Knowledge Management and Organizational Learning

Editor
William R. King

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Knowledge Management and Organizational Learning

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Preface

This volume is the result of a request to me in late 2007 from Professor Ramesh Sharda, of Oklahoma State University, editor of the *Annals of Information Systems*. I had recently completed editing a special issue of the journal, *OMEGA: The International Journal of Management Science*, on "KM & OL" (vol. 36, no. 2, April 2008) and a special issue of the *MIS Quarterly* on the "Offshoring of IS" (co-edited with Reza Torkzadeh) (vol. 32, no. 2, June 2008) both of which I had found to be pleasant learning experiences. There were so many worthwhile papers that were submitted for the "KM & OL" OMEGA special issue that I could not publish because of the severe space limitations of a journal issue, that I thought that it might be useful to do another project on the same topic. So, I accepted his invitation and submitted a proposal to the editors at Springer that was promptly accepted by Springer and the series editor.

I notified all of the prior submitters about the new project as well as posting notices of it on IS World and other electronic venues. Interestingly, I do not believe that any of those who had their papers rejected for the OMEGA special issue submitted those papers for this Annals volume. (Am I to suppose that they were angry at me for their rejections?)

Chapters were due in May 2008. By the due date, more than 40 submissions were received, with a few more received later through special permissions granted by me due to exigencies.

Chapters were reviewed by the authors of other submissions plus several doctoral students at the University of Pittsburgh who I thought would benefit from doing such reviews. In this regard, Greg Moody was especially helpful in reviewing chapters and in performing other tasks related to the review process. Generally, each author did about two reviews. The criteria that were given to the reviewers to judge the papers were: research-orientation, innovativeness, rigor and validity and quality of writing.

Each chapter that was not rejected after the first round of reviews was revised at least once based on the reviews and my recommendations; some were revised several times. Some that were revised were eventually rejected, so the review process was very much like that of a quality journal.

The manuscript for the volume was submitted to Springer in early December of 2008. Thus, the entire project took a little more than a year. This is consistent with my view that most academic publishing projects take far too long and that a combination of good management by the editor, motivated reviewers and a commitment to meeting deadlines on the part of the authors and reviewers permits such efforts to be completed in a manner that will make results available to the academic and practitioner communities much more quickly. This issue is discussed more fulsomely in the introductory paper in the *MIS Quarterly* special issue (32(2), June 2008, pp. 205–226).

I wish to thank Professor Sharda, Neil Levine and Carolyn Ford of Springer, all of the submitter-reviewers and the doctoral students on whom I imposed, for their support in this effort. Obviously, an editor cannot successfully produce such a volume without a great deal of effective and timely work by others.

Pittsburgh, PA William R. King

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Knowledge Management and Organizational Learning

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For centuries, scientists, philosophers and intelligent laymen have been concerned about creating, acquiring, and communicating knowledge and improving the re-utilization of knowledge. However, it is only in the last 15–20 years or so that a distinct field called "knowledge management" (KM) has emerged.

KM is based on the premise that, just as human beings are unable to draw on the full potential of their brains, organizations are generally not able to fully utilize the knowledge that they possess. Through KM, organizations seek to acquire or create potentially useful knowledge and to make it available to those who can use it at a time and place that is appropriate for them to achieve maximum effective usage in order to positively influence organizational performance. It is generally believed that if an organization can increase its effective knowledge utilization by only a small percentage, great benefits will result.

Organizational learning (OL) is complementary to KM. An early view of OL was "…encoding inferences from history into routines that guide behavior" (Levitt and March, 1988, p. 319). So, OL has to do with embedding what has been learned into the fabric of the organization.

1 The Basics of Knowledge Management and Organizational Learning

To understand KM and OL, one must understand knowledge, KM processes and goals and knowledge management systems (KMS).

1.1 Knowledge

Knowledge is often defined as a "justified personal belief." There are many taxonomies that specify various kinds of knowledge. The most fundamental distinction is between "tacit" and "explicit" knowledge. Tacit knowledge inhabits the minds of people and is (depending on one's interpretation of Polanyi's (1966) definition) either impossible, or difficult, to articulate. Most knowledge is initially tacit in nature; it is laboriously developed over a long period of time through trial and error, and it is underutilized because "the organization does not know what it knows" (O'Dell and Grayson, 1998, p. 154). Some knowledge is embedded in business processes, activities, and relationships that have been created over time through the implementation of a continuing series of improvements.

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Explicit knowledge exists in the form of words, sentences, documents, organized data, computer programs and in other explicit forms. If one accepts the useful "difficult-to-articulate" concept of tacit knowledge, a fundamental problem of KM is to explicate tacit knowledge and then to make it available for use by others.

One can also distinguish among "know what," "know how" and "know why" levels of knowledge.

"Know what," knowledge specifies what action to take when one is presented with a set of stimuli. For instance, a salesperson who has been trained to know which product is best suited for various situations has a "know-what" level of knowledge.

The next higher level of knowledge is "know-how" – i.e., knowing *how* to decide on an appropriate response to a stimulus. Such knowledge is required when the simple programmable relationships between stimuli and responses, which are the essence of "know-what" knowledge, are inadequate. This might be the case, for instance, when there is considerable "noise" in symptomatic information so that the direct link between symptoms and a medical diagnosis is uncertain. "Know how"-type knowledge permits a professional to determine which treatment or action is best, even in the presence of significant noise.

The highest level of knowledge is "know-why" knowledge. At this level, an individual has a deep understanding of causal relationships, interactive effects and the uncertainty levels associated with observed stimuli or symptoms. This will usually involve an understanding of underlying theory and/or a range of experience that includes many instances of anomalies, interaction effects, and exceptions to the norms and conventional wisdom of an area.

1.2 Knowledge Management Processes and Goals

Knowledge management is the planning, organizing, motivating, and controlling of people, processes and systems in the organization to ensure that its knowledge-related assets are improved and effectively employed. Knowledge-related assets include knowledge in the form of printed documents such as patents and manuals, knowledge stored in electronic repositories such as a "best-practices" database, employees' knowledge about the best way to do their jobs, knowledge that is held by teams who have been working on focused problems and knowledge that is embedded in the organization's products, processes and relationships.

The processes of KM involve knowledge acquisition, creation, refinement, storage, transfer, sharing, and utilization. The KM function in the organization operates these processes, develops methodologies and systems to support them, and motivates people to participate in them.

The goals of KM are the leveraging and improvement of the organization's knowledge assets to effectuate better knowledge practices, improved organizational behaviors, better decisions and improved organizational performance.

Although individuals certainly can personally perform each of the KM processes, KM is largely an organizational activity that focuses on what managers can do to enable KM's goals to be achieved, how they can motivate individuals to participate in achieving them and how they can create social processes that will facilitate KM success.

Social processes include communities of practice – self-organizing groups of people who share a common interest – and expert networks – networks that are established to allow those with less expertise to contact those with greater expertise. Such social processes are necessary because while knowledge initially exists in the mind of an individual, for KM to be successful, knowledge must usually be transmitted through social groups, teams and networks. Therefore, KM processes are quite people-intensive, and less technology-intensive than most people might believe, although a modern knowledge-enabled enterprise must support KM with appropriate information and communications technology (King, 2008).

1.3 Knowledge Management Systems

Knowledge management systems (KMS) are applications of the organization's computer-based communications and information systems (CIS) to support the various KM processes. They are typically not technologically distinct from the CIS, but involve databases, such as "lessons learned" repositories, and directories and networks, such as those designed to put organizational participants in contact with recognized experts in a variety of topic areas.

A significant difference between many knowledge management systems and the organization's CIS is that the KMS may be less automated in that they may require human activity in their operation. While information systems typically require that humans make choices in the design phase and then operate automatically, KMS sometimes involve human participation in the operation phase. For instance, when a sales database is designed, people must decide on its content and structure; in its operational phase, it works automatically. When a "lessons learned" knowledge repository is created, people must make all of the same design choices, but they must also participate in its operational phase since each knowledge unit that is submitted for inclusion is unique and must be assessed for its relevance and important.

2 Organizational Learning

There are various ways to conceptualize the relationship between knowledge management and organizational learning.

Easterby-Smith and Lyles (2003) consider OL to focus on the process, and KM to focus on the content, of the knowledge that an organization acquires, creates, processes and eventually uses.

Another way to conceptualize the relationship between the two areas is to view OL as the goal of KM. By motivating the creation, dissemination and application of knowledge, KM initiatives pay off by helping the organization embed knowledge into organizational processes so that it can continuously improve its practices and behaviors and pursue the achievement of its goals. From this perspective, organizational learning is one of the important ways in which the organization can sustainably improve its utilization of knowledge.

Indeed, Dixon (1994), in describing an "organizational learning cycle," suggested that "accumulated knowledge… is of less significance than the processes needed to continuously revise or create knowledge" (p. 6). These processes are closely related to the notion of "continuous improvement" through which an organization continuously identifies, implements and institutionalizes improvements. The improvements are embedded in the organization through routines that may be written policies, prescribed machine settings, quality control limits or "best practices" for dealing with frequently occurring circumstances.

3 Knowledge Management in Organizations

Figure 1 shows that KM processes directly improve organizational processes, such as innovation, collaborative decision-making, and individual and collective learning. These improved organizational processes produce intermediate outcomes such as better decisions, organizational behaviors, products, services and relationships. These, in turn, lead to improved organizational performance.

3.1 The Knowledge Management Processes Cycle

Figure 2 is a process cycle model of KM. Such cycle models provide a useful way to organize one's thinking about KM processes. There have been numerous KM processes cycle models that describe the relationships of the key processes of KM, ranging from Davenport and Prusak's (2000) 3-stage model ("Generate, Codify/Coordinate, Transfer") to Ward and Aurum's (2004) 7-stage ("Create, Acquire, Identify, Adapt, Organize, Distribute, Apply").

The process cycle model of Fig. 2 is particularly valuable in that it uses the generally accepted terminology of KM and makes use of alternative paths in order to make important distinctions. The various activities listed as bullet-points under some of the major phases are meant to be illustrative and not necessarily definitional.

The model of Fig. 2 shows that the initiation of the KM cycle involves either the creation or the acquisition of knowledge by an organization. Knowledge creation involves developing new knowledge or replacing existing knowledge with new content (Nonaka, 1994). The focus of this is usually on knowledge creation inside the boundary of the firm or in conjunction with partners.

The four bullet points under "Creation" refer to Nonaka's (1994) four modes of knowledge creation – socialization (the conversion of tacit knowledge to new tacit knowledge through social interactions and shared experiences), combination (creating new explicit knowledge by merging,

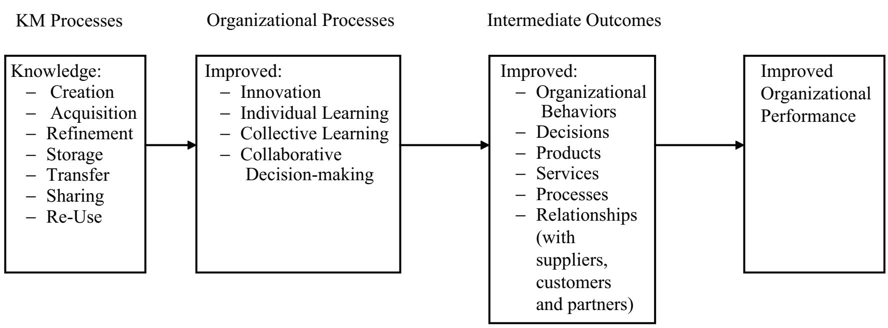

Fig. 1: KM in an Organization

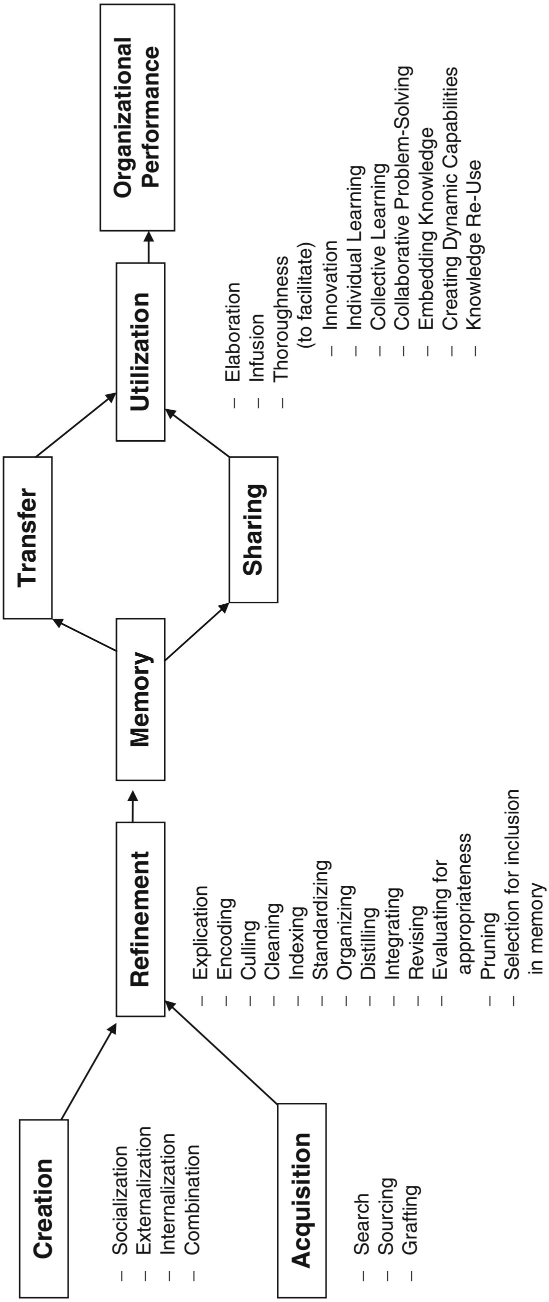

Fig. 2: KM Process Model

categorizing, and synthesizing existing explicit knowledge), externalization (converting tacit knowledge to new explicit knowledge) and internalization (the creation of new tacit knowledge from explicit knowledge). Illustrative of these four modes respectively are apprenticeships, literature survey reports, "lessons learned" repositories and individual or group learning through discussions.

In contrast to knowledge creation, knowledge acquisition involves the search for, recognition of, and assimilation of potentially valuable knowledge, often from outside the organization (Huber, 1991).

The bullet points under "Acquisition" illustrate some processes for acquiring knowledge from external sources – searching (as on the Internet) (Menon and Pfeffer, 2003), sourcing (selecting the source to use) (King and Lekse, 2006) and grafting (adding an individual who possesses desired knowledge to the organization) (Huber, 1991).

After new knowledge is created or acquired, KM mechanisms should be in place to prepare it to be entered into the organization's memory in a manner that maximizes its impact and long-term reusability. Knowledge refinement refers to the processes and mechanisms that are used to select, filter, purify and optimize knowledge for inclusion in various storage media.

Under "Refinement" in the figure, the bullet points suggest that tacit, or implicit, knowledge must be explicated, codified, organized into an appropriate format and evaluated according to a set of criteria for inclusion into the organization's formal memory. Of course, explicit knowledge needs only to be formatted, evaluated, and selected.

Of the various steps that are involved in doing so, "culling" refers to identifying the most significant exemplars in an emerging collection; "organizing" refers to identifying recurrent themes and linking individual knowledge items to the themes and "distilling" is creating a synopsis or set of pointers (McDonald and Ackerman, 1997).

Organizational memory includes knowledge stored in the minds of organizational participants, that held in electronic repositories, that which has been acquired and retained by groups or teams and that which is embedded in the business's processes, products or services and its relationships with customers, partners and suppliers(Cross and Baird, 2000).

As shown in the figure, in order for knowledge to have wide organizational impact, it usually must be either transferred or shared. Transfer and sharing may be conceptualized as two ends of a continuum. Transfer involves the focused and purposeful communication of knowledge from a sender to a known receiver (King, 2006a). Sharing is less-focused dissemination, such as through a repository, to people who are often unknown to the contributor (King, 2006b). Many of the points on the hypothetical continuum involve some combination of the two processes and both processes may involve individuals, groups or organizations as either senders or receivers, or both.

Once knowledge is transferred to, or shared with, others, it may be utilized through elaboration (the development of different interpretations), infusion (the identification of underlying issues), and thoroughness (the development of multiple understandings by different individuals or groups) (King and Ko, 2001) in order to be helpful in facilitating innovation, collective learning, individual learning, and/or collaborative problem solving (King, 2005). It may also be embedded in the practices, systems, products and relationships of the organization through the creation of knowledge-intensive organizational capabilities (Levitt and March, 1988).

The end (right-side) of the cycle in Fig. 2 depicts knowledge having impact on organizational performance. Those who have an academic interest in KM sometimes forget that organizational performance improvement is what KM is ultimately all about. Anticipated improvements are the primary basis that organizations use to judge the value of KM initiatives. Many otherwise-worthy KM efforts are "shot down" because KM "experts" have not taken the effort to assess, forecast and adequately argue for their potential impact on the organization's goals of improved productivity, revenues, profits and return on investment.

3.2 KM Strategies

Most organizations focus primarily on one or the other of two broadly defined KM strategies – "codification" or "personalization" (Hansen et al., 1999).

Codification, is primarily implemented in the form of electronic document systems that codify and store knowledge and permit its easy dissemination and re-use. This strategy is based on "re-use economics" – invest once in creating or acquiring a knowledge asset and re-use it many times.

Personalization, on the other hand, focuses on developing networks to facilitate people-to-people knowledge transfer and sharing. It is based on "expert economics" – channeling individual expertise to others with less expertise who may employ it to further the organization's goals.

Earl (2001) has described various KM strategies, or "schools of thought" at a more detailed level. He developed these empirically through observation in numerous companies. They are listed below in groups that emphasize their reliance on either the codification or a personalization approach.

Codification Sub-Strategies – Earl's codification-oriented sub-strategies are:

1. Systems (creating and refining knowledge repositories and on motivating people to provide content)
2. Process (developing and using repeatable processes that are supported with knowledge from previously conducted processes)
3. Commercial (the management of intellectual property such as patents, trademarks, etc.)
4. Strategic (the development of "knowledge capabilities" that can form the foundation of competitive strategy)

Personalization Sub-Strategies – Earl's personalization-oriented sub-strategies are:

5. Cartographic (creating knowledge "maps" or directories and networks to connect people)
6. Organizational (providing groupware and intranets to facilitate communities of practice)
7. Social (spatial) (socialization as a means of knowledge creation and exchange; emphasizes the providing of physical "places" to facilitate discussions)

While some organizations focus on only one of these strategies or sub-strategies, many use a combination of strategies that suits their needs.

3.3 The Organization of KM

KM is conducted in many different ways in organizations. Often, the KM function is headed by a Chief Knowledge Officer (CKO). If the organization's KM strategy is straightforward, the

CKO may lead a KM Department. In more complex situations, with a diverse set of KM strategies being implemented, the cultural differences that are inherent in different strategies suggest that a single department may not be the best way to organize KM. In such instances, the communications linkages among various KM groups are of great importance (King, 2005; King, 2008)

Related to this is the perceived role of organizational culture in influencing KM practice and success. A "knowledge culture" is one particular variety of organizational culture representing a "way of organizational life that...enables and motivates people to create, share and utilize knowledge for the benefit and enduring success of the organization." (Oliver and Kandadi, 2006, p. 8). Organizational culture is believed to influence the knowledge-related behaviors of individuals, teams, organizational units and overall organizations because it importantly influences the determination of which knowledge it is appropriate to share, with whom and when.

3.4 Extra-organizational KM

KM may be conducted across multiple organizations, such as with suppliers, partners and customers. Such KM activities obviously rely on communications networks and systems (Van de Ven, 2005).

"Value supply chain" inter-organizational networks are in common usage to enable retailers such as Wal-Mart to interact with suppliers to ensure that inventories are always of desired levels on retail shelves, in retail stockrooms and in warehouses and that deliveries are made according to a predetermined schedule. These systems operate on an "automatic" basis that is made possible by the knowledge that is embedded in the software by the participating partners.

The well-known Linux software development project is an example of the effective utilization of a loose network of volunteer knowledge creators. It operates with two parallel structures – one which represents the current "approved" version of the system and the other in which enhancements are continuously being developed and tested (Lee and Cole, 2003).

4 The Future of KM

King et al. (2002) empirically identified a number of "KM issues" through a Delphi study of Chief Knowledge Officers. The resolution of these issues represents a forecast of how KM will be different in the future. The top 10 issues were:

- How to use KM to provide strategic advantage
- How to obtain top management support for KM
- How to maintain the currency of organizational knowledge
- How to motivate individuals to contribute their knowledge to a KM system
- How to identify the organizational knowledge that should be captured in KM systems
- How to assess the financial costs and benefits of KM
- How to verify the efficacy, legitimacy, and relevance of knowledge contributed to a KM system
- How best to design and develop a KM system

– How to sustain progress in the organization
– How to ensure knowledge security

If all, or most, of these issues are resolved as KM matures, the future of KM will be largely determined by the manners in which they are resolved.

5 Conclusion

Knowledge management is a set of relatively new organizational activities that are aimed at improving knowledge, knowledge-related practices, organizational behaviors and decisions and organizational performance. KM focuses on knowledge processes – knowledge creation, acquisition, refinement, storage, transfer, sharing and utilization. These processes support organizational processes involving innovation, individual learning, collective learning and collaborative decision-making. The "intermediate outcomes" of KM are improved organizational behaviors, decisions, products, services, processes and relationships that enable the organization to improve its overall performance.

5.1 Organization of the Volume

This volume is organized into five sections.

After this introductory chapter authored by the volume editor, Sect. I, "Basic Concepts of Knowledge Management," provides up-to-date presentations of some of the fundamental ideas of the field. Frank Land's thoughtful essay, "Knowledge Management or the Management of Knowledge?", places KM in the long historical context of managing knowledge. The chapter by Kiku Jones and Lori Leonard, "From Tacit Knowledge to Organizational Knowledge for Successful KM," identifies organizational characteristics and KM initiative characteristics that may be antecedents or enablers of successful KM. The chapter by James Bloodgood, "Organizational Routines as Mechanisms for Knowledge Creation, Utilization and Storage," describes the role of routines in embedding knowledge into the organization and emphasizes that they may be difficult to manage. In the next chapter, David Schwartz and Doron Tauber present "A Maturity Model for Knowledge Management Systems Integration" which derives from an action research project that documented the development of 15 KM and IS systems over a 5-year period.

Section II, which is titled "Knowledge Management Issues," begins with the chapter "Knowledge Diffusion in R&D Groups: Re-examining the Role of the Technological Gatekeeper." In it, Eoin Whelan. Brian Donnellan and Willie Golden examine the traditional gatekeeper's role in the internet era and find that it has disappeared and been replaced by two new roles. In the next chapter, "Managing Asymmetries in Transferring Tacit Knowledge," Peter Sun discusses the behaviors that may occur in transferring tacit knowledge between two parties. Susanna Perez Lopez, Jose Manuel Montes Peon and Carmilo Jose Vazquez Ordas focus on "Information Technology as an Enabler of Knowledge Management: An Empirical Analysis" in the next chapter. The chapter by Richard Herschel and Ira Yermish deals with "Knowledge Management and Business Intelligence" and Line Gry Knudsen and Bo Bernard Nielsen treat "Antecedents of

Procedural Governance in Strategic Alliances" in their chapter. The last chapter in this section by William Lekse deals with "Enterprise-Wide Management of Intellectual Property."

Section III dealing with "Knowledge Management Applications" begins with "Virtual Worlds as Platforms for Communities of Practice" by Lakshmi Goel, Iris Junglas and Blake Ives. "Open Innovation Through Online Communities" by Paul M. DiGangi and Molly Wasko discusses the incorporation of end-users into the organization's innovation process. Sajda Quershi, Mehruz Kamel and Peter Keen provide "Knowledge Networking to Overcome the Digital Divide" in the following chapter.

Section IV, "Measurement and Evaluation in KM and OL" begins with Meliha Handzic's "Evaluating KMS Effectiveness for Decision Support: A Preliminary Analysis." The next chapter is "Valuing Knowledge Within Virtual CoPs: The Quest for Meaningful Indicators" by Pierre-Jean Barlatier, Yannick Naudet, Geraldine Vidou and Marie-Laure Watrinet. The chapter by Rene J Jorna, Niels Faber and Henk Hadders entitled "Organizational Knowledge, Cognitively Plausible Actors and Multi-Actor Systems" seeks to provide a basis for measuring organizational knowledge.

Section V treats "Organizational Learning." Chyan Yang and Liang-Chu Chen deal with the relationship between KM and OL in their chapter "On Using Organizational Knowledge Capabilities to Assist Organizational Learning." "Organizational Learning and Performance in Two National Cultures: A Multi-group Structural Equation Modeling Approach" by Miha Kerhvaj and VladDimovski empirically compares the impact of OL on organizational performance in two countries. The volume ends with Rene J. Jorna, Niels Faber and Henk Hadders' thoughtful essay titled "Sustainability, Learning, Adaptation and Knowledge Processing."

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Knowledge Management or the Management of Knowledge?

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Abstract. Knowledge Management has become in the past few decades an important branch of the wider discipline of Information Systems. Its importance is based on the observation that we live in a knowledge society and that knowledge has become a crucial component of a competitive organization. This essay argues that knowledge is a mark of civilization and has been discussed, disputed and managed in most spheres of human activity for all of history. The management of knowledge has been and is associated with control and power. Hence knowledge has been and is manipulated to achieve objectives beyond the ideal of truth. There is a dark side to the management of knowledge as exemplified by censorship, spin and propaganda. A study and understanding of the management of knowledge is needed if we want the discipline of knowledge management to be more than an idealistic rhetoric.

Knowledge is Power (Sir Francis Bacon, 1597)
Power tends to corrupt, and absolute power corrupts absolutely (Lord Acton, 1949)

1 Introduction

This essay sets out to show that what we have come to know as Knowledge Management (KM) as a major topic (or a discipline in its own right some advocates may claim) within the discipline of Information Systems is part of a much broader and older discourse relating to the Management of Knowledge. An interdisciplinary and historically grounded study of the Management of Knowledge has much to offer in helping our understanding of the relatively new, but extensively discussed topic of Knowledge Management. In particular it shows that Knowledge Management has a dark side which needs to be recognised and understood as much as the acknowledged benefits proclaimed for the new discipline. The essay is set out as follows.

A first section attempts to define "knowledge" but indicates the difficulty in finding an acceptable definition despite many attempts to nail the concept down.

The second section provides a brief review of the new discipline of Knowledge Management. This is followed by a section which puts KM into the context of the much older and broader study of the Management of Knowledge. Examples are provided of Knowledge Management from a variety of spheres of human activity.

A brief section on the impact of Information Technology on the Management of Knowledge is followed by Conclusions reached from setting KM into the context of Management of Knowledge.

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2 What is Knowledge?

The search for an answer to the question of "what is knowledge?" goes back to ancient times. It has been the subject of philosophical dispute at least since Plato's definition linking "knowledge" with truth. Epistemology is the label given to its study. The nature of knowledge is discussed within each scientific discipline, and outside science in politics, business and management studies, and religion. Each religion, for example, defines its notion of knowledge in terms of the knowledge of God, of life and death and of the hereafter. Knowledge has a complex and subtle relationship to language.[1] To the Eskimo knowledge about ice is conveyed by using the appropriate word in the Eskimo language. Other languages are not as accommodating and similar knowledge must be conveyed by means of descriptions subject to misinterpretations. Language as a means of communicating knowledge is enhanced by a variety of means including gestures, and intonations, many of which are lost in technology mediated communication.

As a way of understanding the term, knowledge has been categorised under a variety of headings such as "scientific knowledge" which is closely associated with scientific method. Another heading is "practical knowledge" based on skill and expertise. Practical knowledge has been valued through the ages. It is interesting to note the roller coaster history of practical knowledge in the evolution of civilizations. The Romans were noted for the extent of their practical knowledge, much of it lost in the so called dark ages. Did the eighteenth century hand-loom weavers of France and England have more practical knowledge and skills than their successors working in the factories created by the industrial revolution? And arguably the twentieth century progress chaser in a manufacturing business may have had more practical knowledge of his supply chain partners than the modern supply chain manager using the latest EDI technology.

However we look at it those seeking enlightenment from the literature may end up confused. Knowledge proves to be a slippery concept.

Within the modern field of Knowledge Management, knowledge has been defined in many ways and there is no consensus about its characteristics. Some prefer a broad definition. Thus the UK based Open Knowledge Foundation founded in 2004 to promote the ideal of making "knowledge" open and freely available sets out its own Open Knowledge Definition: "The term knowledge is used broadly and it *includes all forms of data, content such as music, films or books as well any other type of information*."[2] The definition does not distinguish between data and information and treats both as knowledge. Nor does it distinguish attributes of knowledge such as its relationship to truth, to understanding, and to wisdom.

Others such as Wilson (Wilson, 2002) have a more restrictive view and suggest that knowledge exists only in the human mind and "new" knowledge is created by a cognitive act associating what is in the mind with information perceived via the senses. An attempt to explicate

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[1] Take the biblical phrase "to know a women" and note the many levels at which this phrase can be interpreted.

[2] See http://www.opendefinition.org/ for definition and http://www.okfn.org/ for more about the Open Knowledge Foundation.

knowledge merely creates information which requires the mind of another to become knowledge. Wilson argues that much of what is termed knowledge management, cannot be distinguished from information management – knowledge management is merely a re-branding of the older notion of information management. Indeed he suggests that for the bulk of the knowledge management literature replacing the words "knowledge management" by "information management" would enhance rather than reduce the legitimacy of the arguments. Galliers & Newall (2003) echo much of this argument and suggest that the use of IT to facilitate knowledge management should more properly be regarded as the management of information and data.

More widespread is the view that knowledge can be both in the mind and in an explicated form disseminated and stored. As such, knowledge can be regarded as a commodity which can be traded and indeed stolen. When we purchase a cook book we are buying the knowledge of the author embodied in the text. Of course each time a recipe is used the outcome is the sum of the perceived knowledge culled from the cook book plus the understanding (knowledge) the book's user already has. But does the same apply to the algorithm embedded in a computer program which represents the knowledge of its inventor but is used automatically as part of an optimising process?

Polanyi's distinction between "tacit" and "explicit" knowledge has been the subject of much debate (Polanyi, 1967) Polanyi noted that human action is often based on what to the observer seems inexplicable reasoning. Polanyi found an explanation in the deeply, often culturally ingrained, beliefs and understandings which we carry with us but of which we are not consciously aware. Hence such tacit knowledge cannot be articulated or explicated. At best as observers we may be able to infer at least some aspects of this knowledge from the behaviour of the subject.

Polanyi's insight has been taken up by some of the knowledge management and organizational learning pioneers (Nonaka and Takeushi, 1995; Davenport and Prusak, 1998). They suggested that the conversion of internal tacit knowledge into explicit codified knowledge is the basis of knowledge management and provides the opportunity for sharing knowledge. Although this view is widespread in the knowledge management literature it has been challenged by Wilson (Wilson, 2002) who argues from his interpretation of Polanyi that tacit knowledge, being tacit, cannot be explicated directly by the knower. Instead Wilson prefers the term "implied knowledge" for what much of the KM literature refers to as tacit knowledge.

A deeper form of tacit knowledge is the physiological knowledge which determines all bodily functions such as muscle movements, the sending of chemical signals and so on. This kind of knowledge cannot be articulated, though sufficient is now known about it from medical science that it can be controlled by medication or active intervention such as a pace maker to regulate the heart.

Yet another form of tacit knowledge is the outcome of conditioned reflex. Behavioral psychologists have shown it is possible to modify the behaviour of an individual by associating a signal or stimulus with an action where the failure to act on the signal is associated with some punishment, or acting on the signal yields a reward. In time the subject "knows" that the mere presence of the stimulus requires the action to be taken even if there is no other overt reason for taking the action. Thus soldiers are trained to react automatically to certain signals and their survival may depend on the "automatic" nature of their response.

