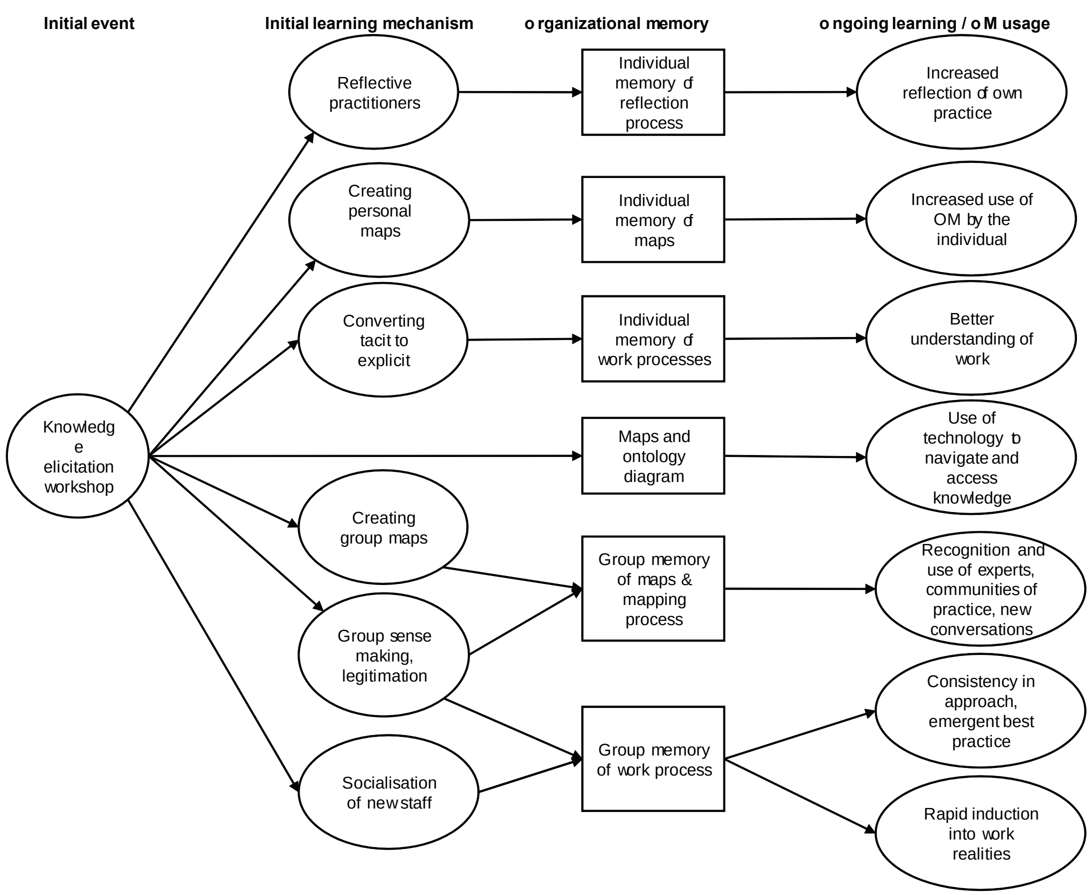
The production of the knowledge map using contextual information raises knowledge objects which would not normally be visible (such as the quality of the relationships and trust) to the level where designer and possibly management attention is focused. Contextual information becomes available to the designer at the object level within an ontology, even though that information may never be a candidate for codification. In addition, the knowledge map forms the basis for thesaurus / taxonomy and designing the Intranet storage and access paths. This could lead to electronic web services later on, if required.

Figure 5 is a schematic of the intended and unintended consequences resulting from the knowledge elicitation workshop.

The main espoused and intended organizational memory outcome is the ontology diagram, which will form the basis for Intranet portal design. Considering the various learning mechanisms which were engaged during the workshop however, we observe the development of other forms of memory, both social and individual.

On the individual learning side, we see employees developing reflective and meta-cognitive skills as they contextualise their inquiry (for example within the SSM CATWOE) and cast a 'cone of light' over the phenomenology of their lived work experience. We see individual learning occurring as they convert their tacit knowledge into explicit rules and heuristics (in order to share or think about sharing it with others). And we see individuals

Figure 5. Diverse forms of learning and organisational memory



"learning what others know" and developing their transactive maps of who-knows-what for future reference. Social knowledge develops through the workshop conversation which objectifies and then legitimates business processes and knowledge maps: this new agreement constitutes new or upgraded collective memory.

The degree to which these various types of memory are subject to ongoing learning and their exploitation depends upon a number of contingent factors, but one could assume that managers and other end-users who are aware of the learning processes can encourage and nurture them to develop a self-sustaining momentum of awareness, reflection and sharing. In terms of the KMS design and development process, the involvement of the end-user in this process and the resultant individual and collective learning can be considered to enhance both the development process and project ouctomes.

conclus Ion

In this case study we achieved two substantive outcomes. Firstly, we developed a contingent methodology for eliciting knowledge by combining existing sense-making and knowledge gathering techniques, namely the soft systems method, causal cognitive mapping and brainstorming. This contingent method had several strengths which made it effective in contextualising discussion, defining process structure and then focussing the participants such that deep or implicit background knowledge could be recognised and its existence recorded. We believe that the method bridges the gap between the soft methods required for sense making in environments (where no single view dominates or is "right" and where judgments, values and expertise are often fuzzy and deeply implicit) and the hard formulations required by designers and procurers of information and knowledge management systems. Secondly, we established that the method was able to uncover and document the existence of a range of "knowledges" which are used in the effective execution of work. We argued that it is important for the creators of work solutions (technology, procedures, and training) or decision makers, such as information systems designers or managers, to be aware of these. A knowledge map which displays these knowledge objects and their relationships can supply important insights. Further, it was proposed that this is an important process which can augment organizational learning through enhancing object learning and making tacit knowledge explicit. The metacognitive aspects of this process both add to organizational memory and improve organizational learning by introducing contextualising objects into the knowledge map or derived ontology.

Systems design and insight into management decision-making require an understanding of both the explicit and tacit knowledge that is exercised in task performance. Effective elicitation techniques are required, as well as elegant representational forms. Tacit elements (skills and relationships) which function as enablers of an effective work environment can be identified and documented using this elicitation method. This produces a clearer idea of what an effective work group knows. What one does with the output is also contingent. Some management solutions may attempt to codify such knowledge, or improve record keeping and procedures. Others may improve knowledge directories or "yellow pages" so that the human repository of a special knowledge or relationship can be located. These can then be used to explain or show how to deal with a particular situation. One can even imagine this method leading to improved staff job descriptions to include the qualities suggested by the tacit knowledge revealed by the ontology.

We expect that using a representational convention like UML class diagrams, tacit information (in the form of classes), relationships (through associations, is-a-kind-of and part-of formalisms), attributes and contextual information through the linking to process models and domains can be clearly and simply displayed. These maps, as meta-data, can then be used as navigational aids to find knowledge repositories in whatever form they may be in. The final process of identifying and contextualising knowledge issues through brainstorming pinpoints sensitivities in the current system, which will prioritise and focus management and developer attention.

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Chapter XIX
Helping to Develop Knowledge Management Systems by Using a Multi-Agent Approach

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Abstr Act

Efforts to develop Knowledge Management have increased in recent years. However, many of the systems implanted in companies are still not greatly used by the employees because the knowledge that these systems have is often not valuable or on other occasions, is useful but employees do not know how to search for that which is most suitable. Moreover, employees often receive too many answers when they consult this kind of systems and they need to waste time evaluating all of them in order to find that which is most suitable for their necessities. On the other hand, many technical aspects should also be considered when developing a multi-agent system such as what knowledge representation or retrieval technique is going to be used. To find a balance between both aspects is important if we want to develop a successful system. However, developers often focus on technical aspects giving less importance to knowledge issues. In order to avoid this, we have developed a model to help computer science engi-

neers to develop these kinds of systems. In our proposal, first we define a knowledge life cycle model that, according to literature and our experience, ponders all the stages that a knowledge management system should give support to. Later, we describe the technology (software agents) that we recommend to support the activities of each stage. The chapter explains why we consider that software agents are suitable for this end and how they can work in order to reach their goals. Furthermore, a prototype that uses these agents is also described.

Introduct Ion

In the last decades, knowledge management has captured enterprises' attention as one of the most promising ways to reach success in this information era (Malone 2002). A shorter life-cycle of products, globalization, and strategic alliances between companies demand a deeper and more systematic organizational knowledge management. Consequently, one way to assess an organization's performance is to determine how well it manages its critical knowledge.

In order to assist organizations to manage their knowledge, systems have been designed. These are called Knowledge Management Systems (KMS), defined by Alavi and Leidner (2001), as IT-based systems developed to support/enhance the processes of knowledge creation, storage/retrieval, transfer, and application.

However, developing KMS is a difficult task; since knowledge *per se* is intensively domain dependent whereas KMS often are context specific applications. Thus, reusability is a complex issue. On the other hand, the lack of sophisticated methodologies or theories for the extraction of reusable knowledge and reusable knowledge patterns has proven to be extremely costly, time consuming and error prone (Gkotsis, Evangelou et al. 2006). Moreover, there are several approaches towards KMS developing. For instance, the process/task based approach focuses on the use of knowledge by participants in a project or the infrastructure/generic system based approach focuses on building a base system to capture and distribute knowledge for use throughout the organization (Jennex 2005). On the other hand, before developing this kind of system it is advisable to study and understand how the transfer of knowledge is carried out by people in real life. However, when developing KMS developers often focus on the technology without taking into account the fundamental knowledge problems that KMS are likely to support (Hahn and Subramani 2000).

Different techniques have been used to implement KMS. One of them, which is proving to be quite useful, is that of intelligent agents (van Elst, Dignum et al. 2003). Software agent technology can monitor and coordinate events or meetings and disseminate information (Wooldridge and Jennings 1995). Furthermore, agents are proactive in the sense that they can take the initiative and achieve their own goals. The autonomous behavior of the agents is critical to the goal of this research since it can reduce the amount of work that employees have to perform when using a KM system. Another important issue is that agents can learn from their own experience. Consequently, agent systems are expected to become more efficient with time since the agents learn from their previous mistakes and successes (Maes 1994).

Because of these advantages different agent-based architectures have been proposed to support activities related to KM (Gandon 2000). Some architectures have even been designed to help in the development of KMS. However, most of them focus on a particular domain and can only be used under specific circumstances. What is more, they do not take into account the cycles of knowledge in order to use knowledge management in the system itself. For these reasons, in this paper we propose a generic model for developing KMS. Therefore, in section two we describe the model and the software agents that we propose to support it. In section three, we explain how the agents are structured and how they have been modeled using the INGENIAS methodology (Pavón and Gómez-Sanz 2003). Later, section four describes an scenario to illustrate how agents collaborate to reach a common goal. Section five summarizes related works carried out with agents. Finally, conclusions and future work are outlined in section six.

A MultI-Agent Model to develop Knowledge MAnAgeMent systeMs

A successful KMS should perform the functions of knowledge creation, storage/retrieval, transfer and application (Jennex and Olfman 2006). Taking this fact into account and after reviewing several knowledge life cycles and models (see Table 1) and seeing what stages most authors considered, we decided to define a knowledge life cycle that

Table 1. Knowledge Life Cycle

Model	Stage1	Stage2	Stage3	Stage4	Stage5	Stage6	Stage7
Nonaka and Takeuchi (Nonaka and Takeychi 1995)	Socialization	Externalization	Combination	Internalization			
Wiig (Wiig 1997)	Creation	Storing/ gathering	Use	Leverage	Sharing		
Davenport and Prusak (Davenport and Prusak 1998)	Generation	Codify/ Coordinate	Transfer	Roles and Skills			
Tiwana (Tiwana 2000)	Acquire	Sharing	Use				
Alavi and Leidner (Alavi and Leidner 2001)	Creation	Storage/ Retrieval	Transfer	Application			
Rus and Lindvall (Rus and Lindvall 2002)	Creation/ Acquisition	Organization/ Storage	Distribution	Application			
Nissen (Nissen, 2002)	Creation	Organization	Formalize	Distribute	Application	Evolve	
Ward and Aurum (Ward and Aurum 2004)	Creation	Distribution	Organization	Adaptation	Identification	distribution	Application
Dickinson (Dickinson 2000)	Identification	Acquisition	Development	Distribution	Use	Preservation	

indicates what process a KMS should support (see Figure1). This is a focus different to the previous one based on describing the knowledge cycle in human being and/or in companies.

The stages of our proposal are: acquisition, storage, use, transfer and evaluation. The first three stages are considered in most knowledge life cycles (see Table 1). We have added transfer (also considered in several cycles) and evolution. The former because a KMS should disseminate knowledge to those people that can need it. The latter because knowledge should always be updated otherwise it would not be used.

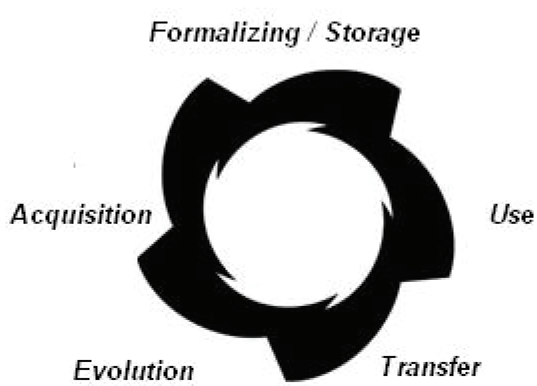
In the following paragraphs each stage of the model is described. At the same time and with the goal of illustrating that it is possible to support each stage by using current technology, we are going to explain how a software agent could be implemented for a KMS.

a. **Knowledge acquisition** is a key component of a KMS architecture. This stage includes the elicitation, collection, and analysis of knowledge (Rhem 2006). During this process, it is vital to determine where in the organization the knowledge exists and how to capture it. The definition of the knowledge to be acquired can be assisted by classifying types of knowledge and knowledge sources (Dickinson 2000). To support this stage we propose to use an agent called a *Captor Agent*. The Captor Agent is responsible for collecting the information (data, models, experience, etc) from the different knowledge sources. It executes a proactive monitoring process to identify the information and experiences generated during the interaction between the user and the system or groupware tools (email, consulted web pages, chats, etc.). In order to accomplish this, the Captor Agent can use different techniques to acquire knowledge since there are several tools and techniques that consolidate and transform corporate data into information (Houari and Homayoun Far 2004). They contain:

- **Front-end system** (i.e. DSS-Decision Support System, EIS-Executive Information System and OLAP-Online analytical processing).
- **Back-end system:** Data warehouse, data mart, and data mining (Giannella, Bhargava et al. 2004).

Agents can also apply classical techniques used by experts to acquire knowledge such as: structured interviews, questionnaires,

Figure 1. Knowledge Life Cycle Model Proposed

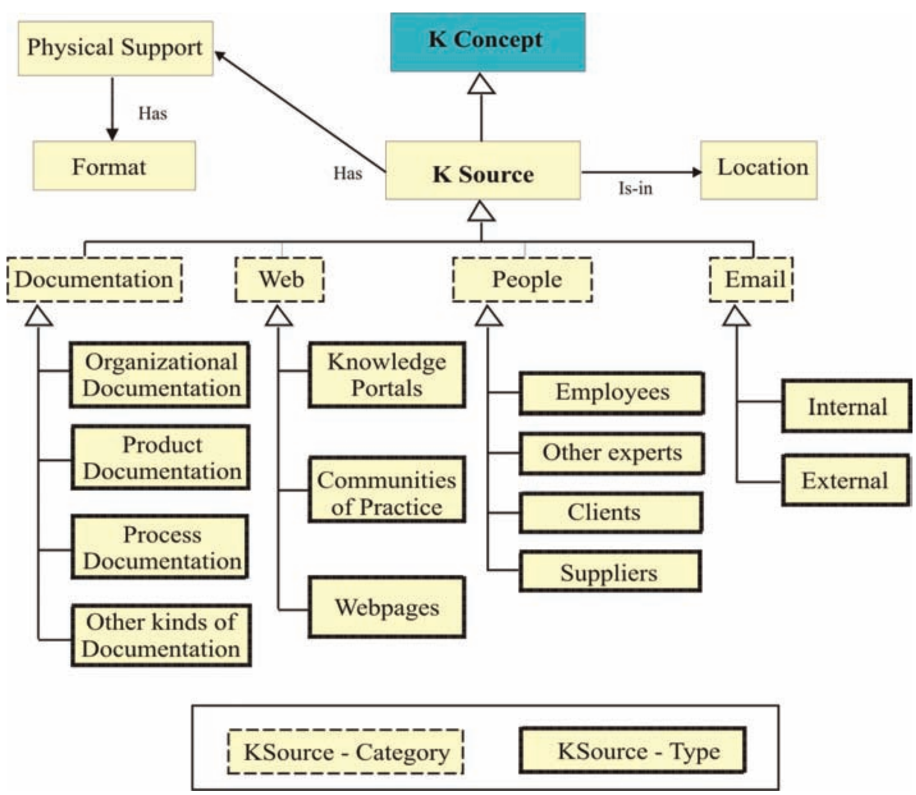


goal trees, decision networks, repertory grids, or conceptual maps (Rhem 2006). More sophisticated techniques such as webParser (Camacho, Aler et al. 2004) to obtain information from the Web, document classification (Novak, Wurst et al. 2003), mailing list management (Moreale and Watt 2003), or data mining and neuronal nets can be also used.

Once the knowledge has been obtained, the Captor Agent can classify it, by using ontologies, according to its type and the knowledge source from it was obtained (see Figure 2). This ontology is based on Rodriguez's ontologies for representing knowledge topics and knowledge sources (Rodríguez, Martínez et al. 2004).

The ontology has four knowledge source categories. These are: Documentation, which can be subdivided into: documentation related to the organization's philosophy, documentation which describes the product/s which the company works with, documentation that describes the process that the company carries out, and other types of documentation that an organization has but that cannot be classified into any of the previous subgroups. Another important source where the Captor Agent finds information is the Web, which can also be divided into other subcategories such as Portals, Communities of Practice, etc. The main knowledge source in a company is, without any doubt, people. Depending on the type of company, people may be classified as clients, employees, etc. The last knowledge source that the Captor Agent can use is email that can be classified as internal

Figure 2. Knowledge Source Ontology



mail (mail sent between employees), and external mail (emails sent to other people outside the organization).