The problem of defining knowledge and knowledge management is illustrated by the case of the honey bee. A honey bee discovers the location of flowers suitable for collecting pollen and nectar. It can communicate its knowledge of the location to its fellow bees in the hive with an elaborate dance. In knowledge management terms this is an example of knowledge sharing for the benefit, even competitive benefit, of the community, the hive. To achieve this the honey bee requires many kinds of knowledge including knowledge of what flowers are suitable, knowledge of the location of the flowers and how to share that knowledge with its fellow bees. Yet the process of knowledge discovery and knowledge communication by means of the dance, appears to be partly learned – locating the source of nectar and pollen – and partly instinctive (genetic) – the language of the dance (Tarpy, 2004).

Reviewing the discussions on what is knowledge, it is perhaps safest to adopt the broader definition, and avoid hair splitting disputes as to what constitutes data information and knowledge though this still begs the important question of the relationship between what is deemed to be knowledge and truth, understanding and wisdom.

3 Knowledge Management

Knowledge Management as a domain of study within the general field of the Information Systems discipline has a relatively short history. Wikipedia gives 1995 as its starting date.[3] Nevertheless, in the 20 or so years of its distinctive existence it has acquired the status of at least a sub-discipline in its own right with conferences, journals, research and teaching communities, job titles and career positions devoted to it. It is characterized by a rich and rapidly growing literature including its own subject encyclopedias (for example, Schwartz, 2006).

It is not the purpose of this essay to define or review the state of the art. However, a brief note of some of its characteristics are in order.

Its main messages are:

That we live in a world where knowledge is now the most important resource or factor of production and that knowledge provides the leverage for success in a turbulent and competitive global system (Halal, 1999; Alavi and Leidner, 2001). To maintain that leverage in the face of rapid change (turbulence) organizations have to evolve improved ways of learning and in particular learning from experience and from the knowledge embedded within the organization as well as knowledge coming from beyond the boundaries of the organization (Senge, 1990; Nonaka and Takeushi, 1995; Blackler, 1995; Choo, 1998). But to enable the organization to maximise the returns from knowledge requires a new function – that of the knowledge manager, responsible for knowledge management.

That knowledge management comprises activities related to the creation, representation, storage, and dissemination of knowledge, and that Information and Communication Technologies (ICTs) provide the tools to enable these activities to be performed effectively (Bontis et al., 1999).

That a key ingredient to organizational learning is knowledge sharing. Shared knowledge, it is suggested, can provide synergy and be a catalyst for the development of new knowledge. This

[3] See http://en.wikipedia.org/wiki/Knowledge_management.

may require a major shift in attitudes in that in the past knowledge has often been regarded as if it were private property to be protected from being made use of by others. Indeed that is the basis for the treatment of intellectual property rights in law and in practice (Baskerville and Dulopovici, 2007). It should also be noted that many advances and innovations are the result not of sharing knowledge, but spring from the debate engendered by contested knowledge.

4 The Management of Knowledge

Knowledge has value, and knowledge can confer power as Sir Francis Bacon pointed out in a book published in 1597 (Bacon, 1597 quoted in Wikipedia), Both provide the incentive necessary for it to be "managed."

If it is accepted that a critical management role includes "control" then those who have knowledge in whatever area of endeavour have attempted to exercise some control over its dissemination and use. Similarly those who do not have the knowledge may seek to exercise some control over those who do have it. And where knowledge appears to conflict, each party attempts to secure control over the knowledge of the other. There are many management strategies. Many involve manipulation of the knowledge in question by such means as misappropriation, distortion, hiding, destruction – as when the ENRON auditors shredded documents which might have provided evidence (knowledge) of ENRON's transgressions – amplification, misappropriation, exaggeration, spin and propaganda (Alter, 2006). The acronym KM can stand for 'knowledge manipulations' as much as for the more familiar "knowledge management."

History provides numerous examples from many fields, and many of the examples were *cause célèbres* at the time they occurred. A well known example still resonates today. Galileo the sixteenth century Italian scientist and philosopher had from his own observations confirmed Copernicus' discovery that the earth moved around the sun and that the then current notion that the earth was the centre of the Universe with the sun moving round the earth was mistaken. The then all-powerful religious establishment claimed that it had a monopoly of (God given) knowledge disputed Galileo's claim and claimed that his heliocentric theory defied the truth as given in the scriptures. It arraigned Galileo before the Inquisition and demanded that he deny the knowledge he had gained on pain of dire punishment. Faced with this threat Galileo recanted and accepted, at least in public, that the church's understanding had more validity than what he knew to be the truth. The knowledge asserted by the church had a greater legitimacy then the knowledge he had gained through observation and rational thinking.

The example provides many lessons. If knowledge is power, then the opposite is also valid. The power and authority of the church made its version of knowledge the only legitimate knowledge and by definition represented the truth. Today much of what is deemed to be knowledge stems from its advocacy by those who have authority and power rather than from rigorous enquiry and evidence. And examples can be cited from most fields of endeavour, including the world of business.

Those who have the power and authority are reluctant to concede that the knowledge which they claim to have and which they may have used instrumentally to serve some purpose, could be false and that in accepting the replacement of their knowledge by the new knowledge they may be also be yielding their position as the authority. Most theologies have tended to deny the legitimacy of their rival's version of truth and have made strenuous efforts, including torture and warfare, to suppress alternative versions of knowledge.

They have also promulgated the notion that the knowledge they claim to have has to be protected. Thus Pope LEO XIII towards the end of the nineteenth century recognised the value of sharing Bible knowledge by publishing it in the vernacular, but prohibited its publication unless carefully supervised by the authorities, because he felt it could provide an opportunity for people to make their own judgment – an outcome which had to be avoided.[4]

This is not a far step from that to the principle of "need to know," enshrined in the management theories of Fredrick Taylor (Taylor, 1911). In many ways Taylor could be regarded as a pioneer of knowledge management. He insisted that workers and managers alike were provided with scientifically obtained knowledge about the tasks and procedures they were engaged in. At the same time work processes were broken down into small segments with each worker assigned to a particular segment, and the knowledge given to the worker was limited to that required for the task in hand. An underlying assumptions was that more knowledge would act as a distraction. Those in authority decreed what their subordinates where permitted to know based on the principle of "need-to-know."

Although scientific management has been criticised, in particular by those from the human relations school of management who advocated a sociotechnical approach to industrial systems design (Hill, 1971; Cherns, 1976; Hofstede, 1979), it, or version of it, were widely adopted, and in many ways lay behind the spectacular increases and success of the twentieth century US economy. Today ideas derived from scientific management, including the need-to-know principle, still drive much management practice.

A more recent example provides more lessons. ENRON is one of a number of major corporations who in recent years sought to cheat the community and enrich its owners by disseminating information about its trading performance which gave the market apparent knowledge which proved to be false and criminally fraudulent. Armed with their apparent knowledge of ENRON's performance the credit rating agencies rated ENRON as AAA. ENRON became one of the most "successful" corporations in the energy field and regarded as an example of best practice. Insiders writing after the fall of ENRON note that employees enjoyed working at ENRON because of its knowledge sharing culture (Cruver, 2003). What ENRON exemplified is an example of the use of, of what Thompson defines as "Counterknowledge" (Thompson, 2008).

Perhaps ENRON's use of the shredder was their version of the Mafia's code of honour – the management of knowledge by *omerta.*

ENRON is not, of course, representative of the way business devises (creates) fraudulent knowledge as a way of achieving the objectives of its senior management. Nevertheless there is sufficient evidence to suggest that business and individuals, both in the private and the public sector, regularly manipulate knowledge for purposes which are sometimes illegal and frequently work to fulfill hidden agendas (Bryant, 2006). There is a dark side to knowledge management, well known in the wider sphere of the management of knowledge, which needs to be more widely acknowledged by the advocates of KM and written into their research agenda.

[4]The Guardian Newspaper, 28 March 2008, 36 pp.

The next example comes from the human genome project (Land et al., 2009). A debate on intellectual property rights was triggered by the very different attitudes towards the ownership of new knowledge by the various teams involved in unraveling the human genome. One team headed by John Sulston of Cambridge University (Sulston and Ferry 2002), argued that the human genome belonged to all humanity and the outcomes of the elucidation should be available to all and should not be exploited by sectional interests. But apart from their ethical stance they believed and argued that taking an "open" to all position was of practical value in helping the project to succeed. 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.[5]

The argument they put forward matches exactly the argument at the centre of the case for knowledge management. The Human Genome Project team in the US, directed by Francis Collins, was working under the auspices of the US Government (the Department of Energy and the National Institute of Health) also held strongly to the view that the discoveries they made should be shared with all (Cooke-Deegan, 1994).

Nevertheless, that view was contested by other workers in the field. Many held that 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. Once again a particular ethical stance was bolstered by arguments about the efficacy of the position taken. Indeed a mission statement on the project 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 catalysed the multibillion-dollar US biotechnology industry and fostered the development of new medical applications.[6]

In May 1998, Craig Venter a senior scientist in the US project announced that he was quitting the Human Genome Project with plans to head up a commercial venture, Celera Genomics, with a mission to bring out the complete sequence three years later, but marketed as a proprietary database.

Collins and Venter eventually shared the outcome of their respective research and together with Sulston the epoch-making Human Genome sequence was published. Venter never gave up on his vision of the supremacy in a free market economy of intellectual property rights. It is ironic that he was fired by Celara Genomics for not being able to deliver the commercial outcomes expected from the project.

However, as Kyle Jensen and Fiona Murray of MIT reported, 20% of the known human genome has, in the USA, been patented mainly by private biotechnology and pharmaceutical companies (Guardian, 14 October 2005). Empirical research (Murray and Stern, 2005) indicated that

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[5] See http://www.sanger.ac.uk/press/2002/021007/shtml.

[6] See http://www.ornl.gov/sci/techresources/human_genome/shtml.

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, discovery and innovation, and those who favour an open stance as encouraging discovery and innovation, rages on.

Both sides in the dispute claim the ethical high ground. Those who favour the legal protection of intellectual property rights regard breaches of their privilege as piracy and the stealing of knowledge. For many years ethics papers have emphasized knowledge theft and software piracy as one of the principal ethical issue to be taught as part of any course on ethics in IS (see for example the section on Property in Mason, 1986).

Two of the most articulate advocates of the opposing view are Richard Stallman[7] of the Free Software Movement and coming from a very different ideological position Eric Raymond (Raymond, 2000) – Raymond from a libertarian free market stance, Stallman from a liberal humanistic perspective. Both espouse the principle of open source, for which they put forward arguments based on both efficacy and values. Critics have pointed out that in practice successful open source projects have relied on far heavier central control of the process than is suggested by the advocates, whilst others point to problems with accuracy and reliability in open source projects such as Wikipedia (Land et al., 2009).

But can the dispute between those who want to manage knowledge through the legal protection of intellectual property rights as against those who follow the open source and free software stance be settled in one direction or the other? In terms of values and ethics we can each make our choice. In terms of efficacy the jury is still out and it is difficult to see how research can settle the issue.

There are many other examples of the Management of Knowledge as practiced in the business world. Adam Smith, the pioneer of free market theory, pointed out that whenever (business) men gathered in a group they would conspire to subvert market forces for their joint benefit by, for example, fixing prices. And another widely practiced method is by the way knowledge is shared amongst selected companies to restrict competition in order to enhance share holder value. Cartels perpetuate themselves by their strict control over knowledge.

But perhaps the best example is the 2008 credit crunch and the consequent crisis in the financial markets. It could be argued that one of the underlying cause of the collapse is the practice of selling on debts by the process called "securitization."[8] This involves salami slicing mortgage debts including the sub-prime debts and enclosing them in packages sold on to other banks and treated by them as assets. The crucial knowledge link between borrower and lender is broken making any assessment of risk a lottery. Is this a deliberate attempt at knowledge management or the unforeseen outcome of manipulating financial instruments?

It also illustrates what knowledge management as advocated by its supporters could achieve. Given a policy of transparency and knowledge sharing the credit crunch might have been avoided and remedial action taken.[9]

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[7] See Wikipedia http://en.wikipedia.org/wiki/Richard_Stallman.

[8] http://en.wikipedia.org/wiki/Securitization.

[9] http://www.citywire.co.uk/adviser/-/news/property-and-mortgages/content.aspx?ID=293217.

The ancient art of advertising and public relations has found its modern incarnation as Customer Relations Management, aided and supported by information technology. Its apologists describe it as a means to improve market knowledge and remove some of the imperfections in the market. Its opponents cite CRM as merely another way of manipulating knowledge for the benefit not of the consumer but of the producer. Both views can be shown to have validity by the use of numerous examples. Again the Management of Knowledge has its dark as well as its light side.

5 Information and Communication Technology

In his keynote address to the IFIP 2006 Congress in Santiago, Chile, Professor Niels Bjorn Andersen[10] (Bjorn-Andersen, 2007) reviewed the impact of ICT on the Organization since the first introduction of IT into business under the title *The never ending story of IT impact on the Organization.* He noted that the current trends in technology, both computing and communications, were radically transforming business models and business practice towards what he terms "organizational re-invention" in the twenty-first century. The "Ambient Organization" applying Ambient Intelligence, is the new model, an organization which uses knowledge intensively (ISTAG, 2001).

The implication of Bjorn-Andersen's analysis is that the new organization will provide a new era of economic and social advance. But technology is neutral. It can be and is used as the optimists predict. But equally it can be and is used by the corrupt, the criminal, and those with political ends in mind. The same ambient intelligence can be used by the Mafia, the drug barons, the tax avoiders and the terrorist. Perhaps we need to remember the laws of mechanics – every action has a reaction equal and opposite to it.

6 Conclusion

Debate about the meaning and significance of knowledge and its relationship to truth, understanding and wisdom has an ancient lineage. Knowledge in its various forms has been valued and hence managed since civilisation began. Today's notions of what constitutes knowledge management with its rather narrow focus on business value and the role of the enabling technology has much to learn from the broader study of the Management of Knowledge through the ages and in most fields of human endeavour. The overt optimism suffusing the discussion of knowledge management in the bulk of the KM literature needs to be tempered by taking a look at way knowledge and the use of knowledge can be and is manipulated to achieve both good and bad outcomes.

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[10] A version was given as a keynote presentation at the IRIS Conference in Tampere, Finland in August 2007.

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From Tacit Knowledge to Organizational Knowledge for Successful KM

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Abstract. Certain organizational characteristics as well as Knowledge Management (KM) initiative characteristics are needed in order to have successful KM. These characteristics may affect each step in the KM process differently. One of the most difficult and interesting steps in the process is moving from tacit knowledge to organizational knowledge. This step is the focus of this chapter. Propositions concerning the effects of organizational characteristics (innovation and collaborative culture) and KM initiative characteristics (top management support, formal KM staff, incentive program based on quality, and communication about KM) are presented, as well as implications for future research in KM.

1 Introduction

Knowledge is considered a valuable asset to organizations (Plessis, 2005). Knowledge is the dominant, and probably the only, source of a company's competitive advantage (Srivastava, 2001). A paradigm shift has changed the way that knowledge is viewed. Employees use to stay at a company for their full career lives. Now, however, employees are switching jobs several times (Kim, 2005). When they leave, they take their knowledge with them. Therefore, knowledge hoarding among individuals can hurt the company; while knowledge sharing and collaboration can benefit the company by allowing the knowledge to stay within the company. Organizations must be able to capture the knowledge and experience of their employees to be able to change their tacit knowledge into organizational knowledge, so it can be used even after the employee is no longer with them.

Knowledge Management (KM) has been introduced into many companies. However, KM initiatives fail as much as they succeed (Malhotra, 2005). In order for organizations to have a successful implementation of KM, certain characteristics of both the organization and the KM initiative need to be present. Several articles in the KM literature have given characteristics needed for a successful implementation (Chong, 2006; Devi et al., 2007; Lee and Hong, 2002; Wong, 2005). Many of which have focused on either the characteristics of the company or the characteristics of the implementation itself. This article integrates both characteristics of the organization and characteristics of the KM initiative needed for success. Several steps are involved in a knowledge management process. One of the most difficult and most interesting steps in the KM process is capturing tacit knowledge and changing it to organizational knowledge (TK to OK). This step and the organizational and KM initiative characteristics' effect on this step are the focus of this paper.

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The rest of the paper is laid out as follows. The next section provides an overview of KM concepts, followed by a discussion of tacit knowledge and organizational knowledge. The subsequent section presents the proposed model for a successful implementation of KM from TK to OK followed by a discussion of propositions suggested by the model. Finally, a conclusion offering future research directions is presented.

2 Knowledge Management Concepts

Knowledge is information that has been understood and embedded in the brain. It is difficult to transfer knowledge from one person to another because of knowledge's personal nature (Osterloh and Frey, 2000). Knowledge is not data or information. Data is simply raw facts without context, where as information is data that comes with context. For example, the number 5,551,687 would be considered data. However, adding the context of a phone number turns the data into information. The continued use and understanding of this information will turn it into knowledge.

There is no universal definition of KM. An organization needs to "know what it knows," but this cannot be the full extent of KM. The organization also needs to be able to put this knowledge in some format where employees can utilize it. In other words, the organization must be able to turn tacit knowledge into explicit information. In turn, employees need to be able to use the explicit information to turn it into their own knowledge and be able to create and share additional knowledge from it. From these aspects of KM, the following definition will be used in this paper: *Knowledge Management is the process of acquiring knowledge from the organization or another source and turning it into explicit information that the employees can use to transform into their own knowledge allowing them to create and increase organizational knowledge.* Figure 1 depicts this definition graphically. The focus of this paper will be on the move from tacit knowledge to organizational knowledge.

There are two types of knowledge, explicit and tacit. Explicit knowledge is the type of knowledge that is easy to disseminate. The knowledge of how to place a bid on eBay is an example of explicit knowledge. It can be turned into explicit *information* by codifying it by way of procedures, policies, rules, etc. (Stenmark, 2001). Tacit knowledge, on the other hand, is not easily articulated. This type of knowledge exists within a person's mind and can be seen in his actions, but may be difficult to codify. The knowledge of knowing the right moment to increase your bid on eBay and

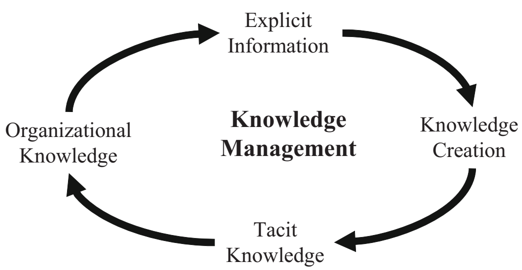

Fig. 1: Knowledge Management

by how much is an example of tacit knowledge. After repeated practice on eBay, this person *knows* this type of information. However, it may be difficult to codify it. This is the hardest of the two types of knowledge to capture and utilize, but may be the most valuable.

2.1 Tacit Knowledge and Organizational Knowledge

As stated earlier, the focus of this paper is to examine the move from tacit knowledge to organizational knowledge. Tacit knowledge exists in a person's mind, but may be difficult to articulate. Polanyi (Polanyi, 1966) stated that tacit knowledge is the background knowledge a person uses when trying to understand anything that is presented to him. Therefore, tacit knowledge can be viewed as including emotional and cultural knowledge. It may be characterized by intuition and impressions which can create incomplete memories (Ein-Dor, 2006). However, those memories can be made complete with the appropriate help. Ein-Dor (2006) gives the example of "identikits" that the police use to help witnesses to describe how a perpetrator looks.

Organizational knowledge is the collection of knowledge which exists in the organization that has been derived from current and past employees. This knowledge is "owned" by the organization in that the organization can take this knowledge and codify it in some way to preserve it within the organization itself even when an employee has left the company. As stated earlier, when knowledge is explicit, it can easily be codified to remain with the organization. However, when that knowledge is tacit, not only is it difficult to codify, but it may be even more difficult to identify.

Information can exist in an organization even when an employee is unaware of its existence, or vice versa. Johnson (1996) defines ignorance as an individual's state of unawareness about information regarding organizational life. This includes information about policies, procedures and organizational culture. Ignorance is present when the information exists somewhere in the organization, but the individual does not have it. In order for the individual to seek out that information, he must see some value or need for possessing the knowledge (Johnson, 1996).

This view of ignorance can be used in terms of an organization as well. By reversing the direction of the knowledge, the organization can be the one seeking the tacit knowledge that is present in the individual employees. Table 1 is a modified version of the mapping ignorance table (Johnson, 1996, p. 70). Each of the cells has been numbered for ease in discussion.

In cell 1, both the organization and the individual have possession of the knowledge. It is possible that either party is aware or unaware of this knowledge. In the case when one or both are unaware of the knowledge, they are still acting and reacting in a manner conducive to the knowledge. For example, an employee may turn in a project a week later than the deadline given.

Table 1: Mapping Organizational Ignorance (Adapted from Johnson, 1996.)

	Individual knowledge	
Organizational knowledge	Known	Unknown
Known	1. Aware and Unaware	2. Known unknowns
Unknown	3. Ignorance	4. Unknown unknowns
Error	5. Error	6. False truths
Proscribed knowledge	7. Denial	8. Taboos

The organization does not get concerned about the late project until it is over a week late. While it is not stated in any formal document that there is a week worth of "padding" for all projects, both parties are acting in a manner contributing to this knowledge.

In cell 2, the organization has knowledge that the individual does not. This may happen when an employee is new to the organization. This can be rectified by the step in KM going from organizational knowledge to explicit information (refer to Fig. 1). Putting the knowledge into some codified format provides the employee with the benefit of gaining the organization's knowledge. This is often done in a type of employee handbook.

Cell 3 is where an individual has knowledge that the organization does not. This knowledge is present within the employee, but not necessarily codified in a document. In other words, this is the employee's tacit knowledge. The organization recognizes the need to obtain this knowledge in order to increase the total organization's knowledge. This is the move from tacit knowledge to organization knowledge (TK to OK).

In cell 4, neither the organization nor the individual employee realizes there is information that is unknown. The "unknown unknowns" can be reduced by increasing the sources of information that the employee and organization use. For example, organizations can interact with the external environment (including customers, suppliers, and competitors) to gather this type of information. Employees can attend conferences to hear about the new technologies and concepts surrounding the organization's industry.

Cell 5 is when the organization thinks it knows what the individual knows but may be mistaken. This type of situation is easily fixed by communicating with the employee and asking that he review the information that the organization has crafted together. If it does not accurately represent the employee's knowledge, he can then correct it.

In cell 6, the organization has tried to understand and explain the knowledge that even the individual does not know. For example, as in cell 5, say that the organization tries to codify a procedure an employee performs. If the employee does not know exactly how he is performing the procedure, he will not be able to refute the codification. Perhaps there is a step in the process that the employee has always done, but never gave it much thought. He may not even realize he is performing the step. However, that very step may make the difference in a perfect product and one with flaws. If the employee does not know the step is needed and is missing from the codified process, he will not be able to correct the document. In turn, the next employee may follow the codified procedure and not be able to replicate the outcome.

The last two cells involve condemning knowledge. Cell 7 represents when both the organization and the individual have knowledge they wish to deny. An example of this may be when something has been done unethically. Perhaps an employee creates a system that is very similar, maybe too similar, to a rival product. Even though both the organization and the individual know it could only have been created by reviewing the competitor's proprietary code, they both choose to deny any knowledge of it.

Taboos are present in cell 8. Taboos are present when there is a penalty that can result from the search of information. For example, if some act were performed questionably, it would be considered a taboo for the organization to seek information regarding it. If they were to do so, they may risk losing the employee who performed the act. The organization may feel that keeping the employee is more important than gaining confirmation of the act.

While each of these cells can be discussed in terms of KM, it is cell 3 that is the focus of this paper. The move from TK to OK is one of the most difficult transfers of knowledge. Much of this knowledge may be difficult to capture because the individual may be unaware it even exists. It is important for the employee to be a willing participant in the organization's quest to obtain the tacit knowledge. There is much evidence to suggest that employees are not willing to share their information (Johnson, 1996). Certain characteristics may encourage this willingness and result in an easier and more successful implementation of KM from TK to OK. The next section presents the proposed model of the characteristics which can affect moving from TK to OK in KM implementation. Propositions are stated as well.

3 Proposed Model

When an organization does not fulfill the goals and objectives set for a technology, there tends to be a lean towards saying that the technology itself was the failure. However, it could actually be a failure of the implementation. An implementation fails when the employees do not use the technology as intended (Holsapple and Jones, 2007). With many organizations around the world practicing KM (Plessis, 2005), it would seem that "KM" as a concept could be considered a success. Therefore, if a KM implementation fails, it may be due to other factors.

As noted earlier, many KM articles have discussed characteristics that are needed for a successful KM implementation. Characteristics can be viewed in two dimensions: organizational and initiative. Companies with the right organizational characteristics can still fail at KM implementation if the needed initiative characteristics are not present. This can also be said in the reverse. Without the right organization environment, even the most thought out initiative can fail.

Hence, the proposed model for implementation includes both organizational and initiative characteristics. There are two organizational characteristics included: innovative and collaborative culture. Within the initiative characteristics there are four factors included: top management support, formal KM staff, incentives based on quality (not quantity), and communication about KM to employees. These characteristics can affect each of the steps in the KM process differently (Fig. 1). Here we discuss the effects on the step from TK to OK. Figure 2 presents the organizational and initiative characteristics and their relationship to the implementation of KM from TK to OK.

3.1 Organizational Characteristics

Characteristics of organizations can differ greatly. Because of this fact, it is important to consider these characteristics when trying to implement a technology that was not specifically created for the organization. Organizational characteristics can support or impede an implementation attempt. More specifically, whether or not an organization is innovative and has a collaborative culture can affect the implementation of KM.

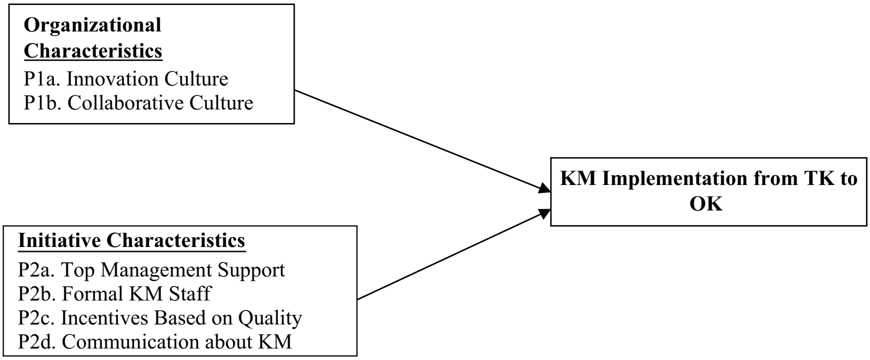

Fig. 2: Proposed Model for KM Implementation from TK to OK

3.1.1 Innovation Culture

Fidler and Johnson (1984) state that one of the factors that can mediate the success of an implementation is the organization's cultural norm towards innovation. Innovation cultures are open to new innovations and are willing to give their full attention to helping the implementation succeed. Employees are encouraged and rewarded for creativity. Everyone's job in an organization with an innovation culture is to become the teacher, coach and/or mentor (Kanter, 2000). This aspect of an innovation culture can particularly help in a KM implementation where the focus is on sharing knowledge. This can increase an employee's willingness to help the organization gain access to his tacit knowledge. If the employees have the mind set that by sharing their knowledge they can help others, the move from TK to OK will be much smoother. In addition, employees may be more willing to continue helping the organization in correcting possible errors and false truths after the knowledge has been obtained and codified.

Damanpour (1991) did a meta-analysis of effects of determinants and moderators of organizational innovation. He found that organic organizations find it easier to implement innovations. An organic organization is one that finds ways to organize for creativity and innovation. Innovation cultures have a clear vision and communicate it well to their employees (Campbell and Collins, 2001). In an organization with an innovation culture, the introduction of an innovation is well communicated. This includes all aspects, from the value of the innovation to the organization to the employee rewards from use of the innovation. In other words, innovation cultures do a good job of setting the correct climate for implementation of the innovation. Klein and Sorra (1996) discuss the conceptualization of climate. Climate is employees' "perceptions of the events, practices, and procedures and the kinds of behaviors that are rewarded, supported and expected in a setting" (Klein and Sorra, 1996, p. 1060). When this climate is set, all employees are on the same page and ready to begin the implementation process. This helps the employees understand and agree on the value of transferring their tacit knowledge to the organization. Because of these qualities, the following proposition is given:

P1a: Innovation cultures will have a more successful KM implementation from TK to OK.

3.1.2 Collaborative Culture

Culture can play a significant role in the KM process (Holsapple and Jones, 2005). An organization's culture in terms of collaboration can severely affect the KM implementation from TK to OK. The whole premise of moving from TK to OK is the sharing of knowledge. If an organization has not set that as the culture, it will have difficulty in implementing this move. Communication can create, maintain and change culture (Johnson, 1993). It is important for the organization to communicate the need and value of a collaborative culture. If not, employees may not wish to participate in the move from TK to OK. Greengard (1998a) states that there are pitfalls in an organization's culture that can cause problems when implementing KM. A couple of these pitfalls are relevant here: people don't like to share their best ideas; and people like to consider themselves as experts and prefer not to collaborate with others.

The first pitfall is due to employees feeling that "knowledge is power." In organizations where employees get promoted for knowledge that only they possess, the employees are more likely to hang on to their knowledge. The organization needs to be clear on what KM is about and what the goals of the implementation are. This pitfall has been present for so long that organizations will have to work hard to change the mindset. But once this is accomplished, the organization has made one step closer to a KM-conducive culture. Brown and Woodland (1999) found in their case study at Essvac, a vaccine manufacturing company, that employees were holding on to information as a means of control. They felt they needed to have "an ace up their sleeve." The willingness of the employees to share is the most critical factor for the success of KM (Holsapple and Jones, 2005). In order for the organization to resolve ignorance, the employees must be willing to share their tacit knowledge.

The second pitfall is a bit different. In this pitfall, the employee feels that the other employees have nothing to offer. This may reduce the organization's ability to gain that employee's tacit knowledge. Also, this employee may not feel the need to correct errors or false truths he identifies. In these cases, the organization needs to find ways to encourage teamwork. By having employees work in teams, the organization may be able to increase the employee's perception of the team members. Working closely with them will give the employees the opportunity to see how valuable their knowledge can be. This in turn may encourage the employee to want to help out his team members when he sees that there is an error or false truth present.

Once these pitfalls have been resolved, an organization can be considered as having a collaborative culture. A collaborative culture is more conducive to a move from TK to OK. The following proposition is given:

> P1b: An organization with a collaborative culture will have a more successful KM implementation from TK to OK.

3.2 Initiative Characteristics

It is not enough to have the organizational characteristics presented in the previous section. There are certain characteristics of the KM initiative that are also needed for a successful KM implementation from TK to OK. Not considering these may lead an organization to make mistakes.

More specifically, top management support, a formal KM staff, incentives based on quality not quantity, and adequate communication to the employees about KM are necessary for success.

3.2.1 Top Management Support

Top management support is critical for any type of change effort (Ehie and Madsen, 2005). There can be other project leaders that actually initiate the project, but top management support is needed in order to get employees on board (Holsapple and Jones, 2005). Employees need to see that top management supports the KM effort, or they may not be convinced it is a valid innovation and not feel comfortable offering their tacit knowledge. Mark T. Stone, director of internal knowledge management for Arthur Andersen's Atlanta-based business consulting division, states that organizations that succeed with their KM initiative always have top management support (Greengard, 1998b).

KM leaders have the task of explaining to top management the value of KM (Quirke, 2001). Top management needs to fully understand the initiative for it to become a reality (Holsapple and Jones, 2007). Because KM will affect most (if not all) areas of the organization, it is important that top management be able to help in decision-making during the initiative. In order for them to do that, they will need to know every aspect of the KM initiative. Top management will also need to be visible in their support of the initiative. This includes speaking intelligently regarding the initiative to other managers and employees. Since these managers will be seen and heard from by the other managers and employees, it is important to have the right top manager's support. This manager needs to be one that is trusted and respected by the employees. If not, it may create or enhance the cynicism in the organization (Reichers et al., 1997). Employees are protective of their knowledge. With the wrong top manager supporting the KM effort, the employees may feel that it would be a mistake to relinquish their tacit knowledge. If the employees do not trust the manager, they may feel as if he is trying to gain their knowledge to make them dispensable. Because of the importance of management support, the following proposition is given:

> P2a: An organization that has top management support of the KM initiative will have a more successful KM implementation from TK to OK.