One advantage of this approach is that the Captor Agent can work in any domain since by changing these ontologies the Captor knows what key knowledge should be found and where it might be.

b. **Knowledge formalizing/storing** is the stage that groups all the activities that focus on organizing, structuring, representing and codifying the knowledge with the purpose of facilitating its use (Davenport and Prusak 1998). To help carry out these tasks we propose a *Constructor Agent*. This agent is in charge of giving an appropriate electronic format to the experiences obtained so that they can be stored in a knowledge base to aid retrieval. Storing knowledge helps to reduce dependency on key employees because at least some of their expert knowledge has been retained or made explicit. In addition, when knowledge is stored, it is made available to all employees, providing them with a reference as to how processes must be performed, and how they have been performed in the past. Moreover, the Constructor Agent compares the new information with old knowledge that has been stored previously and decides whether to delete it and add new knowledge or to combine both of them. In this way, the combination process of the SECI (proposed in (Nonaka 1994)) model is carried out, producing new knowledge resulting in the merging of explicit knowledge plus new explicit knowledge.

   Different techniques exist to store knowledge and frequently the technique used is narrowly related to the retrieval method used. Therefore, if a case-based reasoning is going to be used the knowledge will be stored as "cases". Other techniques are knowledge objects, frames, predicate logic or fuzzy logic. In the case of using ontologies to classify the knowledge, methodologies to represent the knowledge can be used. Examples of these methodologies are: Ontolingua (Gruber 1993) or REFSENO (Representation Formalism for Software Engineering Ontologies) (Tautz and Von Wangenheim 1998).

c. **Knowledge use** is one of the main stages, since knowledge is helpful when it is used and/or reused. The main enemy of knowledge reuse is ignorance. Employers often complain because employees do not consult knowledge sources and do not take advantage of the knowledge capital that the company has. KMS should offer the possibility of searching for information; they can even give recommendations or suggestions with the goal of helping users to perform their tasks by reusing lessons already learnt, as well as previous experiences. In our model the agent in charge of this activity is the *Searcher Agent*, which searches in the knowledge base for the needed knowledge. Different techniques are currently used to search for knowledge. Many of them are based on the use of the position and frequency of keywords (Mohammadian and Jentzsch 2004) or on information retrieval techniques (Frakes and Baeza-Yates 1992; Liang and Huang 2000). Other authors such as (Sung Kim 2004) mix several techniques: data mining and case-based reasoning to develop a recommender system.

d. **Knowledge transfer** is the most investigated stage in knowledge management (Peachey, Hall et al. 2005). This stage is in charge of transferring tacit and explicit knowledge. Tacit knowledge can be transferred if it has been previously stored in shared means, for example: repositories, organizational memories, databases, etc. The transfer stage can be carried out by using mechanisms to inform people about the new knowledge that has been added. For this stage we propose a *Disseminator Agent*, which must detect the group of people, or communities who generate and use similar information: for example, in the software domain, the people who maintain the same product or those who use the same programming language. Therefore, this agent fosters the idea of a community of practice in which each person shares knowledge and learns thanks to the knowledge of the other community members (Wenger 1998). An appropriate knowledge management linked to communities of practice helps to improve the organization's performance (Lesser and Storck 2001). Disseminated information may be of different types; it may be information linked to the company's philosophy or specific information about a determined process. Finally, the Disseminator Agent needs to know exactly what kind of work each member of the organization is in charge of and the knowledge flows linked to their jobs. In order to do this, the Disseminator Agent contacts with a new type of agent called the *Personal Agent* which is in charge of determining the users' profiles (it will be described in next section). Comparing this stage with the SECI model we can say that the *Disseminator Agent* fosters the socialization process since it puts people who demand similar knowledge in touch and once in contact they can share their experience, thus increasing their tacit knowledge.

e. **Knowledge Evolution.** This stage is responsible for monitoring the knowledge that evolves daily. To carry out this activity we propose a *Maintenance Agent*. The main purpose of this agent is to keep the knowledge stored in the knowledge base updated. Therefore, information that is not often used is considered by the Maintenance Agent as information to be possibly eliminated.

Multi-Agents Agencies

Once the model and the agents that we propose to give support to the different stages have been described we are going to explain how the agents are structured into two agencies. Therefore, we group all the agents closely in charge of managing knowledge and supporting the different stages of the model proposed in one agency. Auxiliary agents are in another agency (see Figure 3).

Therefore, the *Knowledge Agency* is in charge of giving support to the KM process. It consists of the Constructor Agent, the Captor Agent, the Searcher Agent, the Disseminator Agent and the Maintenance Agent.

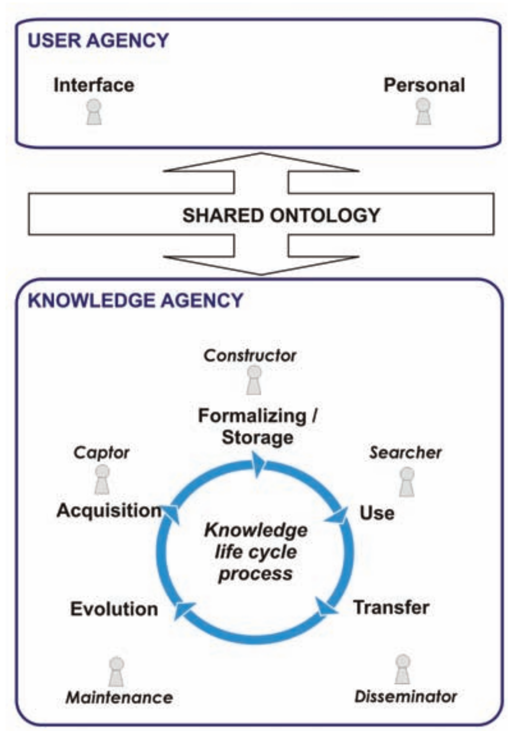
On the other hand, the *User Agency* is formed of the Personal Agent and the Interface Agent. The Personal Agent monitors users' tasks to obtain their preferences and needs. In order to implement the Personal Agent user modeling techniques can be used. User modeling implies obtaining certain knowledge about the user. This knowledge describes what the user "likes" or what the user "knows" (Chin 1986).

The *Interface Agent* is the mediator between the users and the agents. Thus, when an agent wants to communicate a message to the user, the agent sends the message to the Interface Agent which shows it to the user.

Another component is the *Shared Ontology* which provides a conceptualization of the knowledge domain. The Shared Ontology is used for the consistent communication of the agencies.

In order to carry out the analysis and design of the agents involved we have followed a methodology called INGENIAS (Pavón and Gómez-Sanz 2003) which provides meta-models to define Multi-agent Systems, and support tools to generate them. Using meta-models facilitates the development of systems enormously, since they are oriented towards visual representations of concrete aspects of the system.

Figure 3. Agents distribution



Below, we are going to show the different agent meta-model diagrams which describe the roles and tasks of each agent.

Figure 4 shows that the goal of the Captor Agent is to obtain information that should be stored. Its role is "Filter" since it must decide what information should be transformed into knowledge, the purpose being to use this in future projects. In the following lines, we describe each of the tasks carried out by this agent.

- **IdentifyIS:** This task consists of identifying available knowledge sources in the system.
- **CaptureInfo:** The agent must also capture information.
- **SendToConstructor:** Once the suitability of storing the information has been analyzed, the Captor sends it to the Constructor Agent (described in Figure 5) whose roles are: Sculptor and Treasurer since it is in charge of giving an appropriate electronic format to the information (Sculptor) and of storing it in the knowledge base (Treasurer). The tasks developed by Constructor Agent are:
- **CompareInfo:** The agent is in charge of comparing the new information with the previously stored knowledge.
- **CombineInfo:** The agent is also in charge of combining the new information with the previously stored knowledge.
- **ClassifyInformation:** Another task is to classify the information received by the Captor Agent (for instance: models, structures, files, diagrams, etc.).
- **SendToDisseminator:** This is a critical task which consists of sending knowledge to the Disseminator Agent.
- **SaveKnowledge:** One of the most important tasks is to store the new knowledge into the knowledge base.

Figure 4. Captor Agent diagram

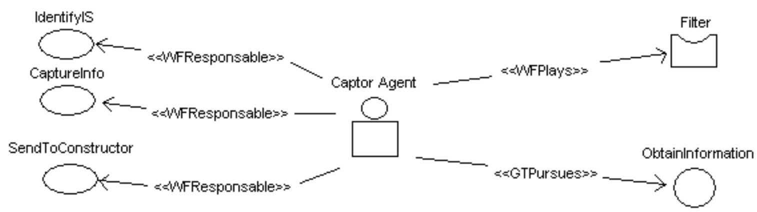
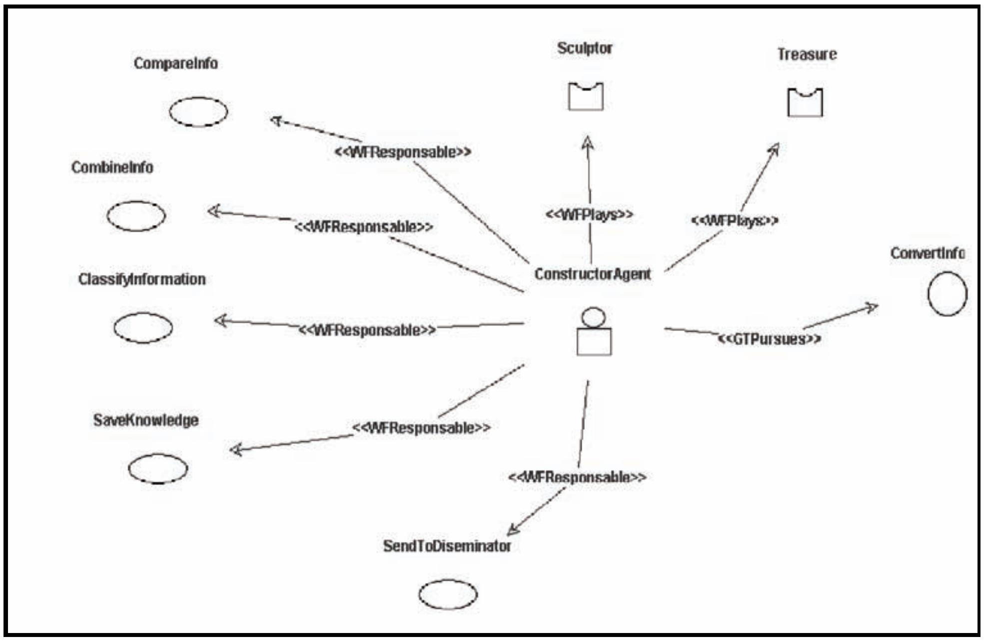


Figure 5. Constructor Agent diagram



The Disseminator Agent, whose role is PostOfficeEmplee, as it behaviours like the "postman" of the architecture, (see Figure 6) is composed of the next tasks:

- **SaveInfoTemp:** The Disseminator Agent stores temporally the new knowledge received by the Constructor Agent.
- **EvaluateProfiles:** Once identified one user profile, the Disseminator Agent evaluates it in order to determine user's needs.
- **LookForActivePersonalAgents:** Personal Agents can be distributed into different nodes, so it must identify all active Personal Agents available in the system.
- **SendInformation:** This is a critical task which consists of distributing the information to those people that can need it (really, the information is sent to their interface agents).
- **EvaluateInfo:** This task is focused on evaluating received information to be able to relate it with different user's profiles.

Another agent that supports the knowledge life cycle is the Searcher Agent. The goal of this agent is to foster the internalization process of the SECI model, since the employees have the opportunity of acquiring new knowledge by using the information that this agent suggests. The

Figure 6. Disseminator Agent diagram

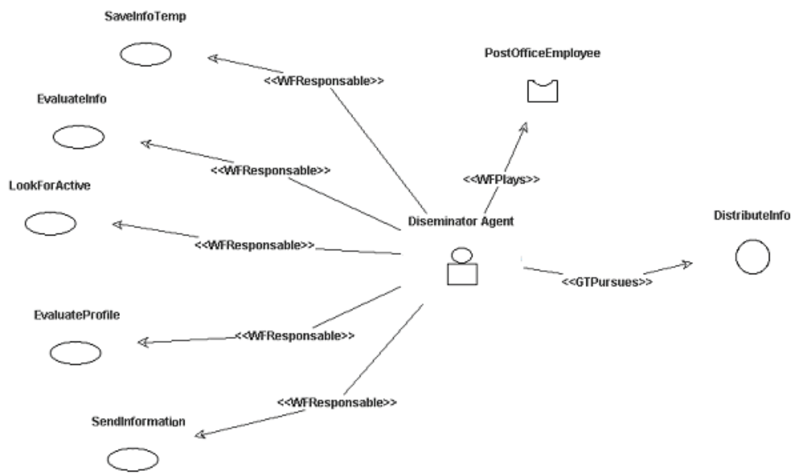


Figure 7. Searcher Agent diagram

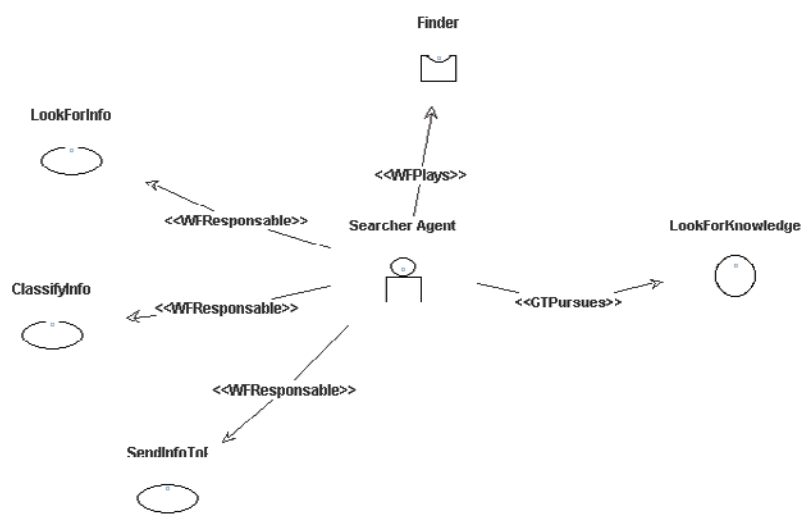
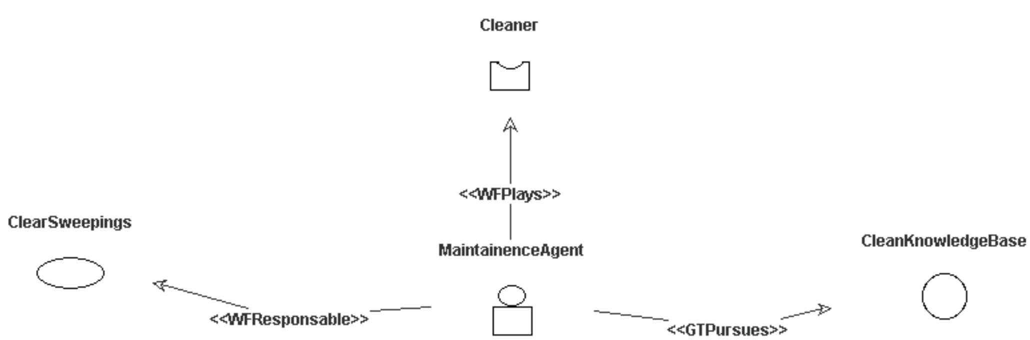


Figure 8. Maintenance Agent diagram



Searcher Agent diagram (Figure 7) is composed of the next tasks:

- **LookForInfo:** This agent is in charge of searching the information required by the users.
- **ClassifyInfo:** This agent also classifies the information found in the knowledge base.
- **SendInfoToI:** Finally, the agent sends the knowledge found in the knowledgebase to a Interface Agent.

Last type of agent of the Knowledge Agency is the Maintenance Agent (Figure 8). The main purpose of this agent is to keep the knowledge stored in the knowledge base updated. Therefore, its task dealt mainly with deleting obsolete information.

Now, the two types of agents of the User agency are described. Figure 9 shows the Personal Agent diagram whose role is called "spy" since the agent must monitor users' activities in order to obtain their profiles. Therefore, its goals are: monitoring users' tasks and recommending information.

In order to attain these goals it should carry out the following tasks:

- **Modeling the users' profiles:** By observing the users' preferences, activities, information consulted, etc.
- **CreateManageLocalKnowledgeBase:** Creating and managing a "local knowledge base" where the relevant information for the user can be stored.
- **Recommending knowledge or knowledge sources:** This agent tries to guess what

Figure 9. Personal Agent diagram

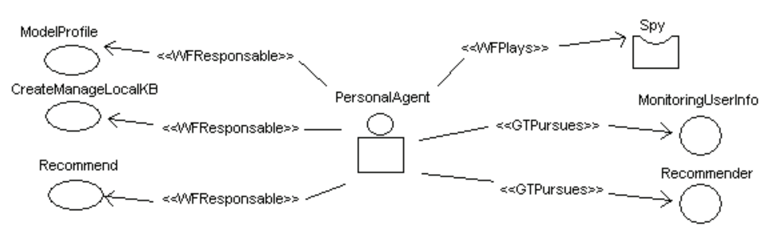
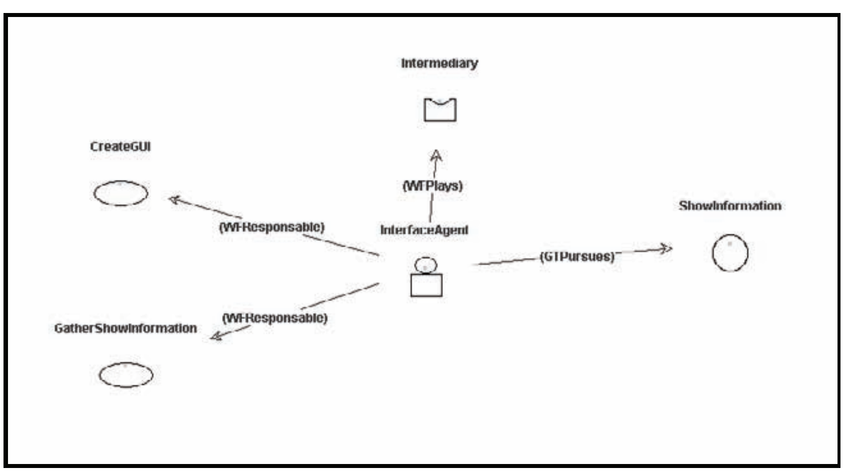


Figure 10. Interface Agent diagram



knowledge would be relevant for the user. To accomplish this, this agent communicates with the Searcher Agent and with the Interface agent.

On the other hand, the Interface Agent is an intermediary between the users and the rest of agents, Figure 10 shows that its main tasks are: creating GUI and showing information to the users

These tasks are defined in order to attain the goal of showing important information to the user, named in the diagram ShowInformation, so we have to create an user interface and put the received information from others agents in a nice way to the user.