3.2.2 Formal KM Staff

Because of the work involved in moving from TK to OK, it is important to have a formal KM staff in place. The staff needs to be in place before implementation begins. The KM staff is needed to find and describe the value of KM before implementation occurs (Wong, 2005). This will help to communicate and gain top management support. Essentially, the introduction of KM and the process of gaining knowledge is a new process to many organizations. The organizations have to change the way employees handle their knowledge. Al-Mashari and Zairi (1999) did an analysis of the literature surrounding the key success and failure factors of a business process re-engineering implementation process. They found that a critical component of success was a formal team devoted to the implementation.

In a survey conducted of information technology (IT) managers, 77% indicated that one of the top three reasons an IT related project fails is poor management of the project (followed by change in business goals during the project – 75% and lack of business management support – 73%) (Umble et al., 2003). Management of the project should be given to trusted individuals who are empowered to make critical decisions. This team will be responsible for the project plan, communicating it to the employees and assigning responsibilities, as needed (Umble et al., 2003).

In the case of KM, during and after the KM implementation, the KM staff will be in charge of determining where the organization's ignorance lies. They will need to target particular employees in order to decrease this ignorance. The KM staff will also be in charge of determining the value of each piece of tacit knowledge given to the KM system (Barth, 2000). They will monitor the use of the system (Ringle, 2001) and identify the pitfalls and try to address them (Smith, 2001). They will be in charge of determining what pieces of information led to the incorrect outcomes (sources of errors and false truths). Without a formal KM staff, the KM system would not get the attention needed for such an effort. Based on the workload involved in KM, the following proposition is given:

P2b: KM initiatives that have a formal KM staff will have a more successful KM implementation from TK to OK.

3.2.3 Incentives Based on Quality

It is important to provide incentives for participating in KM in order to overcome some of the pitfalls (Ardichvili et al., 2003; Desouza, 2003). Arthur Andersen has provided incentives (both monetary and other types) that can add up to several thousand dollars a year for those employees who regularly supply knowledge to their KM system (Greengard, 1998a). However, by providing incentives based on the amount contributed, the KM system may end up being overloaded with non-value adding contributions. This can lead to several errors and false truths.

It can be very easy for KM leaders to feel that volume equals value (Wong, 2005). KM leaders, especially in the beginning, are looking for evidence that the employees are participating in the KM initiative. When they see the amount of contributions, it can be a way to justify the value of the KM system. Arthur Andersen found it necessary to put some type of quality check program in place (Greengard, 1998a). They formed a group of knowledge managers who were responsible for reviewing each submission. Before information was posted to their KM system, it had to be certified as adding significant value to the organization. The consultants would receive bonuses not only on the quantity they submitted, but also by how often their contributions were used. The consulting company felt that while it wasn't a direct assessment of the quality, it at least showed where it could be of value to the organization (Greengard, 1998a).

Scott Smith, member of IBM's Global Knowledge Management Consulting and Solutions in Somers, NY, discovered that their KM repository soon became unwieldy (Barth, 2000). Smith stated that it never occurred to them that they needed to look at and manage the content of the intranet-based repository. The managers were offered incentives for contributing to the repository that were reflected in their performance evaluations and/or bonuses. One of the biggest problems with this was everyone submitted at the same time. Since the evaluations were based on a calendar year, 90% of the submissions came in between December 15 and 31 and most of the submissions were long and unintelligible. Therefore, IBM changed the submission process. A network of experts on a rotating basis would review the contributions to the repository. In this way, each of the contributions submitted were checked for quality before being added to the knowledge base. This can help in cutting down the possibility of errors and false truths. Each expert refining the information until it accurately reflects what is true can reduce the errors. This will subsequently lead to less false truths. Based on these observations, the following proposition is given:

P2c: Organizations with incentive programs based on quality, rather than quantity, will have a more successful KM implementation from TK to OK.

3.2.4 Communication about KM

Communication plays a major role in any successful implementation. The extent to which communication can reduce uncertainty can influence the acceptance and use (Fidler and Johnson, 1984). Therefore, a communications strategy in the KM initiative is vital to a successful implementation (Smith, 2001). The employees need to understand how KM will affect their roles in the organization. The successful move from TK to OK depends on the employees' willingness to participate. If they are uninformed as to its value, they may be less likely to use it. They may also be less likely to participate if they feel that after their knowledge is transferred, they will no longer be needed. It is important for the organization to communicate how KM is a circle and that by employees providing their tacit knowledge, new knowledge can be created. This gives employees a continual opportunity to spawn new knowledge.

Communication regarding the KM system needs to be accurate and given from people the employees trust. Communicating about the innovation in an incorrect manner can hurt the implementation and create cynicism about KM. Reichers et al. (Reichers et al., 1997) give strategies for reducing cynicism from employees regarding organizational changes. One of the strategies is to keep people informed about changes in the organizations (when, why and how); this suggests that it is important to fully communicate the information about KM. The organization needs to discuss when the initiative is to be started, why it is important to the organization (and employee) to do this, and how it will be implemented. Mark Koskiniemi, vice president at Buckman Laboratories, stated that it was an enormous effort to communicate all of the information about KM to the employees (Greengard, 1998a). "We had to assist them in understanding what the system is, what it does and how it can benefit them personally…Managers had to learn they no longer can oversee the flow of information within the company; they have to help employees get the information they need" (Greengard, 1998a, p. 94). KM needs to be clearly defined in order for it to be understood and accepted as a normal working practice (Holsapple and Jones, 2006).

Reichers et al. (1997) also suggest enhancing credibility when communicating a change in the organization. Part of this is using a credible manager as a spokesperson. Ernst & Young Management Consulting Group chose what they call a "missionary" (Mullich, 2001). Gene Tyndall, the missionary, was a senior vice president who had a successful track record in persuading employees to get on board a project. One of his roles as missionary was to individually talk with employees who were noted as not participating in the KM project. Tyndall was able to show the value of the KM initiative and why it is important to everyone. This role made the employees feel as if he took the time to personally explain the vision. Employees responded well and began participating in the project. Quirke (2001) stated that it is important for the organization to change their words when communicating to the employees about a change. It is important to use words that show the personal side to the change. This needs to be focused on the move from TK to OK. Employees need to understand that they will be gaining much more than they are giving.

Another strategy given by Reichers et al. (1997) suggests that there needs to be opportunities for the employees to express their feelings. The Arthur Andersen consulting group included seminars and workshops as a part of their KM initiative (Greengard, 1998a). This gave the employees a chance to learn about KM and voice their concerns. They also created cross-functional teams that included non-technologists to help in making decisions about the KM process. American Management Systems (AMS) also created teams in their KM initiative (Smith, 2001). The team representatives would meet monthly to discuss concerns from the different areas. This helped to provide input from several areas in the organization when developing the mission of the KM initiative. Based on these observations, the following proposition is given:

P2d: Organizations that provide adequate communication to the employees about the KM initiative will have more successful KM implementation from TK to OK.

4 Discussion

Much research has been conducted regarding KM, but little research has been devoted to the knowledge transfer from an employee's TK to OK. This paper provides a starting point for future studies in KM implementation and knowledge transfer. Our proposed model for KM implementation from TK to OK presents two types of characteristics which can affect the implementation – organizational and initiative – and propositions for each. The propositions give researchers a way to study the move from TK to OK in the KM implementation process.

Researchers can test one or all of these propositions in an organizational setting. Surveys can be conducted of organizations that have attempted to implement KM. In the survey, researchers can ask questions regarding the extent to which the organization possessed the proposed organizational and initiative characteristics. Results of the move from TK to OK can also be obtained in the survey. A comparison of the extent to which these characteristics were present and the resultant success/failure of the move from TK to OK can be tested to see if there is a relationship.

Further investigation of the KM implementation from TK to OK can be reviewed for additional characteristics required for success. Some of these characteristics appear as if they may interact with one another. For example, having a formal KM staff may interact with how much communication is given regarding the KM program. Perhaps some of the characteristics will be determined to be a moderator to the other propositions. For example, it may be that top management support leads to a more successful implementation only in cases where adequate communication has been provided.

While the move from TK to OK is very important, equally important is the transfer from OK to explicit information. If the organization is successful at getting employees to submit their tacit knowledge, but unsuccessful at getting their employees to review and use the submitted knowledge from other employees, the cycle of KM is not complete. Essentially, the employee who originally possessed the knowledge is still the only one with that knowledge. Researchers will want to determine what factors affect this step and the other steps in the KM process.

Practitioners can also benefit from this paper. We have provided a framework for practitioners to use when preparing to implement KM from TK to OK. By following the propositions given, organizations can further enhance their KM implementation. Each of the constructs involved can be identified in an organization. The organization can try to improve the relationships suggested by the propositions with their intended outcomes.

5 Conclusion

The KM implementation from TK to OK is an important subject for both researchers and practitioners. While previous literature has given a partial prescriptive for the success of KM implementation, none have been complete. This paper seeks to include all areas for consideration when trying to implement from TK to OK. Researchers and practitioners can use the proposed model to further their understanding and practice of the move from TK to OK.

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Organizational Routines as Mechanisms for Knowledge Creation, Utilization, and Storage

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Abstract. Organizational routines can be viewed as mechanisms for knowledge creation, utilization, and storage. Many routines, by their very nature, become buried in the daily work of an organization. In time, organization members become less conscious of many routines and these routines subsequently become more difficult to manage. This difficulty reduces the likelihood, in some cases, that the knowledge benefits originating from routines will be effectively appropriated by the organization. This paper describes the nature of organizational routines and describes some ways in which they can be managed for positive organizational benefit.

1 Introduction

Knowledge management within organizations includes a wide variety of activities. These activities are designed to capitalize on the positive effect that knowledge can have on the performance of an organization. For example, a firm that has learned how to successfully operate a joint venture with a firm from another country may find that its performance could increase even more if it initiated additional joint ventures and operated them using the knowledge it gained from the first joint venture.

In order for an organization to have the best chance for success at knowledge management, all of the component activities, such as knowledge creation, utilization, and storage, should be focused on by managers within the organization. Obviously, different types of knowledge are going to require different types of management processes in order to obtain the most success from the knowledge. For example, an organization that wants to identify the best approach for increasing the strength of the steel it produces may want to focus its research and development spending on laboratory experiments, while an organization that wants to enhance the teamwork skills of its first-line supervisors may want to send its supervisors to formal training sessions followed up by on-the-job training. The steel producing organization may then want to protect its knowledge from competitors by patenting any new processes it develops, while the organization seeking teamwork skills may want to protect its knowledge by making sure it has appropriate compensation levels for its supervisors in order to inhibit turnover.

The previous examples demonstrate that organizational knowledge can exist in a variety of forms. A new recipe for stronger steel can be written down. A list of supervisor teamwork skills can be written down and then practiced and modified by individuals in order to develop skills that

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best match an individual's unique characteristics. Skills associated with operating an international joint venture may also be written down to some degree, however the majority of knowledge may be tacit and be buried in the minds of individuals or in the routine interactions of multiple individuals developed over time. All of these types of knowledge can be valuable to organizations, but the knowledge that is buried in the interactions of individuals within an organization is typically the most problematic for managers because it is difficult to codify and directly manage (Nelson and Winter, 1982). These interactions are termed organizational routines, and through their operation they create, utilize, and store organizational knowledge that can be used repeatedly in the future. Thus, knowledge management includes the management of the knowledge that exists in organizational routines. The management of the knowledge in organizational routines requires special consideration of the unique characteristics that routines possess. Thus, it is important for managers to fully understand the creation and operation of various types of routines in order to most effectively manage them and the knowledge they represent.

2 The Nature of Routines in Organizations

Routines are thought to characterize much of the work performed in organizations (Feldman and Pentland, 2003). They can operate at the individual level, among groups of individuals, across an entire organization, and interorganizationally. Although the initiation of each of these various types of routines may be planned or unintended, the outcome can be the same. The operation of these routines can result in the accomplishment of a significant portion of the organization's activities.

The activities that organizations engage in as a normal course of doing business have a beneficial side-effect of creating information and knowledge (Porter, 1985) that can aid in the development of new resources and capabilities (Itami and Numagami, 1992). Dierickx and Cool (1989) similarly argue that resources develop internally within organizations over time. As individuals and groups of individuals engage in actions designed to complete tasks and solve problems they often rely on their existing repertoire of behaviors and cognitive abilities. Although their repertoire may be incomplete in regards to providing the means to accomplish certain new tasks, much of what gets done by individuals in an organization can be deemed as routine (Vromen, 2006). The definition of a routine used here will be the same as Cohen et al.'s (1996: 683) which states that a "routine is an executable capability for repeated performance in some context that (has) been learned by an organization in response to selective pressures." Although it is easy to see that repeated tasks are best engaged by triggering an existing routine, many so-called novel tasks are initially handled by accessing the routine that most closely resembles the task's needs. Of course, existing routines may not always be able to successfully deal with novel tasks, but modifications of these routines can occur in the process of completing the task and augment the capabilities of the organization (Cohen, 1991).

One reason why individuals and sets of individuals rely on prior behaviors to guide future behaviors is that moving away from the known to the unknown is considered risky and fearsome (von Krogh et al., 2000). Thus, new behaviors are often avoided when possible and when past behaviors offer a reasonable alternative. This satisficing behavior enables sufficient progress in an activity without the overbearing, and potentially complex, effort to optimize the process (March and Simon, 1958). This general tendency to draw from an existing repertoire of known behaviors is conducive to the creation and maintenance of organizational routines. Routines have even been found to be utilized when more efficient and effective alternatives become available (Cohen and Bacdayan, 1994). Although, routines may be relied upon beyond their appropriate or optimal use, clear failure from the use of a routine increases the likelihood of novel approaches being selected in future attempts.

A second reason why individuals often rely on routine behavior is that they are not always conscious of what they are doing (Cohen and Bacdayan, 1994). When conscious awareness is low, individuals are less likely to actively analyze a situation and create an optimal choice to address the situation (Whittington, 1988). For example, when past behavior has been productive it can affect the evolution of future behavior in an automatic fashion with a resulting diminishment of conscious deliberation (Güth and Stadler, 2006). When this low conscious awareness is combined with few structural elements to consider, a more tacit and routine approach is likely to be taken (Bloodgood and Morrow, 2003). Thus, there is likely to be variance in the amount of routines being used in situations to the extent they differ structurally.

Routines offer repeated performances, thus they can be characterized as organizational knowledge utilization and storage devices (Cyert and March, 1963). When a situation calls for a particular routine to be activated, the routine initiates a set of actions that have been used in the past. These actions are stored because of prior use, and are therefore available for future use in similar situations.

Organizational actions and knowledge have a reciprocal relationship (Smith et al., 2006). Each influences the other in an ongoing manner. As such, organizational routines embody learning, via skilled performance, that takes place within the organization (Cohen, 1991; Singley and Anderson, 1989). As an organization gains experience in a situation, any actions that are presumed to contribute to the completion of a useful task will be called upon each time that task is needed to be accomplished by the organization. Over time, the actions related to the task will become more connected and routinized (Nelson and Winter, 1982). Some of these routines can become automatic once they have been utilized often enough. The knowledge that becomes embedded in these routines can result in productive organizational behaviors that no individual or group of individuals within the organization can fully characterize (Badaracco, 1991).

When an organization is exposed to a frequently observed and acted upon environmental cue, it sets in motion routines that exist to deal with the circumstances that are associated with the cue. For example, if an organization receives a product complaint from a customer it may set in motion a routine that involves multiple parts of the organization with smaller routines subsequently becoming engaged. One part of the routine might consist of a member of the customer service department contacting the customer and collecting additional information about the complaint. This information will then be channeled to appropriate departments within the organization. Another part of the routine might involve members of the manufacturing plant examining production processes to determine if there are any operations that are not operating within normal bounds. A third element of the routine may consist of a purchasing agent calling or visiting a supplier who makes the parts of the product that the customer complained about. As information from these various parts of the routine are sent back to a central point, another part of the routine may include discussion by some organizational members about how these various pieces of information fit together to explain the source of the problem associated with the customer complaint. Over time, if the organizational actions become frequently engaged, the organization members will move from a "what do we do next?" approach to automatically doing what needs to be done with little questioning and little variance in their actions.

The actions that are part of the routine can be envisioned as being stored and available automatically when cued by the environment (Cohen and Bacdayan, 1994). The environment can be internal or external. Thus, the knowledge of how to handle a customer complaint becomes stored in the set of actions that are available when cued. Initially, these actions may be consciously constructed with variance in their employment. Over time and through the routine's frequent enactment, however, the elements of the routine become increasingly automatic, invariant, and tacit. When the organization needs to utilize the knowledge that is buried in the routine, it becomes available automatically through the engagement of the routine, but remains stored for future use as long as the routine is utilized frequently enough to maintain its automaticity (Nelson and Winter, 1982).

The knowledge that is buried in the routine, however, is likely to not be available from a cognitive standpoint. In the most automatic routines, the knowledge is primarily available to the organization only through their use. Conscious reflection will often provide an inaccurate or incomplete description of these routines. Thus, the similarity to tacit knowledge exists from the viewpoint that the knowledge can be applied, but not fully codified.

Successful attempts at the management of knowledge across an organization must include, to some extent, the management of the organization's routines as a central aspect because of the tremendous amount of knowledge buried within them. Although there are many types of knowledge that organizations need to deal with, the knowledge buried in its routines are especially critical to its overall functioning (Nelson and Winter, 1982). These routines are the heart of the operation of many organizations. Useful and valuable behaviors are repeated when appropriate in order to enhance the organization's performance. As these individual behaviors organize into sets of behaviors (routines), the sets that are cued more frequently will become more invariant in their application than the sets that are cued less frequently.

Because these routines are involved in much of the work in organizations, they are highly important and some type of management attention is therefore prudent in order to ensure the judicious operation of the organization. Some examples of routines that are important to a firm might include filling customer orders, quality control inspection, setting up customer accounts, and manufacturing a product. Routinizing these activities in a useful manner provides the organization with a consistent and effective means with which to complete them. Organizations can rely on the outcomes of these activities to be consistent and therefore more easily incorporated into the overall strategy of the organization.

One problematic issue with routines is that there is often nobody in charge of many routines (Sparrow, 1998). This is particularly true for self-generated routines where the routine developed over time by necessity or by accident rather than by fiat. The existence of some of these routines may not even be known by some of the participants. As such, some routines are harder to understand and therefore manage than others.

2.1 The Creation, Utilization, and Storage of Routines

In order to manage routines effectively, an understanding of how they are created, utilized, and stored is necessary. Of course, routines can be self-generating, automatically deployed, and stored without explicit knowledge of their details or even their existence. These characteristics make it difficult to manage routines. They also often make it difficult to track their performance and usefulness to the organization.

A fervent debate has developed as to the degree to which organizational routines can or should be actively managed. One of the main sticking points is the inability for any particular individual to comprehend all of the elements of a well-established routine (Badaracco, 1991). On one hand, the importance of routines to an organization suggests their management is also important for an organization to realize all of the benefits of routines. On the other hand, active management may unduly influence or interrupt the activation and operation of the routine to the extent that the routine does not engage at the correct time or place, or the routine becomes disrupted and inoperable (Nelson and Winter, 1982). An example of this at an individual level would be asking an accomplished pianist to verbally state each note as it is being played, and with which finger, in order to check that the notes are being played efficiently. Although there is good intention on the part of the manager in this case, forcing the pianist to verbalize the notes being played in this way will likely cause the pianist to disrupt his or her routine thereby upsetting the timing and delivery of the notes.

To be sure, a routine that is no longer effective may benefit from disruption and a reordering of its elements. Active management is more likely to be beneficial in these types of routines than it is in longer-standing and effective routines. This is readily apparent in routines that act as buffers to uncomfortable situations for the members of a routine (Sparrow, 1998). For example, decision making involving layoffs may be particularly stressful to a management team. Over time, the management team may have developed a routine that involves each member contributing objective data on all employees, and a spreadsheet program is used to order the employees for layoffs based on some algorithm. Although this process gives the appearance of fairness and appropriateness, it does not provide for an intangible assessment of each employee that could significantly weigh in on the ordering of employees. This process helps managers to avoid the pain of personally selecting individual employees for layoffs, but it may be less effective in selecting the appropriate employees. Over time, if there are ongoing layoffs the process can become so routine that managers do not even comprehend that there is any other way to perform this function. One dysfunctional outcome of the existence of the routine might be that individual employees who are aware of the objective measures used in the algorithm will then completely focus on those objective measures and disregard intangible parts of their jobs that are valuable and may actually be larger contributors to the success of the organization.

2.2 Formal and Informal Routines

The creation of routines can be either formal or informal. In a proactive manner, organizational members can plan out ahead of time the specific actions they believe will enable a certain task to get accomplished. Alternatively, organizational members can be more reactive and deal with work issues as they arise. Both approaches can lead to a routinization of the actions that are engaged in by the organizational members.

Routines can remain constant or they can evolve over time (Howard-Grenville, 2005). Some routines are consciously developed and installed within the organization in order to accomplish a task more effectively than has been done in the past. An example of this type of formalized routine would be when a sales manager at an automotive dealership dictates the steps to be taken when a salesperson is negotiating with a customer. The first step may be to present the list price to the customer. If the customer accepts the price the deal is completed. If the customer makes a counteroffer, then the salesperson must return to the sales manager for consultation and an acceptance or counteroffer to the customer. These steps may be followed until the price is agreeable to both parties or until the customer leaves. Many dealerships will bring in the sales manager directly if the negotiation continues for too long or the customer appears upset or ready to leave. There are many more smaller elements of the routine, but practicing it and utilizing it each time a customer wants to make a purchase will cause the routine to become more stabilized.

Routines can also be formed informally. For example, when a customer service representative for a software company tries to help customers with software problems, she may notice that customers that call early in the morning are very upset because they have not been able to fix their problem all night. She may have found that taking the time to attempt to calm down these customers seems to work and make the customers happier upon completion of the call. The customer service representative may also have found that customers who call toward closing time are in a big hurry so they can fix the problem and go home for the day. The customer service representative may, in this case, find that getting right to the problem rather than spending time on calming the customer works better. She may change her approach as the day progresses, and find that this overall approach works very well. It may have taken months or years for the customer representative to develop this approach. As she tries to improve her effectiveness over time, she has developed a routine that plays out one way in the morning and another way in the afternoon. As these actions begin to involve multiple individuals, the informal interactions that result among them can lead to increases in tacit knowledge (Nonaka and Takeuchi, 1995; Schulze and Hoegl, 2006) that can assist in the performance of the routine without conscious awareness as to the details of that knowledge.

Of course, as the environment changes, these routines can evolve to become more responsive to the changes (Howard-Grenville, 2005). For example, if the automotive dealership faces customer pressure to become a one price dealership (e.g. Saturn or Scion), the sales routine may have to drastically change. In this case, for example, the salesperson may not have any reason to go to the sales manager any longer except to finalize the deal. There are no price negotiations any longer. At the software company, distant new customers from very different time zones may begin calling the customer service representative. Some of these customers may call at the beginning of her shift, but they in fact are toward the end of their work day. Alternatively, some customers may be just beginning their day when the customer service representative is ending her shift. To appease these customers better, she may identify the location of various customers who call in order to better understand what types of time pressures these customers are facing.

2.3 The Activation of Routines

Organizational routines can be activated consciously or automatically. Each type of activation process provides for differing results. As previously mentioned, some routines are automatically cued by the environment while others are consciously chosen by organization members to initiate. Automatic routines, by their very nature, do not require any conscious thought to begin (Cohen et al., 1996). These types of routines tend to be well utilized and their commencement brings little if any attention. Consciously activated routines, on the other hand, require more human awareness and analysis of the environment before the routine is initiated. There is more conscious choice in these types of routines. Although both types of routines are necessary for organizational success in most environments, the results from their use can be very different.

For instance, automatic routines tend to be invariant in their operation (Nelson and Winter, 1982). Without conscious intervention, there is little to alter the elements of the routine as they play out. Much like the bell towers found on many university campuses, once the parts of an automatic routine are set in motion, they do not vary. Certain parts of the timing mechanism move about in a set pattern, which causes other parts to move in their own set patterns, thus commencing in an hourly ringing of the bells in a consistent manner. Consciously activated routines, instead, rely on conscious human involvement to begin. For example, the same bell tower may be used to signal an important event on campus, or to mark an important person's passing. In these instances, someone will trigger the bells to ring in a certain pattern appropriate for the event. There is relatively more variance in these situations than there is in the hourly chiming of the bells because different bell sounds and lengths of play may be used. New combinations of sounds and lengths of play that are under consideration for new purposes, will likely provide the most variance while they are practiced and installed within the repertoire of the bell tower play list. Over time, through frequent use, these new combinations can become more routinized and subsequently more invariant in their operation.

2.4 The Storage of Organizational Routines

The creation and utilization of routines directly affect their storage characteristics. The previous discussion has provided a description of these activities and the affect they have on routines. Although the extremes of the creation and utilization types have been discussed in order to clarify the distinction between each type, a bimodal distribution of routines solely into automatic and consciously activated categories is not being suggested here. Rather, these characteristics are being used to help explain the differences among routines that have more or less of these characteristics. Many routines are likely to involve both automatic and conscious elements (Hoetger and Agarwal, 2007). Both of these elements, however, affect the storage characteristics of a routine within the organization. Routines that are more automatic in nature will provide much less explicit detail about their storage than will consciously activated routines. It is not always clear who is involved in the operation of a routine. Some organizational members may be obvious choices as to their involvement, but others, especially those that may play a smaller role, will be less obvious. The behaviors each organization member engages in that affect the routine is also difficult to identify in automatic routines. Little conscious thought is given to these behaviors so they do not register in the minds of those performing them (Nelson and Winter, 1982). Thus, their storage is primarily based on a series of cues that trigger participating members to behave in certain ways in a certain sequence. These sequences can be very complex, thus further obscuring their explication. To bring an automatic routine out of storage, one must activate the routine and let it play out.

Consciously activated and utilized routines are much easier to delineate when stored than are automatic routines (Bloodgood and Morrow, 2003). The conscious thought that goes into their activation and subsequent use enables these types of routines to be explicated to a much greater degree than an automatic routine. The clarity of this portrayal is dependent on how closely the routine is followed in relation to its formal design. Human nature influences individuals to improve their work practices over time. Thus, over an extended time period, minor changes that members of the routine initiate to improve efficiency or effectiveness can snowball into much larger changes that are very different than the original formal design of the routine. Gleaning knowledge from the operation of the routine may become more difficult when this occurs. Managers who assume that the routine is running as designed, when it really is not, may see the routine's deficient outputs and decide on a course of corrective action that interferes with the actual beneficial operation of the routine. Thus, in this case, the managers are inadvertently making the problem worse for the organization.

3 Managing Organizational Routines

The preceding discussion described the various types of organizational routines and provided an understanding of how they operate within organizations. The following discussion provides, through a series of questions and responses, an explanation of how managers can address important issues related to the role of routines within their organization. Important questions that managers may ask have been identified and answers provided in order to assist managers in better understanding how routines can best be handled within their organization.

In what situations are various types of organizational routines the most beneficial?

Although the architecture that connects various knowledge management elements of an organization can be very important for integrating these elements in an effective manner (King, 2006), specific elements by themselves, such as routines, can vary in usefulness to the organization's success depending on the circumstances. For example, the external and internal environment of an organization can significantly affect when and where routines are likely to be most useful (Cohen et al., 1996). External environmental characteristics (situational factors), such as industry type, can affect the usefulness of knowledge management (Liang et al., 2007). In industries undergoing significant change, like high-technology, there may be a premium placed on knowledge management activities such as knowledge creation and transfer. For example, it may be very important in the television manufacturing industry to be able to create new product knowledge during the research and development processes of multiple technologies and then combine the knowledge from these technologies to create new or better products. In contrast, more mature industries, such as paper mills, may rely more on the utilization of existing knowledge. For example, quick and effective access to existing knowledge during operations may provide paper mills with the ability to more quickly ramp up production after lines are shut down for maintenance.

Both of the previous examples have the potential for routines to develop. In the television manufacturing industry, for example, certain types of basic research processes could be routinized. The testing of new materials, for instance, may be more productive if a particular protocol is used consistently. Over time the organization members involved in new material testing are likely to become more fluid and automatic in their actions related to the protocol. In a paper mill, organizational members that are involved in the production startup after maintenance shutdown will also become more fluid and automatic in their actions related to this function. Of course, the frequency with which these actions are engaged will significantly affect their resulting automaticity (Nelson and Winter, 1982).

Other characteristics of the external environment can also affect the types of routines that develop within organizations. Dynamism within an industry can make it difficult for some basic routines to develop because of the frequency of change hindering the progression toward automaticity. For example, simple activities such as accounting or payroll processes are usually very amenable to routinization (Saarinen and Vepsalainen, 1994). However, if frequent compensation, legal, and payment changes occur, routinization becomes more problematic. If dynamism is continually high in an industry, higher-level routines may develop to handle it (Eisenhardt, 1989). For example, in the automobile manufacturing industry there are many changes that occur in the environment. Factors such as fuel prices, customer design preferences, pollution, safety, and fuel usage regulations, and technological advances occur frequently enough to make it difficult for automobile manufacturing firms to routinize car design. However, the firms in this industry may be able to routinize the handling of these changing demands by setting up a repetitive process (Beck et al., 2008) at the executive-level that regularly assesses the status of a large set of changing variables that affect car design. With this process initially being formalized, the participants can begin to automate their interactions rather than just calling a meeting, with a resulting open and unstructured discussion, because fuel prices have increased or demand for pickup trucks has dropped.

Characteristics of the internal environment can also affect the creation of routines within an organization. Factors such as organizational culture, job design, reward systems, and technology utilization can influence the degree to which organizational members routinize their behaviors. For example, in a highly sequential organizational activity, an organizational culture that is unified and stresses trust among its members may enable these members to perform their actions and pass on their completed work to other organization members without the need for explanation or worry that the work will be misinterpreted. Without the interruption of organization members having to intermittently meet to explain to, discuss with, or check up on fellow members, the members can continue working without interruption, thus making it a more automatic routine.

Based on the degree to which various external and internal environmental factors affect the formation of routines, it can be estimated how beneficial these routines are for organizations. Routines that develop under one set of conditions are likely to be less valuable when those conditions change. The value of a routine is based on its invariant and appropriate performance. The appropriateness of a routine can change tremendously when it is performed in a different situation (Nelson and Winter, 1982). Moreover, managers' recognition of environmental change and organizational performance fluctuations are often delayed to some degree, and this can cause a gap to develop between the actual situation and its perception by managers (Sastry, 1997). This gap can slow down or distort organizational responses to change, which further disrupts the process of recognizing that a routine is no longer effective and requires adjustment or elimination.

To summarize, organizational routines are most beneficial during periods of internal and external stability. For managers, this means that they should plan to have their employees rely on existing routines during stable periods and plan to consider blocking existing routines and possibly initiating new routines during periods where internal and external change is predicted. Continued reliance on existing routines during stable periods enables the organization to more fully tap into its knowledge reservoir. Blocking existing routines during periods of instability prevents the organization from engaging behaviors that are inefficient or ineffective in the changing situation. Non-routine behaviors are typically more useful in these conditions. If conditions are expected to remain unstable for an extended period of time, a manager may want to consider implementing a routine for the employees that presumes instability in the industry. These types of routines typically stress flexibility and adaptability because they enable the organization to react more quickly and effectively to new conditions. If stable conditions return, however, flexibility and adaptability become inefficient compared to more constant or recurring behaviors, thus increasing operating costs for the organization. Therefore, as conditions return to stability, managers should institute or develop routines that are specifically suited for the newly stable condition. Employees can then practice, through utilization, the elements of the routine in order for it to become more automatic in its activation and operation.

How can the creation of routines be better managed in order to develop more useful routines?

Routines preserve knowledge about prior successful organizational actions (von Krogh and Roos, 1996). To the extent that the repetition of successful organizational actions is desired, the creation of these routines is also desired. Routines can be created anywhere along a spectrum between formal and informal. Routines at the ends of that spectrum each benefit from different types of management during creation. As discussed below, the management of more formal routines involves planning the steps of the routine. The planning of predominantly informal routines, on the other hand, is more focused on making the conditions suitable for the natural development of the routine. For example, making sure the right individuals are accessible to one another provides the opportunity for potentially routinized, useful actions to begin as individuals develop methods for accomplishing tasks with others.

3.1 Assisting Formal Routine Creation

Managers often create formal processes for organizational members to follow. A lot of conscious thought may be expended toward developing a process that has the highest chance for successful operation and outcome. Each step may involve one or more organizational members engaging in a preplanned behavior. The accumulation of the steps and who is to perform each of them is supposed to result in an optimum, or at least satisfactory, outcome.

As formal routines are being established, organizational members often adjust their required behaviors with actions that they perceive as essential to the optimization of the routine (Howard-Grenville, 2005). These adjustments may occur as a natural result of hands-on effort by the individual performing part of the routine (Lévi-Strauss, 1966). The end result can be a routine that looks similar to its formal design, but that is practically unrecognizable in those cases where the participants to the routine engage in extensive, informal modification. For managers, the performance improvement of the modified routine is usually welcome, but it comes at a cost to managers who no longer are able to effectively manage the routine as compared to its initial, formal form. Some managerial effort at tracking any changes to the routine may prove difficult, but fruitful, if they are done as the informal modifications to the routine occur. Alternatively, managers may be better off recognizing that the design of the formal routine is no longer accurate and any managerial influence of the routine must take into account its now uncertain structure.

3.2 Assisting Informal Routine Creation

By their very nature, informally developed routines have little to no preplanning of their steps or intended participants. In the natural course of getting things done, organizational members will seek increasingly efficient and effective ways to complete their tasks (Hoare and Beasley, 2001). The use of trial and error mixed with satisficing and optimizing behavior helps to create a unique and increasingly useful routine. To manage the creation of this type of routine it is best for the manager to focus on providing the right conditions during development. Stability is key, as is repetition, in promoting the development of a routine without getting involved in its details. Managers can thus improve the chances of a useful and informal routine developing by increasing communication potential among employees and by limiting unnecessary interruptions that jeopardize stability and the engagement of repetitive actions. By doing so, managers can give the routine's participants time to develop their own ways of getting the job done in a shorter time period.

A note of caution is merited, however. Managers should not artificially limit interruptions during routine development if those interruptions will likely be frequent in the future. If interruptions are likely to be frequent in the future, the participants in the routine should be given the chance to take them into account while developing their repertoire for the routine. Otherwise, future interruptions may be ignored or mishandled by the routine to the detriment of the organization.

An additional method for positively influencing the creation of useful routines is to increase the networks of the individuals that are likely to be involved in a routine. A larger network of appropriate individuals provides more resources of knowledge and action for the individual that may enhance their routine and the capability it provides to the organization (DeFillippi et al., 2006). Links to individuals in other areas of an organization access structural holes (Burt, 1992) and provide brokerage whereby an individual can access novel information that can add value to a routine. Links to individuals in the same area can provide closure which enhances trust and provides a platform for increased helping by others (Burt, 2005). Together, brokerage and closure lead to more capable routines that can provide greater benefit to an organization. An example of this networking process can be found at the Center for Business Knowledge (CBK) at Ernst & Young. The CBK is responsible for promoting linkages among employees in order to improve knowledge sharing (McDonald, 2005). As more linkages are established, more efficient and effective routines can develop among the linked employees.

Thus, for managers who want to create more useful routines for their organization, they should first identify the degree of formality that is best for the routine. If the industry conditions are projected to be stable, formal routines should be clearly laid out for those participating in them. Any modifications to these routines by participants should be tracked if possible. Informal routines, on the other hand, should begin with the manager focusing on the conditions in which each routine will operate rather than the steps of the routine. Managers, in this case, should work on building new relationships among organizational members involved in the routine as well as providing early, but temporary, stability where necessary in order to help establish the routine. Creating interdepartmental task forces and project teams periodically can provide organizational members with opportunities to enlarge their networks. To provide early stability, managers can structure work elements such as compensation and workload in order to enable organization members to focus on the task at hand rather than worry about potential, critical fluctuations. For example, a manager in a pizza restaurant could make pizzas when orders get too frequent for a new set of employees to handle. With too many pizzas to produce, the new employees may not be able to create an effective routine that meets the quality standards of the restaurant. With an artificially limited workload, the new employees could then initially focus on making pizzas at a normal rate until they built a routine that meets the quality requirements. After the routine is developed, the new employees could be given higher quantity pizza orders to produce.

Managers should also recognize that informal routines are difficult to manage after they develop. A less intrusive management approach is more likely to be accepted by organizational members and less likely to create unforeseen problems related to the disruption of the routine. In this case, managers can focus on managing the outputs of the routine. For example, if a manager performs a quality check on completed video cameras in a manufacturing facility and finds that too many cameras have minor assembly defects, the manager has two main choices. One choice would be to formally investigate the assembly process and identify where problems are occurring and create protocols to reduce the defects. If the cameras are hand assembled by individuals this approach may be rather intrusive and time consuming. Instead, the manager could point out to the assemblers that the defects are too high and let the assemblers change their assembly routine on their own. If the assembly routine was informally established by the assemblers, this may work better because it allows the assemblers to modify their own routine. The assemblers know the routine much better than the manager does in this case, and they would be in the best position to fix it. An additional benefit is that the manager shows trust in the assemblers and this could increase motivation and job satisfaction (Ballinger and Schoorman, 2007).

How can the utilization of routines be managed in order to activate routines at appropriate times and avoid activating them at inappropriate times?

Cues in the environment naturally trigger existing routines to activate (March and Simon, 1958). In consistent and stable situations these cues will normally accurately trigger the correct routines. However, if conditions change and become novel, the cues that arise from these new conditions may trigger routines that are not going to be useful (or could even be damaging) (Staw et al., 1981), or fail to trigger routines that would be useful in that situation. A thorough understanding by managers of an organization's routines is desirable, but not likely, in this case.

Formally created and modified routines are relatively more likely to be supervised by managers who will subsequently be in a position to provide more input into their utilization. Informal routines, on the other hand, are more problematic in this regard. Informal routines are more likely to be automatically triggered if an environmental cue is similar enough to the usual and familiar accepted cue. Thus, for more informal routines, managers should look out for potential environmental scenarios that could emit cues that are very similar to traditional cues. Once recognized, managers could keep these cues from being perceived by the organization. Alternatively, if the perception of this cue is likely to occur, managers could foreworn participants of the routine to ignore the cues. For example, a significant drop in expected revenues at a retail store may automatically trigger a routine for employees to begin a sale. Perhaps in the past these types of declines were caused by changing styles or new trends developing that made the current products outdated. However, if the current drop in revenue is due to customers staying home because of inclement weather or due to a delay in university students returning from summer break, the activation of the sale routine may be premature. Once the weather clears up or the students return, the retail store may see an upturn in revenue without a having a sale. Thus, in this case, the manager may decide to announce to employees possible reasons for a potential decline in revenue so that the sale routine will not be activated.

How does the storage of routines affect the ability of knowledge managers to keep competitors from discovering and copying them?

In general, organizational routines are difficult for competitors to fully imitate unless a competitor is immersed in some type of in-depth relationship with the organization (Badaracco, 1991). The closeness created from this type of relationship can, to some degree, provide an awareness of various elements of routines and the context with which to interpret them. For example, a strategic alliance among competitors may provide each with insight into some of the workings of the other alliance partner.

There are several ways that competitors can try to access an organization's routines. Formal routines are more often explicated in written form than are informal routines. This enables them to be more easily transferred between organizations (Bloodgood and Salisbury, 2001). Moreover, routine participants who leave the organization may be able to provide their new organization with details of some of the elements of the routine. However, an informal routine will be harder for the departing organization member to comprehensively delineate than will a formal routine. Thus, informal routines are typically less at risk of successful imitation than are formal routines.

Details of formal routines are best safeguarded by keeping their explication locked up or otherwise inaccessible. The fewer organization members who are aware of the complete routine the less the chance of the entire routine becoming divulged to competitors. Of course, keeping knowledge like this out of the hands of organization members also prevents them from increasing their understanding of the routine and potentially improving it.

Informal routines are naturally safeguarded from complete access by competitors even when a routine participant leaves the organization because no single participant is knowledgeable about the entire routine (Cohen et al., 1996). What awareness a routine participant has about the routine is usually limited to an imperfect understanding of their own portion of the routine. The same lack of knowledge about the elements of the routine found in inaccessible formal routines is present with informal routines in the sense that each routine participant is unable to comment upon or modify other elements of the routine with which they do not participate.

To summarize, if imitation attempts by competitors are likely, managers can focus on several alternatives. They can avoid alliances with competitors in order to reduce visibility of their routines. They can also limit access to formal routines to only those who have to utilize them. In addition, any informal routines that develop can be protected from imitation by avoiding direct managerial intervention in order to maintain a high level of informality which provides a natural defense because of the imprecise understanding it possesses.

How closely should various types of routines be actively managed?

Long established routines, because of their automatic nature, are not easily and consciously accessible, and therefore are resistant to being actively managed (Cohen, 1991). Even though these types of routines are resistant to direct control, however, it does not mean they should never be managed. In general, if a routine is no longer providing an effective outcome some attention should be given to modifying it so that it can become more effective (Knott, 2001). Any attempt at direct modification will likely disrupt the routine, thereby causing it to be even less effective in the short run as employees struggle to complete it consciously rather than automatically. However, the disruption is not all bad. It provides an opportunity to open up the routine and better evaluate its more readily accessible components. During evaluation, modifications can be planned and organized such that upon implementation the routine will begin to gravitate toward more effective operation. As an example, the Human Resources department at Ernst & Young developed a Web-based portal for employees that required new procedures for storage and content review (McDonald, 2005). Detailed examination of the information flow between the staff and the Human Resources department provided ideas for the upgraded system.

This type of formal intervention can bring about the costs and benefits that naturally occur with the implementation of formal routines previously mentioned. Informal routines, on the other hand, do not lend themselves to easy fixes with minimal costs. Managers should recognize that no individual or group of individuals is aware of the complete construction of an informal routine. Thus, splaying it open for analysis and modification is risky from the standpoint that presumed fixes may inadvertently affect parts of the routine that are hidden and that could be inalterably impaired if the wrong component of the routine is added, subtracted or modified. This is especially true for managers who seek to manage tacit-laden routines rather than trusting the routine and its members to autonomously and properly adjust to environmental changes over time (Gourlay, 2006).

Even when managers intervene in routines that are accessible, unforeseen changes can result. Small, initial changes in activities can amplify into larger and very different changes than intended (Plowman et al., 2007; Weick, 1979). One solution that has been proposed to alleviate some of the negative repercussions of changes to a routine is to focus on the learning process of the routine members in order to promote shared understanding and psychological safety during experimentation (Edmondson et al., 2001). In this case, routine members may become less defensive about making mistakes and more interested in learning about how to improve the routine. In this way, managers can work with their employees to redesign routines that become more useful to the organization.

What role should organizational knowledge, in the form of routines, play in the competitive strategy of an organization?

It is clear from the discussion thus far that routines provide a way to store organizational knowledge. Although the storage medium may make it hard to transfer the knowledge to other locations in the organization, it also makes it difficult for competing organizations to obtain the knowledge (Bloodgood and Salisbury, 2001). This can be very useful when certain valuable knowledge, such as a core competency, needs to be protected from imitation by competitors. For organizational strategies that require extensive knowledge transfer throughout the organization, establishing informal routines may not be as beneficial as formal routines or performing organizational activities in a more conscious manner that enables related knowledge to be more easily transferred. Similarly, the ease of transfer must be more critical to the strategy than the efficiency gains that come from routinization of activities in order for the minimization of routines to be a viable part of a strategy.

Once established, routines provide reliable performance which subsequently frees up time for managers to focus on non-routine issues. Thus, with limited management resources more total organizational work can be managed when much of it is routine. As more work is managed, however, and less managerial focus is placed on a particular routine, knowledge of the specific elements of the routine are no longer consciously available to the manager. When this occurs, there is an increased chance that the routine will not be modified when appropriate, will be transferred when it should not be, or will not be discontinued when it is no longer desirable. Managers should therefore be cognizant of this potential and periodically monitor the inputs and outputs of routines to the extent possible to make sure that each routine is operating in a suitable manner for the organization. This is particularly important in dynamic environments that provide fluctuating demands that are difficult to handle with a routine.

Competitive strategies of organizations can be strengthened by improving routines and increasing the appropriate cueing of them (Cohen, 1991). In many cases, managerial influence of routines may be limited but setting the right conditions for their improvement may be possible. For example, sending out pairs of salespeople to call on customers may result in productive routine interactions between the two salespeople as they become more used to working with each other. Although managers may not be able to see the details of that interaction they may be able to deliberately provide varied sales calls to the team that enable the sales team to build a more varied repertoire that they can routinize over time.

The above discussion suggests that knowledge that is critical to the organization's strategy should be maintained and protected from competitors. To do this, managers can include organizational members in the redesign of formal routines in order to limit any inadvertent disruptive changes to the routine. Managers could also avoid changes to long-standing routines that seem to be working well as these routines are likely contributors to organizational success and inimitability of core competencies by competitors. In addition, managers can enhance routines by expanding their capabilities through the exposure of the routines to additional situational variables and letting the members of the routine autonomously develop steps to handle the new situation. These additional experiences can enable the members of the routine to engage in collective improvisation (Erden et al., 2008) in an effort to further develop the capacity of the routine. Finally, managers can avoid pressuring routine members from divulging their tacit knowledge about their role in the routine in order to prevent their knowledge from becoming more explicit and therefore imitable (Stenmark, 2001)

In what types of situations should knowledge be managed in a way that it does not become part of an organizational routine? What would this type of knowledge management include in order to be most effective?

Routinization of tasks reduces the ability to consciously inspect their details. For many tasks this is useful because it frees up time to focus on other activities. This is especially true for simple or straightforward tasks. However, some activities can benefit from continued conscious attention by managers. Activities that are likely to undergo significant alteration in the future as a result of predicted changing environmental conditions would fall into this category. This is particularly true for alterations to the routine that are needed quickly. Routines are able to informally adjust over long periods of time, but in the short run they tend to adhere to their innate, repetitive nature (Cohen and Bacdayan, 1994). This concept is similar to Leonard-Barton's (1995) notion of core rigidities whereby an organization's competence can become so ingrained in the organization it outlives its usefulness when conditions change and is very difficult to alter in an effort to improve the organization. Managing a set of organizational tasks in a way that limits their routinization enhances their transparency and enables managers to more easily and clearly adjust them in a prompt manner. For instance, an organization that is researching multiple types of technologies that may be used for advanced steering mechanisms in automobiles may want to consciously monitor and explicitly evaluate each technology in order to prevent any one of them from becoming implicitly accepted and ingrained in the organization at too early a stage. If implicit acceptance occurs, this can lead to one of the steering mechanisms prematurely taking over as the primary alternative and guiding future product development and spending. Perhaps forthcoming but sporadic new governmental regulations, energy prices, and safety issues will strongly influence the final choice of technology rather than pure product performance. Management can keep tabs on the environmental factors and forecast their projected impact to help guide the direction of research and integration of product design in the organization.

When knowledge is needed to be quickly and extensively transferred throughout the organization, routines can become a hindrance to transfer if the knowledge is buried in the routine (von Krogh and Roos, 1991). Organizations that attempt to identify best practices within various parts of the organization and then attempt to transfer them to other areas find that the better they can be documented, the more easily the best practices can be transferred (Coakes et al., 2004). Merely installing existing members of routines that are to be transferred is not necessarily sufficient. Explication of elements of the routine is crucial to any type of thorough transfer.

As mentioned previously, core capabilities in the form of routines may end up as core rigidities that inhibit the transfer of knowledge within organizations (Leonard-Barton, 1995). Managers should be cognizant of the structure of any existing core capabilities that are to be included in the organization's future strategy as eligible for transfer to other parts of the organization. The ability to recognize the degree to which various capabilities can be transferred when necessary can lead to more successful implementation efforts.

4 Conclusion

The nature of routines within organizations was presented here to explain their role in knowledge creation, utilization, and storage. Routines were portrayed as behaviors engaged in by individuals and sets of individuals in order to accomplish the work of the organization. Different types of routines, such as formal and informal, provide different challenges to managers who desire to engage in knowledge management. Appropriate actions by managers to handle these challenges were discussed.

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Toward a Maturity Model for Knowledge Management Systems Integration

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Abstract. We present a maturity model that reveals the levels an organization traverses in the move from *independent and distinct* to *integrated* analysis and development of information systems and knowledge management systems. The Knowledge Management Systems Integration Maturity Model emerged from a 5-year action research project in the Israeli Navy documenting the development of 15 systems as the organization went through the different stages of maturity. Comparison is made with other maturity models related to knowledge management and software development. Implications for monitoring and evolving the systems development group of a large organization are discussed.

1 Introduction

The development of complex information systems is a formidable task and the subject of well-developed processes and procedures followed by organizations around the world. The nature of information systems development changes when one begins to take into account the need to integrate classic structured information systems with the types of knowledge management systems that deal with unstructured information. Different approaches are taken to facilitate this new type of development, ranging from independent development of KMS and IS through to IS/KMS integrated projects. New analysis and design methodologies have begun to emerge, such as Knowledge Integrated Systems Analysis (KISA) (Tauber and Schwartz, 2006). As organizations make the move towards this type of integrated systems development it is instructive to note and understand the different stages that the organizational systems development teams go through. To that end we have studied a large organization over the course of 5 years in order to distill a Maturity Model (MM) that reflects how the development organization matures towards integrated systems development.

Maturity models are closely related to Stages of Growth Models which, according to King and Teo (1997), can be used to describe organizational phenomenon including but not limited to Information Systems Planning, Organizational Life Cycle, and Product Life Cycle. Such models are deemed attractive by researchers and practitioners due to their sequential nature, usually irreversible hierarchical progression, and inclusion of a broad range of organizational activities and phenomenon. (Lavoie and Culbert, 1978).

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Maturity models for knowledge management have thus far been primarily devoted to understanding the maturity of the organization in terms of specific knowledge areas such as: knowledge sharing (Lee and Kim, 2001), knowledge engineering (Berztiss, 2002, 2006), and knowledge capabilities (Kulkarni and Freeze, 2006). Other MM's include the project management maturity model (Crawford, 2006), service organizations (Herndon et al., 2003), People Capability Maturity Model (Curtis et al., 2001), Systems Security (ISO, 2002; ISSEA, 2003), Systems Engineering (Bate et al., 1995), Telecom Product Development and Support Process (Bell Canada, 1994), Software Project Management (Aneerav et al., 2007), Cognizant Enterprise Maturity Model (Harigopal and Satyadas, 2001).

Each of these is, of course, an important area for which capabilities and maturity should be measured individually. A more recent approach, K3M, targets a comprehensive maturity model, encompassing both strategy and implementation (Liebowitz and Beckman, 2008). The present study focuses specifically on a maturity model for Knowledge Management Systems Integration (KMSI) and development processes. In other words, we are seeking to understand the recognizable maturity stages that an organization may enter as it begins to recognize, analyze, design, develop, and deploy Knowledge Management Systems (KMS) alongside or integrated with its mainstream Management Information Systems (MIS).

In essence we seek to better understand the different stages an organization's IT shop can go through in changing their approach to systems analysis in order to integrate unstructured knowledge systems with structured MIS systems and along the way point to new and future development directions for integrated development teams. This does not simply entail the flip of a switch causing an MIS group to move from structured to unstructured systems development. Rather there would appear to be identifiable stages of maturity that an organization goes through in developing its capabilities to produce and field integrated IS/KMS systems. This work, being focused on IS/KMS systems development, extends two streams of earlier research. The first is that of the Stages of Growth of Information Systems (King and Teo, 1997) in the sense that it continues the tradition of studying stages of growth related to information systems development, and the second is that of Knowledge Management Maturity Models (Liebowitz and Beckman, 2008) in the sense that it adds a new dimension to be studied when determining overall maturity of knowledge management.

The maturity model we shall present was developed through an action research program that traced the evolution of the development process in a large organization and through that process clearly identified maturity stages that we believe can be applicable to other such organizations.

2 Background

Before introducing the maturity model that emerged from this research, we will first survey maturity models in general, provide background on the analysis process for knowledge management systems, and describe the action research methodology used to develop the KMSI maturity model.

2.1 Maturity Models

A maturity model is best defined as a reflection of the distinct, repeatable, and identifiable stages that an organization goes through as it evolves from an initial stage to a final stage. Each stage in a maturity model has its defining characteristics which may include the existence of certain procedures, roles, norms, activities and other aspects related to the area being modeled. A given maturity model will focus on a certain aspect of organizational development, or maturity, and document each stage with its defining characteristics. Using a maturity model gives an organization a place to start, a chance to define the organizational roles, a common language and shared vision and most important a benchmark for equivalent comparison.

Understanding maturity models means understanding the difference between an immature and mature organization (Paulk et al., 1995). In an immature organization, processes related to the area of concern are generally improvised by practitioners and their management, using ad hoc procedures leading to only periodic heroic success. Processes specified may not be enforced or followed rigorously, and management is reactionary dealing more with fire-fighting than proactive planning and execution.

In a mature organization there exists an organization-wide ability for managing the processes in question and such procedures are accurately communicated to all employees and team members. The processes, once determined, are repeatable, defined, managed and optimized and when followed result in the desired organizational goals being met. There are transparent roles and responsibilities related to the processes that are understood and accepted across the organization. Such mature processes are followed because all of the participants understand the value of doing so, and the necessary supporting infrastructure exists (Paulk et al., 1995).

The path leading from immature to mature organization can have myriad stages. In areas of organizational evolution and information systems planning, models ranging from 3–6 stages have been documented (King and Teo, 1997)

In an attempt to focus maturity models on specific organizational capabilities, many have turned to Capability Maturity Models. These models "…focus on improving processes in an organization. They contain the essential elements of effective processes for one or more disciplines and describe an evolutionary improvement path from ad hoc, immature processes to disciplined, mature processes with improved quality and effectiveness" (CMMI, 2006, p. 5).

The *CMM for Software Development* describes the progression of software organizations from an ad hoc immature process to a mature disciplined one (Paulk et al., 1995). It includes practices for planning, engineering, and managing software development and maintenance (Fig. 1).

Another well known maturity model is the *Software Acquisition Capability Maturity Model* (Ferguson et al., 1996; Cooper et al., 1999; Cooper and Fisher, 2002). Ferguson et al. (1996) present five common features that can be used to assess the capabilities at a given level of maturity. They are:

1. Commitment to perform
2. Ability to perform
3. Activities performed
4. Measurement and analysis
5. Verifying implementation

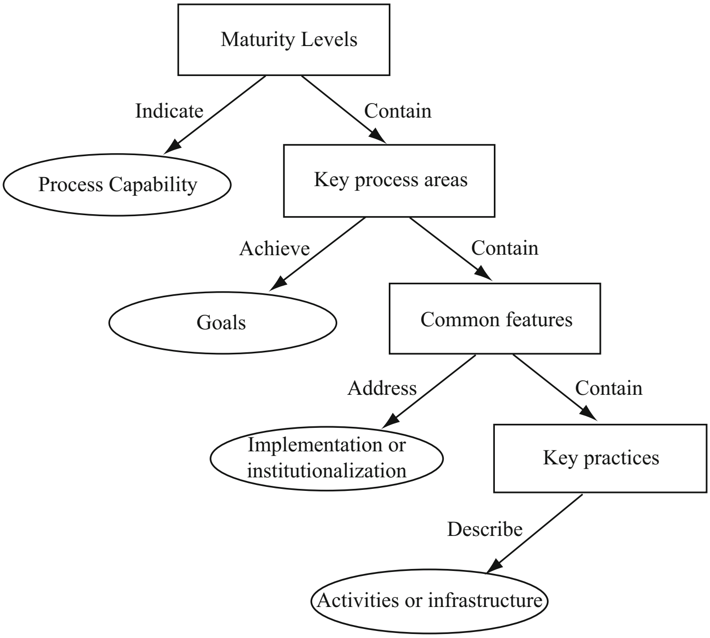

Fig. 1: Maturity Model Structure (From Paulk et al., 1995.)

In the presentation of the KMSI maturity model that follows we will address these common features to the extent that they appear at each of the levels.

2.2 Knowledge Management Systems

Knowledge Management Systems are designed and built to help organizations manage unstructured information, in-house expertise, lessons learned, and the accumulated wealth of the organization's experience. KMS has been recognized as sufficiently distinct from MIS (Alavi and Leidner, 2001; Hahn and Subramani, 2000; Plass and Salisbury, 2002; Malhotra, 2002) and can range from standalone tools that facilitate the discovery of a specific expert within a pool of tens of thousands of employees, to systems that correlate a corporate ontology with free-text documents in order to find knowledge inputs to a decision process. KMS can be fully integrated with classic Management Information Systems, they can run synchronously in parallel with such systems, or can be standalone referred to independently of any other organizational information system. Knowledge in an organization can be characterized as unstructured or semi-structured, whereas information and data are fully structured and can be managed by common information management methods. Estimates show that unstructured and semi-structured information account for about 80% of the information volume within organizations (Lindvall et al., 2003; Ferrucci and

Lally, 2004). Therefore, a structured MIS that aids organizational processes will only be addressing 20% of the information management needs. KM flourishes in this gap.

While the first generation of KMS has been developed as add-on or parallel systems living alongside pre-existing structured Management Information Systems, the next generation of systems development needs to deal with fusion systems. A fusion system (Gray et al., 1997) is a system that integrates structured and unstructured knowledge in real time allowing for full situational assessment based on both information and knowledge resources. This type of integrated system can be best achieved through a systems analysis process that is tailored to the needs of both structure IS analysis and unstructured KMS analysis (Tauber and Schwartz, 2006).

2.3 Action Research

Action research provide researchers with a rich body of data and situations for knowledge building (Kock, 2003; Mumford, 2001) and have been recognized as an approach to the development of new methodologies based on iterative interactions with an organization from which a new methodology could emerge (Baskerville and Wood-Harper, 1996; Avison et al., 1999; Dick, 1993). It differs significantly from the Case Study approach in that case studies generally view an organization at a specific point in time and do not, in an interactive manner, influence the actions taken at the organization (Avison et al., 2001; Benbasat et al., 1987; Yin, 1994). In action research (Fig. 2), the results from a cycle of interaction with the organization are used as a basis for modifying certain actions, and then re-engaging with that organization (Susman and Evered, 1978). At the end of a number of action research cycles, a refined methodology emerges.

In this research, the action research methodology was applied to a large military organization over an extended period in order to distill a new systems analysis methodology which is reported elsewhere (Tauber and Schwartz, 2006). In parallel to the creation of the methodology,

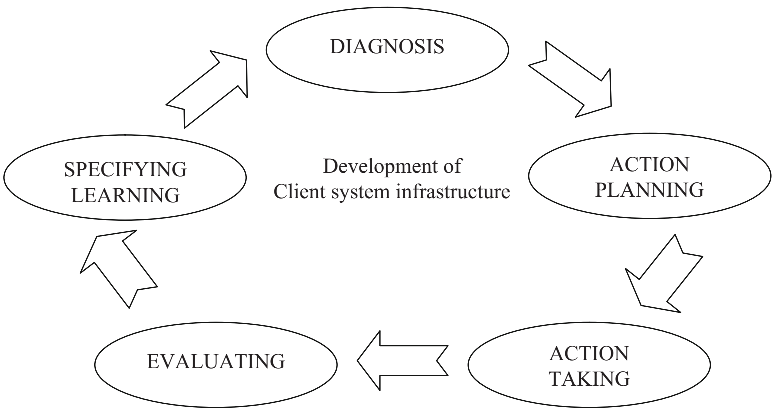

Fig. 2: Action Research Cycle (Paulk et al., 1993)

the evolution of the organization through stages of maturity was documented forming the basis for the findings presented here.

In the following section we will describe the target organization where the field work from which the MM emerged was conducted. We then describe the four main maturity levels in our model. This is followed by a discussion of how each level can be identified and what are the key determinants of level membership. We then put our work in the context of related research and present some possible future directions.

3 The Target Organization and Development Stages

This research was undertaken at the CIO Offices of the Israeli Navy. The Israeli Navy can be characterized as an early adopter of new technologies and methodologies.

The Israeli Navy is the naval arm of the Israel Defense Forces, operating primarily in the Mediterranean Sea in the west and in the Gulf of Eilat, Red Sea, in the south. Major Naval ports are located at Haifa and Ashdod, and the Gulf of Eilat with a naval facility. The Navy Headquarters is located in Tel Aviv (Fig. 3). Haifa base is home to the Missile Boats Flotilla, the Submarine Flotilla and Patrol Boats Unit. Ashdod and Eilat bases are mainly occupied by Patrol Boat Units. The Naval training base is located in Haifa. The Missile Boats Flotilla main objectives are protecting Israeli commerce at sea against foreign fleets, preventing a possible naval blockade of Israeli ports during wartime and blockading enemy ports at wartime. The Submarine Flotilla's main objectives is attacking enemy craft in their home ports, and acting as a support unit for other units. Naval commando flotilla is an elite special forces and counter terrorist unit. The Israeli Navy is consisted of few thousand officers and enlisted personnel, in addition to thousands of reserve personnel.

The 5-year action research program enabled us to track the maturity stages of the organization as it moved from the independent design and development of IS and KMS systems towards a fully integrated design and development process. By tracking the development of multiple information systems, some purely IS, some purely KMS and others integrated, we were able to observe the changes in development methodology, team interactions, and specification procedures.

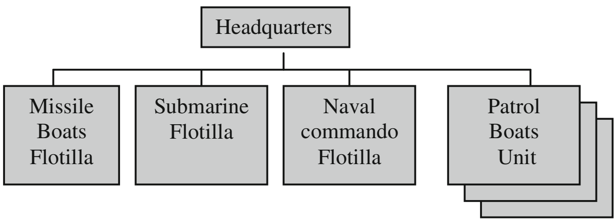

Fig. 3: Navy Structure

Table 1: Navy Projects

Project	Type	Start year	Systems analysis methodology
Naval commando flotilla – operational procedures	KMS	1999	Unstructured
Missile boats flotilla – operational procedures	KMS	2000	Unstructured
Submarine flotilla – operational procedures	KMS	2001	Unstructured
Patrol boats unit – operational procedures	KMS	2001	Unstructured
Operation branch – operational procedures	KMS	2002	Unstructured
Naval commando flotilla – operational procedures	IMS	2000	Structured
Missile boats flotilla – operational procedures	IMS	2001	Structured
Submarine flotilla – operational procedures	IMS	2002	Structured
Patrol boats unit – operational procedures	IMS	2003	Structured
Operation branch – operational procedures	IMS	2003	Structured
Integrated (knowledge & process) naval commando flotilla	KISA	2004	Semi-structured
Integrated (knowledge & process) missile boats flotilla	KISA	2004	Semi-structured
Integrated (knowledge & process) submarine flotilla	KISA	2004	Semi-structured
Integrated (knowledge & process) patrol boats unit	KISA	2004	Semi-structured
Integrated (knowledge & process) operation branch	KISA	2004	Semi-structured

During the years 1999–2005 there were 15 development projects observed within the Navy flotillas and branches. The projects, summarized in Table 1, were part of a large initiative to build a system for operational life cycle management. Operational life cycle management covers systems to support the complete life cycle of a Naval operation, from the planning of an operation or a mission, through the preparation and training phases, via command and control and last but the most important phase, the investigation phase that produces lessons learned nourishing knowledge for the next operation planning.

For each project a team of system analysts and CKO was assigned, the team was guided by the CIO office. The CKO organizes, cleanse, formalizes, and stores the knowledge items into the system in the way to align with the flotilla operational processes. Each knowledge item has its metadata and the hundreds of knowledge items are grouped into several types. Using the metadata as parameters for integration allows connecting the right items to their relevant processes at its relevant stage. Still the knowledge is reachable also in a free mode disassociated from a specific information system, using a morphological search engine, and organized in a knowledge tree for use in unstructured activity, such as round table or brainstorming activities.

The approach used to develop each information system was based on the UML (Unified Modeling Language) methodology for systems analysis and design. One example of how the knowledge items were added into the UML charts is shown in Fig. 4 and an example of an integrated system, the Integrated Missile Boats Flotilla system, was developed according to the schematic shown in Fig. 5.