Agents coll Abor At Ion

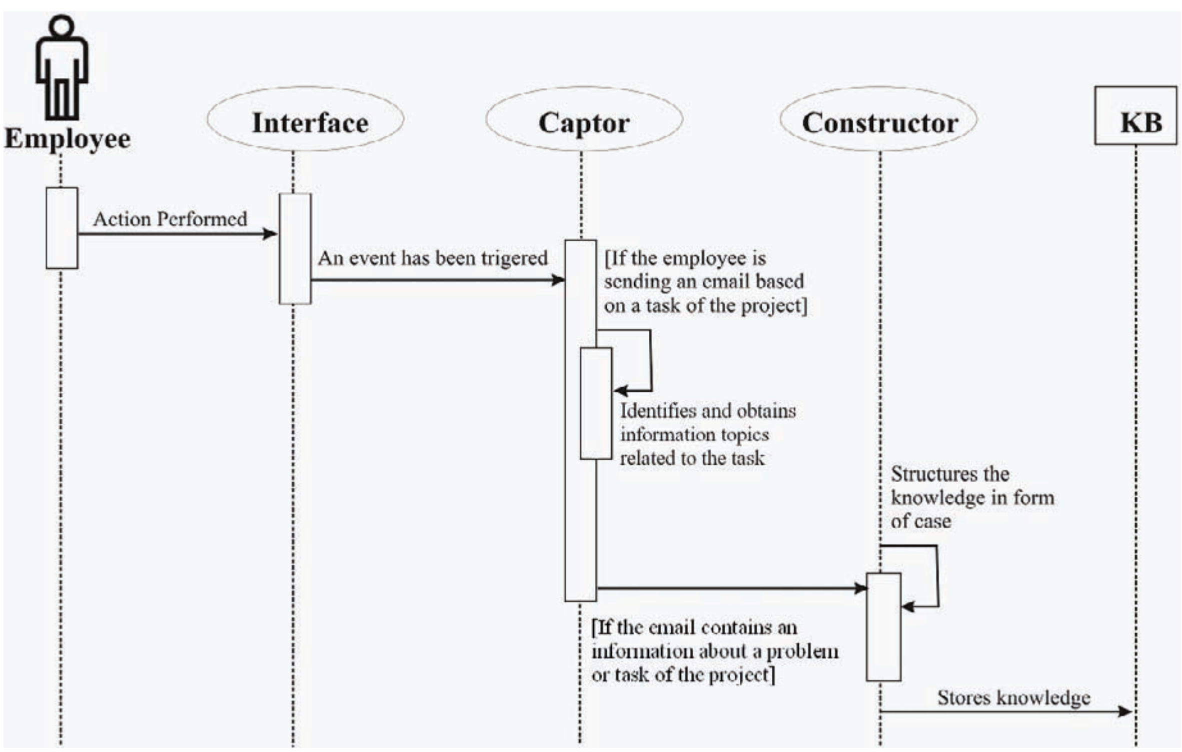
As it was mentioned before, the agents must collaborate with other agents. In order to show an example of this collaboration we are going to describe a possible scenario that can take place in an organization.

scenario

Let us imagine that a person is writing a mail and the agents start to work in order to check whether the mail contains information that should be stored in the data base (we suppose that the employees know that the mail are reviewed and they agree with this).

As Figure 11 shows, the Interface Agent captures each event that is trigged by the Employee. In this case the employee sends an email. Then,

Figure 11. Scenario of Agent Collaboration



the Interface Agent warns the Captor Agent that an even has been triggered. Afterwards, the Captor Agent determines the type of groupware tool used (email) to identify and obtain information topics about related task. In order to obtaining information from the mail, a new agent can be added to the system (it would not form part of our architecture) but would be an agent that has been already developed to assist in this task. There exist several agents implemented to deal with email (Segal and Kephart 1999). Most of the current implementations are text classifiers (Takkinen, and Shahmehri, 1998) or keyword extractors (Mock 2001). The Captor Agent would study whether the information sent by the "email agent" should be transformed into knowledge. Finally, the Constructor Agent receives the information which is structured in form of, for instance, cases for its later storage.

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Traditional KM systems have received certain criticism, since employees are often overloaded with extra work, as they have to introduce information into the KMS and worry about updating this information. One proposal to avoid this extra burden was to add software agents to perform this task in place of the employees. Later, intelligent agent technology was also applied to other different activities, bringing several benefits to the knowledge management process.

The benefits of applying agent technology to knowledge management include distributed system architecture, easy interaction, resource management, reactivity to changes, interoperation between heterogeneous systems, and intelligent decision making. The set of knowledge management tasks or applications in which an agent can assist is very wide, for instance:

- To manage organizational memory, an example being the CoMMA project, (Gandon 2000) (Corporate Memory Management through Agents), which combines emergent technologies, allowing users to exploit an organizational memory.
- To support cooperative activities. For instance in (Wang, Reidar et al. 1999) the authors propose a multi-agent architecture to provide support to cooperative activities.
- To recommend. For instance in (Sung Kim 2004) a system to customize recommendations is described.
- To find experts. Some systems are used to help people find experts which/who can assist them in their daily work.
- To share knowledge. For instance in (Mercer and Greenberg 2001) a multi-agent system is proposed for knowledge sharing in a system designed to advise good programming practice.
- To manage mailing lists , or document classification (Moreale and Watt 2003).

These and other existing systems were often developed without considering how knowledge flows and what stages may foster these flows. Because of this, they often support only one knowledge task, without taking into account that knowledge management implies giving support to different process and activities. On the other hand, KM systems often focus on the technology, without taking into account fundamental problems that these kinds of systems are likely to support (Hahn and Subramani 2000).

c onclus Ion And future wor K

The main contributions of this paper are the design of knowledge cycle for developing KMS where the main functions that this kind of systems must support are described. Moreover, a multi-agent architecture is outlined to help KMS developers to implement these kinds of systems. The advantages of these contributions are:

- The model provides support to different activities: knowledge creation, storage/retrieval, transfer and application. All are activities which, according to the authors who specialize in evaluating KMS, should support this kind of system.
- The architecture is based on a KM life cycle that we have proposed for this end. Therefore, we try to avoid the lack of other architectures that are focused on the technology and forget the knowledge aspects.
- The architecture makes use of intelligent agents. This is a technique that have proved to be very convenient in knowledge management activities since it avoid one of the problems of some KMS such as overloading the employees with extra work instead of helping them during their daily work. Agents can carry out many tasks on behalf of users. Moreover, they act when they consider that it is necessary to do so without needing users' instructions. Another advantage of using agents is that they can collaborate with other agents already implemented to carry out concrete knowledge tasks. For instance obtaining information from the Internet or from e-mail. Thus, the development of KMS would be easier since only the basic agents of our model would have to be implemented and these could collaborate with other agents that have already been tested.

On the other hand, we are modelling the agents in a systematic way by using INGENIAS methodology whose meta-models help future developers to understand how the different agents work.

As future work we aim to compare the implementation of a KMS based on our proposal with developments using other architectures. Without any doubt this evaluation will help us to improve our proposal. On the other hand, we are also working on extending the model documentation with a more wide and detailed description of the possible techniques that could be used to implement each type of agent according to the main needs that organizations usually demand.

From a technological point of view, we are also studying JADEx in order to see how easy it would be to migrate to this new platform. The current prototype was implemented by using JADE (Java Agent Development Framework) since it is FIPA compliant and is currently one of the most widely used. Moreover, JADE has been successfully used in the development of other systems in the domain of knowledge management (Bergenti, Poggi et al. 2000; Gandon 2000).

Ac Knowledg Ment

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Chapter XX
Adopting the Grid Computing & Semantic Web Hybrid for Global Knowledge Sharing

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Abstr Act

The purpose of this chapter is to examine the requirements of Knowledge Management (KM) services deployment in a Semantic Grid environment. A wide range of literature on Grid Computing, Semantic Web, and KM have been reviewed, related, and interpreted. The benefits of the Semantic Web and the Grid Computing convergence have been investigated, enumerated and related to KM principles in a complete service model. Although the Grid Computing model significantly contributed to the shared resources, most of KM tools obstacles within the grid are to be resolved at the semantic and cultural levels more than at the physical or logical grid levels. The early results from academia, where grid computing still in testing phase, show a synergy and the potentiality of leveraging knowledge, especially from voluminous data, at a wider scale. However, the plethora of information produced in this environment will result in a serious information overload, unless proper standardization, automated relations, syndication, and validation techniques are developed.

Introduct Ion

Grid Computing is a significant transformation in the global computing which is expected to bring unprecedented benefits on leveraging of Knowledge Management (KM) processes and procedures to globalized levels. The essences of grid physical network are to continuously speed information flow through improved processing, storage, discovery, retrieval, acquisition, and sharing within expansive colossal social networks. Grid Computing synchronizes computer resource sharing and effective deployment, which help in faster assimilation, representation, and mobilization of knowledge. Grid Computing has shown a notable success, however, this success is still limited to scientists and researchers in the e-Science community. Consequently, this early implementation of the Grid Computing focuses on computational capabilities and pattern recognition, but very little has been achieved in the enterprise ecosystem relations and federated databases for sharing knowledge. As a result, the relationship between Grid Computing concepts and KM principles is still blurred. For instance, it is not obvious how Grid Computing can amalgamate collaborative machine semantics with human cognitive activities. The clarification of such complex relationship may qualify this intergalactic network to minimize difficulties in transferring tacit knowledge across communities for creating authentic global business ecosystem.

g r Id c o Mput Ing

In its historical progression computer network ameliorate to emulate social networks overtime. The mainframe, then client/server and presently the Grid Computing came as a result of this developmental succession. Cabbly (2004) reports that "IBM defines Grid Computing as a standards based application/resource sharing architecture that makes it possible for heterogeneous systems and applications to share, compute and storage resources transparently". Unlike traditional client-server architecture, Grid Computing activates dormant micro-processing power to perform parallel processes, and utilize massive storage facilities around the globe. However, constructing such network as its predecessor client/server is not trouble-free. De Roure et al. (2003) report that the traditional client-server model can be a performance bottleneck and a single point of failure, but it is still prevalent, because decentralization brings its own benefits.

To mitigate the risk of global operations catastrophes during climax computing demand, the grid offers better performance load balancing and fault tolerance through failover on a massive scale. The processing and storage determination is not required prior to the disaster, because they are inherently available in the system. The main benefits of Grid Computing for many companies will be the ability to integrate systems and to dynamically allocate resources, and manage risk. In addition, Grid Computing improves Return-On-Investment (ROI) through maximizing the performance/cost ratio and minimizing the Total Cost of Ownership (TCO). In conclusion, these features result in solving problems in less time with less cost and through using the exact same computing machinery, but with more power that is dynamically added.

s e MAnt Ic w eb

Berners-Lee (2001) the pre-eminent thinker of the Internet world, state that Semantic Web is not a separate Web, but an extension of the current one, in which information is given well-defined meaning, better enabling computers, and people to work in cooperation. In view of that, Daconta et al. (2003) report that Tim Berners-Lee has a two-part vision for the future of the Web. The first part is to make the Web a more collaborative medium. The second part is to make the Web understandable, and thus processable, by machines. This futuristic thinking found its way to reality, where Semantic Web Services contribution through XML protocols has been enriching the Web with outstanding collaborative features. The Web Services has been defined by Daconta et al. (2003) as software applications that can be discovered, described, and accessed based on XML and standard Web protocols over intranets, extranets, and the Internet.

XML is a specification for coding markup language that is appropriate for building data models. XML is not only application and platform independent, but it is human and machine-readable language. XML transformed the Internet from the level of human-to-machine communication to the level of machine-to-machine communication. Adams (2001) stated that XML is an important step towards offering efficient resource discovery on the Web, although it does not completely solve the problem. XML facilitates increased access to and description of the content contained within documents. The technology separates the intellectual content of a text from its surrounding structure, which means that information can be converted into a uniform structure. This capability is employed to improve indexing and searching criteria for the content management; however, XML itself is nothing more than a collection of tags on how information is structured for storage and search. In contrast to HTML, XML does not contribute to how information is presented. The capability of presenting a mixture of document format in an interoperable environment through the public grid (open grid architecture) is imperative since different organizations, even those sharing the same domain, have different ways of styling, classifying and interfacing their contents. This multiplicity makes it extremely complicated to present documents across the grid.

XML adds meaning and context awareness to the document sharing only when all parties understand the tag references or when ontology is adding clear specific meaning. This fits better into specific domain classification that narrow the epistemological spectrum, hence, the community concept is very critical to the success of such effort. In reference to information overload, Geldof (2004) reports that one of the main obstacles is that most of information in the Web is made for human interpretation, and is not evident for the agents that browse the Web. The Semantic Web is an effort to improve the current Web by making resources "machine-understandable", where the current Web resources do not support machine-understandable semantics.

SEMANTIC GRID EVOLUTION

The recent convergence of Grid Computing and semantic web in the Semantic Grid constitutes a promising platform for better data-information-knowledge continuum representation. De Roure et al. (2005) define the Semantic Grid as an extension of the current Grid in which information and services are given well-defined meaning, better enabling computers, and people to work in cooperation. Originally, the Grid Computing added the sharing of resources, while the semantic web added the sharing of information and knowledge. This convergence is enhanced by XML revolution which itself came as a result of advances in the computing power. XML needs an enormous processing power because it is a text-based rather than binary-based language (interpreted rather than compiled). In fact, the conversion happened in a broader scale as Friedman (2005) states that the world is flat because sometime in the late 1990s a whole set of technologies and political events converged--including the fall of the Berlin Wall, the rise of the Internet, the diffusion of the Windows operating system, the creation of a global fiber-optic network, and the creation of interoperable software applications, which made it very easy for people all over the world to work together--that leveled the playing field. It created a global platform that allowed more people to plug and play, collaborate and compete, share knowledge and share work, than anything we have ever seen in the history of the world.

Semantic Web and grid networks objectives are inextricably interrelated, and the Semantic Grid is the resultant synergetic effect of the two. The larger the grid, the more synergetic effects will occur as Robert Metcalfe posits that: the value of a communications network is proportional to the square of the size of the network (n^2). Another advantage of such network is its capability of ensuring highest standards for business continuity through zero downtime of the network. Daconta et al. (2003) state that the marriage of Grid Computing and Web Services may bring some sort of stability to dynamic environments. When a Web Service shuts down, the network grid should be able to route a request to a substitute Web Service within the domain of that specific network grid. Web Services do not offer Graphical User Interface (GUI), but could use a distributed number of machines to talk to each other and share their processing power. This is where the coordination and the power of machine-to-machine at the application level comes into play.

Most of the mature Semantic Grid initiatives are deployed for e-Science purposes, such as myGrid, CoreGRID and CoAKTinG. MyGrid is a collaborative e-Science project between UK universities. The CoreGRID Network of Excellence (NoE) aims at the progressing research knowledge on the grids, while CoAKTinG project acts as a gird portal. In addition, there are many promising projects from the Global Grid Forum (GGF) concerning the Open Grid Services Architecture WG (OGSA-WG).

Recently, some semantic grid projects have emerged addressing areas in the industry and services such as ARGUGRID, InteliGrid, SIMDAT, and The Biomedical Informatics Research Network (BIRN). ARGUGRID project adopts InforSense® integrative analytics technology to develop collaborative service oriented computing using argumentation technology. InteliGrid provides the interoperability and the integration of complex industry infrastructure. SIMDAT grid is used for team collaboration in federated industrial product development. And the BIRN is employed for sharing clinical research and complex diagnosis between medical communities in a widely distributed geographical area.

KM r eQu Ire Ments Model

KM solutions requirements are not inherently parts of the Grid Computing architecture, but all are added value to utilize this networked resources to leverage knowledge for competitive advantage. Unsurprisingly, the mechanisms for these requirements exist in the market today; but not specifically deployed at the grid level. Luckily most of the grid applications are designed with information sharing in mind; this qualifies the existing grid applications for KM deployments with minor modifications.

Fox (2005) states that given the enormous multiplication of the quantity of content now available in the digital world, the need to connect ideas via commonly understood

Semantic Grid Computing presents unprecedented opportunities for knowledge management discipline to thrive. This contribution is expected to be in the areas of the information volume and the speed of the knowledge processing and distribution. Daconta et al. (2003) define semantic network as a structure for the expression of semantics, or a node-and-link representation of knowledge constructs and their relationships. In addition, distributed Web Services can create large collaborating groups that can solve problems on a massive scale. Consequently, Semantic Grid can assist in promoting system thinking because of the increased amount of information through sharing of information patterns and relationships at a wider range. Furthermore, the context switch that results from the provision of completely different knowledge within the grid computing may lead to paradigm shifts that lead to innovations. This can be attributed to the speedy and easy access of disparate knowledge ecosystems. In his fifth discipline conceptual framework, Senge (1990) states that today system thinking is needed more than ever because we are becoming overwhelmed by complexity. Perhaps for the first time in history, humankind has the capacity to create far more information than anyone can absorb, to foster far greater interdependency than anyone can manage, and to accelerate change to a faster than anyone's ability to keep pace.

There are many outstanding mechanisms and protocols of Semantic Grid that contributed and expected to revolutionize the way we carry out knowledge activities across geographies, domains, and time zones. Table 1 shows knowledge management main services and mechanisms that are required in Semantic Grid environment. Figure 1 depicts the model of strata of elements that satisfies the requirements of knowledge management services within the grid environment.