Fig. 4: UML Use Case Exit Points for Knowledge Import

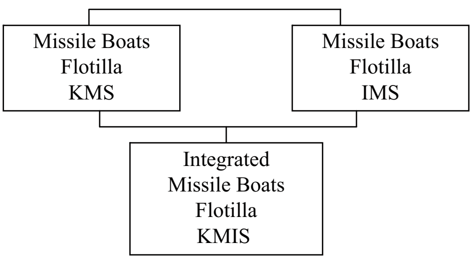

Fig. 5: Naval Flotilla Systems Integration

4 Knowledge Management Systems Integration Maturity Model (KMSI-MM)

In our analysis KMSI-MM presents four maturity levels, each one of which carries a set of organizational capabilities. The four levels are:

1. Independent design and development
2. Post-development integration
3. Independent design, coordinated development
4. Integrated design and development

Each level indicates certain roles that are identified or filled in the organization and key processes that are implemented. We present the main characteristics of each level, key roles and competencies.

4.1 Level 1: Independent Design and Development

This level is characterized by separate system analysis tracks. The IS track and the KMS track run in parallel by separate systems analysis teams working with different methodologies. In general it was found that the IS track worked according to classic IS development approaches that closely followed the structured information systems analysis methodology (Norman, 1996; Kendall and Kendall, 2001; Whitten et al., 2001; Gane and Sarson, 1979; Demarco, 1978; Yourdon, 1989) or the object analysis methodology (Jacobson et al., 1999; Booch, 1994). This depended primarily on the development history of the unit in question.

A classic system analysis process contains the following phases (Booch, 1994; Demarco, 1978; Pressman, 2000; Whitten et al., 2001; Yourdon, 1989):

1. Initial problem/opportunity identification (including feasibility testing)
2. Study of the current system
3. Requirements discovery and analysis
4. Data modeling
5. Information modeling
6. Process modeling

Each of these phases was followed in each of the independent development streams and can be seen as indicated on the independent IS and KMS methodology tracks and classic phases column of Fig. 6.

In this level, the features observed were as follows:

1. *Commitment to perform:* There was no commitment on the part of either team to creating an integrated system. Commitment bounded within each team and system.
2. *Ability to perform:* Each group was competent and experienced in their own performance tasks.
3. *Activities performed:* Each group conducted independent analysis and development cycles.
4. *Measurement and analysis:* Each group independently measured and monitored its progress with no cross-checking or coordination with the other groups.
5. *Verifying implementation:* Each system was tested and verified independently.

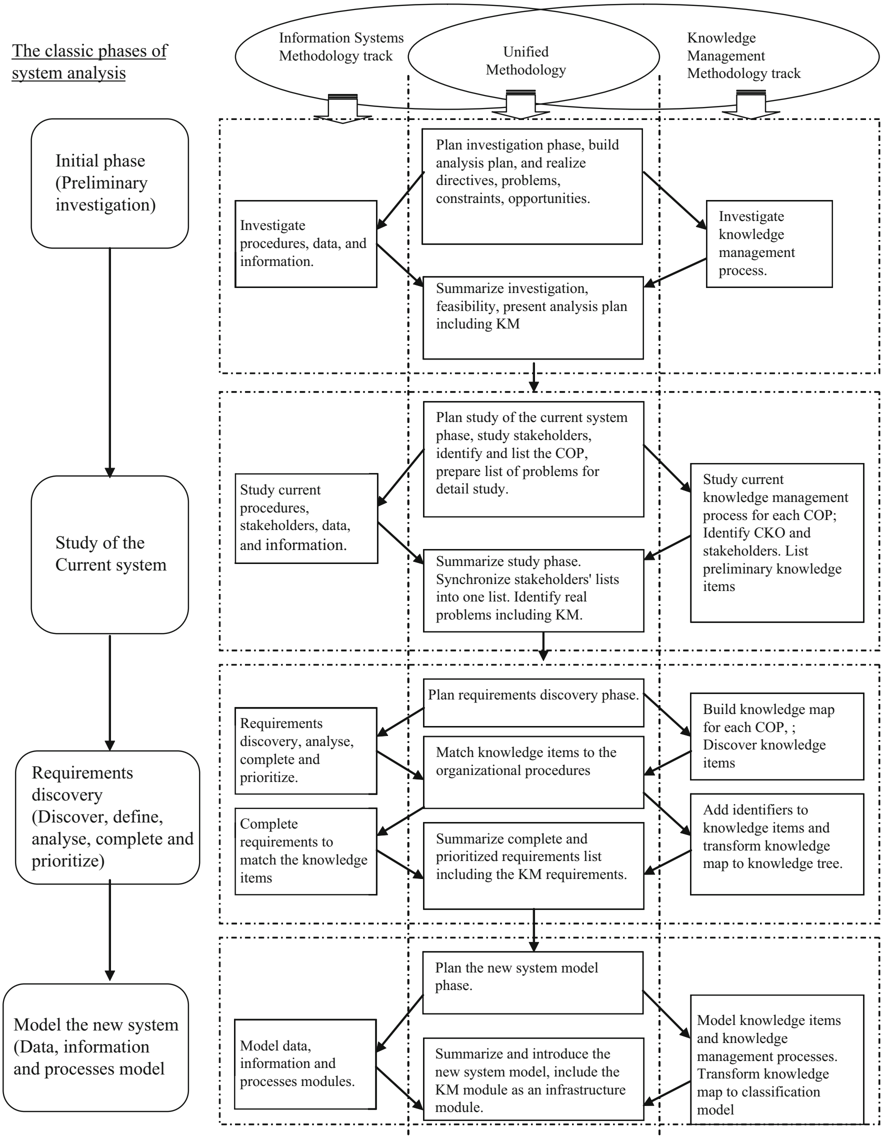

Fig. 6: An Integrated Analysis and Design Process to be Found in Stage 4

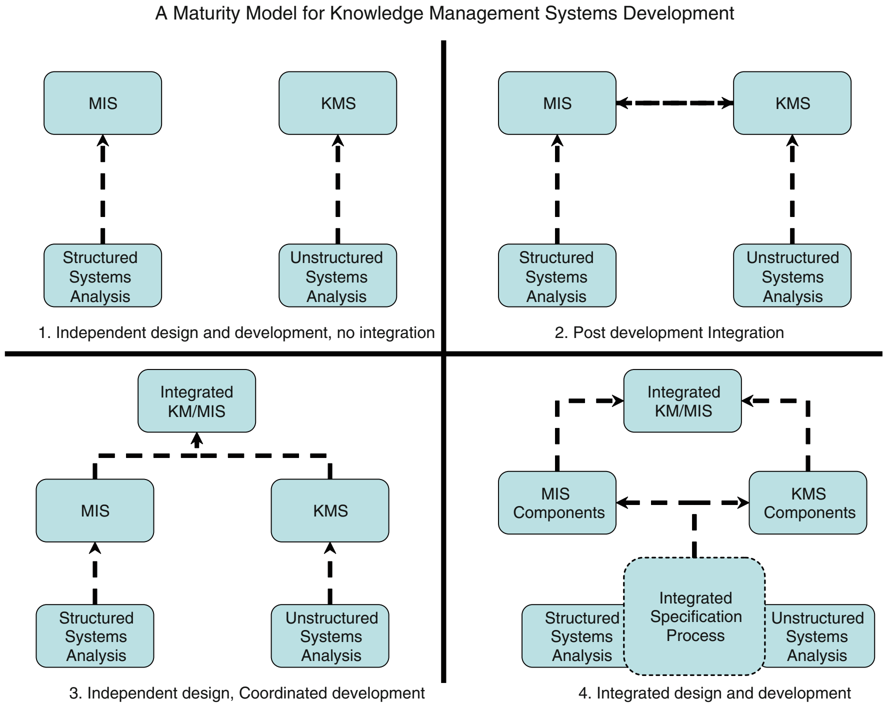

Fig. 7: KMSI Maturity Model Stages

The result is two separate systems, the KMS and the MIS (Fig. 7(1)). There are no significant capabilities at this stage that relate to the desired integrated development. Only the individual capabilities of each team in their own analysis domain are important. Lead roles include systems analysts and top/expert users for the IS development track, and systems analysts and the CKO for the KMS development track.

4.2 Level 2: Post-development Integration

This level is characterized by integrating the two systems after they have been individually specified, designed, and developed. This is done mostly by coordinating the human–computer interface (HCI) of the two systems. In practice, this integration is superficial and limited in its abilities to create a fusion system because the KMS and the IS are already fully designed and developed.

The systems analysis techniques followed here are the same as in the previous phase with no awareness to the post-development integration goals or needs. Lead roles here are similar to those of the Independent Design and Development stage, with the addition of required HCI expertise.

The result is two separate systems, the KMS and the IS (Fig. 7(2)).

4.3 Level 3: Independent Design, Coordinated Development

This level is characterized by the recognition that while there are distinct design goals and methodologies, an integrated fusion system is desired at an organizational level. It is here that we find the first meeting of narrow development and broad organizational goals that characterizes this more advanced stage of maturity. As such an effort is made to coordinate the different system designs in creating an integrated system. This is not unlike the approach taken by many organizations that coordinate the purchase of unrelated independently developed off-the-shelf software packages with the intent of interfacing between them to serve a set of specific organizational goals not met by the systems independently.

In this level, the features observed were as follows:

1. *Commitment to perform:* A pre-design and pre-development commitment to the organizational need for an integrated system exists.
2. *Ability to perform:* Each team is skilled in its distinct analysis and design methodologies. Additional expertise in mapping distinct designs to a joint development process is apparent.
3. *Activities performed:* Analysis is done in parallel by each team, producing distinct design documents that are then analyzed to determine the required points of integration. Development is then planned so that the points of integration are created and dealt with as an inherent part of the development process.
4. *Measurement and analysis:* Each group independently measured and monitored its design progress. Upon completion of the designs another analysis cycle is required to produce the integration development plan.
5. *Verifying implementation:* Verification and testing is performed on a single integrated system.

Lead roles remain the same as in previous stages; however the teams are now integrated and work as if on a single project. The result is an integrated system, the KM/MIS (Fig. 7(3)).

4.4 Level 4: Integrated Design and Development

This level is characterized by fully synchronized KM and IS design and development. The system analysis phases include integrating the knowledge items as part of the system analysis process, and adding the knowledge items into the UML or DFD annotated charts. The clear goal is to achieve tight coupling between KMS and MIS by integrating knowledge items (or knowledge artifacts) into the organizational procedures that were handled by the information system. Team members are made aware that a "new" type of analysis procedure is being followed and that addition steps of divergence and convergence for the two system designs will be followed.

This level actually achieves "just-in-time delivery" as characterized by Davenport and Glaser (2002) stating the key to success is "to bake specialized knowledge into the jobs of highly skilled workers to make the knowledge so readily accessible that it can't be avoided."

The main modifications apparent in the mature integrated design and analysis phase result in the bifurcation of classic system analysis process into two tracks. As shown in Fig. 6, the IS track and the KMS track run in parallel with clearly defined points of intersection. The two tracks must be well planned and synchronized so the work in the two tracks will be able to be done independently applying different tools and techniques yet synchronously.

4.5 Divergence

Each phase begins by planning the KMS and the IS activities to be accomplished within this phase, then each track is allowed to diverge and proceed according to its distinct IS or KMS methodologies. The synchronization focuses the KMS on serving the IS and results in a situation in which knowledge serves the organizational procedures by nourishing those procedures with the knowledge items at the appropriate IS stages. For example, well-known tool of KMS methodology is the knowledge map or conceptual map (Vail, 1999; Jackman and Pavelin, 1989). In a level-four organization this tool is still used by the KMS track, but it is also be directed to serve the organizational procedural processes as demanded by the IS track. Specifically, the knowledge items to be mapped will have the process notification with each item able to address the organizational procedures it serves.

4.6 Convergence

At the end of each analysis step in the integrated phase of maturity there is a convergence of the KMS and IS tracks. The synchronization between the two tracks is crucial for the success of the whole process. This demands a clear definition of the activities in each track so full cooperation avoids unnecessary overlap and results in the *fusion* that is reached by joining the IS and KMS groups. The convergence process involves not only data and information modeling, but also the knowledge modeling. The system analyst is required to define not only the organizational procedure but also the knowledge items that serve each event of these procedures. The new system model then handles the knowledge management process as part of the organizational procedures. This is led by the CKO's continuing and maintaining the integration into the next stage of the KMIS life cycle, the maintenance phase.

4.7 Full System Modeling

As the process chart of Fig. 6 shows, two groups of system analysts conduct the system analysis phases, the KM group is accompanied by the CKO and the IS group is accompanied by the User Representative who operates the organizational procedures. The two groups plan each phase activities together and meet several times along the phase. The result is an integrated system from a single design process, the KM/MIS (Fig. 7(4)).

5 Related Work

Maturity models have been used to address many aspects of information systems, software development and management.

The Software Acquisition Capability Maturity Model, developed by Ferguson et al. (1996), focuses on the maturity of an organizations internal software acquisition process. They document five maturity levels as follows: Initial; Repeatable; Defined; Quantitative; and Optimizing. The software acquisition process, while sufficiently complex to warrant a maturity model, deals with a more compartmentalized procedural aspect of software use in an organization and has limited applicability to the questions regarding systems development.

A more complex and relevant model is that of the IT Service Capability Maturity Model developed by Niessink et al. (2002). This is a CMM that specifies different maturity levels for organizations that provide IT services. They document five maturity levels as follows:

1. *Initial level*: The IT service delivery process is characterized as ad hoc, and occasionally even chaotic. Few processes are defined, and success depends on individual effort and heroics.
2. *Repeatable level*: Basic service management processes are established. The necessary discipline is in place to repeat earlier successes on similar services with similar service levels.
3. *Defined level*: The IT service processes are documented, standardized, and integrated into standard service processes. All services are delivered using approved, tailored versions of the organization's standard service processes.
4. *Managed level*: Detailed measurements of the IT service delivery process and service quality are collected. Both the service processes and the delivered services are quantitatively understood and controlled.
5. *Optimizing level*: Continuous process improvement is enabled by quantitative feedback from the processes and from piloting innovative ideas and technologies.

The relevance of this model to the current work is in that it assesses management maturity in the provision of a certain type of IT-related service. Considering that systems analysis and development is a core IT service, the four maturity stages of KMSI can be superimposed on the IT Service Capability Maturity Model and each if KMSI's stages can potentially be analyzed in terms of it own maturity within the other model – in other words it can be used to determine the level of organizational maturity *within* each stage of KMSI's model.

A maturity model for the implementation of software process improvement was developed by Niazi et al. (2005) to focus specifically on quality issues and how relevant software quality maturity levels might be identified. While a narrow focus for a maturity model this nonetheless provides important insights into how maturity models can be applied to software analysis and development processes, as is done in the current case.

Lee and Kim (2001) discuss six top-level organizational capabilities for their Knowledge Management CMM: Creation, Integration, Combination, Absorptive, Leveraging, and Knowledge Link capabilities. These capabilities refer to the organization's abilities in dealing with the knowledge itself and not the development of knowledge management systems discussed in this work. Their studies focusing on the knowledge aspect identifies four maturity stages: initiation, propagation, integration, and networking. It is notable that in their analysis four different categories of capabilities are modeled, namely Organizational Knowledge, Knowledge Workers, Knowledge Management Process, and IT Systems. It is the latter category of IT Systems that most closely relates to the current work. Their characterization of IT Systems across the stages of maturity are: Closed (Initiation stage), Isolated (Propagation stage), Enterprise (Integration stage), and Global (Networking stage) (see Table 2).

This characterization of the IT-component of knowledge management is minimalist in our view, and the current research extends consideration of this area to much greater depth. In addition, while the Lee and Kim (2001) framework proposes what might be a plausible stage model for IT systems development related to KM, it does not go beyond the proposal stage to actually studying organizations. The findings of the current research provide us with actual development maturity stages that can be incorporated into a broader model.

The detailed KMCA assessment instrument and model (Freeze and Kulkarni, 2005; Kulkarni and Freeze, 2006), presents a comprehensive view of the capabilities contributing to successful KM projects, and the associated maturity stages. Capability areas identified include: Expertise; Lessons Learned; Knowledge Documents; and Data availability/accuracy. However here again the focus is on Knowledge Capabilities and not on the development capabilities for knowledge management systems, nor on the organizational characteristics that set the stage for the integration of MIS and KMS.

Muller et al. (2003) illustrate how maturity models can be applied to the assessment of an organization's adoption of a specific technology or application. Their study of an Instant Messaging Maturity Model highlights an Early stage characterized by easy adoption, immediate changes in the use of other collaborative technologies, and pragmatic and informal use. This is followed by the Maturity stage characterized by changes in chat behavior, use in higher stakes collaborations, a growing appreciation of values, and development of dependence. They then hypothesize an anticipated later stage to be characterized by visibility management and interruption management – two technological advances expected to impact instant messaging usage. We note that the parallels between adoption of a single technology/application such as IM, and adoption of a new approach to systems analysis share essential features in the maturity stage such as increased use in higher stakes projects, an increase in appreciation, and a clear development of dependence.

Table 2: Knowledge Management Stages and Object Characteristics (From Lee and Kim, 2001.)

	Initiation	Propagation	Integration	Networking
Organizational knowledge	Acquired knowledge	Created knowledge	Integrated knowledge	Networked knowledge
Knowledge worker	Knowledge absorber	Knowledge creator	Expert	Knowledge coordinator
Knowledge management process	Acquisition	Creation	Internal sharing	Global sharing
IT systems	Closed	Isolated	Enterprise	Global

Gottschalk and Solli-Saether (2006) propose a three-stage maturity model for IT outsourcing relationships that includes a Cost stage, Resource stage, and Partnership stage; suggesting that as an outsourcing relationship matures, performance measures develop beyond cost and efficiency into mutual business benefits for both client and vendor. A similar type of progression was evident in the current research in that the relationships between the IS and KMS teams, which can be paralleled to that of client and vendor, moved beyond efficiency concerns toward an embracing of the organizational benefits found in the integrated development process.

6 Discussion

The four stages that emerged from this research present a seemingly viable migration path for organizations seeking to move proactively from independent to integrated development of IS/KMS. Yet even a proactive move can be fraught with difficulties and adjustments ranging from incompatible analysis tools and data representation methods, to lack of teamwork and coordination due to improper team composition and balance.

As Fig. 8 summarizes, each of the four levels observed throughout the action research showed distinct characteristics that can be sought out, identified, managed and modified in organizations going through the types of processes discussed. The move between stages as observed happened over an extended period of time and was not a function of "deciding" that the

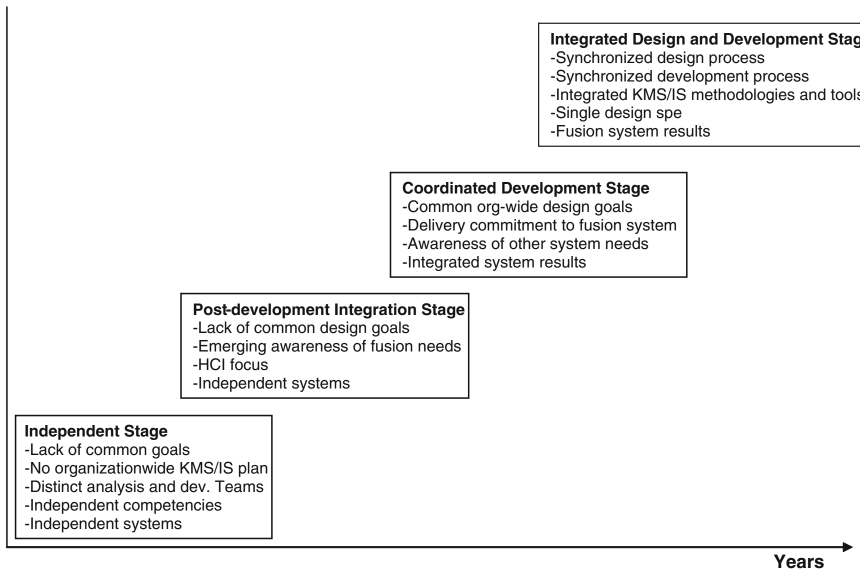

Fig. 8: Maturity Levels for Knowledge Management Systems Integration

organization should be in a certain stage. There was no attempt to say "let's only do integrated analysis now." It is quite possible that due to the distinct nature of KMS and IS development, and the different types of experience and foci that personnel involved in each type of system bring with them, only through an evolutionary maturity process can effective integrated development be reached. What this research has documented is the existence of the different stages. What remains to be seen is how an organization may or may not be capable of jumping from the initial stage to the end stage without the interim steps.

7 Future Research

The KMCA assessment instrument and model (Freeze and Kulkarni, 2005; Kulkarni and Freeze, 2006) discussed earlier gives us one possible direction for future research. KMCA attempts to provide a comprehensive view of the capabilities contributing to successful KM projects, yet falls short of addressing development procedures as one of those capabilities. Examining how the maturity stages of KMSI fits into KMCA could provide interesting insights and lead to an extension or combination of the two models.

A similar research direction can be followed by studying how the K3M approach (Liebowitz and Beckman, 2008) can be extended to incorporate the development maturity we have discussed.

The IT Service Capability Maturity Model (Niessink et al., 2002) was discussed earlier as relevant to the current work given its ability to assess management maturity in the provision of a certain type of IT-related service, one of which could be systems analysis and development. Future research should examine if the four maturity stages of KMSI can be superimposed on the IT Service Capability Maturity Model and each if KMSI's stages can potentially be analyzed in terms of it own maturity within the other model enabling one to determine the level of organizational maturity within each stage of the KMSI maturity model.

In terms of extending the KMSI maturity model itself, areas requiring additional research include questions such as the effect of skipping stages, for example going directly from independent IS/KMS development to an integrated approach using KISA (Tauber and Schwartz, 2006).

8 Conclusions

This attempt at distilling a MM for integrated KM and Information Systems development, and any other such attempt for that matter, should not conclude without considering the words of Claudio Ciborra (2002) in characterizing a realistic perspective of such models.

> There is a tension between the ideal, the measurement techniques that should locate the messy life world within the model, and the various actions that should be taken to make the life world of the software organization conform to the model. The instrumental and abstract role of the CMM organization is forgotten. Instead the ideal model is taken as self-evidently describing the evolution of the software organization 'as it is in itself'. Hence the software specialists are induced to push their organization

> along the prescribed learning curve. Good performance requires strict adherence to the methodological steps, regardless of circumstances: even in a learning-oriented methodology the abstract model and the related measurements come to dictate human behavior up to the point that leading software experts admit that CMM with its bias for 'technologies of reason' needs to be supplemented with a proper concern for experimentation (or tinkering) and true organizational learning (pp. 20–21).

In other words, Ciborra is warning against taking a CMM model too literally and applying it to the exclusion of the actual living and breathing influences of the target organization. Any maturity model, including the present, is at the end of the day only a model. And while we can use a model to guide our analysis and inform our planning, we should be wary of attempts to mold an otherwise learning and evolving reality into a pre-constructed and possible pre-constricted model.

The model that we have articulated is based on a field study of a large and complex organization over an extended period of time. Future longitudinal research is needed to conduct similar studies in other large organizations to see to what extent similar stages are observed.

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Knowledge Diffusion in Contemporary R&D Groups: Re-examining the Role of the Technological Gatekeeper

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Abstract. Knowledge flows are the lifeblood of any R&D organisation. These firms are increasingly discovering that the knowledge they require is often located beyond their boundaries. In this paper, we investigate how R&D groups acquire and diffuse external knowledge and the role Internet technologies play in this process. The focus of our study is on the technological gatekeeper. Previous studies have found that gatekeepers are key nodes in the innovation process. These sporadic individuals have the skills to identify useful knowledge outside the firm and disseminate this among their local colleagues. However, much of the seminal gatekeeper research has been conducted over two decades ago. In the time since, there have been huge advances in ICT and especially Internet technologies. These technologies have dramatically altered how knowledge workers source and share their information. Our objective is to advance the gatekeeper theory into an era where the knowledge worker is saturated with information. Using case study methods, we examine knowledge flows in the R&D group of an Irish medical devices firm. Our results indicate that due to advances in Internet technology, the traditional gatekeeper no longer exists to any great extent. Instead, the modern R&D group acquires and diffuses external knowledge through a combination of a "Web star" and a "knowledge transformer."

Keywords: Technological gatekeeper, Knowledge management, Social networks, Internet, Web 2.0

1 Introduction

In today's rapidly changing business environment, few firms can afford to remain completely self-sustaining. For firms competing on knowledge and the ability to innovate and adapt, it is essential that they keep abreast of the latest scientific and technological developments. Increasingly, this knowledge is dispersed outside the firm's boundaries (Chesbrough, 2003). How does this external knowledge which is critical to success get integrated and diffused around the firm? A large body of literature exists which highlights the importance which informal social networks play in transferring knowledge within and between organisations (Hansen, 1999; Allen and Cohen, 1969; Wenger et al., 2002; Wasko and Faraj, 2005). It has been found that within these informal networks, there exist a small number of key people upon whom others rely heavily for information (Allen and Cohen, 1969; Allen, 1971, 1977; Tushman, 1977; Katz and Tushman, 1981; Tushman and Scanlan, 1981). These "technological gatekeepers" scan the external environment

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for useful knowledge and disseminate this among their local colleagues. They are critical nodes in the innovation process as they keep the organisation up-to-date with technical advances beyond their firms' boundaries.

It is therefore surprising that the technological gatekeeper concept has received scant attention in the past 20 years. This is all the more surprising in the current era when innovation is at the top of many managers' agendas. Previous gatekeeper studies have shown that external knowledge gets integrated into the firm in a two step process – the knowledge seeker contacts their gatekeeper for specific knowledge, the gatekeeper then sources this knowledge from the external environment. With the emergence of the Internet, nowadays everyone in the organisation can easily gather information from the external environment, thus potentially negating the need for specialised gatekeepers. But is this actually the case? The gatekeeper theory as it stands may no longer be relevant to the twenty-first century where we have easy access to the information super-highway.

The objective of this study is to build a theory of how the traditional gatekeeper function of diffusing external knowledge is performed in an ICT rich and information saturated environment. Such an extension to the gatekeeper theory needs to be built as knowledge flows are the lifeblood of any R&D organisation. The gatekeeper was the hub that orchestrated the flow of this knowledge but it is unclear how their functions are now performed in contemporary R&D organisations. Maybe search engines like Google have become the new gatekeeper? All the indications are that knowledge workers will rely more heavily on ICT to support knowledge flows in the coming years. For example, a recent McKinsey Consulting survey which examined how businesses are using Web 2.0, reported that over 75% of executives say they plan to maintain or increase their investments in technology trends that encourage online user collaboration (McKinsey Quarterly, 2007). Therefore, it is critical to R&D organisations that they understand how these ICT advances impact knowledge flows within and between organisations. The research question addressed by this paper reads as follows: "How do Internet technologies impact the technological gatekeeper role of acquiring and disseminating external knowledge?"

This paper is structured in the following manner; in Sect. 2 the role of the technological gatekeeper in the innovation process is discussed. Section 3 reviews how advances in ICT impact the information sourcing and distribution practices of today's knowledge workers. Our research strategy and data collection methods are considered in Sect. 4. Section 5 presents the preliminary findings from our study. A discussion of these findings is given in Sect. 6 with a conclusion to the paper in Sect. 7.

2 The Technological Gatekeeper Defined

Technological gatekeepers are defined as those key individual technologists who are strongly connected to both internal colleagues and external sources of information (Allen and Cohen, 1969; Allen, 1971, 1977; Tushman, 1977; Katz and Tushman, 1981; Tushman and Scanlan, 1981). Gatekeepers are also capable of translating technical developments and ideas across contrasting coding systems. They keep up-to-date with new technical developments outside the organisation by reading the more technically sophisticated literature and by communicating with external technical experts. The gatekeeper is frequently consulted by local colleagues because they have demonstrated their technical competence in a particular field. Allen and Cohen (1969) noted when studying gatekeepers in the R&D division of a large aerospace firm that "…if one were to sit down and attempt to design an optimal system for bringing in new technological information and disseminating it within the organisation, it would be difficult to produce a better one than that which exists." Though not essentially innovators themselves, gatekeeper conversion is the key to launching an idea or an innovation (Barabasi, 2003).

Allen (1966, 1969, 1970, 1977) has made seminal contributions to the research of gatekeepers. His research has focused on the intra-organisational aspects of knowledge flows and he has made some interesting findings. While direct communication by all project members may be effective for internal communications, the particular method for effectively keeping up-to-date with technical advances outside the organisation are very different. Similar studies have found that when the work involves locally defined tasks which require the integration of external knowledge, then it is more effective to have only a small number of gatekeepers (Allen and Cohen, 1969; Katz and Tushman, 1981). In fact, the presence of a high number of gatekeepers in these types of projects has a detrimental effect on performance. In explaining these findings, Allen and Cohen (1969) concluded that most engineers are unable to communicate effectively with external information sources. Thus, only a few key actors should have external links. Widespread direct contact by all project members is not an effective method for transferring technical knowledge into a project from external sources.

Given their ability to scan and interpret information from external areas and to transfer this information to the innovating unit, persons filling these boundary spanning roles can be seen as an important information processing mechanism in the innovation process. In fact, Brown and Duguid (2000) conclude that the key to competitive advantage is a firm's ability to coordinate autonomous communities of practice internally and leverage the knowledge that flows into these communities from network connections. Figure 1 illustrates the two-step process through which

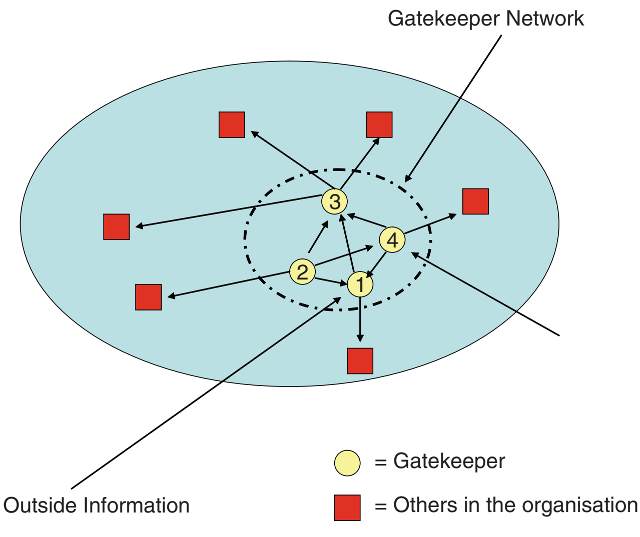

Fig. 1: The Function of the Gatekeeper Network. New Information is Brought into the Organisation by (1). It can be Transmitted to (2), (3), and (4) via the Gatekeeper Network. It Reaches Its Eventual Users (*Squares*) Through Their Contacts with Gatekeepers (Adapted from Allen and Cohen, 1969.)

Table 1: Knowledge brokering cycle (Hargadon and Sutton, 1997)

Brokering process	Description
1. Capture good ideas	Knowledge brokers scavenge constantly for promising ideas, sometimes in the likeliest places. They see old ideas as their primary raw material
2. Keep ideas alive	To remain useful ideas must be passed around and toyed with. Effective brokers also keep ideas alive by spreading information on who knows what within the organization
3. Imagine new uses for old ideas	This is where the innovations arise, where old ideas that have been captured and remembered are plugged into new contexts
4. Put promising concepts to the test	Testing shows whether an innovation has commercial potential. It also teaches brokers valuable lessons, even when an idea is a complete flop

gatekeepers mediate the transfer of information from external information areas into the organisations internal communication network.

The knowledge brokering cycle offered by Hargadon and Sutton (1997) provides an insight into the brokering practices of gatekeepers and how they contribute to innovation. Gatekeepers occupy a "structural hole," a gap in the flow of information between subgroups in a larger network. They act as the broker transferring knowledge from the group that has it to the group that needs it. Table 2 demonstrates the knowledge brokering processes (Table 1).

In one of the few recent papers examining the gatekeeper concept, Harada (2003) actually found that the usual definition of a gatekeeper (being both high internal and external communicators) did not apply in the R&D group of a Japanese tool manufacturer. Instead, he found that knowledge is brought into the firm by boundary spanning individuals who do not necessarily have high internal communication. These boundary spanners are connected to internal stars who translate the external knowledge into organisational specific knowledge and subsequently transmit it to other members of the firm. He calls these individuals "knowledge transformers." Harada suggests that the Japanese lifetime employment approach may be the reason why few gatekeepers existed in this firm. All the engineers surveyed never worked outside the organisation, thus the daily routine plays a huge role in the R&D group. Less attention is paid to external developments because firm specific knowledge is so important with such a company. If new engineers were entering on a regular basis, firm specific knowledge may not be so important.