Each layer contributes a package of services for knowledge management:

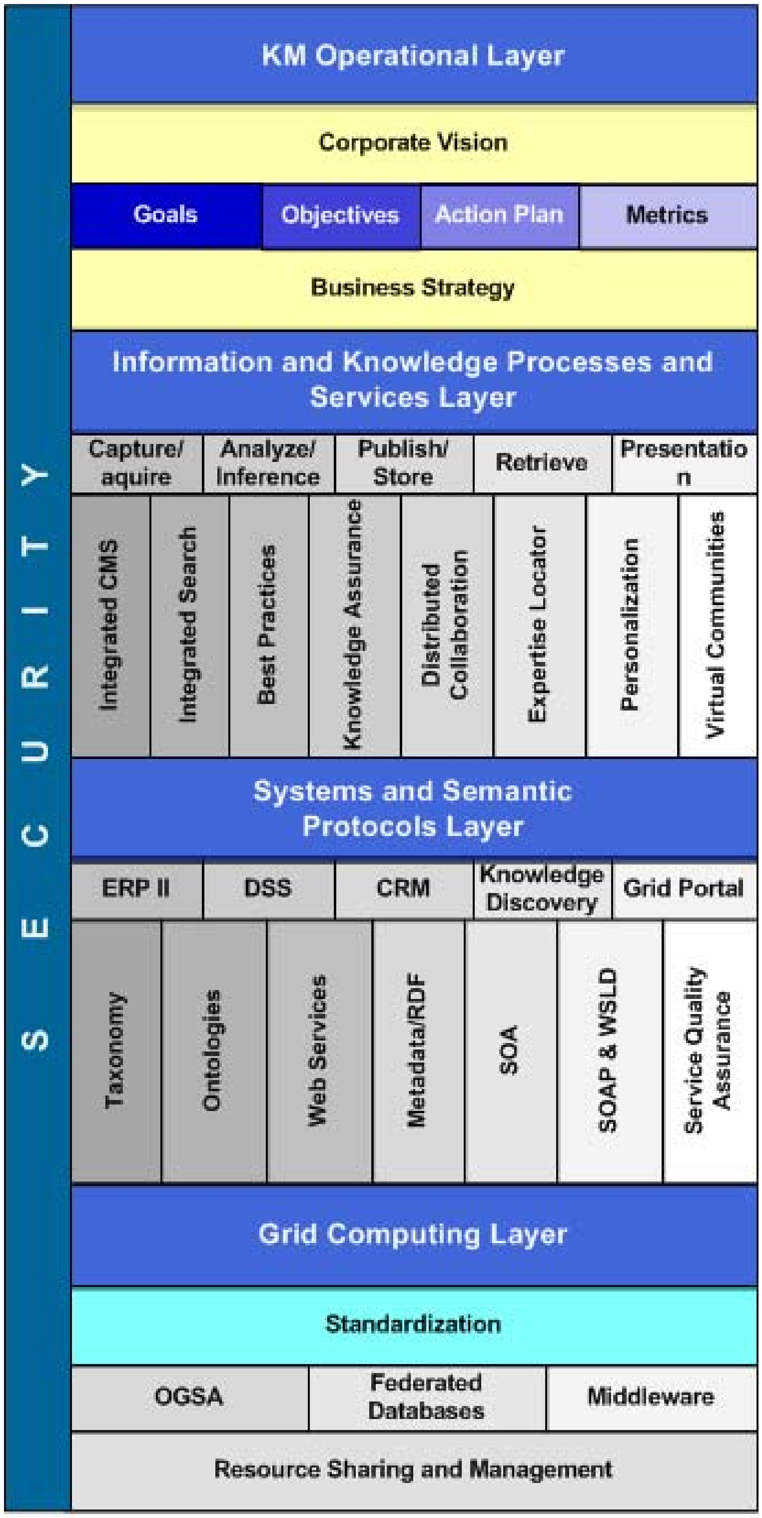
First Layer: Grid Computing

The lowest layer consists of major components in the Grid Computing architecture that assists upper levels in providing the needed KM services.

- **Open Grid Services Architecture (OGSA):** Defined by Global Grid Forum (GGF) as the merger of Grid Computing and Web Service standards Foster et al. (2002). OGSA adopted most of XML protocols to provide service oriented grid standards and contributed to the convergence of the Semantic Grid. The integrative nature of OGSA made the database federation possible. Foster et al. (2005) report that OGSA data services allow the creation of a virtual data resource that incorporates data from multiple data sources that are created and maintained separately. When a client queries the virtual resource, the query is compiled into sub-queries and operations that extract the appropriate information from the underlying federated resources and return it in the appropriate format
- **Federated database:** is a monolithic database that coalesces domains with the same subject matter from different communities. In federated databases data and information stores permanently in different databases and retrieved temporarily by one server of these databases for data manipulation then return to its original machines storage. Raman et al. (2003) state that the federated DBMS provides two kinds of virtualizations to users:
  - o Heterogeneity transparency, via the masking of the data formats at each source, the hardware and software they run on, how data is accessed at each source, and even about how data stored in these sources is modeled and managed.
  - o Distribution transparency, via the masking of the distributed nature of the sources and the network communication needed to access them.

  Accessing the member databases is not the problem. However, leveraging the databases for the improvement of the query results is the crux of the issue. Hence, the success of federated databases depends on the standardization of the metadata in each of the contributing databases. The architecture of federated database involves the middleware.
- **Middleware:** Provides the main grid functionality for knowledge discovery in a seamlessly agile virtual organization. Middleware collects information from all configuration items distributed within the specific grid domain. It consolidates these data and publishes them to increase their

Figure 1. Knowledge services strata for transformation of e-science grid computing into e-commerce Semantic grid



visibility for interfacing purposes. Middleware resembles the knowledge broker in real life; with exception of the fact that it coordinates all the available resources used by one instance into one virtual machine. This will achieve not only interoperability, but it will add the meaning to information through Semantic Web Services

- **Resource Sharing and Standardization** for the configuration management across the Semantic Grid domains is critical for consolidating and distributing information from all participating nodes.

second layer: systems and semantic protocols

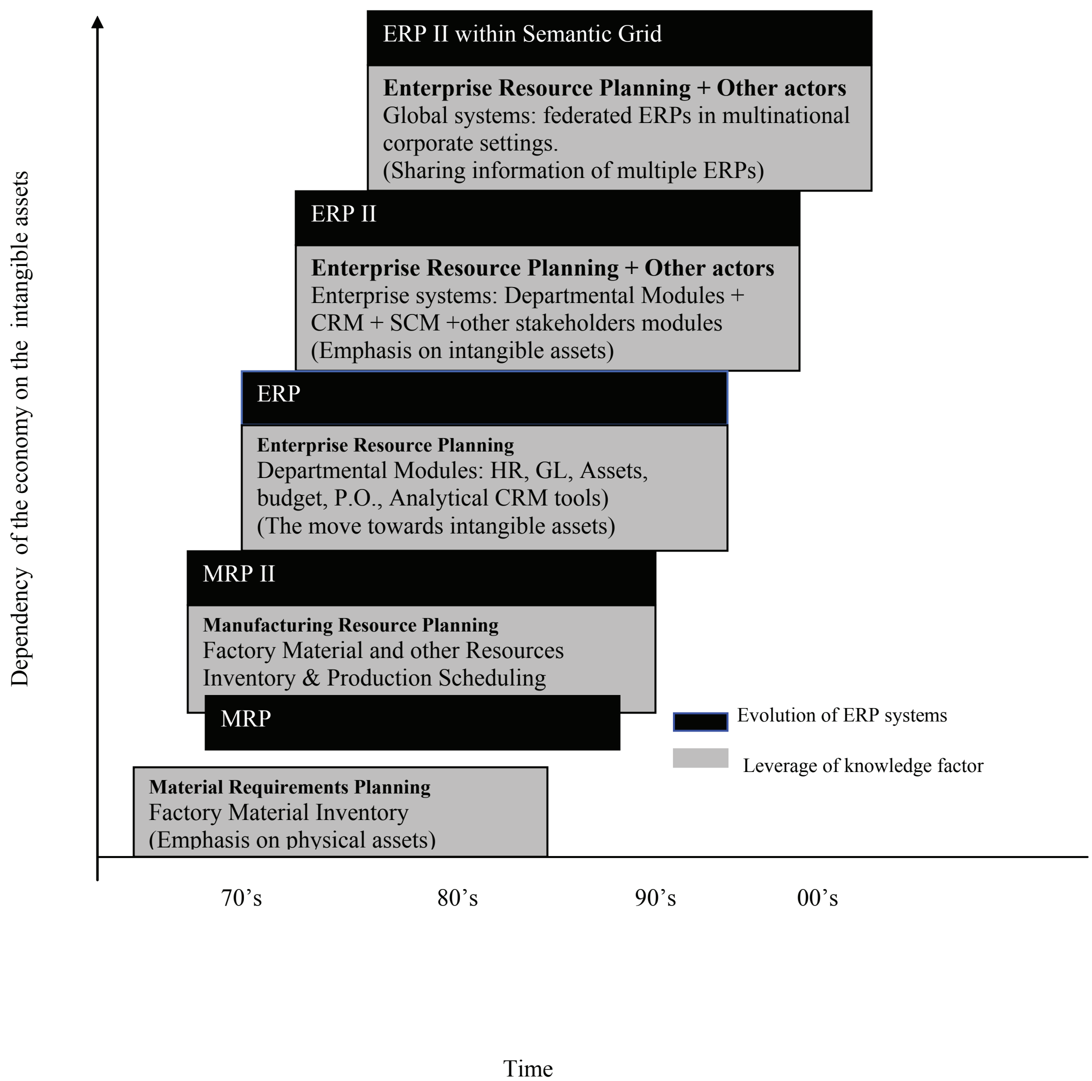
The second layer consists of the most popular systems and protocols that contribute to the delivery of KM services within the Grid environment. The second layer provides various capabilities of semantic services that are necessary for KM to excel in the grid environment. This layer is divided into two sub-layers:

- **Systems sub-layer:** Consists of enterprise systems such as the next generation of ERP II which constitutes a major shift towards KM at global levels Mohamed (2002) as shown in Figure 2.

The systems sub-layer consists of other knowledge discovery systems such as Decision Support Systems (DSS), Customer Relationship Management (CRM), data warehousing, data mining, and the Grid Portal. Grid Portal allows users to access and manipulate resource information obtained and stored on remote federated databases De Roure et al. (2003). This portal can also be personalized which makes the grid portals the appropriate access points for grid high performance resources.

- **Protocols sub-layer:** This sub-layer consists of important protocols that transformed the Grid Computing environment to semantic grid where knowledge can be transformed as it transfer through the grid nodes. This layer is critical to the success of KM in the Grid and it consists of the following elements:
    - **Taxonomy:** The taxonomy results in mapping information into predefined classes, contains basic intrinsic child-parent relations. Classification itself is non-objective and has neither standards nor specifications. It depends on how individuals understand and relate information about objects in the real world. Accordingly, each organization or even unit within the same organization may has its own classification hierarchy and uses its own vocabulary. Hence, for each organization to be able to exchange information with other organizations, it must understand their classification scheme(s). In many environments this may be impractical and extremely difficult even in domains within one organization, let alone multiple geographically separated organizations in a grid environment. XML schema can be used as a source of standardization within the domain. XML schema defined by W3c (2001b) as "XML Schemas express shared vocabularies and allow machines to carry out rules made by human. They provide a means for defining the structure, content, and semantics of XML documents". In addition, the problem of unstandardized classification can be addressed through Document Type Definition (DTD), which is an ontology-driven searching criterion that offers high degree of domain-specific semantic terms and knowable concepts.

Figure 2. The Evolution of ERP and the Leverage of Intangible assets in Response to the Economy and Technology Advancesment



- **Ontologies:** Ontology is a set of shared concepts and relationships commonly conceptualized and interpreted within specific domain. In other words, ontologies assist in developing the general conceptualization of the content. In the Semantic Grid environment, this will simplify the retrieval, improve the search precision, and promote synthesis of knowledge. Semantic search depends not only on the keywords or tags, but also on the concept of the search. Semantic mapping (cognitive mapping) is particularly important in grid environment as stated by Daconta et al. (2003) that semantic mapping is a critical issue for information technologies considering the use of multiple knowledge sources. The magnitude of ontology hermeneutical power depends on how close it expresses tacit knowledge. In fact, ontology offers search capabilities that are based on meanings and relationships more than static keywords. The value of ontology is expressed by Daconta et al. (2003) through his explanation of the concept of machine-interpretable ontology as, semantics of the model that is interpretable by the machine; in other words, the computer and its software can interact with the semantic model directly i.e. without direct human involvement. In the future, this will move the machines up to human level instead of the opposite, as it is the norm in the current binary technology.

- **Web services** make sharing of data, processes, business logic available for use. KM requirements for the Semantic Grid can be represented within the sphere of grid services and semantic Web Services. W3c (2002) defined Web Services as a software application whose interface and binding are capable of being defined, described and discovered by XML artifacts and supports direct interactions with other software applications using XML based messages via Internet-based protocols.
- **Metadata and RDF:** XML is used in encoding metadata and it offers semantic dimensions for document descriptive parameters. In Grid Computing, Atkinson et al. (2003) found that metadata is essential to the development of Grid services, because it enables data operations to be abstracted to a sufficient degree that services can be created and made reusable. This facility makes it possible to access and manipulate data content without knowing where it is physically located, or how it is structured. Resource Description Framework (RDF) can be deployed in Semantic Grid environment to form rich semantic interrelations in metadata. This will offer more meaning to the document and increase the possibility of its sharing. Due to the semantic relations and unified vocabulary, both RDF and metadata may work toward just-in-time content processing at a global scale
- **SOA:** Service-oriented architecture is vital in the realm of Semantic Grid because there is a high need for reusability of services, agents, and objects. Although SOA already played a significant role in Semantic Grid, the service-oriented knowledge architecture that assists in deploying the concepts of knowledge management at the industrial level is not mature yet. This can be attributed to the fact that the architecture of the Semantic grid is not materialized for enabling virtual organization and virtual communities' usage. Nevertheless, a comprehensive framework based on semantic web protocols and Grid Computing new techniques may be adopted in the near future. SOA was originally designed for a client/server environment, but its architecture and functionality makes it suitable for the Grid Computing. Nitais & Schulte (2003) state that SOA differs from the general client/server

model in its definitive emphasis on loose coupling between software components, and in its use of separately standing interface. The fundamental intent of SOA is the nonintrusive reuse of software services in new runtime context. Valdes (2004) reports that when adopting SOA architecture the frequency of data transfer will greatly increase because communication that formerly occurred inside a machine boundary will cross machine and LAN/WAN boundaries. The volume of data transfer will increase because Web Services protocols are text-based rather than binary and encoded in XML, which is more verbose than other text-based formats by up to a factor of ten.

- **SOAP & WSDL:** The Simple Object Access Protocol (SOAP) and Web Service Description Language (WSDL) formed principal protocols on which Web Services are built. WSDL is descriptive language that offers information about the services, their location, role, and interface. SOAP provides a simple mechanism for exchanging structured and typed information between peers in a decentralized, distributed environment using XML W3c (2000). SOAP acts as an envelope that contains XML messages which travel via HTTP between web services. While WSDL is an XML format for describing network services as a set of endpoints operating on messages containing either document-oriented or procedure-oriented information W3c (2001a). The two protocols can be employed in application to application communication i.e. metadata and ontologies can be accessed through WSDL.
- **Service Quality Assurance:** In the current client/server architecture, both information and machines are underutilized. Semantic web and its associated interoperability is one-step toward machines that gain experience and intelligently uses it to furnish seamless integration. In the grid environment, for interoperability and inter-enterprise communication i.e. Business-to-Business (B2B), companies must publish themselves into UDDI registry, described their interfaces in WSDL, and enables its applications with SOAP. Therefore, it is imperative to make the middleware available for knowledge management services that perform knowledge synthesis and targeted dissemination.

t hird l ayer: Information and Knowledge s ervices

The third layer provides the platform for the knowledge continuum which includes the transformation of data to information and finally to knowledge. The transformation of knowledge in this layer can be represented in Figure 3, which depicts the relationship between social and physical networks space and the status of the cognosphere at each knowledge functional unit. Yolles (2000) refers to this sort of creation as a coalesce process, which converts information to knowledge throughout the distillation that occurs through the renewal of patterns of meaning that constitutes knowledge. The demand for knowledge is the driving force for its extraction from information as stated by Lang (2001) that the shift from information to knowledge means that the awareness of the value of knowledge in most firms is exceeding their ability to extract it from the goods and services in which it is embedded, and to create new knowledge. Skyttner (1998) concluded that pure information, like pure knowledge, signifies nothing at all; it is the context in which it is employed that gives it existence and value. Information becomes knowledge only when we decide to put it into use. Without this transformation, stored information is nothing more than physical or electronic signs.

The transformation from data to information to knowledge involves the addition of context. Abowd & Dey (1999) define context as any information that can be used to characterize the situation of an entity. A system is context-aware, if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task. Schilit & Theimer (1994) describe context as location, identities of nearby people and objects, and changes to those objects. While Hull et al. (1997) considered context to be aspects of the current situation in a certain environment. The importance of context is not only limited to the differentiation between data, information and knowledge, but it also contributes to the decision-making process, problem solving techniques and sharing of tacit knowledge. Data-information-knowledge continuum contextuality is expressed by Davenport & Prusak (1998) as information is "data transformed by the value-adding processes of contextualization, categorization, calculation, correction and condensation".

This layer consists of two prominent sub-layers:

- **KM processes sub-layer:** The main theme of this layer in Semantic Grid is to determine the best way to develop knowledge life cycle that captures, coalesces, synthesizes, and disseminates domestic and exotic knowledge within Semantic Grid environment.
- **Services Sub-layer:** The prominent KM services and their associate tools and mechanisms for fulfilling KM processes sub-layer are depicted in Table 1.

f ourth l ayer: KM o perational

The fourth layer is where the KM within the Semantic Gird shows the business benefits and the competitive advantage. The adoption of service-oriented grid architecture in business may significantly shift the market from competition

Figure 3. The role of physical and social networks in knowledge transformation through the continuum

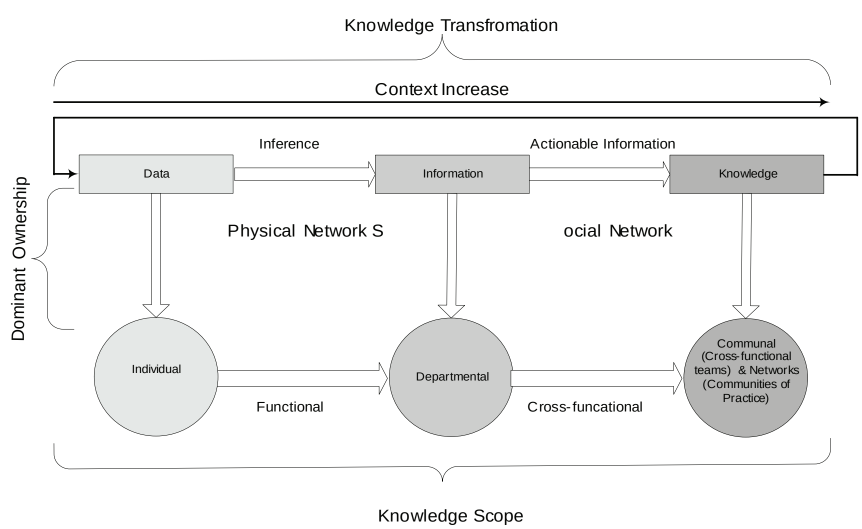


Table 1. Examples of KM Major Services and the Possible Associated Mechanisms in Semantic Grid Environment

Services	Description	Possible Mechanisms
Content Management	This service includes sub-services such as library services[1], rendition[2] management, Workflow[3] etc.	Distribution and Discovery – soft agents Syndication and storage – metadata Locking, Federated databases, Storage Request Broker (SRB)
Integrated Search	Specific domain shared terabytes of pooled storages including coopetivite sharing contribution at SAN levels. Standard taxonomy, domain ontology and Namespace[4] can be used for vocabulary standardization in RDF. Example is the domain best practices services across the participating grids.	Search engines based on natural languages and semantic relations. Description logic langues of web services such as OWL, DAML+OIL, Knowledge Interchange Format (KIF), RDF, XQuery, GridFTP. Other knowledge specific mechanisms such as Hierarchical Distributed Dynamic Indexing (HDDI), Knowledge Query Language (KQL), Unstructured Query Language (UQL)
Knowledge Assurance	This consists of information security and other KM procedures that assure the knowledge such as intellectual right protection etc.	Data security, Topic Maps, WS-security, WS-SecureConversation, WS-Trust and WS-Federation. Self-certifying File System (SFS)[5]
Collaboration	Remote collaboration for specific domains sharing computing resources including federated databases. For cognitive workflow grid applications must deal with the cognosphere between metadata and ontology. Virtual Communities of Practice.	Web services orchestration[6],. The CoAKTinG (Collaborative Advanced Knowledge Technologies in the Grid)[7]
Expertise Locator	Profile fetching in a common registry for expertise in the specified area.	Expertise space , Personalization, LDAPs, NDSs etc.

to coopetition where proprietary knowledge dissemination occurs at a larger scale. Firms within the same domain can cooperate regardless of their geographical location. This will allow KM initiatives effects to extend beyond the enterprise boundaries. However, for this objective to be satisfied the organization possesses a learning organization vision i.e. to link between intellectual capital and business strategy. In such organization, learning is the principal futuristic driver for business goals and objectives. The hosting of KM initiatives within Semantic Grid will encourage various forms of networking among employees; hence, it may propel the organization towards fulfilling its objectives through implanting knowledge culture within its environment.

t he s ecurity c ontinuum

Network and computer security sub-layer covered the first three layers, while the security measures for the fourth layer depends on other human activities such as proper sharing, business trust, intellectual property rights etc. Without security-aware KM applications, knowledge in the Grid can be subjected to considerable compromises including theft and unauthorized changes. At the Grid level Foster et al. (2005) argue that obtaining application programs and deploying them into a Grid system may require authentication and authorization. Also sharing of resources by users requires some kind of isolation mechanism. In addition, standard secure mechanisms are required which can be deployed to protect Grid systems while supporting safe resource sharing across administrative domains.

Meder et al. (2004) report that, in 1997 the Globus Project introduced the Grid Security Infrastructure (GSI), an implementation of a security mechanism for Grid computing that uses the Generic Security Services Application Program Interface (GSSAPI) standard between hosts and clients. This implementation uses public key protocols for use in programming Grid applications. On the other hand, Moore & Merzky (2003) suggested the use of the Grid Security Infrastructure (GSI) to authenticate users to the logical name space, and to authenticate servers to other servers within a federated architecture. In general, the Grid security architecture is compiled and by Globus (2006) in security tools that are concerned with establishing the identity of users or services (authentication), protecting communications, and determining who is allowed to perform what actions (authorization), as well as with supporting functions such as managing users' credentials and maintaining group membership information. Furthermore, across domain security can be handled through authentication transparency, Moore & Merzky (2003) define authentication transparency as the ability to create a single sign-on environment for authenticating use of resources in multiple administrative domains.

It is not the intention of this article to advocate any security practice or protocol to be deployed for any specific KM application in the Semantic Grid environment. There are miscellanea of security technologies that can be employed in such distributed environment such as Self-certifying File System (SFS), GridFTP security, Semantic Grid Security protocols etc. Allcock et al. (2003) report that GridFTP was designed with security in mind from the start and was, in fact, the driving force that started this effort. The Semantic Grid security protocols include (WS-security, WS-SecureConversation, WS-Trust and WS-Federation). WS-Security plays a major role in sharing knowledge, Atkinson et al. (2002) concluded that WS-Security describes enhancements to SOAP messaging to provide quality of protection through message integrity, message confidentiality, and single message authentication. These mechanisms can be used to accommodate a wide variety of security models and encryption technologies.

Argonne et al. (2004) argued that in open Grid Service Architecture flexible environment, resources will over time be used for multiple content titles. Therefore, trust has to be built on the side of the content providers that such a dynamic environment will not interfere with the goal of consistent user experience. Proper isolation between content offerings also has to be ensured. This level of isolation has to be ensured by the infrastructure security.

At the KM operational layer, security measures depend on human activities and relations. Sharing knowledge across time and space is the essence of KM systems. Furthermore, knowledge does not obey the law of diminishing returns i.e. the more sharing of knowledge the higher likelihood that there would be more return from that knowledge and the more insight developed into it. However, when there is a need for knowledge protection the more people that are aware of that knowledge the more vulnerable the asset would be. It is obvious that there is a conflict of interest between knowledge sharing and the knowledge assurance or information security. Knowledge can be considered as a relationship and sharing is a natural outcome of interpersonal relationships, formal and informal networks. The degree of sharing is determined by many intermingling organization, social, political and economical factors.

The authors believe that there is a wide range of grey area between sharing and hoadring which entails the categorization of sharing within the grid open environment into categories such as:

- **Domestic sharing:** Knowledge for internal use of the firm only i.e. closed-loop. This knowledge category should not be stored in any of the Grid nodes.
- **Supportive sharing:** Knowledge sharing within the business value network which is limited by the in-house and other partner's usage such as suppliers and customers.
- **Domain sharing:** Knowledge is shared within certain areas with standardized vocabulary, concepts, and relations such as scientific group collaborating in single field. In business this can also be represented by communities of practice, communities of interest etc. but collaboration in one particular field is critical in this case.
- **Collaborative sharing:** Sharing for mutual benefit such as sharing with strategic partners and the business communities at large.
- **Coopetitive sharing:** Sharing of knowledge with other companies that compete and cooperate. There is no room for absolute competitive intelligence in the grid. However, key competitive data may not be disclosed i.e. developing decision support system based on competitive intelligence, which can be limited to domestic sharing.

GAPS AND CHALLENGES

Most of KM tools obstacles within the grid are to be resolved at the semantic and cultural levels more than at the physical or logical grid layers. In general, challenges facing the new KM itself are related to organizations as social constructs where knowledge embedded in human behavior and where knowledge production activities resulted in serious problems such as information overload, knowledge irrelevancy, knowledge leakage, and vulnerability. The seriousness of loosing knowledge is mainly attributed to its true value being compromised. This value results from the additions of proprietary contextual strata during the process of knowledge production from data. By extension, this intense context augmentation makes knowledge a super set of information and that makes the loss of knowledge more serious than the loss of information. In the business world, this knowledge value is protected through competitive intelligence practices and intellectual properties.

With the current plethora of information in the network, without developing new standards for narrowing down the search results the grid will lead to information Overload. Information explosion is one of the challenges that face the grid, where there is a move of voluminous data and documents at global levels. There will be a high need not only on the search capabilities, but also on methods of developing patterns, syndication and validation.

Other Semantic Grid most difficult obstacles to overcome are:

- Standardization of domain specific metadata across the globe using standards such as Resource Description Framework (RDF) in federated databases.
- Replacing competition with coopetition in the market, and the mobilization of knowledge from the academia to the industry.
- Resolve the conflict between global collaboration versus intellectual property rights and international patents.

The Future Vision

Looking at Figure 3 we may find a clear distinction between the role and capabilities of physical network and the human network. This distinction is becoming more blurred by the introduction of the semantics into the equation. The convergence between the machine and the human thinking will be reflected in better extraction of knowledge from information which may result in minimization of information overloading through better controlled transformations using "gridified" semantics and ontologies. In fact, we are in a verge of dynamic adaptive convergence model for semantic web and Grid Computing. And there is a need for machine learning algorithms, in which not only human can think and work collaboratively, computers must follow suit.

The Bottom Line

To bridge the research-practice gap and to enhance productivity for better competitive advantage organizations must move fast into this arena with their knowledge and information needs. The authors call for Semantic Grid standardization initiatives to consider the conceptual framework and requirements of KM in their efforts. Due to the exponential increase in the amount of information, Grid Computing will put the world on the verge of information danger, unless dealt with at the knowledge levels. On the other hand, data storage capabilities increased at the same rate, but this is not the solution because it results in more information overload and massive amount of data with no apparent progress in knowledge extraction mechanisms.

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Endnotes

1. Check in/out of documents
2. Create the document in different format
3. Document authoring, review, approval, publishing and distribution processes
4. XML Namespaces, which is used for standardizing and avoidance of the conflict in the content tagging and naming of elements and attributes of XML. This will facilitate the work of metadata across the domain in the grid environment. In addition, the structure of the metadata itself and the description for each of the services necessitate the use of KM terminology for improved search, discovery, and selection performance.
5. SFS is a global network file system with decentralized control where documents can be shared with anyone anywhere.
6. Communication between different web services
7. The CoAKTinG project objective is to develop integrated collaborative spaces in the Grid. It consists of tools such as presence notification, instant messaging, group memory and meetings. These applications are still limited to e-Science domain.

Chapter XXI
The Effect of Knowledge Process Capabilities and Knowledge Infrastructure Capabilities on Strategy Implementation Effectiveness

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Abstr Act

The creation and the use of knowledge have increasingly been regarded as important issues for management. A wide range of studies have investigated this topic during the past decade. Notwithstanding these contributions, very little systematic attention has been paid to the linkages between knowledge capabilities and strategy implementation. Drawing from knowledge capabilities theory and strategy implementation literature, two aspects of knowledge capabilities in an organization and their effect on strategy implementation effectiveness are investigated; knowledge process capabilities (KPC) and knowledge infrastructure capabilities (KIC). This study hypothesized that KPC affects strategy implementation effectiveness (SIE) and that KPC affects KIC. The third hypothesis proposed the effect of KIC on SIE by examining the mediating role played by KIC in linking KPC and SIE. 1,321 middle-managers were sent questionnaires via electronic mail and 162 were returned. The findings indicated the presence

of a mediation effect of KIC on the relationship between KPC and SIE. This study provides guidelines for middle-managers to better understand how to develop activities of KPC and KIC for SIE. It is hoped that the results of this study will enhance our understanding of the strategic importance of knowledge in an organization, especially in the area of strategy implementation.

Introduct Ion

Organizations improve their performances by enhancing current capabilities or developing new capabilities. This capability is complicated and believed to coincide closely with organizational knowledge that can be conceptualized in terms of digested information embedded within organizational routines and processes (Myers, 1996; Davenport & Prusak, 1998; Eisenhardt & Martin, 2000). In order to compete effectively, firms must leverage their existing knowledge and create new knowledge in their organizations (Grant, 1996). To achieve these effects, it is imperative for firms to develop and to utilize knowledge capability. Knowledge capability is important because it enables knowledge to flow across organizational routines, thus facilitating knowledge utilization and creation (Allard, 2003; Helfat & Raubitschek, 2003). It is a belief that knowledge can be conceptualized in terms of digested information embedded within organizational routines and processes. Nevertheless, there are few empirical studies that investigate the relationship between organizational knowledge and strategy implementation.

A review of the relevant literature suggests an open interesting area between general strategy process and KBV. The area of strategy implementation is open to investigation. The area mainly questions how to effectively manage and translate firm strategy into action. New contents and constraints in the knowledge economy pose challenges to implementing strategies. Some organizations have to reengineer organizational processes and restructure organizational units by delayering the number of hierarchical levels or shorten the distance between top management and operational management (Keidal, 1994). Some organizations use information technology instead of humans to monitor and control activities directly (Leonard-Barton, 1995). The traditional strategy process has to adapt to the dynamic environment of the knowledge economy.

Since strategy implementation involves all activities in organizations (Beer, 1996; Nobel, 1999; Gadiesh & Gilbert, 2001) and knowledge capability is an important organizational capability, this study argues that these two areas are linked and support each other. Explicitly, from a review of the literature, little systemic attention has been given to the linkage between knowledge capabilities and the effectiveness of strategy implementation. This study proposes to examine that linkage. Middle-managers were selected as respondents because they are the linkage between the two ends (Floyd & Wooldridge, 2000; Huber & Power, 1985; Nonaka, 1991). At the front-line, middle-managers are responsible for the strategy implementation by mixing and matching organizational capabilities and resources for strategy implementation effectiveness. Furthermore, middle-managers play important roles by integrating both vertical and horizontal knowledge flow (Nonaka, 1991). Their integrations rely on in-depth experiences and situation-specific knowledge. The result of this study aims to benefit the strategy field in bringing about a better understanding concerning the relationship between knowledge capability and strategy implementation effectiveness.

This study addresses an important question: "How do knowledge capabilities affect strategy implementation?" It argues and demonstrates that knowledge capability influences the effectiveness of strategy implementation. Two kinds of knowledge capabilities are explored: Knowledge Process Capabilities (KPC) is the capability of a process to transform knowledge that is stored in the form of standard operating procedures and routines throughout the firm into valuable organizational knowledge, experience, and expertise and Knowledge Infrastructure Capabilities (KIC) is the capability to manage infrastructures in the organization in order to support and facilitate organizational activities. These two knowledge constructs are believed to contribute to Strategy Implementation Effectiveness (SIE) is described by the fulfillment of strategy implementation tasks (Ramanujam & Venkatraman, 1987).

This study argues that KPC are an antecedent of KIC. Also, KIC supports, assists, and facilitate SIE. To support the argument, this study employs a mediating model by positioning KIC as mediator between KPC and SIE. The study empirically demonstrates that KIC fully mediate the relationship between KPC and SIE. The demonstration involves two statistical steps. First, the study examines the positive influence of KPC over SIE when KIC is absented. Second, the study attempts to prove that when KIC is present, the positive influence does not hold. Furthermore, the positive influence from KPC to KIC and the positive influence from KIC to SIE are examined.

The contribution of the study is to expand the knowledge of the fields of strategic and knowledge management by providing empirical evidence of the effects of KPC and KIC on SIE. The findings of this study are expected to shed light on linkages between knowledge capabilities and strategy implementation effectiveness in the organization. Furthermore, contributions of this study could potentially go to other fields, such as human resources and management information systems. Not only in the academic field but also in the practical world, the results of this study potentially contribute to the effectiveness of middle-managers in strategy implementation. Consequently, when good strategies are more successfully implemented, improvements in business' bottom line are more likely.

theoret Ic Al fr AMewor K And hypotheses

Organizational capability has its root in the resource-based theory of the firm, whose main argument is that a firm is a bundle of heterogeneous resources and capabilities, which support competitive advantage. Organizational capabilities concern an organization's ability to combine different types of resources; especially, firm-specific knowledge enables employees of firms to create new resources. Kogut and Zander (1992) mention that organizational capabilities are a set of specific and identifiable processes that resemble a concept of routines consisting of specific strategic and organizational processes that are complicated and depend on existing knowledge. Nelson and Winter (1982) argue that a great deal of knowledge is stored in the form of standard operating procedure and routines throughout the firm that are embedded in employees. Grant (1996) also suggests that knowledge is integrated in organizational capabilities, embedded in employees. They point out that knowledge is shared across products and is linked to activities within the organization and also depend on social interaction among individuals who share and combine their knowledge to create new resources, bringing effectiveness to an organization.

It was mentioned that strategy implementation is an antecedent of organizational effectiveness (Floyd & Wooldridge, 2000) involving all types of activities in the organization (Gadiesh & Gilbert, 2001). Many innovative strategies have failed because they could not be implemented. Leonard-Barton (1995) suggests that strategy implementation involves knowledge embodied in employees and related to communication patterns.

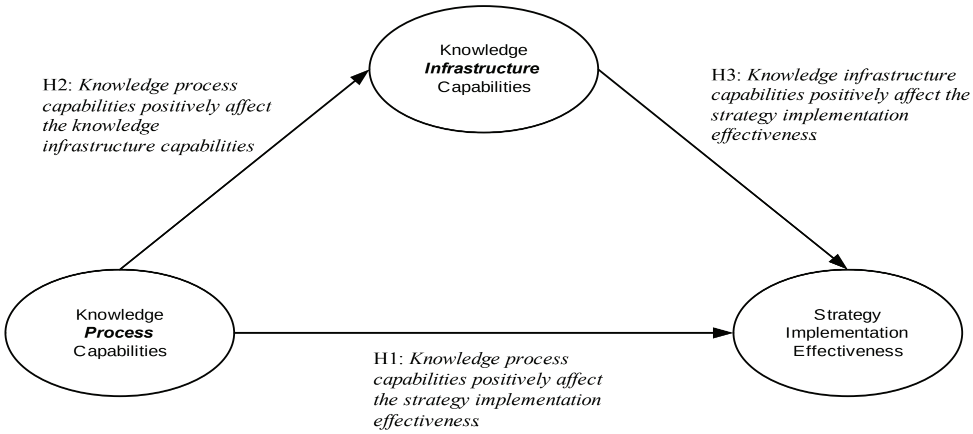
The success of strategy implementation depends on leadership and implementation style as well as the communication and interaction process of employees (Argyris, 1991). According to Nobel (1999), strategy implementation is viewed as interpersonal process related to understanding among and commitment among co-workers. Digman (2006) mentions that top managements have to build organizational capability to carry out their strategies. In organizations, strategy usually emerges from top management and is implemented by organizational members. Top managements have to communicate their vision, strategy, and knowledge to organizational members. Also, they have to encourage employees to utilize existing knowledge and to create new knowledge to benefit SIE. Middle managers, who are at the center of the organizational capabilities development and strategy implementation, have to create social interactions by communicating, refining, executing and interacting among organizational members in order to achieve SIE (Floyd & Wooldridge, 2000; Nonaka, et al., 2001).