3 The Impact of ICT on the Gatekeeping Processes

This paper argues that the gatekeeper concept needs to be revisited as advances in ICT have radically altered how external knowledge gets integrated into the firm. In the time before the World Wide Web, any efforts to interact with others outside an organisation's legal boundaries were

Table 2: A comparison of the technological gatekeeper with modern gatekeepers

	Traditional gatekeeper	Knowledge transformer	Web star
Industry experience level	More than10 years	More than10 years	More than 3 but less than 10 years
Communication specialisation	Both internal and external communication star	Internal communication star only	External communication star only
Preferred information source	Social contacts (mostly external contacts). Technically sophisticated journals	Social contacts (mostly internal colleagues)	Internet (Google, online discussion forums, RSS feeds)
Oral communication skills	High	Medium	Low
Primary function	To gather external knowledge and diffuse locally To help local colleagues interpret their external communications	To validate the reliability of external knowledge and to diffuse locally To help local colleagues interpret their external communications	To gather external knowledge To assist local colleagues in gathering external knowledge
Formal position	Middle management	Middle management	Junior – first line supervisor
Preferred communication medium	Oral	Oral and electronic	Electronic

often fruitless since they could be time-consuming or cumbersome. Individuals may not even have known whom to contact or how to find a relevant person. Furthermore, if management did not provide the resources to attend external conferences or other events, finding other like-minded individuals with whom to discuss work-related problems often proved difficult (Teigland and Wasko, 2003). The costs for the average employee of sourcing knowledge directly from the external environment were extremely high. Consequently, the locally constrained employee turned to the gatekeeper to mediate between them and the external environment, thus substantially reducing the knowledge transfer costs.

The situation is quite different nowadays. Due to the emergence of Web technology, the cost of participating in collaboration has plummeted. Processing, bandwidth, storage and memory all just continue to get cheaper. Likewise, expertise barriers to putting content on the Web have basically vanished. If you get a Blogger account, you do not need even basic HTML skills to start getting your thoughts up on the Web. In addition, the search costs of actually finding the information you need have decreased significant in the Internet age. Google have made a huge leap forward in Internet search quality by taking advantage of the information contained in links between Web pages. Links are an excellent guide to what is important and provide structure to online content. The "best" pages are the ones that are most frequently linked to. Recent research by King and Lekse (2006) found a positive correlation between the extent to which managers use the Internet to search for external knowledge and their performance. These authors conclude that a major paradigm shift for knowledge and information search is evident – one that is heavily influenced by the Internet.

Sharing information with like-minded individuals has become even easier with the emergence of social networking sites, wikis, blogs, podcasts and folksonomies. These digital platforms for generating, sharing and refining information are hugely popular on the Internet, where they are collectively labelled "Web 2.0." User-driven online services, such as Facebook, Wikipedia, YouTube and SecondLife, are to the fore of Web 2.0 technologies. McAfee (2006) believes that these technologies are particularly noteworthy because they can potentially knit together an enterprise and facilitate knowledge work in ways that were never possible before. He adds that "Wikis, blogs, group-messaging software and the like can make a corporate intranet into a constantly changing structure built by distributed, autonomous peers – a collaborative platform that reflects the way work really gets done."

If one wants a preview of how the knowledge worker of the future will use these Internet technologies, one only has to look at the activities of today's teenagers:

- The Internet is now the second most popular source of information for students aged 11 to 16 years (e.g. Wikipedia, Google, etc.), after asking a parent, other members of the family or teachers
- This audience spends an average of 3 h per session online
- 30% of teenagers actively generate their own online media
- 50% of this audience access the Internet on a daily basis
- 45% have experimented with their own blog (Source: Comscore Media Matrix, April 2006)

Unlike the teenagers of the 1980s and 1990s, this "Net generation" do not spend their evenings watching hours of TV. In the autumn of 2004, teens aged 12–17 spent 12.9 h a week in front of the TV, 2 h less than in 2003 and almost 3 h less than 5 years ago (http://www.statcan.ca). TV is a medium which offers very little in the way of interaction. The Net generation have grasped the tools that enable peer-to-peer collaboration. Pass any Internet café today and you are bound to see groups of teenagers playing multi-player online games such as Quake and World of Warcraft. Such games are characterised by collaboration – players from all over the world can connect to the same server and form a team. The team have a strategic mission to complete and players co-operate together using instant messaging or voice via a headset. These knowledge workers of the future are not constrained by geographical boundaries. They use ICT tools to cross these boundaries, building their knowledge along the way. Tapscott and Williams (2007) argue that it is inevitable that they will bring the same mindset with them when they move into industry.

Today's knowledge worker has become overloaded with information as a result of ICT. Many people routinely receive upwards of 100 emails each day, of which only a small percentage is of any relevance. A recent Silicon Valley survey shows that 33% of IT staff now receive 200-plus emails daily, compared to just 23% in 2005. Where once the problem was accessing information, the problem is now how to wade through and make sense of all the information that is at one's fingertips. The technological gatekeeper theory was formed at a time when it was difficult and costly to search and acquire external knowledge. What we know is that the gatekeeper was a key node in the innovation process because he or she had the skills to connect the firm to external knowledge sources. What we do not know is how external knowledge is acquired and diffused in the ICT rich and information saturated environment of today's world and, what role, if any, the gatekeeper now plays in this process. This paper aims to contribute to our understanding of this neglected field of study. The following section describes the methodology used to provide the data to investigate this problem.

4 Research Setting and Methods

The purpose of this study is to build onto the gatekeeper theory. Most of our knowledge of the gatekeeper concept stems from research that was conducted over two decades ago. Advances in ICT have impacted the gatekeeper function but we have a limited understanding of what those impacts are. We do not even know if the traditional gatekeeper still exists. To extend the gatekeeper theory, we need to investigate the complex social processes involved in seeking and giving assistance. Case study methods are justified for this purpose because of the rich qualitative data produced. The required insight into these complex social processes are not easily revealed through quantitative methods (Eisenhardt and Graebner, 2007).

This study was carried out at the R&D division of a medium-sized Irish medical device firm. This firm designs and develops innovative technologies and products that assist medical device manufacturers improve outcomes for patients. The R&D group primarily provides design and development expertise for medical device companies who wish to outsource their device design. The group's core competence is in the area of catheter-based minimally invasive devices. The group numbers 42 in total, mostly consisting of design and mechanical engineers. The new product development work performed by this group involves identifying existing and emerging technologies and applying these to solve a particular technical problem.

Our case study data was gathered during the months of October and November 2007 and consisted of two phases. *Phase 1* involved analysing the communication pattern of the R&D group. The purpose of this phase was to identify who the internal and external communication stars of the group were. To collect this communication data, all 42 group members were asked to complete a short online questionnaire which sought responses on their level of internal and external communication. Thirty-eight completed questionnaires were received giving a response rate of 90%. We used a technique called social network analysis (SNA) to visually illustrate the communication pattern within the group (see Fig. 2). In *phase 2* we conducted 10 semi-structured interviews with selected group members. The interviewees were selected based on our analysis from phase 1. We categorised each individual as being a gatekeeper, an internal communication star, an external communication star or a non-star. To get a non-biased view of how knowledge flowed around the group, we interviewed 2 gatekeepers, 2 external communication stars, 2 internal communication stars and 4 non-stars. We also ensured that all levels of the formal group hierarchy were represented in the interview sample. All interviews were conducted face-to-face and ranged in length from 30 min to 1 h. In addition, all interviewees gave permission for the interview to be recorded.

5 Findings

5.1 Existence of Gatekeepers

Figure 2 illustrates the flow of technical information within the R&D group. A particular SNA software package called UCINET (Borgatti et al., 2002) was used to produce this diagram. The nodes in the diagram are the individual members of the group and the lines represent the flow of technical information between them. The more connected nodes tend to gravitate towards the centre of the network while those nodes with fewer connections are found on the periphery. Nodes 4, 16, 35 and 40 did not complete the questionnaire, hence the reason they are isolated on the left. Nodes 2, 11, 38 and 42 are in the same position because they have no reciprocated interactions with another group member. Following the approach of Allen (1977) those group members who are in the top fifth percentile of interactions are considered to be internal communication stars. The internal communication stars of this group are nodes 6, 25, 37, 3, 26, 7, 24, 28.

We identified external communication stars using the same logic. Each respondent was asked how often they use each of the four external sources of information i.e. more than once a day, once a day, once every two days, once a week, once every 2 weeks, once a month, or more seldom. The analysis of this question revealed that some group members relied heavily on external

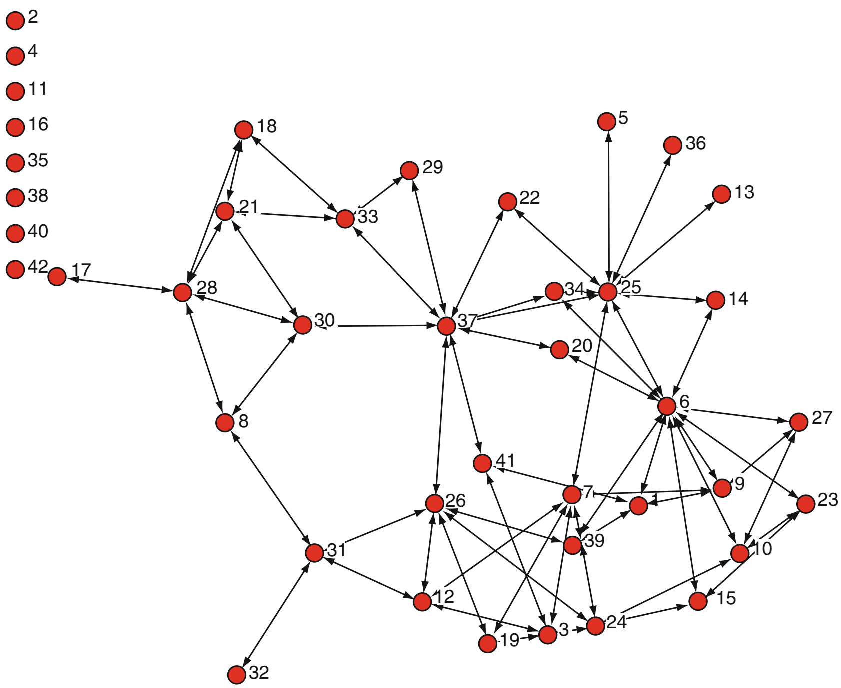

Fig. 2: The Social Network Analysis of the R&D Group

sources while others did not. The external communication stars are those in the top fifth percentile and these were nodes 9, 11, 15, 33, 17, 37, 7, 5 and 29.

Gatekeepers are those individuals who are in the top fifth of *both* internal communication and external communication measures (Allen, 1977). The analysis of group communication pattern reveals that only two group members, nodes 7 and 37, can be defined as gatekeepers.

5.2 The Impact of ICT

Rather than relying on an intermediary, the engineers in this R&D group primarily use the Internet to bring in new knowledge and to keep up-to-date with technical advances outside the firm. One of the gatekeepers interviewed explained the importance of the Internet in the following manner:

> It's a necessity these days. One of the questions I ask when I'm being interviewed for a job is…do you have Internet access? Is it high speed? I don't even use rolodex anymore [instead] I put their Web site in my favourites… Internet is huge because all your vendors are on there right now… I use it like a card system.

When faced with a technical problem that they are struggling to solve, the engineers from this group turn to the Internet for knowledge that will lead to a solution. Before the widespread availability of Internet technologies, these engineers would more than likely have turned to their local gatekeeper for assistance. It would seem that the advances that Google have made in search have contributed to the decline of the gatekeeper. An external communication star recalls an instance where Google Images provided an unlikely solution:

> We were trying to design a handle for a shaft that would be fitted to a catheter. We had a brainstorming session but we just couldn't come up with a solution. We decided to type a couple of key words from the design idea into Google Images and see what results we got back. In all, it threw up images of around 10 different devices…one in particular that used the same design we were after. That device was a ball point pen…and we ended up using a similar shaft design to the pen for our device. We would never have thought of that otherwise. It worked perfectly as it turned out.

5.3 The Web Star

Many of the engineers interviewed acknowledged that much of the useful information they need for their job is available on the Internet. However, even with the advances of Google, finding the exact information they want on the Internet can be difficult. As a result, the average engineer turns to a local colleague who is more competent in ICT and Internet search. We call this individual a "Web star." The Web star possesses an intimate knowledge of where certain information can be found on the Web – a human search engine of sorts. Web stars are external communication stars who assist their local colleagues in finding the specific information they want. The Google search engine and online discussion forums would seem to be their external communication medium of choice. The following quote from a project leader emphasises the important role which Web stars play. This team were given a project to complete on a topic which they did not know much about:

> We had it in here when we had a project on gammo induction… We generically knew it wasn't going to be great for us…and this person went off and they came back in half a day and had reams of information…some people are just really good at finding stuff out on the Net, [whereas] some people are just type in gammo induction and print off the first page they find. There's two people I have, if you want to find something out…they'll find it out and it will all be off the Net.

5.4 The Knowledge Transformer

Although the engineers find the Internet an extremely useful information source, much of the information gathered from it is of a very generic and non-specific nature. The following quote from an internal communication star is reflective of many of the interviewees' opinions:

> The Internet is good for finding analytical and theoretical stuff…it's really good for that calculation stuff, you find that there really really quickly. But for the more specific industry stuff, you don't find that there, or if you do find it, it's very very difficult to get the exact information you want from it. Companies that make glue for instance, you'll get all the data you need on glue gaps, the Internet is good for finding that kind of stuff. But if you have a specific question about something, that stuff is very hard to find you know…is this catheter going to track into the artery? Does it have the right flexibility? That stuff is very hard to find.

To be useful to the R&D group, this generic information from the Internet needs to be turned into knowledge and applied to the specific technical problems facing the group. Likewise, with so much information freely available on the Internet, determining the reliability and validity of this information is an issue. We found that a small number of experienced individuals are frequently consulted by the rest of the group with these issues in mind. This experienced person is usually an internal communication star – one of the "go to" people of the group. We call this individual a "knowledge transformer" (Harada, 2003) as they help transform information from the Internet into the knowledge to solve a particular problem. The following quote from one such knowledge transformer in the quality management field emphasises the information validation role she plays and the type of questions she gets asked:

> Some of the project managers do go off and look for quality information off the FDA Web sites… they are well capable of finding out that information themselves but they double check that they have done it correctly with me. So, they are capable of finding information themselves but they don't run with it until they have had the OK… Is this the way I should be doing this? Do you know of a better way of doing it? How did we do it previously?

6 Discussion

Our analysis of this R&D group's communication pattern reveals that the traditional gatekeeper does not exist to any great extent. Only 2 out of the 42 group members could be classified as gatekeepers. Four decades ago, Allen and Cohen (1969) found that 20% of engineers in an energy conversion R&D lab acted as gatekeepers. If the traditional gatekeeper still existed, we would have expected to see 7 or 8 individuals in our case study group conforming to this profile, instead of just 2. The traditional gatekeeper was a "jack of all trades" – well connected to external sources of information and also well connected to internal colleagues. From the analysis of our interview data, we find that the traditional gatekeeper has been replaced by separate individuals who are either internal or external communication specialists. External knowledge enters and diffuses around this R&D group through a combination of Web gatekeepers and knowledge transformers. Our findings are consistent with those of Harada (2003) who also found that separate communication specialists have replaced the traditional gatekeeper.

Figure 3 contrasts the traditional two-step process to integrating external knowledge along with the two new ICT facilitated paths that we have discovered. Route 1 reflects the traditional gatekeeper role. The gatekeeper acts as an intermediary between the knowledge seeker and the external environment. Step 1 sees the knowledge seeker contacting their gatekeeper for external knowledge. In step 2, the gatekeeper sources this knowledge from the external environment. In route 2, ICT enables knowledge workers to essentially become their own gatekeeper. When they need external knowledge, they search the Internet (step 1). However, the knowledge sourced from

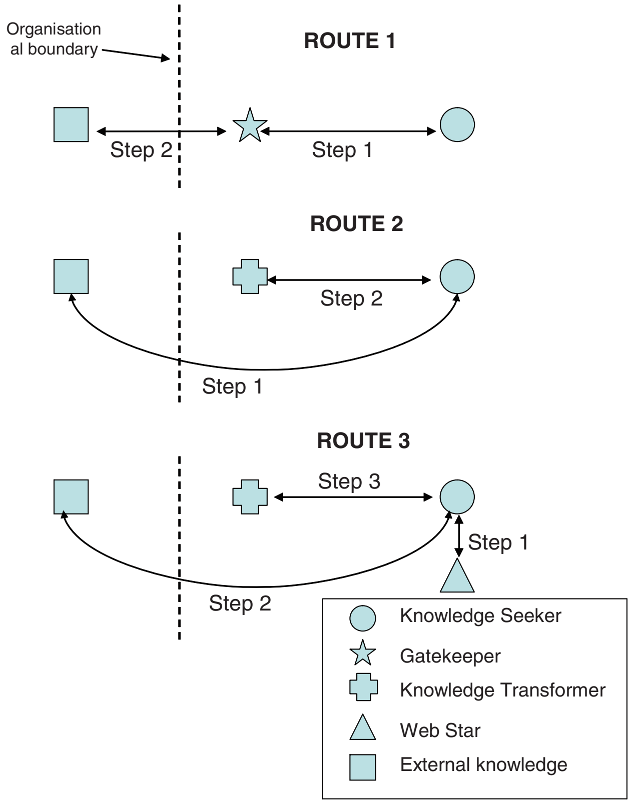

Figure 3: Accessing External Knowledge; Three Routes

the Internet is of a more explicit, generic and codified form. In step 2, in order to relate this explicit knowledge to the organisational context the knowledge seeker will have to discuss this knowledge with an experienced colleague, a knowledge transformer. A two-step process still exists but the order is reversed. In route 3, the knowledge seeker first contacts the Web star to assist them in finding the external knowledge they want. They then follow the same path as in route 2.

Although we cannot say with absolute certainty that advances in ICT have led to the extinction of the technological gatekeeper, our analysis of the interview data does point to such a scenario. With a couple of clicks of their mouse, the R&D engineer can access vast amounts of external knowledge relevant to their particular field. One possible reason why the prominence of the gatekeeper is eroding may be due to the fact that the knowledge seeker incurs less cost when they search the Internet for information. Many authors have noted that knowledge does not transfer smoothly between people because there are certain costs involved in asking others for assistance (von Hippel, 1994; Szulanski, 1996; Hansen, 1999; Teigland and Wasko, 2003). If the knowledge source demands a cost which the seeker feels is too high, then the knowledge transfer is unlikely to take place. Esteem and reputation issues come into play when seeking help from others as we are motivated to maintain positive self images and so often seek out information that confirms a positive sense of self (Lee, 1997). For example, admitting ignorance on a given topic to a colleague is too high a cost for many to bear. This cost "…lies in the expected damage sustained by the ego if one's question is met with a critical response. To be told you have asked a dumb or foolish question is the ultimate in rebuffs. Few people are willing to entertain such a risk." (Allen and Cohen, 1969).

There are very strong differences between the profile of a traditional gatekeeper and those of a Web star and a knowledge transformer. In Table 2, we provide a comparison of these three categories of communication stars.

7 Conclusion

This paper investigates the impact of Internet technologies on the traditional gatekeeper role. The seminal gatekeeper research by Tom Allen, Ralph Katz and Michael Tushman shows us that gatekeepers are critical nodes in the innovation process. They are the social conduits through which knowledge of new technologies, potential markets, customer needs, and competitor offerings enter the firm. We conducted a case study of the R&D group of an Irish medical device firm. Our findings indicate that the traditional gatekeeper no longer exists to any great extent. With the aid of a Web gatekeeper, most R&D engineers use the Internet to find the external knowledge they need. This knowledge is then validated and distributed internally by an experienced colleague called a knowledge transformer.

The findings of this paper are of benefit to both theory and practice. We contribute to the advancement of the gatekeeper theory into the twenty-first century. However, our findings our based on only a single case study. Future research studies should examine multiple R&D groups in differing industries. Practitioners are increasingly aware that innovative knowledge is located beyond the boundaries of their firm. This study shows that the Internet is a vital tool for accessing this knowledge and that certain people exist who have the innate ability to find relevant knowledge on the Internet. It will be increasingly important for R&D firms to find people with these skills. In their recent book entitled "Wikinomics," Tapscott and Williams (2007) argue that we are only beginning to see how the Internet can be used for mass collaboration and gathering innovative knowledge. With the Internet being so engrained in the everyday lives of today's youth, we will really only see these advances come to fruition when this "Net generation" moves into industry. Thus, it is vital that we now begin to understand how ICT impacts how external knowledge gets integrated into the firm.

We see two additional areas for future research. Firstly, the gatekeeper theory states that effective communication with the external environment can only be done by these few key individuals. As a result, R&D project teams that contain a gatekeeper are more likely to be higher performers. Nowadays, all knowledge workers can easily access knowledge from outside the company through the Internet. A future area for research is to investigate how this impacts project performance. Secondly, social networking sites like LinkedIn or Facebook poorly support the knowledge gathering work of Web gatekeepers. We foresee a need for social networking research that investigates innovation and knowledge gathering, and how these social networking sites could work inside the company.

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Managing Asymmetries in Transferring Tacit Knowledge

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Abstract. Tacit knowledge forms a vital part of knowledge in an organization and needs to be effectively managed. One aspect of its management is its transfer from "source" to a "recipient." Whilst situating the discussion for a dyad, this paper attempts to theoretically synthesize and clarify key concepts involved in such a transfer process.

This paper introduces two dimensions that influence such a transfer: "ease of transfer" and "motivation to transfer." The varying degree to which these dimensions exist in the source and recipient bring in asymmetries. This contributes to knowledge as most studies have assumed symmetric behaviours between source and recipient in tacit knowledge transfer. It is critical to identify these asymmetries in managing tacit knowledge transfer as intervention strategies differ. Appropriately applied intervention strategies not only enable transfer, but also facilitate learning and growth. This paper concludes with the need to conduct research under conditions of asymmetries as most studies imply symmetric behaviours.

Keywords: Tacit knowledge, Knowledge management, Ease of transfer, Motivation to transfer, Learning

1 Introduction

Tacit knowledge is commonly accepted as a source of inimitable and sustainable competitive advantage for an organization (Ambrosini and Bowman, 2001; Osterloh and Frey, 2000; Coff et al., 2006). Tacit knowledge therefore needs to be effectively managed and protected from spill over to competitors (Coff et al., 2006). An important aspect of tacit knowledge management is the need to transfer tacit knowledge through dyadic exchanges between "source" and "recipient" so that highly specialized knowledge would not be lost with labour turnover (Bhardwaj and Monin, 2006; Sun et al., 2005). It is this aspect that is considered in this study.

This study would focus on a dyad and consider tacit knowledge transfer from "source" to "recipient." Most studies that have looked at this aspect of knowledge transfer have implicitly assumed symmetric behaviours between source and recipient, irrespective of whether such symmetric behaviour is conducive or detrimental to knowledge transfer (e.g., Hansen, 1999; Ko et al., 2005; Levin and Cross, 2004; Reagans and McEvily, 2003). Tie strength, which is the extent of physical proximity and frequency of contact have been empirically established to influence knowledge transfer (Hansen, 1999; Ko et al., 2005; Levin and Cross, 2004). Higher tie strength positively influences inter-personal trust and aids in the transfer of tacit knowledge (Levin and Cross, 2004; Lin, 2007). Levin and Cross (2004) analyses the various dimensions of trust on tie strength and suggests that both competency-based trust (i.e., trust in one another's

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competency) and benevolence-based trust (i.e., the extent of care and support extended towards each other) mediates the extent of knowledge transfer. Reagans and McEvily (2003) established that individual factors such as absorptive capacity of the individual and relational factors such as interpersonal connections and social cohesion, eases knowledge transfer. A similar study done by Ko et al. (2005) shows that knowledge transfer between a consultant and a client (in an ERP implementation environment) is dependent on absorptive capacity and interpersonal connections. Although such studies provide a range of valuable insights in helping manage tacit knowledge transfer, these studies are primarily based on a premise of symmetric behaviours.

In this chapter I suggest that asymmetries exist, and that it is important to recognize these asymmetries in managing tacit knowledge transfer in a dyad. Two dimensions are proposed that influence tacit knowledge transfer in a dyad: "ease of transfer" and "motivation to transfer." The varying degree to which these dimensions exist in the source and recipient creates asymmetries. I attempt to theoretically analyze these asymmetries which would aid future research in tacit knowledge transfer.

I make two assumptions in this study. First, the process of transfer is framed as an organizational role. It is a role that skilled employees are asked to take on as part of their daily work activity. Such an organizational role is important for employees who have gained valuable tacit knowledge through extensive experience and a need exists to transfer such tacit knowledge to minimize the vulnerability of the organization. Second, tacit knowledge is difficult to codify, owned by the individual and defines their competency and worth to the organization, and hence the transfer is at their discretion. Instituting organizational policies and regulations to force the transfer is not possible (Osterloh and Frey, 2000).

The chapter is structured as follows: I begin with a brief discussion of the nature of tacit knowledge and then introduce the dimensions of "ease of transfer" and "motivation to transfer." I then suggest some practical orientations in managing tacit knowledge and conclude with implications for practitioners and academics.

2 What is Tacit Knowledge?

Although the concept of tacit knowledge has a long history, starting with Polanyi (1966) and developed by subsequent researchers, there is little evidence of a convergence in the field with Hazlett et al. (2005) suggesting that the field of knowledge management is at the pre-science stage. It appears that two diverging camps are emerging with regards to the nature of tacit knowledge: tacit knowledge is explicable (e.g., Brown and Duguid, 2000; Davenport and Prusak, 2000; Dyck et al., 2005; Nonaka and Takeuchi, 1995) versus tacit knowledge is ineffable (e.g., D'Eridata and Barreto, 2006; Tsoukas, 2003; Tsoukas and Vladimirou, 2001). The latter camp suggests that "Nonaka and Takeuchi's widely adopted interpretation of tacit knowledge as knowledge awaiting translation or conversion into explicit knowledge is erroneous: contrary to Polanyi's argument, it ignores the essential ineffability of tacit knowledge" (Tsoukas, 2003, p. 410). The divide can be bridged by suggesting that each camp emphasises different aspects of tacit knowledge. The first camp emphasises the specifiable aspect of tacit knowledge, whilst the second camp emphasises the non specifiable aspect which Cook and Brown (1999) refers to as "knowing."

Tacit knowledge has a specifiable component and as such can be possessed in the individual's cognition and hence explicable (Cook and Brown, 1999). Let me illustrate this with an example of a touch typist. As the skilled individual focuses her attention on the goal (which are the sentences to be typed), she tacitly observes the set of subsidiary rules (which in this case is the position of the characters on the key board). These sets of subsidiary rules, once explicitly known, have recessed into human sub-consciousness to possess tacit character – i.e., she is aware of its operation in action but loses her ability to explicitly define it. They form cognitive patterns that require no conscious thought in its operations (Ambrosini and Bowman, 2001; Nonaka and Takeuchi, 1995). Such specifiable aspect of tacit knowledge have varying degree of tacitness (Ambrosini and Bowman, 2001; Lam, 1997), with some knowledge that can be easily explicated whilst others are recessed into the deeper memory structures of the individual. However, when intelligently and intensely considered outside the context of its operations, such tacit knowledge can be made explicit (Ambrosini and Bowman, 2001; Nonaka and Takeuchi, 1995; Polanyi, 1966). This type of knowledge need not necessarily be technical in nature. It can also be aspects of normative behaviour in skilful actions that can be made explicit through careful observation, as in Nonaka and Takeuchi's (1995) case of the head baker in Osaka International Airport twisting while kneading the dough.

The specifiable aspect of tacit knowledge by itself does not make an individual skilled. Two individuals may have the same amount of specifiable knowledge, but may exhibit large variation in practical performance. For example, knowing that the dough needs to be twisted whilst kneading is practically useful, however, this does not mean that two bakers applying that specifiable knowledge may have similar outcomes. The individual develops an aspect called "knowing," whilst experiencing multiple use of the specifiable knowledge in a practical context. This "knowing" is the non-specifiable aspect of tacit knowledge (Cook and Brown, 1999), and is that aspect of skill (essentially muscular acts) that cannot be possessed. These are hard-to-pin-down skills that do not exist outside the context of its operations. Cook and Brown (1999) suggest that knowing is developed through the principle of dynamic-affordance. When an individual interacts with the world in performance of their skill, they encounter facilities (that aid them) and frustrations (that impede them) and they dynamically make necessary adjustments. This dynamic affordance is what constitutes knowing. For example, a cyclist develops such adjustments (i.e., "knowing") when he rides under different road and wind conditions. Outside the context of its operation, the cyclist cannot explicate such knowing.

It is the specifiable aspect of tacit knowledge that can be transferred from source to recipient, and from henceforth let me call this specifiable aspect as "tacit knowledge." The non specifiable aspect, which is called "knowing," can only be developed by the recipient through experiencing multiple episodes of the event where tacit knowledge operates.

3 Dimensions of "Ease of Transfer" and "Motivation to Transfer"

Few studies have examined asymmetries at the level of a dyad. Studies that have considered asymmetries in knowledge transfer have been primarily at the interorganizational level, and such studies have focused on work structures, systems and processes (e.g., Lam, 1997; Lane and Lubatkin, 1998).

Lam (1997), in their study of collaboration between Japanese and British companies, conclude that asymmetry in knowledge transfer is primarily due to the different degree of tacitness of knowledge in these companies. Japanese companies' knowledge is highly contextual due to the social and structural arrangement of their work-roles, whilst the work role of British companies' tends to be more specialized and hence knowledge is more explicit. These differences in tacitness of knowledge create asymmetries which impact its transfer. Lane and Lubatkin (1998) shows how dissimilar knowledge processing systems and dominant logic of inter-organizations impact knowledge transfer. However, their study makes no distinction between tacit and explicit knowledge.

In this study I focus on the dyad and suggest that the effectiveness of the transfer is dependent on the "ease of transfer" and the "motivation to transfer." I suggest these dimensions due to the nature of tacit knowledge. Tacit knowledge requires intelligent cooperation of the recipient (Polanyi, 1966), and the capability of the source as a teacher (D'Eridata and Barreto, 2006). These factors, along with the complexity of the knowledge being transferred, combine to determine the ease of transfer of tacit knowledge. Further, because tacit knowledge is personal, the source must have the motivation to transfer (Ko et al., 2005). The varying degree to which these dimension exist in a dyad creates asymmetries in the transfer of tacit knowledge.

3.1 Ease of Transfer

Tacit knowledge transfer is a discretionary activity that follows the path of least resistance (Levinthal and March, 1993). Therefore the ease of transfer, which is the amount of time and effort spent in helping others understand the source of knowledge, is an important determinant of the success of the transfer process (Reagans and McEvily, 2003). I suggest in this study that the ease of transfer is primarily cognitive based and is dependent on three factors.

First, the ease of transfer depends on the complexity of the tacit knowledge transferred. Tacit knowledge is contextual and therefore creates ambiguity in transfer. Some tacit knowledge is complex involving multiple and interdependent subsidiary rules and multiple interdependent contexts in which it operates (D'Eridata and Barreto, 2006) whilst in others it is simpler. For e.g., transferring tacit knowledge of a Formula 1 racing driver is more complex than transferring tacit knowledge of learning to drive on a motorway. In Formula 1, it is not only the subsidiary rules of gear, brake and acceleration that matters, but how such subsidiary rules are dependent on other subsidiary elements such speed, extent of curvature of the track, etc. Further, these interdependent subsidiary elements operate in multiple contexts such as the surface condition of the track and wind direction and speed.

Second, the ease of transfer is dependent on the intelligent cooperation of the recipient to comprehend and absorb the new knowledge conveyed (Polanyi, 1966). For this, the existence of common knowledge and overlapping competency would ease the transfer process (Levin and Cross, 2004; Ko et al., 2005; Reagans and McEvily, 2003); as such common knowledge increases the absorptive capacity of the recipient.

Third, the ease of transfer depends on capability of the source to transfer. In the operation of tacit knowledge, the individual focuses on the goal whilst he develops an awareness of the subsidiaries (which are the specifiable aspects of tacit knowledge). For example, in driving a vehicle the individual focuses on the road (i.e., the goal) whilst they develop a tacit awareness of the operations of the brake, accelerator, and clutch (i.e., the subsidiary). By focusing on the subsidiary, the operation of the tacit knowledge is destroyed (e.g., the skill of driving is lost if the individual focuses on the operations of the brake, accelerator, and clutch, and not on the road – a collision is inevitable!!!). However, paradoxically, to transfer their tacit knowledge the source must purposefully draw the attention of the recipient to these subsidiaries and its interpretation in relation to the goal (D'Eridata and Barreto, 2006; Polanyi, 1966; Tsoukas, 2003). This is a capability that the source must have, and such capability develops when the source is engaged with multiple cycles of transfer episodes or events (D'Eridata and Barreto, 2006).

3.2 Motivation to Transfer

Motivation is behaviourally based and it requires the source to be sufficiently motivated to engage in attention-drawing of the recipient, and in helping him experience multiple episodes of events so that the recipient develops knowing. This dimension signals the willingness of the source to be involved in the transfer process.

Although the motivation to transfer can be said to be a dimension distinct from ease of transfer, it may have some degree of association. Given the absence of other factors, the ease of transfer may impact positively on the motivation of the source to be involved in the transfer process. However, the existence of other factors (organizational as well as individual factors) can give rise to asymmetries. If the source believes that by transferring tacit knowledge can result in their harm by diminishing their value to the organization, then competitive intent can arise. This would diminish their motivation to transfer even in the face of a capable recipient.

There are limited studies in the extant literature (e.g., Ko et al., 2005; Osterloh and Frey, 2000) that specifically look at the impact of motivation on tacit knowledge transfer. The conceptual study done by Osterloh and Frey (2000) is particularly relevant for this paper. Their study looks at two types of motivation (intrinsic and extrinsic) and discusses their relevance to knowledge transfer. Intrinsic motivation is the willingness and the excitement to be engaged in an activity for the sake of activity itself and such activity is undertaken for one's immediate need satisfaction (Deci, 1975). Extrinsic motivation is an indirect form of motivation. The individual is not motivated by the activity itself, but by an external and indirect form of reward which is usually monetary. Because tacit knowledge is personal and difficult to codify, there should be intrinsic motivation of the source (as well as the recipient) to be involved in the transfer process. Unless the source feels that he has control and ownership of the transfer process, and derives immediate satisfaction from such a process, tacit knowledge transfer does not take place. It is the intrinsic motivation, more so than extrinsic motivation that determines the effectiveness of the tacit knowledge transfer (Osterloh and Frey, 2000). Ko et al. (2005) empirically established this by showing that it is the intrinsic motivation of the source and recipient, rather than any extrinsic motivation, that influences knowledge transfer.

The interplay of intrinsic and extrinsic motivation, especially on tacit knowledge transfer, is important for us to understand. The extent of influence of extrinsic motivation (such as monetary reward) on intrinsic motivation depends on two closely related issues (Osterloh and Frey, 2000). The two issues are:

1. How the source feels that their perceived locus of control of their personal knowledge is affected (Deci, 1975). For example, if through an extrinsic motivation such as a monetary reward the source feels that the organization is trying to buy their skills, there would be a perceived shift in the locus of control to an external source. This means, the source feels that the organization is trying to wrest control of their tacit knowledge through reward manipulation. This would lower the intrinsic motivation of the source to be involved in the transfer process.
2. The extent of reciprocal appreciation of intrinsic motivation (Rousseau and McLean Parks, 1993). Individuals have socio-emotional ties with the organization as well as with other individuals. These ties represent a form of an implicit psychological contract (Rousseau and McLean Parks, 1993), with a degree of good faith and an understanding of expected behavioural patterns. If an external reward breaches the good faith by violating the expected behavioural pattern, then the psychological contract turns into one that is transactional and lowers the intrinsic motivation. For example, the source might be intrinsically motivated to transfer tacit knowledge to the recipient because of his commitment and loyalty to the organization. If the organization decides to compensate this tacit knowledge transfer with monetary incentive, the behaviour might be viewed by the source as a lack of appreciation of his intrinsic motivation. The source might feel that the gesture cheapens his loyalty and commitment to the organization. However, the socio-emotional relation is enhanced when behaviour is perceived by the source as an appreciation of their intrinsic motivation. In the above example, a non-monetary gesture such as public recognition of the source's commitment might enhance the intrinsic motivation.

3.2.1 Factors that Influence Intrinsic Motivation to Transfer Tacit Knowledge

Although literature does not explicitly link factors with intrinsic motivation, I suggest that factors such as strong interpersonal connection that leads to trust (Choi et al., 2008; Lin, 2007; Levin and Cross, 2004; Reagans and McEvily, 2003), commitment to the organization (Lin, 2007; Nonaka and Takeuchi, 1995), and corperativeness (Lin, 2007; Nonaka and Takeuchi, 1995), influences tacit knowledge transfer via their impact on intrinsic motivation of the source to transfer tacit knowledge.

Interpersonal connection has been empirically established to aid in tacit knowledge transfer (Hansen, 1999; Lin, 2007; Nonaka and Takeuchi, 1995; Reagans and McEvily, 2003). Levin and Cross (2004), as well as Lin (2007), suggests that interpersonal connections positively impact on interpersonal trust and thereby influences tacit knowledge transfer. Reagans and McEvily (2003) established that strong interpersonal connection (gauged by emotional attachment to each other with a strong desire to support one another, and by the extent of communication and interaction) is positively associated with the ease of transfer. However, Reagan and McEvily's study does not consider the temporal process of knowledge transfer. It is probable that strong interpersonal connection is spuriously related to the ease of transfer only at the later stages of interactions. When interpersonal connections develop, there is a sharing of mental model and experiences. This sharing develops a shared cognitive framework that positively influences the ease of transfer. Therefore it is this shared cognitive framework (and overlap of common knowledge) that influences the ease of transfer, and not the interpersonal connection per se.

Interpersonal connection increases the intrinsic motivation of the source and recipient to be involved in the transfer process. A strong interpersonal connection increases the benevolence-based trust between source and recipient (Levin and Cross, 2004). Such an increase of benevolent-based trust establishes a socio-emotional relation where the norms of behaviour include supporting one another, ensuring each others actions do not cause harm or hurt to one another, and increasing the tendency for individuals to be vulnerable and open to one another. Such norms of behaviour increases reciprocal appreciation of intrinsic motivation, thereby increasing the motivation of the source to transfer tacit knowledge. The consequence of such interpersonal connection is the development of shared cognitive maps and shared experiences, which in turn has a positive influence on the ease of transfer.

Commitment to the organization is another factor that is proven to increase the motivation of the source to transfer. Lin (2007) suggests that organizational commitment is brought about by the existence of organizational justice and cooperativeness. Organizational justice, which is the presence of procedural justice (i.e., the reward mechanism is perceived to be just) and distributive justice (i.e., the distribution of the amount of reward is perceived to be fair), re-enforces the belief that the organization is fair. Fairness is an important part of the psychological contract between the source as an employee and the organization. Fairness enhances the perception that the external reward is an appreciation of one's intrinsic motivation, and that the external reward does not shift the locus of control away from the source. Such fairness positively influences the climate of trust within the organization (Lin, 2007) and facilitates knowledge transfer (Choi et al., 2008).

Cooperativeness is the extent to which employees identify with the ideals and mission of the organization (Lin, 2007; Nonaka and Takeuchi, 1995). Nonaka and Takeuchi (1995), in their many case studies of Japanese organizations, found cooperativeness to be a major factor motivating Japanese employees to be involved in the knowledge creating process. When the source identifies with the ideals and mission of the organization, there is a mutual agreement of common goals. The source would participate in striving to achieve these common goals. Participation strengthens self-determination rather than a feeling of being stressed from outside through external rewards (Osterloh and Frey, 2000). Such participation gives the source a sense of control of their destiny thereby enhancing their intrinsic motivation.

In this section, I introduced and delineated the two dimensions that influence tacit knowledge transfer in a dyad: "Ease of transfer" which is cognitively based and "motivation to transfer" which is behaviourally based. When the two dimensions are considered together in the transfer process, it enables a richer insight into asymmetries in behaviour between source and recipient. In the next section, I will introduce these asymmetries and suggest ways of practically managing them.

4 Practical Orientations in Managing Tacit Knowledge Transfer

The previous discussion on the dimensions of "ease of transfer" and "motivation to transfer" gives rise to multiple orientations as illustrated in Fig. 1. If the source and recipient display similar capabilities and behaviour patterns, then symmetry exist as illustrated by quadrants "A" and "B." However, asymmetries can arise as illustrated by the quadrants "C" and "D." These 2×2 orientations

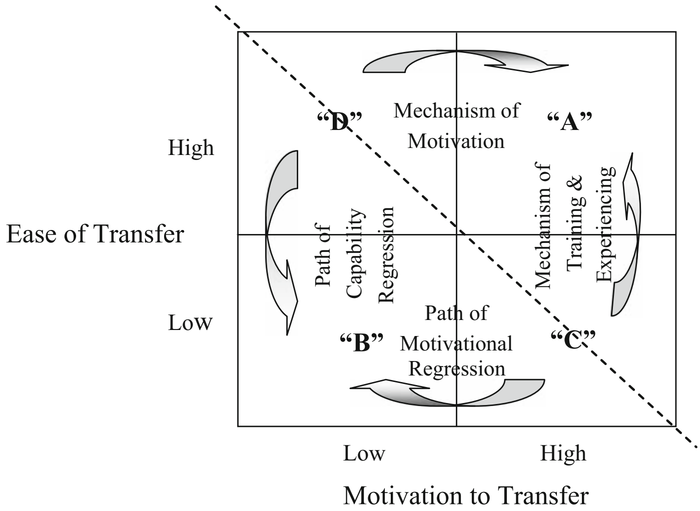

Fig. 1: A 2×2 Orientation of "Ease of Transfer" and "Motivation to Transfer"

take into account ideal as well as less than ideal situations and therefore contribute to our understanding of tacit knowledge transfer.

Figure 1 above gives us varying practical orientations in managing tacit knowledge transfer. The terms used in the figure would be explained in the sections to follow. A "one size fits all" approach would not be suitable given the asymmetries that can arise. The ideal scenario would be the quadrant "A" where high transfer of tacit knowledge takes place. I shall start with this idealized scenario. In order to re-enforce concepts discussed, I would begin the discussion of each quadrant with a hypothetical mini-case of that scenario.

4.1 Quadrant "A": High "Ease of Transfer" and High "Motivation to Transfer"

Joe was a committed and experienced machinist in his organization. Having worked for 30 years in the organization, he has seen it grow from a small job-shop outfit to a large niche manufacturer of sailing equipment. Having a love for the ocean, Joe loved the work that he did, and identified passionately with the goals of the organization in trying to support abused children. In his spare time, Joe worked with a charitable organization (that his company supports) that works with abused children. Joe's skill is invaluable for the organization and is not easily bought from outside. Coming close to retirement, Joe has had a discussion with the organization in training someone who can carry out his specialized work.

Mark, a young skilled machinist from a different industry segment was recruited to understudy Joe. Joe struck an immediate affinity with Mark due to his friendly and open style of working, and reminded Joe of his younger days. Joe was particularly pleased that the organization had recruited someone with good skills

In this scenario, Mark has the absorptive capacity to acquire and assimilate the tacit knowledge transferred. Such absorptive capacity positively influences the ease of transfer (Ko et al., 2005; Reagans and McEvily, 2003). This ease of transfer is coupled with a greater intrinsic motivation by Joe to be involved in the transfer process. This greater motivation is due to high interpersonal connection between them as well as Joe's commitment to the organization. The higher interpersonal connection ensures that each party has the welfare of the other at heart, and increases the trust and affective bond between them. This ideal scenario has two consequences.

First, Joe will likely show greater willingness to be involved in dialogue and expose his mental model. The willingness of Joe to be vulnerable by exposing his mental model coupled with the higher absorptive capacity of Mark increases the explication of tacit knowledge. Second, the tacit knowledge transferred has to be interiorized by Mark and this requires him to experience the tacit knowledge in the context of its operation (Polanyi, 1966). Due to the greater trust in Mark's ability by Joe, there is greater willingness to delegate work and involve Mark in situations where tacit knowledge operates. This trust-delegation interact can be a virtuous self-reinforcing loop (Bauer and Green, 1996). Greater trust leads to greater delegation, and effective performance of Mark in the task delegated in turn leads to greater trust. This repetitive cycle not only develops the capability of Joe as a teacher (thereby further increasing the ease of transfer), it also develops Mark's knowing in the tacit knowledge operation.

This is the idealized scenario that leads to high transfer of tacit knowledge. Although such an idealized scenario ensures rapid transfer of tacit knowledge from source to recipient, it can be detrimental for new learning and growth. Where there is strong interpersonal connection, individuals would not be willing to share sensitive information, hampering useful knowledge transfer (Selnes and Sallis, 2003). There is also the psychological tendency of individuals to turn to each other for information rather than external explicit knowledge (Allen, 1977). This tendency is enhanced when there is greater interpersonal connection, hampering the opportunity to validate and combine the tacit knowledge explicated with new external sources of information.

How could an organization intervene to minimize this detrimental effect? I suggest two possibilities: first by selecting the right type of recipient to be involved in this transfer process; and second by weakening the tie with the source by purposefully interacting them with outside sources of knowledge. Recipients who have a high sense of personal mastery know their personal goal and vision. They have the capacity to evaluate their current position vis-à-vis their personal vision, and have a greater control over life's events (Senge, 1990). Such a discipline predisposes the recipient towards new learning and growth. It is also important to allow the recipient to interact with outside sources of knowledge. Such interaction permits combination with new external knowledge and reduces the importance placed by the recipient on the knowledge explicated by the source, permitting learning and growth.

4.2 Quadrant "B": Low "Ease of Transfer" and Low "Motivation to Transfer"

Laura was the chief pattern maker in a highly specialized lingerie manufacturer. Laura's skill was second to none, admired by the technical people of the retail chain stores that deal with the organization, and was a skill that was rare in the apparel sector. Although Laura's skill was highly valued, she was a particularly difficult employee to manage. She handled all the complex work herself and rarely passed on such knowledge to her sub-ordinates. She had threatened the organization on several occasions by saying she would leave, and had got above average salary increments. Recently, she derailed the TQM programme that was implemented by refusing to participate in any TQM workshops and activity.

The company sensed their vulnerability and decided that someone had to be trained to have skills equal to that of Laura. Laura's job description was revised to include training. Some of her administrative duties were removed to free some time for training, and the company incentivised her monetarily for the role. Because of her poor interpersonal relations with her current subordinates, the organization recruited a fresh fashion school graduate Antoinette as Laura's understudy. Laura was particularly cynical of the capability of Antoinette.

This represents a symmetric yet non-ideal scenario. The culture is such that Laura fears the transfer of tacit skills, and retains the skill in order to enhance her value and position in the organization. Laura shows no particular commitment to the organization. Although the organization contributes an additional resource to free Laura of some administrative duties and provides incentives for skill transfer, she feels that these are means of wresting the locus of control away from her. These factors induce a low intrinsic motivation to transfer tacit skills. Coupled with this low intrinsic motivation, Antoinette has low absorptive capacity to understand the implications of the tacit knowledge and this diminishes the ease of transfer. Although Antoinette had studied the basics of pattern making, she was never exposed in fashion school to the complexities of a structured garment like lingerie. This combination of low ease of transfer and low motivation to transfer is not conducive to tacit knowledge transfer and no transfer takes place.

4.3 Quadrant "C": Low "Ease of Transfer" and High "Motivation to Transfer"

Andrew was regarded as the best store manager for his organization. Due to his consistent excellent performance, Andrew was put in charge of the organization's flagship store. Andrew's long tenure in the organization was due to his loyalty and commitment. The organization had always had a human touch and Andrew has personally benefited, and seen others benefiting, from the humane approach of the organization. Human capital was regarded as the most valuable capital for the organization, and the organization consistently invests in their people development. Such values of the organization appealed to Andrew.

Andrew almost had a 'sixth sense' when it comes to store layout. His ability to pick and place the right product was legendary. Andrew instinctively knew sales patterns, consumer preferences, and spent a lot of his time interacting with frontline staff and customers. Recently, the company had given him a role to mentor and train aspiring store managers. The company decided that the best route to follow is to select fresh management trainees, so that fresh thinking could be injected into the organization. Tom, a likable and enthusiastic young graduate was selected to be a recipient in this mentoring programme. Andrew took an instant liking to Tom.

The above scenario represents an asymmetric situation. The psychological contract established between Andrew and Tom requires a reciprocal appreciation of each other's skills. It requires Tom to appreciate the tacit skills of Andrew. Such appreciation can be enhanced if Tom shows capability to acquire and assimilate new knowledge that is transmitted, and this would increase the intrinsic motivation of Andrew to be involved in the transfer process. Likewise, it requires Andrew to appreciate the growing capability of Tom to be a good store manager.

However, if Andrew continues to find it difficult to explicate and transfer tacit knowledge due to the lower absorptive capacity of Tom, Andrew would feel that Tom does not understand and appreciate his skills. This violates the implicit psychological contract between them and therefore lowers the intrinsic motivation of Andrew to be involved in the transfer process. This can lead to outburst by Andrew such as "it frustrates me that Tom just cannot get it."

Due to the lack of capability of Tom, there would also be reluctance on the part of the Andrew to delegate work and engage Tom in the practical operations of the tacit knowledge. Tom would not be given any opportunity to experiment and design his own store layout. This would in turn hinder the development of Andrew's capability as a teacher, as he finds it difficult to intellectually engage with Tom. These results in a reduction of Andrew's trust on Tom's competency and can even hinder interpersonal relation. When this occurs, the *path of motivational regression* sets in leading eventually to the quadrant where no transfer takes place (see Fig. 1).

How does one avoid the path of motivational regression? To avoid such a path, the organization can introduce the *mechanism of training and experiencing* (see Fig. 1). Such a mechanism operates in two ways. First, the organization must have an explicit agenda to train Tom in areas which he lacks. Given the pressure of work, the organization cannot expect Andrew to engage in such training. Such training is best handled by an external institute or in-house training unit. These training programs should not only facilitate the transfer of widely accepted explicit knowledge, but also the less openly conveyed tacit knowledge (Sternberg et al., 2000). Such transfer can be facilitated by the use of lectures, group discussions, cases, behavioural role modelling, and simulations (Sternberg et al., 2000). This intervention seeks to develop the absorptive capacity of Tom, by building the base of his prior knowledge. Second, Tom once trained must be given the opportunity to experience the tacit knowledge in operation. On-the-job training (or learning from experience) plays a more defining role in developing tacit skill than any formal training programme (Sternberg et al., 2000). However, this requires the organization to buffer Andrew from any failure or setbacks caused. These interventions of training and experiencing would push the process to the high transfer quadrant.

In this asymmetric scenario one cannot realistically expect new learning and growth to take place. The organization must first ensure that mechanisms of training and experiencing are in place and the process has moved to the high transfer quadrant. Only when the high transfer quadrant has been reached that intervention such as purposefully engaging the recipient with outside sources of knowledge can be enacted.

4.4 Quadrant "D": High "Ease of Transfer" and Low "Motivation to Transfer"

Sunil was the most experienced and the best folder maker in his organization (an organization that manufactures long seam clothing). He knew how to construct mechanical folders to guide the operators when sewing long and complex robes. His folders generally increase sewing efficiency by more than 30% and have a tremendous impact on the profitability of the organization.

However, Sunil never went to technical school to be qualified as a tradesman, and the skill he has acquired was through many years of experience in the organization. He has worked himself up to the position he is in today. The work that he did gives him satisfaction and raises his sense of importance to the organization. Sunil's self esteem was significantly based on his role in the organization. For this reason he was fearful of losing his job, and fearful of losing his value to the organization. He never documented the work that he did (which was required by the organization). Quite often his department had to wait for his return (when he was on leave) to select the right folder or to re-design the folder for another closely related job.

Due to pricing pressure in the market place, the organization had to raise factory floor efficiency. Having the appropriate folders became a critical concern. More folder makers, in the calibre of Sunil, were a critical requirement. The organization decided to move Praveen to Sunil's section in order to enhance his folder making skills. Praveen had been with the organization for 5 years and had shown good folder making skills. Sunil had always been threatened by the potential capability of Praveen, and never closely associated with him.

This represents another asymmetric scenario where a capable recipient (Praveen) has been selected to receive and develop tacit skills. Competitive intent sets in because Sunil fears the dilution of his value to the organization if the tacit knowledge is transferred. Sunil fears that Praveen could harm him if his tacit knowledge is transferred, and this fear is a perceived reality as their interpersonal relations is weak. Sunil feels that the organization is trying to take away his skills, and in so doing feels that he would lose control over the skill that he had gained over many years of experience. These factors lower the intrinsic motivation of Sunil to be involved in the tacit knowledge transfer process.

Coupled with low intrinsic motivation to transfer are negative emotions such as fear, anxiety, and distress. Such negative emotions, either singularly or in conjunction, are capable of narrowing the perceptions of Sunil (Fredrickson, 2001). This can alter Sunil's perception of Praveen's competency. Even a small mistake by Praveen would be exaggerated by Sunil as a reflection of Praveen's incompetence to take on the role. This breeds mistrust between the individuals. Such mistrust will also diminish the value placed by Praveen on Sunil's knowledge and competency. Praveen would be suspicious of any information passed by Sunil. Such actions by Praveen would be perceived by Sunil as a lack of appreciation of his tacit skill and further lowers the intrinsic motivation to transfer. This perceived lack of trust on each other's competency can set the process on the *path of capability regression* (even though it is more a perception than reality) and eventually lead to the no transfer quadrant (see Fig. 1).

How can the organization avoid the path of capability regression? I suggest the *mechanism of motivation* as a possible intervention for this scenario (see Fig. 1). Extrinsic motivation must be induced, however, in a manner that enhances the intrinsic motivation of Sunil to be involved in the transfer process. Such extrinsic motivation should not violate Sunil's sense of control over his tacit skill, and should seek to appreciate his tacit skill. By assuming that paying Sunil a bonus or monetarily compensating him would suffice is misplaced. Such mechanism would have the opposite effect to what is intended, and might enhance Sunil's perception that the organization is trying to buy his hard earned skills. Therefore, the package of extrinsic motivation should be carefully designed and implemented. Perhaps the organization can involve Sunil in a larger role in the future (like a trainer) where he can exercise his locus of control of his tacit knowledge. A role such as a trainer, with significance and importance attached, can also show appreciation of his tacit skill and enhance his intrinsic motivation to be involved in the transfer process. In order to reduce the possibility of failure in such a role, there must be a simultaneous process of developing Sunil's capability as a trainer. However, this is easily said than done, as the successful implementation of this mechanism of motivation is determined by the prevailing culture of the organization.

5 Conclusion: Implications for Practitioners and Academics

In this paper I attempted to theoretically synthesize key concepts in the knowledge management literature in order to understand asymmetries between source and recipient in tacit knowledge transfer. In so doing, I suggest two dimensions that influence tacit knowledge transfer: "Ease of transfer" and "motivation to transfer." The ease of transfer, being cognitively based, is determined by the capability of the recipient to receive tacit knowledge and the capability of the source as a teacher. The motivation to transfer, being behavioural based, is the willingness on the part of the source to be engaged in the transfer process. Such willingness is based more on the intrinsic motivation to be involved, rather than induced extrinsic motivation that can crowd-out intrinsic motivation (Ko et al., 2005; Osterloh and Frey, 2000). Such intrinsic motivation is influenced by the strength of the interpersonal connection between the source and recipient and their commitment to the organization. These dimensions give rise to a 2×2 orientation (see Fig. 1), and each orientation requires different intervention mechanisms. This extends our insights into tacit knowledge transfer by considering asymmetries (i.e., high and low "ease of transfer" with low and high "motivation to transfer"). Most previous studies on tacit knowledge transfer at the level of a dyad have been based on a premise of symmetric behaviours.

This study has important implications for practice. The study calls for practitioners to evaluate the situation and design the right interventions to improve the transfer process, as asymmetric situations require different intervention strategies. For example, by implementing an intervention of *mechanism of motivation* in the asymmetric situation of low "ease of transfer" and "high motivation to transfer," the transfer process would not be enhanced as the low absorptive capacity of the recipient is not addressed. This wrongly placed intervention strategy would push the situation to the "no transfer" quadrant.

The study also has important implication for academics. It specifically highlights the need for research to be carried out in conditions where asymmetries exist. Previous research on the implications of tie strength, trust, and commitment has been done on an implied premise of symmetric behaviours. It would be interesting to see if the results hold true under conditions of asymmetries. Asymmetries also highlight the need to carry out a more longitudinal study of the tacit knowledge transfer process. How do the dimensions of ease of transfer and motivation to transfer change in the temporal process of transfer? What appropriate interventions strategies are needed and at what stage of the temporal process of transfer? Empirical research in these areas would in turn greatly benefit practitioners.

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Information Technology as an Enabler of Knowledge Management: An Empirical Analysis

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Abstract The past two decades have seen growing interest in knowledge management and the use of information technologies. However, it is not clear how the relation between IT competency and knowledge management works. This study provides a better understanding of that relation. Through an empirical study of 162 Spanish firms, the work finds that IT competency has a direct effect on the processes of knowledge management: knowledge generation, knowledge transfer, and knowledge codification and storage. At the same time, IT competency also has an indirect effect on knowledge management by facilitating the development of organizational structures that favor the development and expansion of knowledge. These findings reinforce a field that is of increasing interest to researchers, and which has seen only a limited number of empirical studies to date**.**

Keywords: Information Technology Competency, Organizational Learning, Knowledge Management

1 Introduction

Firms are facing a competitive environment characterized by the globalization of markets, increasingly complex business problems, and the acceleration of change phenomena. Consequently, the traditional sources of competitive advantage, such as protected markets, and physical and financial assets, have lost importance compared to knowledge assets (Foray and Lundvall, 1996; Grant, 1996; Johnston and Rolf, 1998). This has contributed to the growing interest in the concept of knowledge management in the past two decades.

Knowledge management has emerged as a discrete area in the study of organizations and is frequently cited as an antecedent of organizational performance. If organizations implement knowledge management practices successfully they are able to perform intelligently to sustain their competitive advantage by developing their knowledge assets (Wigg, 1999). Thus, it is essential to know how to generate knowledge, how to disseminate it in the organization and what factors facilitate these processes (Stewart, 1997; Davenport and Prusak, 1998).

In recent years, several researchers have associated knowledge management with the development of information and communication technologies, (ICT) (Ruggles, 1997; Scott, 2000; King, 2005). The new technologies are characterized by their capacity to influence the traditional ways of understanding certain organizational phenomena and behaviors and affect how organizations tackle the challenges thrown up by the knowledge society (Duffy, 2001). Researchers have gone from studying the effects of ICT on economic-financial variables to studying its comple-

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mentarity with intangible resources such as knowledge (Martin et al., 2004). But it is not clear how the relation between IT competency and knowledge management works. Empirical work in this area is lacking.

Thus, the objective of this paper is to develop a better understanding of how IT competency affects knowledge management. This study proposes a theoretical model whose basic contention is that the relation between IT competency and knowledge management is twofold: both direct and indirect. Information systems can directly influence the knowledge management processes. They can also indirectly influence knowledge management by affecting contextual factors such as structure, which, in turn, influence knowledge management. The following sections discuss the concepts of knowledge management and IT competency. Then, the hypotheses representing the relations between IT competency, structure and knowledge management are formulated. The hypotheses are tested with the structural modeling technique, using data collected from managers in 162 Spanish firms. The work concludes with a discussion of the results and their implications.

2 Knowledge Management

Defining the concept of knowledge management is not straightforward, because this subject has been studied by several disciplines and from different approaches. For example, Davenport et al. (1998) defines knowledge management as a process of collection, distribution and efficient use of the knowledge resource. O'Dell and Grayson (1998) see knowledge management as a strategy to be developed in a firm to ensure that knowledge reaches the right people at the right time, and that those people share and use the information to improve the organization's functioning. For Bhatt (2001), knowledge management is a process of knowledge creation, validation, presentation, distribution and application. And Bounfour (2003) defines knowledge management as a set of procedures, infrastructures, and technical and managerial tools, designed to create, share and leverage information and knowledge within and around organizations.

Although the above definitions vary in their description of knowledge management, there seems to be a consensus to treat knowledge management as a set of processes allowing the use of knowledge as a key factor to add and generate value (Bueno and Ordoñez, 2004).

In the conceptual framework of this work, knowledge management is composed of three main processes, which are namely: knowledge generation, knowledge transfer, and knowledge codification and storage.

Knowledge generation can be defined as the process by which the firm obtains knowledge, either from outside the company or generated internally (Lee and Hong, 2002; McCann and Buckner, 2004). The objective is to obtain new and better knowledge that helps the organization improve its competitiveness (Wiig, 1997). Thus, knowledge generation is not just about generating new contents, but also about replacing, validating and updating the firm's existing knowledge (Alavi and Leidner, 2001; Bhatt, 2001). Firms can acquire knowledge externally from different sources, for example talking to external agents, collaborators and partners, buying patents or taking on new employees (McCann and Buckner, 2004). Internally, knowledge creation can involve developing new contents or replacing existing contents (Alavi and Leidner, 2001) by investing in R&D or training and development (McCann and Buckner, 2004).

Knowledge transfer refers to the process by which an organization shares knowledge among its units and members, promoting new understanding (Wiig, 1997; Alavi and Leidner, 2001). It is essential for the firm to develop an adequate design of informative interaction networks that allow individuals of diverse specialties, cultures, and geographic locations, not only to access the same information but also to come together through the network to undertake a particular project. Moreover, for the transfer of tacit knowledge, which requires more interaction between the individuals, the firm must develop mechanisms that encourage dialogue and interaction (Lave and Wenger, 1991; Cook and Yanow, 1993; Brown and Duguid, 1998; Wenger, 1998; Fox, 2000; Gherardi and Nicolini, 2002).

Finally, knowledge codification and storage is a very important aspect in the effective management of knowledge (Levitt and March, 1988; Huber, 1991; Simon, 1991; Casey, 1997; Cross and Baird, 2000). The existing knowledge must be captured, codified, presented and put in stores in a structured way, so it can be reused later (Choi et al., 2008). However, it is vital to remember that organizational knowledge is dispersed and scattered throughout the organization. It is found in different locations, in people's minds, in organizational processes, and in the corporate culture, embedded in different artifacts and procedures, and stored in different mediums such as print, disk and optical media (Bhatt, 2001). Thus, some authors suggest that capturing, codifying and storing knowledge are the most challenging aspects of knowledge management.

3 IT Competency

Firms need internal information about their financial situation, the effectiveness of their products, their production costs, and so on. And they need external information about the environment in which they operate– competitors, customers, suppliers, etc. – that helps them to get to know their customers and satisfy them immediately and effectively, and so gain sustainable competitive advantages (Maier et al., 1997).

Getting information is no longer the problem. The difficulty lies in obtaining quality information, where quality is measured in terms of accuracy, reliability, precision, and timeliness, and the extent to which the information is relevant in the decision making (Huber, 1990).

The IT revolution has facilitated the processes of searching for and recovering information, but at the same time it has led to an important growth in the database industry. Firms must be able to use IT to obtain useful information for their decision-making.

Following Tippins and Sohi (2003), this study defines IT competency as how the firm uses these technologies to manage its information effectively. While IT is a generic term fundamentally used to refer to programs, computers and telecommunications, the term IT competency is broader and refers to the use of these technologies to satisfy the firm's information needs (Gunasekaran et al., 2001). This study differentiates between three dimensions of this concept: IT knowledge, IT operations, and IT infrastructure. These dimensions represent cospecialized resources that indicate the organization's capacity to understand and use the tools necessary for managing information about markets and customers (Tippins and Sohi, 2003). Moreover, although they are independent, all three aspects must be present for the firm to achieve IT competency. For example, many firms invest in technical tools but at the same time fail to achieve IT competency because they lack the knowledge required to use these tools efficiently. Brief definitions for these three dimensions follow.