In order to compete effectively, organizations must leverage their existing knowledge and explore new knowledge by developing knowledge management (KM) processes to create the ability to use knowledge and to develop SIE. The ability of employees to combine, transfer and create knowledge (including ability to learn) is fundamental to KM and SIE in an organization. It can be implied that KM increases organizational effectiveness and enhances organizational capabilities. Jennex and Olfman (2005) mention that KM enhances decision making effectiveness by improving the ability of decision makers to find and retrieve appropriate knowledge. They propose a KM success model based on Delone and Mclean (2003). Three main parts of their KM success model consist of system quality, knowledge quality, and service quality. Jennex and Olfman view the Knowledge Management System (KMS) as a system that includes Information Technology (IT) components, users, and processes that use and generate knowledge. They also view knowledge quality in the process of linkage and richness of knowledge and service quality in a view of management support. Gold, Malholtra, and Segras (2001) studied the relationship of KM and organizational effectiveness. They studied the effect of KPC and KIC on organizational effectiveness. They believe that capabilities to manipulate and to manage knowledge that build on the organization's members enable a firm to expand organizational ability and strategy initiatives that benefit organizational effectiveness. Nonaka, et al (2004) state that knowledge creation succession depends on "Ba," or physical and environment factors supporting the process. Even though KM is defined in many different constructs, most of the KM constructs are proposed as KM processes and KM infrastructures. Furthermore, two capabilities of KM that knowledge scholars believe benefit organizational effectiveness capabilities in KM process and capabilities in dealing with infrastructures that support and facilitate the process (Gold et al., 2001; Jennex and Olfman, 2005). Therefore, in order to simplify the area of KM, this study proposes to break the analysis of KM into two main constructs—KPC and KIC.

Causal Model of the Study

Figure 1 shows the causal model of this study. Three hypotheses were proposed to support the research question. Based on the model, the study hypothesized that the impact of KPC on SIE may actually be a result of the mediation of KIC .This study believes that effective execution of KPC promotes organizational growth by allowing the organization to launch strategic initiatives effectively. KPC are believed to enable organizational members in acquiring, creating, sharing, and transferring knowledge in the organization. These KPC activities are believed to influence SIE. Thus, KPC are hypothesized to affect SIE. The study hypothesized that the impact of KPC on SIE may actually be a result of the mediation

Figure 1. Causal Model and hypotheses



of KIC. From a review of literature, the mediation effect of KIC is presented by two arguments: First, there is evidence supporting the view that KPC requires and affects KIC. Changes in the capabilities to create knowledge are believed to result in changes in the capabilities to manage the organization's infrastructure. In other words, the KPC are antecedents of KIC. Second, this study argues that the KIC are a basic system in the organization that support and facilitate organizational activities. KIC are believed to inspire organizational members to work with greater effectiveness and efficiency in organizational activities. The capabilities to manage infrastructures in the organization are believed to influence SIE. Therefore, SIE is hypothesized to be effected by KIC.

t he effect of Kpc on sIe

KPC are organizational capabilities to manipulate knowledge that are stored in the form of standard operating procedures and routines throughout the organization. KPC are believed to contribute positively to organizational effectiveness by enabling individuals to effectively exploit existing knowledge and explore new knowledge (Prahalad and Hamel, 1990). Effective execution of KPC can promote growth by allowing the organization to launch business initiatives, as well as gain cost and other advantages by improving operations (Trussler, 1998). KPC has been studied by many researchers. The first well-known KPC study is that of Nonaka (1991). He proposed four modes of "Spiral of Knowledge," or a "SECI" model, for the knowledge creation process that consists of knowledge socialization, externalization, combination, and internalization. Edvission (2000) suggests that KPC should consist of four steps: sharing tacit knowledge, creating concepts, justifying concepts, and cross-leveling knowledge. Gold, et al (2001) offer another four-stage KPC model: acquisition, conversion, application, and protection, by grouping processes from other empirical studies. Van der Spek and Spijkervet (1997) propose still another four-stage KPC model: creation and sourcing, compilation and transformation, dissemination, application and value realization. This process is believed to create new knowledge in organization. Alavi and Tiwana (2003) investigate KM process framework that consist of four stages of; creation, storage/retrieval, transfer, and application. There is no empirical and systematical investigation to suggest which KPC is the preferred pattern. Holsapple and Joshi (2002) develop knowledge chain through the Delphi study with participant panelists who are knowledge management practitioners and academicians. They introduce five activities of the knowledge chain in order to realize KPC in an organization: knowledge acquisition, generation, selection, assimilation, and emission. Five activities under the knowledge chain are believed to be a component of KPC which is an important driver to transform knowledge in the organization (Holsapple & Singh, 2001) because their work systematically studied the visible principle of KM ontology, which is a branch of philosophy dealing with the order and structure of reality.

In sum, the result of efficiently managed KPC is believed to enhance SIE. Therefore, the components of KPC in organization are believed to assist in the task of translating strategy into action, bringing about the achievement of implementation (Spinello, 1998). This study proposes the first hypothesis below:

Hypothesis 1: *Knowledge process capabilities positively affect strategy implementation effectiveness.*

Knowledge Infrastructure c apabilities as a Mediator

From the KM success model of Jennex & Olfman (2005), infrastructure is mentioned in terms of system quality and the KMS. Jennex and Olfman determined the KMS as a common network structure focusing on systems hardware and software. They also suggest that the KMS enhances KM decision making skills by improving ability of decision makers. In strategy field, infrastructure is always mentioned in conjunction with the information system, organizational infrastructure, and management system (Digman, 2006). Infrastructure is a basic system that must function properly. Many researchers suggest that infrastructure mediates organizational activities by supporting and facilitating. Madhok (1997) observes that when companies want to transfer know-how within or across organizational boundaries, managers must rearrange the structures to support the transfer. Gomex-Mejia (1992) reveals that infrastructure is shaped to support organizational process and enhance organizational effectiveness in strategy formulation and implementation. Dyer and Nobeoka (2000) assert that infrastructure supports KPC among suppliers that create coordinating principles between networks. Worren, Moore, and Cardona (2002) mention that infrastructure facilitates knowledge sharing by using electronic networks and databases. In addition, King and Zeithaml (2001) point out that infrastructure is engineered in order to facilitate KPC among and between organizational levels.

Knowledge researchers have described infrastructure as capabilities that are required to support knowledge activities in organizations (Wiig, 1999). KIC are required to build and to maintain generic capabilities that are shared with organizational activities and functions. In this study, KIC includes information technology, management system, and organizational structure. A review of literature shows that KIC mediate organizational activities by supporting and facilitating organizational activities. However, once the organizational process or planning is changed, KIC is shaped and rearranged to match a new process and planning (Powell & Dent-Micallef, 1997).

Kpc as an Antecedent of KIc

Infrastructures in the organization were believed from researchers to mediate organizational activities by supporting and facilitating organizational activities (Madhok, 1997; Dyer & Nobeoka, 2000; Worren et al., 2002). However, there are limited empirical investigations on the relationships among KPC, KIC and organizational effectiveness. A recent study by Gold, et al., (2001) shed light on the relationships among KPC, KIC, and organizational effectiveness. The results unveil the positive relationships between KPC and organizational effectiveness, and between

KIC and organizational effectiveness. However, the study did not show the relationship between KPC and KIC.

While past studies have examined the role of infrastructure within the organization, it is still not clear how KIC affect KPC. However, there are interesting arguments that imply the effect and relationship of both KPC and KIC. Keidel (1994) suggests that in order to improve competitiveness, an organization redesigns, restructures, or reengineers its configuration to better serve its customer. Keidel mentioned the reengineering process starts with a "blank sheet of paper," and then determined the pattern that requires the flow charting of the entire work process. The flow charting of the work process is needed before redesigning, reengineering, and restructuring the organization. Keidel also points out that infrastructure may be a mirror image of organizational learning that results from knowledge. It can be thus implied that KPC is an antecedent of KIC. In addition, Keidel suggests that redesigning the way of thinking or the process of knowledge management is needed before the capabilities of restructuring and reengineering infrastructures take place in organization. McDermott (1999) argues that redesigning is associated with a capability to create knowledge that is needed before changes to infrastructures in the organization. Wang and Majchrzak (1999) stated when the organization wants to change or extent their organization infrastructures, such as work procedures, or physical layout, management should encourage organizational members sharing their expertise capabilities by brainstorming ideas and discussion problems. Another piece of literature from El Sawy and Josefek (2003) mentions that the newly created value results from the design of infrastructure capabilities supporting around the process.

These studies show evidence supporting the argument that KPC are an antecedent of KIC. This study argues that KIC support and facilitates organizational activities. However, it does not cause any augmentation of KPC. On the contrary, changes in KPC cause augmentations in the organizational infrastructure to support it. Thus, this study hypothesizes that:

Hypothesis 2: *Knowledge process capabilities positively affect knowledge infrastructure capabilities.*

t he effect of KIc on s Ie

In this section, we describe how KIC evolved in response to strategy implementation needs. In the organization, principally, KIC are changed when they no longer provide the coordination, control, and direction, when the organizational process or organizational structure is changed. As a basic system, infrastructure is a fundamental to organizational activities. Also, there were suggestions from strategy implementation scholars that infrastructure is needed as a supportive capability for the implementation activities.

Daft and Mcintosh (1984) studied the role of formal control system in the strategy implementation process. They found that a formal control system helps managers to manage business unit outputs and to control their functional activities. Broadbent, et al., (1999) suggest that infrastructure capability is fundamental to the architecture of business process and the availability of appropriate infrastructure capability was a key factor preceding the successful implementation of redesigned business process. Shaw, et al., (2001) comment that strategy implementation is inevitably involved with the decision of organizational infrastructures, such as technological, human resource, finance, or other systems. They mentioned that the congruence of those infrastructures effect relationship of strategy implementation effectiveness. Longman and Mullins (2004) suggest that a proper organization structure is an influence on the success of project implementation.

In organizations, synergies result from combining infrastructure capabilities and other organizational resources (Powell & Dent-Micallef, 1997; Melville et al., 2004). Infrastructure is required to build and maintain organizational capabilities and to share capabilities with other functions within and across organizations. KIC are essential capabilities to support organizational activities by coordinating and controlling strategies among divisions and business units. To increase SIE, the level of KIC is hypothesized to increase as well. The third hypothesis is proposed:

Hypothesis 3: *Knowledge infrastructure capabilities positively affect the effectiveness of strategy implementation.*

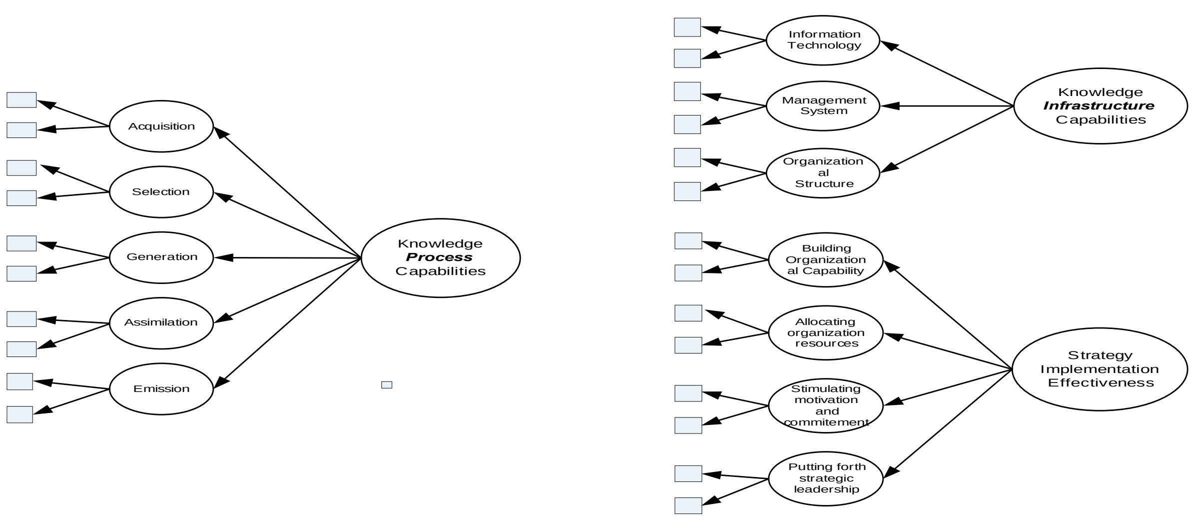
Measurement Model and variables

This measurement model consists of three main latent constructs: KPC, KIC, and SIE. In KPC, five sub-constructs are knowledge acquisition, knowledge selection, knowledge generation, knowledge assimilation, and knowledge emission, tested as components of KPC. In KIC, three sub-constructs are information technology, management system, and organizational structure, tested as components of KIC. In SIE, four sub-constructs are building organizational capability, allocating organizational resources, stimulating motivation and commitment, and putting forth strategic leadership that will be tested as components of SIE. Figure 2 presents the measurement model of the study.

Methods

This study focuses on middle-managers as prime respondents. Huber and Power (1985) recognized that these managers are positioned toward the upper echelons of organizations and have important information about their organizations. Relevant to this study, middle-managers are deeply and directly involved in strategy implementation (Floyd & Wooldrige, 2000). In addition, middle-

Figure 2. Measurement Model



Note: A square represents an observed variable. KPC has four observed variables for each latent variable. SIE has three ovserved variables for each latent variable.

managers are crucial in developing organizational capabilities, facilitating adaptability, synthesizing information, and championing strategic alternatives (Gadiesh & Gilbert, 2001). They use their knowledge and social interaction to accomplish tasks and innovate and create new capabilities. In this study, middle-managers are defined as those positioned below executive officers but above operational managers (such as the functional department managers, regional managers, and district managers (Floyd & Wooldridge, 2000).

Standard and Poor's COMPUSTAT database was utilized to provide the sample, with sample firms randomly selected from this population. In order to control for industry bias, the study gathered a multi-industry sample to minimize the influence of systematic inter-industry difference; the pool of industries from which sample was generated is random. Using the COMPUSTAT database as a sampling frame, the study population includes firms that have a formal organizational structure and clear organizational function because all functions in organizations have already been set and include activities that relate to knowledge activities. Important selection rules are applied to determine the scope of the study's population. In order to enhance the validity of the study, selection criteria are: 1) The firm must have been in business for at least five years, 2) The firm's capital registration must have been more than $50 million in 2003, and 3) Firm's profit must have been more than $300 million in 2003. We argue that those criteria are designed to narrow the study scope to firms that have potentially broader profiles of knowledge activities and broad ranges of strategy implementation. Finally, a total of 1,321 middle-managers were found from the sampling population**.**

This study used a survey-questionnaire as the measurement instrument. Questionnaires were used to elicit responses related to attitude or preference of constructs (Bartholomew and Knott, 1999). Two main types of scaling techniques--the seven-point Likert scale and descriptive information--have been developed for deriving information. The questionnaire is divided into four main parts (Appendix A). The first part has one question. The objective of this part is to define "how well respondents understand the definition of "strategy" by providing the definition of strategy and asking respondents to identify their degree of familiarity with the definition, using the seven-point Likert scale. The scale in the first part is from "not familiar" at 1 to "very familiar" at 7.

The second part addresses knowledge capabilities and has thirty-two questions. As stated earlier, eight sub-constructs (i.e. knowledge acquisition, knowledge selection, knowledge generation, knowledge assimilation, knowledge emission, information technology, organizational structure, and management system) are measured. In this part, seven-point Likert scales are applied to thirty-two questions. The scale in the second part is from "none" at 1 to "extremely high" at 7.

The third part addresses strategy implementation tasks and aims to answer "how much samplers agree with the key implementation tasks in organizations." There are five measurement constructs and fifteen questions in this part. In this part, seven-point Likert scales are applied to the fifteen questions. The scale is the same as the second part. The last part involves demographic information. In this part, the respondents were asked to provide descriptive information.

The initial draft of the questionnaire was reviewed by three faculty experts to ensure the face validity and readability of the scale items. Data was collected by sending questionnaires via electronic mail. This substantially reduced the cost of reaching potential respondents (Schonlau et al., 2001).

There were two main stages of the data collection: the first stage included the two pilot projects; the last stage was the full survey. These two stages were implemented to ensure high reliability and validity of data collection.

The pilot study was conducted to determine the clarity and readability of the questionnaire, and to test the internal reliability of the measures. In the first pilot survey, a cover letter and questionnaires were sent via electronic mail linked to the questionnaire web-site to 100 target respondents. Seven days following the initial mailing, a follow-up letter and the same web-link were presented to non-respondents. Seven days after the follow-up mailing, a second follow-up letter and the same web-link were presented to the remaining non-respondents.

Based on the experience of previous research, these three steps (the initial mailing and two follow-up mailings) could be expected to generate a high response rate. The response rate in the first pilot project was ten percent (10%). Although, the returned questionnaires were not enough for a statistical test, "eye-ball" assessments could be made. The questionnaire was modified by adding one question to each construct in part two, and rewording ten questions in part two and one question in part three. These modifications were made to achieve both high internal consistency and high discriminant validity.

For the second pilot survey, modified questionnaires linked to the questionnaire web-site were sent via electronic mail to another 100 target respondents. The response rate in this pilot project was twenty nine percent (29%). The result from the second pilot survey was enough to have a statistical test. The result of the statistical test shows that questions in each construct have high reliability. In order to confirm the face validity and readability of the scale items, the questionnaire was reviewed by experts for the third time. No significant change was required. Therefore, the study used this questionnaire for the full survey.

For the full survey, questionnaires were sent by electronic mail linked to the questionnaire website to 1,321 target respondents. Questionnaires were sent to respondents three times, consisting of an initial letter and two follow-up letters. There was a waiting period of seven days before sending a follow-up questionnaire.

resul ts

The first step in descriptive statistics was to analyze the response rate. The 1,321 questionnaires were sent to middle-managers. Following the initial and two follow-up electronic mails, the total number of returned questionnaires was 162 middle managers, or a 15.99 percent response rate. The respondents' positions are 101 division managers (62.3 % of total returned questionnaires), and 61 regional managers (37.7% of total returned questionnaires). An average score re: "How familiar are you with the concepts and practices of 'Strategy'?" in the first part of questionnaire is 6.02 with 7.00 being the most familiar. This result shows that respondents feel they are familiar with the given meaning of strategy. In part four, respondents reported an average of 6.08 years in their current position, an average of 11.57 years in their current organization, an average of 17.44 years in knowledge management, and an average of 12.78 years in strategy implementation. The responses to the qualification questions indicated that the survey respondents were well qualified to respond to the questionnaire; the respondents are familiar with strategy implementation and knowledge management.

s tructural e quation Modeling Analyses

A majority of the analyses were conducted by SEM framework utilizing MPlus 3 (Muthen & Muthen, 1998-2004) structural equation modeling software. The two stage procedures recommended by Kline (2005) are: 1) measurement model analysis; and, 2) causal model analysis and the testing of three hypotheses. The data screening was needed because maximum likelihood estimation, which is the primary estimation method of SEM, relies on the normal distribution. The study's variables were assessed through multiple data screening methods. Distributions were inspected for completeness, normality, and outliers. The examination reveals that data fell within range with no outliers. Normality was assessed for all variables. All questionnaire items were confirmed to be normal. Data screening suggests no critical data-related problems in the study (Appendix B)

There are three goals in examining the measurement model. First is to remove non-representative items. Second is to assess the reliability of constructs. Third is to assess the correlation relationships among constructs. Confirmatory Factor Analysis (CFA) was utilized in the examination of the measurement model of the constructs in this investigation. The initial CFA models of the three constructs indicate less fit between the theoretical model and empirical data; model respecification was needed. Item removal is recommended (Kline, 2005). Modification indices and factor loading were used to assist item removal. The indicators that failed to have substantial loading on the factors to which they are originally assigned and indicators loaded on a different factor were removed (Kline, 2005). Indicators with good psychometric characteristics and that have relatively high factor loadings were taken into account in the respecification stage (Match & Hau, 1999).

To assess the degree of compatibility between empirical data and study models, this study used three fit indices through our investigations; Comparative Fit Index (CFI) index (Bentler, 1990; Marsh & Hau, 1999; Carlson & Mulaik, 1993); Root Mean Square Error of Approximation (RMSEA) index (Klien, 2005; Hu & Bentler, 1999); and Standardized Root Mean Square Residual (SRMR) index (Kline, 2005; Hu & Bentler, 1999). These fit indicators have been shown as the most stable in confirmatory factor analysis and structural equation modeling (Anderson & Gerbling, 1988; Hu & Bentler, 1999).

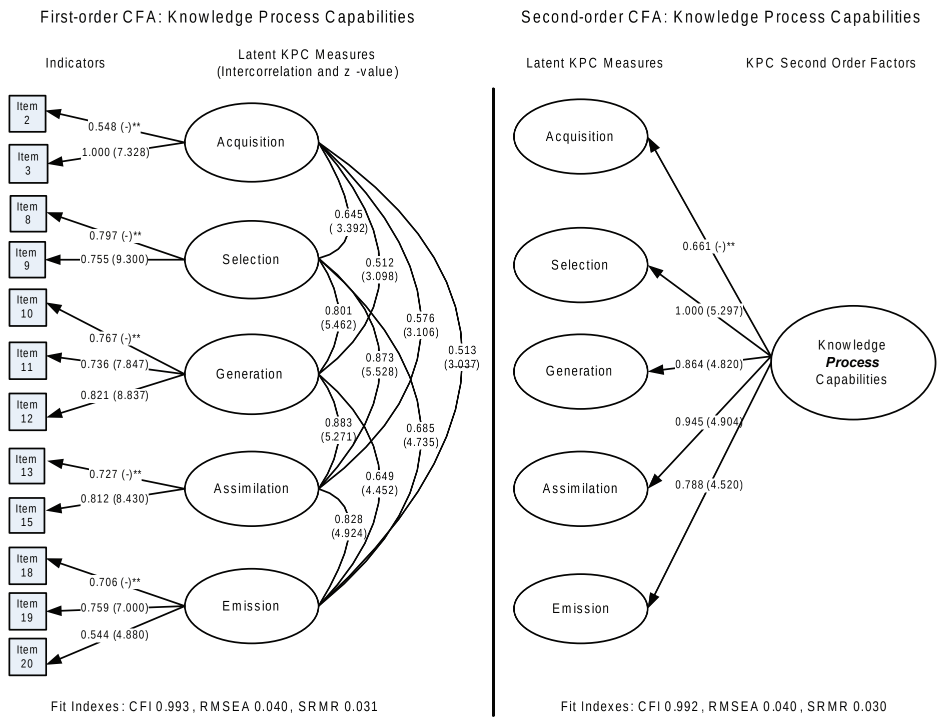
Hierarchical Confirmatory Factor Analysis was used to examine whether the five activities of KPC, three KIC, and four SIE can be viewed as components of KPC, KIC, and SIE, respectively. We use the following procedures. According to Kline (2005), two analytical steps are part of the hierarchical CFA model. In the first order, we assess the bivariate correlations between the different measures to determine whether they are related. In the second order, in the presence of positive correlation, we estimate a CFA model that permits the identification of the relationship between the indicators, taking measurement error into account. After model respecification, all factor loadings provided acceptable loading on each construct. The results of fit indices of both first-order CFA and second-order CFA are within or better than the cut-off criteria. Especially, SRMR indices of every models show excellent fit. **Figures 3, 4 and 5** present the result of the first-order and the second-order CFA. The results of the measurement model indicated that three first-order factor models under CFA showed that all factors are related and observed variables explained each factor well. In the other words, it can be concluded that the empirical data matches the theoretical model.

evaluating r eliability and validity

In order to evaluate the validity of the observed variables in a first-order level of measurement, examination of factor loadings of observed variables (items) on latent variables (factors) is recommended (Anderson and Gerbling, 1988; Bollen, 1989; Mueller, 1994; Doll et al., 1994). In this study, the results of first-order factor models show all items have large and significant loading on their corresponding factors. The result of the second-order factors model showed similar results. Based on the loading results, the measurements of the constructs have high validity.

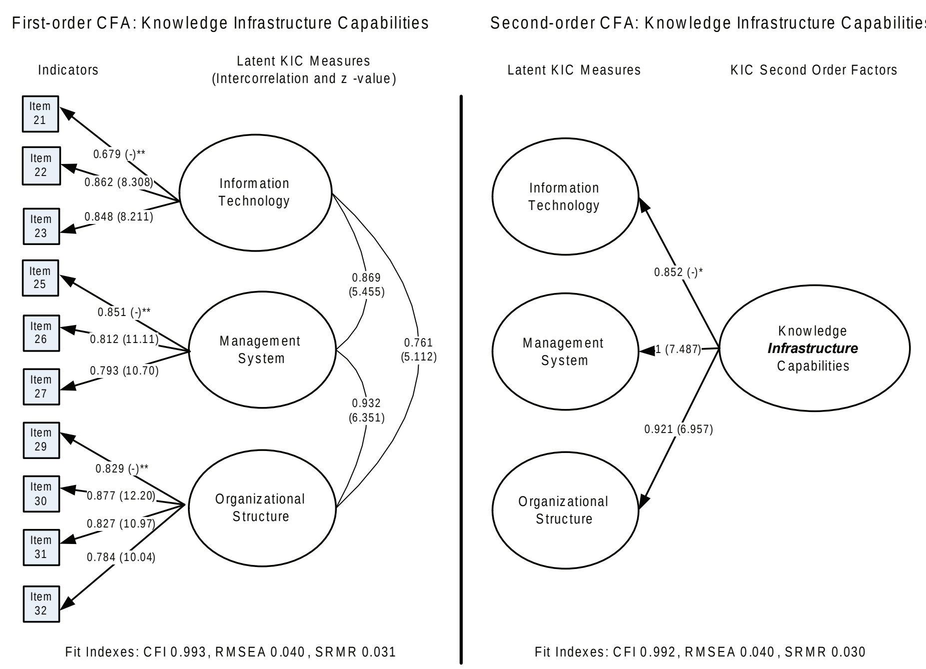
Examining reliability, the majority of construct reliabilities exceed the suggested level of 0.70. The

Figure 3. Summarized Results CFA of KPC



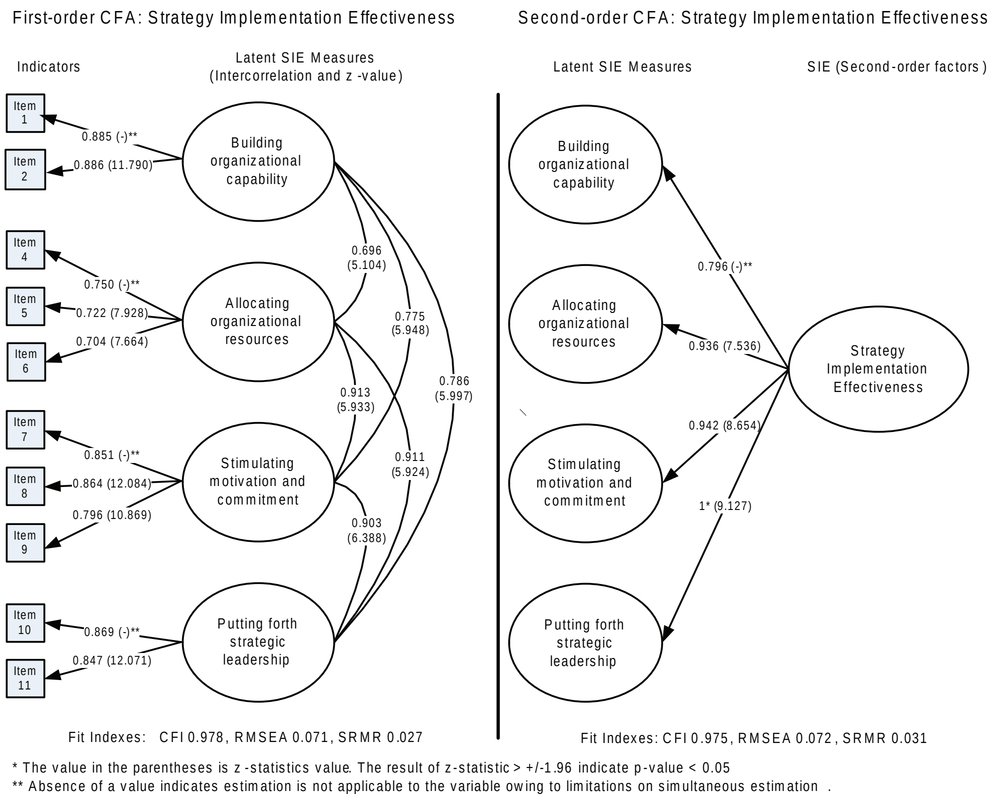
* The value in the parentheses is z -statistics value. The result of z-statistic > +/-1.96 indicate p-value < 0.05
** Absence of a value indicates estimation is not applicable to the variable owing to limitations on simultaneous estimation .

Figure 4. Summarized Results CFA of KIC



* The value in the parentheses is z -statistics value. The result of z-statistic > +/-1.96 indicate p-value < 0.05
** Absence of a value indicates estimation is not applicable to the variable owing to limitations on simultaneous estimation .

Figure 5. Summarized Results CFA of SIE



reliability in this study ranges from 0.540 to 0.969. Only two components in the KPC showed a result lower than 0.70: 0.540 for knowledge acquisition; and 0.675 for knowledge emission. However, in many of the recent empirical investigations in the organizational knowledge area, the results of reliability tests are between 0.54 and 0.85 (e.g. Sabherwal & Becerra-Fernandez, 2003; Zander & Kogut, 1995; Szulanski, 1996). The lower-than-the-suggested-level of the two components may suggest that knowledge is an abstraction that has moderate reliability by itself. Taking the observations into account, the reliability results suggest that the indicators are sufficiently reliable to measure latent constructs.

c ausal Model

The overall model fit is examined through fit indices and is done to make sure that the empirical observed data actually correspond with the proposed model. For the first measure, the Comparative Fit Index (CFI) index (Bentler, 1990), has a value of 0.923 that is above the commonly accepted rule of thumb at 0.90 to indicate a well-fitting model (Carlson & Mulaik, 1993; Marsh & Hau, 1999). We get the RMSEA of 0.060 for our proposed model. The result of RMSEA is in the range of recently researched results from 0.04-0.09 (Isobe et al., 2000; Hoskission et al., 2002). The result of RMSEA showed a good fit model. We get a SRMR of 0.056 for our model, well below the cutoff criteria for SRMR at 0.08 (Hu & Bentler, 1999). Compared with most recent

Table 1. Measurement Model: Construct Reliability

Construct	Construct Reliability Estimates**
Knowledge process capabilities (KPC)	
Knowledge acquisition	0.540
Knowledge selection	1.000*
Knowledge generation	0.773
Knowledge assimilation	0.898
Knowledge emission	0.675
Knowledge infrastructure capabilities (KIC)	
Information technology	0.755
Organization structure	0.858
Management system	1.000*
Strategy Implementation Effectiveness (SIE)	
Building organizational capability	0.633
Allocating organizational resources	0.876
Stimulating motivation and commitment	0.888
Putting forth strategic leadership	1.000*

** Use as the reference or an anchor item.*
*** Construct Reliability formula = $(\Sigma\lambda)^2 / (\Sigma\lambda)^2 + \Sigma\sigma^2$ ($\Sigma\lambda$ represents summation of factor loading in each factor, and $\Sigma\sigma^2$ represents summation of measurement error of each fact.*

Table 2: Structural Equation Modeling Results

Construct relationship	Parameter estimates	*z-statistic*	*Result*
The first stage			
H1: KPC → SIE	0.791	4.654	Supported
The second stage			
H1: KPC → SIE	0.260	0.952	Unsupported
H2: KPC → KIC	0.927	4.617	Supported
H3: KIC → SIE	0.571	2.221	Supported

research where the SRMR was used to measure model fit, and the results were in the range of 0.08-0.09 (Isobe et al., 2000; Hoskission et al., 2002). The SRMR index showed an excellent fit of the causal model.

hypotheses t esting

A main objective of this paper is to provide evidence supporting that KIC is a mediator of the causal model. From the literature review, we believe that KPC in organizations is an antecedent to KIC, and that KIC supports SIE. According to the methodology described by Baron and Kenny (1986), in order to demonstrate the mediation effect of KIC, two stages of hypotheses testing are required. The first stage is to demonstrate the positive effect from KPC to SIE, leaving KIC out of the model. This stage confirms Hypothesis 1. As shown in Table 2, the second stage is to integrate KIC and demonstrate a positive path from KPC to KIC and from KIC to SIE. Moreover, there must be no significant path from KPC to SIE. This stage is captured by confirming Hypothesis 2 and Hypothesis 3, and does not confirm Hypothesis 1. Perfect mediation holds if the independent variable has no effect on the dependent variable or outcome variable when the mediator is presented in the model (Baron & Kenny, 1986). Therefore, the results of this study show the complete mediation effect of KIC over the path from KPC to SIE.

IMpl IcAt Ions And conclus Ion

r esults d iscussion

The purpose of this study is to understand the effects of organizational knowledge capabilities on strategy implementation effectiveness. Two organizational knowledge capabilities (i.e., KPC and KIC) are hypothesized to positively influence SIE. The results demonstrate that the two knowledge capabilities have positive effects on the effectiveness of strategy implementation. However, one of them, KIC, exhibits a mediator property. The result confirms the beliefs of many and sheds deeper light on relationships between the two capabilities and strategy implementation effectiveness.

The discovery of the relationships involved two-step statistical testing, aimed to uncover a mediator. In the first step, the relationship between KPC and SIE was analyzed by disregarding KIC from the model. In this step, the result showed the positive effect of KPC on SIE. In support of prior suggestions (Prahalad & Hamel, 1994; Liebeskind, 1996; Hertog & Huizenga, 2000), the result indicates that the social interaction of KPC affects all functions and resources in the organization, including SIE. Furthermore, the company's capability to combine individual knowledge and skills across boundaries to create knowledge and to launch business initiatives enables firms to enhance SIE. The first-step result indicates that the capability of KPC directly benefits SIE in the organization.

In the second step, all three constructs were presented simultaneously in the model. The result clearly demonstrates the mediator effect of KIC. The positive relationship between KPC and SIE no longer exists. Instead, there are positive effects from KPC to KIC and from KIC to SIE. Our results provide strong support for our second hypothesis that suggests that KPC are an antecedent of KIC. This result supports the prior suggestion (Keidel, 1994; McDermott, 1999; El Sawy & Josefek, 2003) that infrastructures in the organization are changed after the pattern of work process is determined. In other words, the changes in process of knowledge determine any changes in organizational infrastructures (Wang & Majchrzak, 1999). The result supports our argument that KPC causes KIC. KIC do not influence the process as many have believed. Activities inside the five main knowledge-chain activities (such as brainstorming, sharing ideas, recruiting employees from outside, or participating in community practice) may benefit the capability to manage infrastructure in the organization.

Our result also provides strong support for our third hypothesis that KIC affect SIE. This finding suggests that KIC affect SIE as a whole. This result is consistent with position of Shaw et al., (2001) that strategy implementation is inevitably involved with the organizational infrastructure -- such as information technology, human resources system, or organizational structure -- and it is also consistent with Longman and Mullins (2004), who argue that a proper infrastructure influences the success of strategy implementation.

In the second step, the no-longer-existing Hypothesis 1 may suggest that the organization may gain advantages by using infrastructure to leverage intangible, complementary human and business resources (Melville et al., 2004). In addition, the results are thus consistent with the suggestions of Madhok (1997) and Dyer and Nobeoka (2000), who assert that KIC support and facilitate organizational members to transfer and to create knowledge within and across organizations. Furthermore, consistent with this explanation, Worren, et al., (2002) and King and Zeithaml (2001) suggest that management restructures organizational infrastructures in order to facilitate

KPC and to support organizational activities. In short, it may be concluded that the organization needs KIC in order to enhance organizational activities. It is influenced by KPC and it supports and facilitates strategy implementation tasks. In the knowledge economy, the fast- changing environment causes the organization to develop, mix, and match two kinds of knowledge capabilities in order to enhance SIE.

In addition to the contributions of the causal models, the results also demonstrate and confirm components of KPC and KIC. The measurement model of KPC clearly demonstrates that the five components are significantly correlated. Furthermore, all components load significantly under KPC. The statistical results could only suggest that knowledge acquisition, knowledge selection, knowledge generation, knowledge assimilation, and knowledge emission are the components of KPC. Bringing the components under a single construct shows the powerful nature of knowledge activities linked through the social fabric. A picture of social interactions among knowledge process activities can be drawn from the following: leveraging information outside the company; training employees to know how to acquire new knowledge; training employees by using professionals inside organizations, using the company database; brainstorming; ongoing interaction; communicating new information; sharing information among organizational members; producing a market report; and encouraging inter-organizational activities. All of these activities create seemingly positive effects on SIE until KIC is brought into the canvas.

In the second measurement model concerning KIC, the model shows and demonstrates information technology, the management system, and organizational structure as the three components of KIC. The interconnection of the three components takes an important place in the relationship between KPC and SIE. They support, assist, and facilitate organizational strategy implementation activities. They are also a function of KPC. In the light of these connections, it becomes important to reorient our understanding that good infrastructure may help strategy implementation. However, good infrastructure is a requirement for a good process. Both scholars and practitioners must balance the importance between KPC and KIC, because the two are important in SIE.

In the third measurement model concerning SIE, the model shows and demonstrates four tasks of strategy implementation as the four components of SIE. The measurement model of strategy implementation clearly demonstrates that the four tasks are significantly correlated. Furthermore, all components load significantly under KPC. The statistical results could only suggest building organizational capability, allocating organizational resources, stimulating motivation and commitment, and putting forth strategic leadership as the components of effective strategy implementation. These four tasks of strategy implementation are tasks that top management and middle-managers must concern themselves with. If an organization can achieve these four tasks, it can be concluded that the organizations have succeeded in the implementation process.

In conclusion, the result of casual the support theoretical framework of the study, also the result of the measurement model, benefits the organizational to understand activities under each measurement. These results allow management in the organization to enhance the organizational capabilities in the knowledge economy

Implications

Overall, this study expands the view of how knowledge capabilities affect the effectiveness of strategy implementation as well as the view of knowledge infrastructure capabilities as a mediator. Through analysis of theories and empirical testing, this research strongly supports the notion that organizations may possess powerful ingredients for successful strategy implementation through the development of key knowledge capabilities

Implications for Management practice

Beyond the theoretical contribution, there are some issues in which organizations should develop knowledge capability to ensure effectiveness of strategy implementation.

First, building on the knowledge capabilities, management should promote and develop knowledge process activities in the organization's members. Because knowledge is embedded into organizational routine and activities, promoting knowledge process activities will create social interactions among an organization's members and create knowledge sharing and culture transference. In addition, top management team should recognize importance of knowledge by creating a position specifically to knowledge management (e.g., Chief Knowledge Officer: CKO). This position will play an important role in overseeing knowledge activities and managing organizational knowledge. To enhance knowledge management efficiency, the CKO must establish programs to balance organizational knowledge and capabilities in leveraging knowledge.

Second, another direct implication for managerial practice regarding key knowledge processes is that management should advocate the development of knowledge capabilities for effectiveness of strategy implementation. Management should pay and balance attention to both knowledge process activities and infrastructure. Davenport and Prusak (1998) caution management that optimizing one aspect of knowledge capabilities can cause detrimental effects in the development of organizational capabilities. Focusing only on process capabilities creates rich knowledge. However, the knowledge is not utilized because no infrastructure exists for it. Organizations must not forget that the observed benefits of knowledge are the result of a well-matched infrastructure. The knowledge process needs the infrastructure to store and to increase the efficiency of knowledge process activities. On the other hand, a study by Hansen, et al., (1998) revealed that overemphasizing technology to capture and disseminate knowledge does not yield a satisfactory result. The organization does not have sources of knowledge to exploit for competitive advantage.

Third, the findings of this study point to the unique importance of knowledge infrastructure. Organizations should prepare the readiness of the three infrastructures (i.e., IT, management systems, and organizational structures). Ready-for-knowledge infrastructures help organizations to realize benefits of their knowledge in a timely manner when the knowledge becomes available from the knowledge process. If the infrastructure is not ready for knowledge, the knowledge from knowledge activities is less likely to be utilized effectively. The findings of this study also support the fact that strategy implementation tasks need infrastructure to support and to facilitate their activities. The evolution of technology, management, and organizational structure has to be assessed and their readiness for supporting organizational activities must be tuned.

Fourth, the findings also indicate an important implication that managing knowledge process capabilities and knowledge infrastructure capabilities gives the transportation community an opportunity to continue to build a collaborative and knowledge-sharing culture that is always engaged in the activity of learning. In this way, competency-building will be a natural evolution within participating organizations. In addition, a central principle of knowledge management is that organizations can best foster the capture and exchange of knowledge through communities of practice — professional networks that identify issues, share approaches, and make the results available to others. A community of practice is a virtual community connected by interest and expertise in a specific discipline. Fostering and supporting these communities with improved tools is the first step in creating a knowledge network in organization.

Fifth, another important implementation of the knowledge process lies in the area of incremental innovation. The importance of sharing knowledge for better innovation has been investigated and discussed by many researchers, Hinloopen (2003); Carlile (2004); Smith, et al., (2005). Therefore, improving KPC not only benefits SIE but also innovations that span within the knowledge process. It should be noted that innovations can happen almost anywhere in an organization (Damanpour, 1996). Furthermore, innovation involves more than product innovation. It includes process innovation, innovative adoption of technology, and innovative problem solving. In fact, innovation can be said to extend to strategy innovation (Hamel, 2002). Thus, organizations can expect the benefit of the KPC to include more than merely SIE.

Last, another implication of an implementation of knowledge process and strategy related to a paradigmatic social situation called social dilemma. Social dilemmas describes paradoxical situations in which individual rationality—simply trying to maximize individual payoff—leads to collective irrationality. This situation constitutes a dilemma because individual attempts to maximize payoff can result in collective damage. This situation also often prevents cooperation in social members that would affect knowledge management results. As a consequence organization should increase a chance of cooperation by creating some interventions during the implementation. Also, balancing KPC, KIC and SIE must be managed.

Implications for f uture r esearch

In the near future, the study model can be improvised to study the interplay among the components of the KPC and KIC. Furthermore, the interplay can be extended to each component of SIE. It is interesting to speculate that the whole is greater than the sum of the parts for each of the three main constructs. The result of the relationships among the three main constructs could be changed in light of the analyses of the interplay among their smaller components of them.

In the long run, the study presents many opportunities to expand beyond its basic findings. Many questions that require further analysis and investigation have been raised. Both knowledge capabilities, (examined in this study) and process and infrastructure can be explored further. There are several research areas with which this study can be integrated. New research is needed to understand specific strategies and organizational programs that facilitate knowledge capability and lead to an increase in the effectiveness of strategy implementation.

Concerning KPC, we could expand our understanding to explore obstacles in exercising knowledge process activities. Especially, the areas of political and social interaction at each component and across components of the process promise to yield insightful detail. Human resources management can also be linked to knowledge process capability. The area of recruiting and selecting knowledge workers can be linked to knowledge capabilities development.

Concerning the infrastructure capabilities, one direction of future research is to explore how to manage the readiness of infrastructures in organizations, what factors influence the change of infrastructures in organizations, as well as how to design infrastructures that benefit both the efficiency of a bureaucratic organization and the flexibility of knowledge process creation. Furthermore, in strategy implementation areas, we could study middle-managers by linking them with strategy innovation and corporate entrepreneurship. Floyd & Wooldridge (2000) believe that middle-managers occupy the position that creates organizational capability, knowledge capability, and strategy innovation.

The last interesting direction of future research is to explore how different project characteristics might change the result of this study. This study gathered only general information on strategy implementation effectiveness. However, the spectrum of strategy project characteristics can be explored in contingency with the study model.

The spectrum of characteristics could range from evolutionary improvement to revolutionary improvement, from arm's length collaboration to close collaboration, or from intrafirm to interfirm. The end result is to observe how knowledge process and knowledge infrastructure respond to many characteristics of strategic initiatives.

l imitations of the s tudy

The main limitations of this study relate to the "snapshot nature" of the data; that is, the data represent a picture at only one point in time of organizational life. In reality, the relationships between knowledge capabilities and the effectiveness of strategy implementation are incrementally developed throughout the life of an organization. They could not be developed in a short period, especially the capability of knowledge process which is based on day-by-day social interactions among organization members. Although the snapshot enables us to conduct many analyses and to answer the research question, it limits our ability to analyze beyond current relationships. Therefore, in order to find out the in-depth relationship of knowledge capabilities and strategy implementation, longitudinal action research is recommended.

c onclus Ion

Knowledge and capabilities have to be built up slowly over time, shaped, and channeled in certain directions by hundreds of daily managerial decisions. The results of this study show that knowledge process capabilities positively affect the effectiveness of strategy implementation when knowledge infrastructure is ignored. However, KPC does not directly affect the effectiveness of strategy implementation when KIC is presented. The infrastructure plays the mediator role. Therefore, organizations should balance both types of knowledge capabilities. Effective execution of knowledge capabilities can promote growth by allowing an organization to launch business initiatives more effectively and successfully. Furthermore, contributions of this study could potentially go beyond the field of strategic management to other fields, such as human resources management and management information system. The result of this study also benefit practitioner's world by contributing to the effective works of middle-managers in knowledge capabilities. Successful managing the capabilities to transform knowledge will bring to the development of knowledge of organizational members. Organizational members will learn more new knowledge that is acquired from existing and explore new knowledge that can enhance the efficiency and effectiveness of strategy implementation. Furthermore, successful managing the capabilities to manage infrastructures will also increase an efficiency to facilitate and support organizational activities. Therefore, managing both knowledge capabilities activities will contribute to the effective works of middle-managers in strategy implementation. Consequently, when good strategies are more successfully implemented, the improvements at business' bottom tine are more certain.

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Append Ix A

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Knowledge Management and strategy Implementation

The objective of this questionnaire is to study the effect of knowledge processes and knowledge infrastructure capabilities on strategy implementation. Please respond to this questionnaire through the perspective of strategy implementation.

Part 1: This section focuses on your interpretation of the term "Strategy" Please use the following definition:

"Strategy is the means that the organization utilizes or employs to achieve its goals, objectives, and vision as part of the company mission."

From the definition above, how familiar are you with the concepts and practices of "Strategy" Please answer by using the scale below.

(Not very familiar) 1 2 3 4 5 6 7 (Very familiar)

Part 2: This section focuses on the measurement of components of "knowledge capabilities" within your organization. Please use the following scale to rate the extent of your organization's use of the various components.

Rating definitions:

1=none, 2=slight, 3=below average, 4=average, 5=above average, 6=significant, and 7=extremely high

My organization…	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Recruits and hires employees from other firms in order to access knowledge and expertise developed at these firms.	1	2	3	4	5	6	7
Uses information from outside the company, by such means as conducting external surveys or purchasing external data sets, in order to get more new information and generate new products and strategies.	1	2	3	4	5	6	7
Provides effective training for employees on how to identify and acquire information from external sources.	1	2	3	4	5	6	7
Utilize knowledge of customer needs to benefit new product development and organizational strategies.	1	2	3	4	5	6	7
Encourages employees to exchange or share their ideas, information, knowledge, and work experiences.	1	2	3	4	5	6	7

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Uses appropriate procedure for forecasting	1	2	3	4	5	6	7
Routinely extracts and collects information and knowledge from available data bases.	1	2	3	4	5	6	7
Train employees by utilizing experienced colleagues or professionals within the organization	1	2	3	4	5	6	7
Uses company database (such as customer profile) in generating consistent, accurate, and faster decision about customers.	1	2	3	4	5	6	7
Promotes or supports brainstorming among employees to create new insights or to solve problems.	1	2	3	4	5	6	7
Promotes or supports various kinds of new inventions by employees.	1	2	3	4	5	6	7
Enables employees to create new knowledge through ongoing interactions and improvisations while they perform their jobs.	1	2	3	4	5	6	7
Encourages employees to share their information, ideas, or knowledge by using internal information systems (e.g. bulletin board, internal groupware, or internal publications.)	1	2	3	4	5	6	7
Provides on the job training to enable employees to better understand their responsibility/duty of their position.	1	2	3	4	5	6	7
Communicates new innovations, new policies, or new ideas to employees.	1	2	3	4	5	6	7
Promotes employee to participate in community service that related to their profession.	1	2	3	4	5	6	7
Provides information systems tools in order to enable its employees awareness utilize such information sources as the Internet	1	2	3	4	5	6	7
Gives lecture and presentations about product development and company situations to employees	1	2	3	4	5	6	7
Produce or publish market research reports and other status reports.	1	2	3	4	5	6	7
Participates in inter-organizational activities, such as trade groups, professional societies, etc.	1	2	3	4	5	6	7
Has effective information technology (IT) to provide information for business units planning (e.g. data mining for marketing forecasts)	1	2	3	4	5	6	7
Utilizes information technology (IT) to facilitate collaboration and communication among employees and business partners.	1	2	3	4	5	6	7
Encourages employees to find new information, innovations, ideas, knowledge, or skills using information technology (e.g. searching the Internet).	1	2	3	4	5	6	7
Identifies and tests new technologies for business purposes by developing applications specific to business-unit.	1	2	3	4	5	6	7
Enables employees to cooperate or to interact with the organization's planning system.	1	2	3	4	5	6	7
Encourages employees to develop work standards in day-to-day operations in order to stabilize organizational processes and quality.	1	2	3	4	5	6	7
Enhances development of employees' ideas, knowledge, or skills by job rotation, job redesign, or extensive training.	1	2	3	4	5	6	7
Encourage employees to build social relationships within the organization.	1	2	3	4	5	6	7
The organizational structure (divisions, departments, units) enhances effectiveness of interactions and sharing of knowledge.	1	2	3	4	5	6	7

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Append Ix A cont Inued

Facilitates the transfer of new knowledge, ideas, skills, and innovations across the organizational hierarchy and functional boundaries.	1	2	3	4	5	6	7
Encourage employees to go where they need for knowledge regardless of the organizational structure.	1	2	3	4	5	6	7
Fosters an interdependent work community in which employees are able to exchange/transfer their information.	1	2	3	4	5	6	7

Part 3: This section focuses on the measurement of "strategy implementation tasks" used to make the strategy successful. Please use the following scale to rate your organization on each of the various components.

Rating definitions:

1= strongly disagree, 2= disagree, 3= somewhat disagree, 4= neither agree or disagree, 5= somewhat agree, 6= agree, and 7= strongly agree

Do you agree or disagree that your organization…………	1	2	3	4	5	6	7
Employee skills match the needs of its strategy	1	2	3	4	5	6	7
Has effectively built and nurtures a distinctive competence and staffs positions with the proper talent and technical expertise.	1	2	3	4	5	6	7
Core executive group effectively carries out strategic plans.	1	2	3	4	5	6	7
Have units utilize budgets and programs guidance to carry out their part of the strategic plan.	1	2	3	4	5	6	7
Focuses on the performance of tasks relating achieving organizational objectives rather than on carrying out the assigned duties.	1	2	3	4	5	6	7
Co-workers coordinate their tasks and activities among units.	1	2	3	4	5	6	7
Has units and individuals motivated to accomplish its strategic goals.	1	2	3	4	5	6	7
Creates a "results-orientation" and a spirit of high performance.	1	2	3	4	5	6	7
Links its reward structure to strategic performance.	1	2	3	4	5	6	7
Initiates necessary corrective actions to improve strategy execution.	1	2	3	4	5	6	7
Exhibits innovation, responsiveness, and opportunistic behavior.	1	2	3	4	5	6	7
Deals with the politics of strategy by effective coping with power struggles, and building consensus.	1	2	3	4	5	6	7

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Part 4: Demographic information: Please provide the following descriptive information about your position with your organization. Your responses will remain anonymous and will not be associated with your name.

• What is your job title?	…………………
• How many years have you been in this job?	…………….years
• How many years have you been with this organization?	…………….years
• How many years' experience do you have in knowledge management in this or other organizations?	…………….years
• How many years' experience do you have in strategy implementation in this or other organizations?	…………….years

Append Ix b

descriptive statistics: Assessment of the data normality (n=162)

Items	Mean	Std. Statistic	Variance	Skewness		Kurtosis	
			Statistic	Statistic	Std. Error	Statistic	Std. Error
p2_1	4.261	1.462	2.137	-0.304	0.217	-0.335	0.430
p2_2	3.679	1.421	2.020	-0.245	0.217	-0.214	0.430
p2_3	5.221	1.398	1.954	0.358	0.217	-0.150	0.430
p2_4	4.897	1.388	1.925	-0.611	0.217	-0.229	0.430
p2_5	4.847	1.301	1.691	-0.268	0.217	-0.158	0.430
p2_6	4.483	1.360	1.849	-0.616	0.217	0.387	0.430
p2_7	4.696	1.462	2.138	-0.426	0.217	0.187	0.430
p2_8	4.528	1.442	2.079	-0.344	0.217	-0.162	0.430
p2_9	4.698	1.438	2.068	0.003	0.217	-0.564	0.430
p2_10	4.509	1.530	2.341	-0.589	0.217	0.355	0.430
p2_11	4.623	1.483	2.200	-0.443	0.217	-0.134	0.430
p2_12	4.569	1.224	1.499	0.054	0.217	-0.525	0.430
p2_13	4.759	1.418	2.011	-0.256	0.217	0.198	0.430
p2_14	4.695	1.267	1.606	-0.188	0.217	-0.395	0.430
p2_15	4.077	1.204	1.450	0.001	0.217	-0.188	0.430
p2_16	4.987	1.570	2.465	-0.060	0.217	-0.267	0.430
p2_17	4.469	1.329	1.766	-0.602	0.217	0.492	0.430
p2_18	3.992	1.435	2.058	-0.491	0.217	0.511	0.430
p2_19	4.811	1.376	1.894	-0.111	0.217	-0.018	0.430
p2_20	4.513	1.386	1.920	-0.610	0.217	0.488	0.430
p2_21	4.810	1.434	2.056	-0.356	0.217	-0.065	0.430
p2_22	4.644	1.281	1.641	-0.054	0.217	-0.442	0.430
p2_23	4.478	1.302	1.694	0.010	0.217	-0.582	0.430
p2_24	4.073	1.330	1.768	-0.113	0.217	-0.414	0.430
p2_25	4.727	1.250	1.562	0.052	0.217	-0.043	0.430
p2_26	4.003	1.293	1.672	-0.435	0.217	0.487	0.430
p2_27	4.223	1.425	2.030	-0.154	0.217	-0.419	0.430
p2_28	4.083	1.315	1.728	-0.242	0.217	-0.184	0.430
p2_29	4.162	1.330	1.768	-0.077	0.217	-0.385	0.430
p2_30	4.419	1.340	1.795	-0.041	0.217	-0.111	0.430
p2_31	4.368	1.428	2.040	-0.273	0.217	0.219	0.430
p2_32	4.820	1.415	2.002	-0.409	0.217	0.493	0.430
p3_1	4.853	1.238	1.533	-0.648	0.213	0.188	0.423

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p3_2	4.932	1.265	1.600	-0.525	0.213	-0.284	0.423
p3_3	5.116	1.322	1.748	-0.635	0.213	0.098	0.423
p3_4	4.445	1.327	1.762	-0.594	0.213	0.151	0.423
p3_5	4.581	1.404	1.970	-0.587	0.213	0.118	0.423
(Continued)							
Table 4.5: (Continued) Descriptive Statistics: Assessment of the Data Normality (N=162)							
Items	Mean	Std. Statistic	Variance	Skewness	Kurtosis		
			Statistic	Statistic	Std. Error	Statistic	Std. Error
p3_6	4.852	1.271	1.616	-0.518	0.213	0.135	0.423
p3_7	4.834	1.337	1.787	-0.652	0.213	0.362	0.423
p3_8	4.834	1.470	2.162	-0.512	0.213	0.234	0.423
p3_9	4.500	1.681	2.824	-0.579	0.213	-0.525	0.423
p3_10	4.716	1.442	2.078	-0.629	0.213	0.309	0.423
p3_11	4.545	1.352	1.829	-0.635	0.213	0.324	0.423
p3_12	4.662	1.447	2.093	-0.277	0.213	-0.220	0.423

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