IT knowledge. Knowledge is information combined with experience, context, interpretation and reflection, so knowledge has a tacit component that is difficult to quantify (Davenport et al., 1998). Taylor (1971) defines technical knowledge as the set of principles and techniques that are useful to bring about change toward desired ends. Thus, the current study defines IT knowledge as the extent to which the firm possesses a body of technical knowledge about elements such as computer systems.

IT operations. This concept refers to the IT-related methods, processes and techniques that may be needed if these technologies are to create value (Maier et al., 1997). In the context of the current study, IT operations is defined as the extent to which the firm uses IT to improve its effectiveness and decision making.

IT infrastructure. The IT infrastructure acts as an enabler, and to a large extent is responsible for the growing interest in the production and dissemination of information (Reardon et al., 1996). IT infrastructure refers to the artifacts, tools and resources that contribute to the acquisition, processing, storage, dissemination and use of information. According to this definition, the IT infrastructure includes elements such as hardware, software and support staff.

4 Theoretical Model and Hypotheses

Information technology has been a central topic in the knowledge management literature (Stein and Zwass, 1995; Constant et al., 1996; Hayes and Walsham, 2003). Information and communication technologies have been closely associated with the development of the great majority of knowledge management initiatives. It is estimated that almost 70% of publications on knowledge management focus on the design of IT systems (Franco and Mariano, 2007).

The influence of IT competency on knowledge management can be considered two fold: direct and indirect. Information systems can directly influence the knowledge management processes. They can also indirectly influence knowledge management by affecting contextual factors such as structure, which, in turn, influence knowledge management. This section develops the hypotheses about the relations between IT competency and knowledge management.

4.1 IT Competency and Knowledge Management Processes

ICT improves the efficiency of organizational management processes and provides new ways of improving the capacity of response to environmental requirements. According to Olivera (2000), those technology systems serve a variety of functions such as storing large amounts of information, making information accessible to individuals, providing means of communication, generating records of interactions and transactions, and automating processes.

On the basis of the above reasoning, the influence of IT on the previously identified knowledge management processes (knowledge generation, knowledge transfer, and knowledge codification and storage) is now analyzed.

Strategic applications of information systems for knowledge generation can take two forms (Mason, 1993): capabilities for assimilating knowledge from outside (such as competitive intelligence systems acquiring information about other companies in the same industry); and capabilities for creating new knowledge from the reinterpretation and reformulation of existing and newly acquired information (such as executive information systems or decision-support systems).

Likewise, IT facilitates the process of knowledge transfer. Technology enables individuals to coordinate the logistics of face to face meetings. It can also be used to catalogue expertise of organizational members and a result facilitating access to the right people and enhancing knowledge sharing (Al-Hawamdeh, 2002). Certain systems (e.g., groupware or collaborative systems) provide a virtual space where the participants can process the information and knowledge in real time, giving them more chance to interact (Marwick, 2001; Lee and Choi, 2003). Exchange spaces become the ideal place to develop innovative and creative behaviors around problems and situations. One of the most important characteristics of these exchange spaces and virtual communities is that they are founded on the democratization of knowledge, so they enable the appearance of natural flows of transference and collaboration and consequently favor creativity and innovation (Narayanan, 2001).

Finally, IT supports the process of knowledge codification and storage. IT facilitates the standardization and automation of certain tasks, supporting the transformation of tacit knowledge into explicit knowledge (Anand et al., 1998). Similarly, IT also provides the necessary mechanisms to codify and store knowledge. In order to be useful, however, knowledge stores must be accessible to firm members and must be in a form that will enable each member to interpret in a similar manner, thereby becoming a part of the whole firm's knowledge base. IT, with its protocols and platform standards, provides an ideal mechanism for connecting widely dispersed individuals via a common system and enabling firm members to access more easily the knowledge that is stored in memory bins, so that new information can be interpreted and synthesized with existing knowledge (Tippins and Sohi, 2003).

Given this theoretical framework, the first three hypotheses are as follows:

H1. IT competency has a positive effect on the process of knowledge generation.
H2. IT competency has a positive effect on the process of knowledge transfer.
H3. IT competency has a positive effect on the process of knowledge codification and storage.

4.2 IT Competency, Structure, and Knowledge Management

The development of IT is having a considerable effect on firms, and researchers argue that these technologies have a critical role in the appearance of new organizational forms, which go under a large number of names. Clearly, a relation exists between the appearance of new organizational forms and technological development, and these technologies are considered the causes of the structural changes and of the emergence of new, more flexible organizational forms capable of rapidly and effectively adapting to the growing changes in the environment (Barley, 1990; Malone, 1997; Robey et al., 2000).

IT moderates vertical differentiation and allows fewer levels in the hierarchy to handle as much or more problem solving and decision making, resulting in a flatter organization (Dewett and Jones, 2001).

IT systems, by increasing the level of formalization or allowing "controlled" decentralization, can substitute for the control typically provided by the hierarchy (Keen, 1990). In addition, since IT provides low-level employees with more freedom to coordinate their actions, employees can experiment and find better ways to perform their tasks (Huber, 1990; Malone, 1997).

Consequently, the link between IT, organizational structure and knowledge management is evident. To the extent that IT has led to a reduction in the traditional boundaries between hierarchical levels (vertical boundaries) and between functions (horizontal boundaries), these technologies favor the development of organic structures where information, ideas and knowledge can flow rapidly through the organization and hence improve the chances of processing and generating knowledge effectively.

On the basis of the above arguments, the fourth hypothesis is as follows:

H4. IT competency has an indirect effect on knowledge management through its positive effect on new, more flexible organizational forms.

5 Methodology

5.1 Sample and Data Collection

The first step in testing the above hypotheses was to choose the population object of analysis. This study focuses on IT competency, so the sectors of reference are those that use these technologies most intensively (Fundación BBVA, 2007). The sectors included are as follows: electrical energy, gas and water, paper industry, publishing and graphic arts, electronic, electrical and optical equipment, transport and communications, financial intermediation, business services, health and private social services, and other social and service activities.

After choosing the sectors, the population object of study was specified more precisely. This work uses 1,660 firms from the SABI database satisfying the following requisites: belonging to one of the aforementioned sectors, with a sales volume exceeding €10 million, and employing at least 50 workers. Large firms use IT more than SMEs, which is the reason for choosing reasonably sized firms. This study follows the recommendation of the European Commission 2003/361/EC, which defines the following types of firm: microenterprise, one with fewer than ten workers and not exceeding €2 million annual turnover; small enterprise, firm with fewer than 50 workers and an annual turnover of less than €10 million, medium-sized enterprise, firm with fewer than 250 workers and an annual turnover of less than €50 million, and large enterprise, firm with more than 250 workers and an annual turnover exceeding €50 million.

The data collection period was January to June 2007, and involved a postal survey. The sampling unit chosen was the CEO, who had been identified as the appropriate key respondent based on two criteria: (a) possession of sufficient knowledge; and (b) adequate level of involvement with regard to the issues under investigation (Campbell, 1955).

A number of approaches were used to ensure response quality and to enhance the response rate. These collectively constitute a modified version of Dillman's (1978) "total design method." More specifically, the process was organized as follows: first, the research instrument was pretested twice. The draft version was pretested with the CEOs from four companies.

A second pretest was conducted after in-depth discussions with academics and questionnaire design experts. This second pretest involved seven firms. After some minor modifications, the final questionnaire was mailed to CEOs together with a letter explaining the purpose of the study and assuring anonymity. Further, given the low response rates associated with organizational research, the respondents were promised a complementary summary of the results. Six weeks after the initial contact, the authors sent a follow-up mailing including the same material as the first.

The number of valid questionnaires returned is 162, which represents a response rate of 9.75%. This rate is not as high as in US or UK studies, but nor is it out of line with comparable survey-based studies in Spain, such as López et al. (2006) and Prieto and Revilla (2006), whose response rates are 7.8 and 10.52, respectively.

To check the representativeness of the sample, the sample and the population were compared in terms of two criteria: the company size (considering four levels: between 50 and 200 employees, between 200 and 1,000 employees, between 1,000 and 5,000 employees, and over 5,000 employees) and the sector of activity (differentiating between industrial, financial and nonfinancial service companies). The test (chi-square) shows that no significant differences exist between the sample and the population. The next analysis was to determine whether any differences exist in the means of all the variables used in the study between early and late respondents. The rationale behind such an analysis is that the late respondents (i.e., sample firms in the second wave) are more similar to the general population than the early respondents (Armstrong and Overton, 1977). These comparisons do not reveal any significant differences, indicating that nonresponse bias is not a serious issue in this study.

5.2 Measures

This section describes the scales used to measure IT competency, knowledge management and organizational structure (see also Appendix). All the variables were measured on Likert 5-point scales ranging from 1 = strongly disagree to 5 = strongly agree.

IT competency. This scale was adapted from Tippins and Sohi's (2003) scale, and includes 11 items to measure the dimensions of IT knowledge, IT operations and IT infrastructure. Items about the firm's knowledge, skills and experience in the use of IT measure the first of these dimensions. For the second dimension, the items measure the use of collaboration technologies, as well as the tools and systems available in the firm to acquire and store information that is useful in the decision making. Finally, to evaluate the firm's infrastructure, the scale includes items considering whether the firm develops software tailored to its own needs, the allocation of funds to acquire new equipment, or the existence of a person or department in charge of IT.

Knowledge management. Respondents were asked to indicate the level of agreement on each of the 11 items measuring various aspects of knowledge management processes including knowledge generation, knowledge transfer and sharing, and knowledge codification and storage. The scale was generated using some of the items from the scales proposed by Gold et al. (2001) and Zaim et al. (2007). The remaining items were built after theoretical contributions and extensive discussions with academics and chief executives during the pretesting phase of the questionnaire development.

Organizational structure. To measure this construct, the authors selected four items evaluating organizations' degree of centralization, complexity and vertical differentiation that are adapted from Pugh et al. (1969) and Miller (1987).

6 Analysis and Results

6.1 Psychometric Properties of Measurement Scales

The psychometric properties of the measurement scales were assessed following accepted practices (Gerbing and Anderson, 1988). This included establishment of content validity and construct validity (see Table 1 for means, standard deviations, and factor correlations). Content validity was established through personal interviews with academics and chief executives during the pretesting phase of questionnaire development. Moreover, considerable efforts were made during the field-based validation to ensure that the scale items were relevant and generalizable across the industries in the sample. After an initial examination procedure that sought to identify items exhibiting low item-to-construct correlation or items loading significantly to more than one construct dimension, the authors tested the construct validity of the measures employing confirmatory factor analysis (CFA) using EQS (Bentler, 1995). A series of empirical tests examined the measurement properties of the indicators, namely reliability, convergent validity, discriminant validity and dimensionality.

To assess scale reliability, the composite reliability estimates were calculated (Fornell and Larcker, 1981). These are directly analogous to the commonly used coefficient alpha statistics. As Table 1 shows, all measures have a composite reliability greater than the recommended level of 0.7 (Bagozzi and Yi, 1988). Establishing convergent validity requires examining the significance of the factor loadings (Gerbing and Anderson, 1988). As Table 2 shows, all the loadings of the measurement items on the hypothesized construct are significant ($p < 0.001$), which provides evidence of convergent validity. Discriminant validity was assessed by comparing the χ^2 differences between a constrained confirmatory factor model (where the interfactor correlation is set to 1, indicating they are the same construct) and an unconstrained model (where the interfactor correlation is free). As Table 3 shows, all χ^2 differences are significant, providing evidence of discriminant validity (Gerbing and Anderson, 1988).

To confirm the dimensionality of the higher-order constructs – IT competency and knowledge management – the authors ran second-order confirmatory factor analyses. Table 2 shows the results for the estimated models. The factor loadings of the first-order factors (IT knowledge, IT operations, and IT infrastructure) on the second-order factor IT competency are all significant at the $p < 0.001$ level. Similarly, the factor loadings of knowledge generation, transfer, and codification and storage on knowledge management are also significant. Further, the comparative fit index (CFI) exceeds the recommended norm of 0.9 for both the models (CFI = 0.962 for IT competency and 0.969 for knowledge management). This indicates good model fits and confirms the scale dimensionality.

Table 1: Factor Correlations, Means, Standard Deviations, and Reliabilities

	Mean	SD	Reliability	IT know.	IT ops.	IT inf.	K. gen.	K. tran.	K. stor.	Struct.
IT know.	3.887	0.845	0.920	1.000						
IT ops.	3.757	0.826	0.803	0.668	1.000					
IT inf.	4.102	0.945	0.877	0.652	0.551	1.000				
K. gen.	3.601	0.760	0.819	0.296	0.489	0.211	1.000			
K. trans.	3.698	0.734	0.836	0.349	0.373	0.284	0.594	1.000		
K. stor.	3.706	0.732	0.740	0.347	0.443	0.359	0.436	0.338	1.000	
Struct.	3.694	0.808	0.886	0.311	0.351	0.291	0.570	0.565	0.337	1.000

Table 2: Convergent Validity and Dimensionality Tests

Measures	Factor loadings (*t* value)
IT competency[a]	
First-order measurement model	
V1←IT Know.	0.83 (13.851)
V2←IT Know.	0.92 (18.437)
V3←IT Know.	0.92 (15.704)
V4←IT Ops.	0.84 (12.971)
V5←IT Ops.	0.81 (13.965)
V6←IT Ops.	0.56 (6.853)
V7←IT Ops.	0.61 (8.123)
V8←IT Inf.	0.91 (12.113)
V9←IT Inf.	0.86 (11.219)
V10←IT Inf.	0.79 (10.204)
V11←IT Inf.	0.62 (8.965)
Second-order factor model	
IT Know.←IT Competency	0.89 (11.098)
IT Ops.←IT Competency	0.89 (10.335)
IT Inf.←IT Competency	0.72 (7.235)
Knowledge management[b]	
First-order measurement model	
V12←K. Gen.	0.68 (9.987)
V13←K. Gen.	0.79 (11.353)
V14←K. Gen.	0.74 (9.223)
V15←K. Gen.	0.70 (9.492)
V16←K. Trans.	0.68 (7.446)
V17←K. Trans.	0.77 (8.274)
V18←K. Trans.	0.78 (9.967)
V19←K. Trans.	0.76 (10.691)
V20←K. Stor.	0.62 (7.337)
V21←K. Stor.	0.77 (9.205)
V22←K. Stor.	0.70 (7.475)
Second-order factor model	
K. Gen.←Knowledge Management	0.87 (8.673)
K. Trans.←Knowledge Management	0.82 (5.432)
K. Stor.←Knowledge Management	0.59 (4.192)
Structure[c]	
First-order measurement model	
V23←Structure	0.80 (10.304)
V24←Structure	0.87 (12.017)
V25←Structure	0.78 (9.928)
V26←Structure	0.80 (10.625)

(continued)

Table 2: (continued)

[a]Model summary statistics:
First-order model: S-Bχ^2=69.7816, d.f.=41 (p=0.003); RMSR=0.066; NNFI=0.952; CFI=0.964;
Second-order model: S-Bχ^2 = 72.5315, d.f.=42 (p=0.002); RMSR=0.067; NNFI=0.951; CFI=0.962
[b]Model summary statistics:
First-order model: S-Bχ^2=51.4367, d.f.=41 (p<0.001); RMSR=0.044; NNFI=0.961; CFI=0.971;
Second-order model: S-Bχ^2=52.6089, d.f.=42 (p<0.001); RMSR=0.047; NNFI =0.96; CFI=0.969
[c]Model summary statistics: S-Bχ^2=7.3103, d.f.=2 (p=0.025); RMSR=0.025; NNFI =0.945; CFI=0.982

Table 3: Discriminant Validity Test

	Correlation coefficients	
IT competency		χ^2 (d.f.=42)
IT know. – IT ops.	0.79	138.184 (p*<0.001)
IT know. – IT inf.	0.67	227.061 (p<0.001)
IT ops. – IT inf.	0.60	181.761 (p<0.001)
Base model (unconstrained)		χ^2=79.20 (d.f.=41)
Knowledge management		χ^2 (d.f.=42)
K. gen. – K. trans.	0.72	121.100 (p<0.001)
K. gen. – K. stor.	0.56	120.670 (p<0.001)
K. trans. – K. stor.	0.42	139.393 (p<0.001)
Base model (unconstrained)		χ^2=60.69 (d.f.=41)

*Denotes significance of χ^2 differences between constrained and unconstrained model

6.2 Hypothesis Tests

To test the hypotheses proposed in the theoretical section of this study two structural equation models were estimated using the statistics package EQS Version 6.1. The first relates IT competency with the knowledge management processes. Figure 1 depicts the specific model that was evaluated. This figure shows the fit indices, the variance explained by the model (R^2), the standardized path coefficients (β) and the t values.

As the figure shows, the overall model demonstrates an acceptable fit. Although the Satorra–Bentler statistic is significant, there is much discussion in the literature about whether this test is really a valid indicator of the model fit, given its sensitivity to sample size. Consequently, the current study also uses the indices NNFI, CFI, and RMSR. Their values are in all cases at acceptable levels.

The results provide clear support for hypotheses H1, H2, and H3. The findings show that IT competency has a positive effect on knowledge generation (β=0.3, t=4.107, p<0.01), knowledge transfer (β=0.28, t=3.611, p<0.01), and knowledge codification and storage (β=0.3, t=4.258, p<0.01).

To test the fourth hypothesis, the authors estimated a model relating IT competency with the organizational structure and knowledge management considered globally. Figure 2 shows the

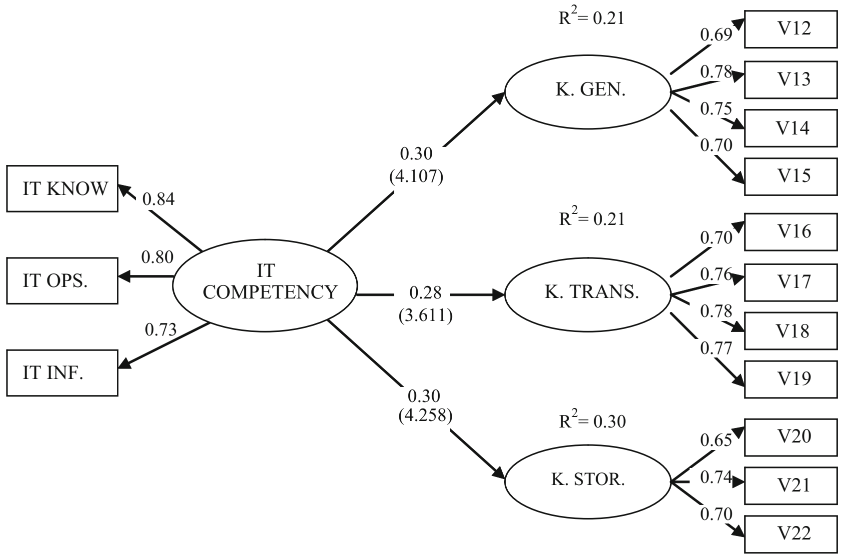

Fig. 1: Representative Model of Relations Between IT Competency and Knowledge Management Processes (*Notes*. Relation diagram shows standardized parameters; *t* value in parentheses; Model summary statistics: S-Bχ^2 = 126.082, d.f. = 71, *p* = 0.000; RMSR = 0.054; NNFI = 0.925; CFI = 0.941)

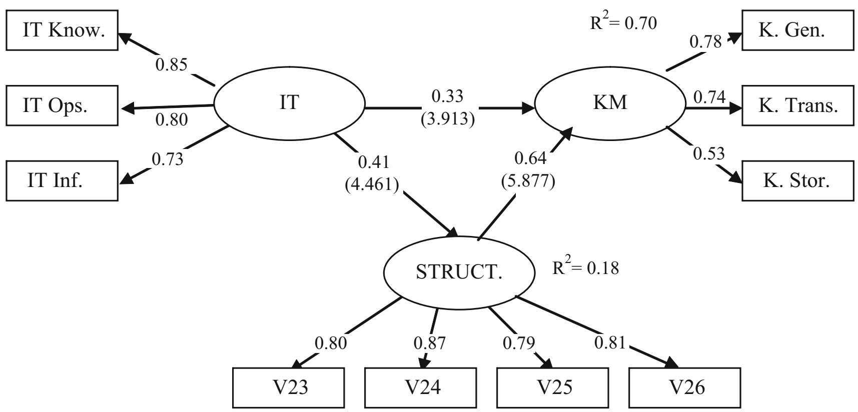

Fig. 2: Representative Model of Relations Between IT Competency, Structure, and Knowledge Management (*Notes*. Relation diagram shows standardized parameters; *t* value in parentheses; Model summary statistics: S-Bχ^2 = 56.7132, d.f. =32, *p* = 0.004; RMSR = 0.054; NNFI = 0.939; CFI = 0.957)

results of this structural equations modeling analysis. As in the previous model, the Satorra–Bentler statistic is significant, but other relevant fit indices suggest that this model has a good overall fit. The results support our fourth research hypothesis.

First, IT competency evidently has a significant effect on the organizational structure, favoring the development of flatter, more-flexible structures ($\beta = 0.41$, $t = 4.461$, $p < 0.01$). Second, a significant, positive relation exists between this type of structure and the firm's capacity to manage knowledge, thereby supporting Hypothesis 4 ($\beta = 0.64$, $t = 5.877$, $p < 0.01$). Finally, a direct, significant relation exists between IT competency and knowledge management considered globally ($\beta = 0.33$, $t = 3.913$, $p < 0.01$).

Thus, and as initially hypothesized in this paper, IT competency has a direct effect on knowledge management, and also an indirect effect through the organizational structure.

7 Discussion

The emergence of the knowledge management concept is motivating, particularly in organizations with a certain complexity, some concern to invest in initiatives that help the firm to share and develop its organizational knowledge. This explains the growing recent interest among both academics and company managers in analyzing IT.

In recent years a large number of studies have stressed the importance of IT for knowledge management. But it is not clear how the relation between knowledge management and IT competency works. This is due to a number of reasons.

First, the literature generally recognizes that IT has a positive effect on knowledge management, but researchers do not empirically analyze how IT affects each of the individual processes (knowledge generation, knowledge transfer, and knowledge codification and storage). One of the main contributions of the current work has been to analyze the impact of IT on these three knowledge management processes. The results of the empirical test of the model help to clarify the role that IT plays in knowledge management considered globally, and even more importantly, in each of its constituent processes. Although most studies stress the importance of IT in knowledge transfer and storage, and rather less its importance for knowledge acquisition, the results here make it clear that IT has an important role in all three processes: generation, transfer and codification and storage.

Second, previous studies do not empirically analyze the indirect relation between IT and knowledge management. The current work analyzes how IT indirectly influences knowledge management by affecting contextual factors, such as structure, which, in turn, influence knowledge management. The introduction of information systems flattens the structure of the organization and promotes greater dissemination of information to all individuals, which ultimately facilitates the different processes of generation and transformation of knowledge.

Finally, many research works measure IT using global spending or investment. There is considerable debate about whether this is suitable given the problems observed in estimating monetary values. Rapid technological development, falling equipment costs, and the spread of all sorts of different technologies throughout the firm mean that measurements of monetary aggregates are frequently of dubious reliability (Piñeiro, 2006). On the other hand, other authors have focused on the adoption of a specific technology as an approximation to the firm's IT competency. For example, Hayes et al. (2001) find increases in market value after announcements of the adoption of ERP systems. This study, in contrast, opted to evaluate IT from a broader perspective. The objective is to measure the use of technologies to manage the information inside the firm effectively, so the work considers three dimensions of IT competency: IT knowledge, IT operations and IT infrastructure. It is necessary to consider factors such as the firm's knowledge, skills and experience in the use of IT, the tools and systems that the firm uses to acquire and store information that is useful in the decision making, and also the firm's infrastructure, which involves aspects such as whether the firm develops software tailored to its own needs, the allocation of funds to acquire new equipment, or the existence of a person or department in charge of IT.

8 Conclusions, Limitations, and Future Lines of Research

To summarize, this study contributes empirical data to the predominantly theoretical literature on knowledge management and IT competency. It is, to a certain extent, common sense that IT has a positive impact on knowledge management. However, this paper takes an important step forward by detailing how IT competency influences knowledge management directly, favoring its processes, and indirectly, favoring the development of an organizational structure that in turn favors knowledge transmission.

Moreover, the findings of the research also have important implications for managers. Managers should not only focus on allocating sufficient resources for IT investments. Firms must focus their attention on intervening processes such as knowledge management in order to determine what benefits are being derived from IT-based information systems. In order to meet this challenge, the authors recommend developing an information and knowledge strategy before developing an IT strategy. This is in line with Fielder et al. (1994) and Johannessen et al. (1999), who argue that when applying IT, it should not be assumed that the design of the original process is satisfactory. This implies that before developing an IT strategy, firms must develop a knowledge strategy to provide the basis for the IT strategy, not the other way around. Organizations lacking such a strategic foundation could fail to understand the complementarities between IT and information and knowledge resources in the organization and consequently miss out on successful innovations and improved performance. Firms need to: develop a clear policy of knowledge generation, identifying what knowledge is important for the organization and under what circumstances it should be disseminated; foster the transfer and integration of knowledge between workers, exploiting the interrelations between workgroups; and elaborate a knowledge map that determines in which people and systems the firm's accumulated knowledge base should reside.

Organizations should also be aware of the potential that ICT has for favoring the development of more decentralized and flexible structures that ultimately facilitate the processes of knowledge generation and transformation. The existence of mechanisms that spread information throughout the whole firm helps decentralize decision-making power and initiative. This speeds up the decision making, helps the firm exploit specific knowledge and ensures responsibility and commitment from the employees, who feel they have an important role in the company, as well as involved in its success. Substituting horizontal for vertical communication stimulates the exchange of information between employees and fosters the development of teamwork.

The analysis described here may provide some insight into the relations between information technology competency and knowledge management, but it suffers from some limitations.

Possibly the most important limitation is the fact that the study is a cross section, especially considering that the firm's experience in IT may be an important element to measure the effectiveness of the competency, and that time is needed for the consequences of learning to translate into improvements in performance. It would consequently be interesting to conduct a longitudinal study, taking measures at different points in time. This would allow the relations established in the theoretical model proposed here to be confirmed.

A second limitation concerns the fact that all data were collected from the key respondent. This is currently the standard methodology in strategy research but is known to suffer from certain drawbacks. The authors tried to correct these drawbacks by carefully selecting the respondents and cross-checking on their knowledgeability and involvement, but the drawbacks cannot be completely ruled out.

Finally, a third limitation concerns the fact that the study involves IT-intensive sectors. Future research is needed to determine if these results can be generalized to other industries.

9 Appendix: Measurement Scale Items

IT competency	
IT knowledge	
V1	Overall, our technical support staff is knowledgeable when it comes to computer-based systems.
V2	Our firm possesses a high degree of computer-based technical expertise.
V3	We are very knowledgeable about new computer-based innovations.
IT operations	
V4	We routinely utilize computer-based systems to access information from outside databases.
V5	We use computer-based systems to analyze customer and market information.
V6	We utilize decision-support systems frequently when managing customer information.
V7	We have set procedures for collecting customer information from online sources.
IT infrastructure	
V8	Our company has a formal MIS department.
V9	Our firm employs a manager whose main duties include the management of our information technology.
V10	Our firm's members are linked by a computer network.
V11	Our firm creates customized software applications when the need arises.
Knowledge management	
Knowledge generation	
V12	We regularly meet with our customers to find out what their needs will be in the future.
V13	The company is in touch with professionals and expert technicians.

(continued)

Appendix (continued)

V14	We have a system that allows us to learn successful practices from other organizations.
V15	New ideas and approaches on work performance are experimented continuously.
Knowledge transfer	
V16	All members are informed about the aims of the company.
V17	Meetings are periodically held to inform all the employees about the latest innovations in the company.
V18	The company guarantees the sharing of best practices among the different fields of the activity.
V19	Teamwork is a very common practice in the company.
Knowledge codification and storage	
V20	Databases are always kept up to date.
V21	Employees often consult the databases.
V22	The codification and knowledge administration system makes work easier for the employees.
Structure	
V23	Organizational structure is flat.
V24	Departmental structure facilitates interaction between individuals and exchange of knowledge.
V25	Communication is fluid in both directions of hierarchical pyramid (horizontal and vertical).
V26	Decision making is decentralized.

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Knowledge Management in Business Intelligence

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Abstract. This paper explains the nature of the integration between Knowledge Management (KM) and Business Intelligence (BI) and reveals how KM is embedded in BI. There has been some confusion as to the relationship between KM and BI. The lack of clarity is seen to be, in part, dependent on how the two concepts are defined. BI focuses on explicit knowledge, but KM encompasses both tacit and explicit knowledge. Both concepts promote learning, decision-making, and understanding. However, KM influences the very nature of BI itself, because KM informs BI relative to organizational knowledge creation, knowledge transfer, and learning. BI knowledge and its analytics must for practical purposes be understood and shared. This means that BI's effectiveness is subject to organizational culture, which affects sensemaking and knowledge sharing. The employment of KM-based *knowledge exchange protocols* to facilitate knowledge sharing and the contextual understanding of BI activities is examined. Use of the *knowledge exchange protocols* framework is shown to provide the potential for observing how BI analytics affect decision-making tacit behavior over time. KM principles are shown to provide important elements that facilitate BI's performance and efficacy.

Keywords: Business Intelligence, Knowledge management, Knowledge exchange protocols, Knowledge transfer, Sensemaking

1 Introduction

Business intelligence (BI) seems to thrive in tough economic times almost as well it does in good times. Based on a survey of IT and business leaders in Europe, China and the United States, AMR Research predicts that in the near future the global market for BI will be $57.1 billion, with the U.S. market accounting for $25.5 billion of the total. The growth rate is expected to be somewhat slower than in the past at about 5%, but increasing over the next several years (Lamont, 2008).

Some of the resiliency in BI comes from the fact that businesses need to understand what's happening whether their markets are rising or falling. Basically, a company that has insight into its operations and its customers has an advantage over companies that do not and this is especially true during times when other indicators might suggest pulling back on their technology investments.

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During a strong economy, BI can be used to guide business expansions, while in a tight economy, the emphasis can shift to cost cutting. The key is to be progressive and to have a well-rounded BI program that can provide enough good information to offer actionable insight as to whether the trend is up, down or flat. However, how well BI affects decision-making will depend to a large degree upon the effectiveness of the knowledge management principles and practices that directly impact BI's capabilities.

This chapter examines how Knowledge Management (KM) principles are embedded in BI activities. KM practices in a firm inform, construct, communicate, interpret, and value Business Intelligence (BI) efforts in the organization. In essence, KM provides the fundamental framework upon which BI operates.

2 KM & BI Background

In many contexts, Knowledge Management (KM) and Business Intelligence (BI) are seen as distinct fields that appear disparate in their approaches to sensemaking in organizations. Both concepts espouse strategies for promoting learning, decision-making, and understanding in organizations. Sometimes, what appears to differentiate KM and BI is the perception that BI focuses on the interplay between data, technology, and software-based analytical tools, whereas KM deals with explicit and tacit knowledge sharing.

BI does involve the use of decision support systems, data warehousing technology, on-line analytical processing techniques (OLAP), data mining, statistical analyses, and other business analytic tools. Information technology and data analysis techniques are used to understand how the business is doing and to determine which factors are driving business performance.

Where BI is seen to focus on the use of explicit multidimensional and longitudinal data, the domain of KM is viewed as incorporating both explicit and tacit information as well as the dynamics of the interplay between them. Knowledge management is conceptualized with reference to collaboration, content management, organizational behavioral science, and learning. KM technologies include those employed to create, store, retrieve, distribute, and analyze both structured and unstructured data and textual information.

Herschel and Jones (2005) analyzed the difference between the KM and BI and concluded that BI should be viewed as a subset of KM. They document how concepts in knowledge management can and should factor into the understanding and practice of business intelligence. For example, using BI analytics to manipulate and assess data oftentimes itself depends upon the application of domain-specific knowledge, the evaluation of findings, the analysis of potential solution feasibility in cultural or political contexts, and the sharing of knowledge with relevant constituencies. This suggests that while the data and analytics of business intelligence are explicit in nature, their deployment and utility are oftentimes dependent upon tacit dimensions that serve to define their meaning and utility.

Herschel and Jones (2005) argue that the importance of seeing BI as a subset of KM is that it necessarily removes BI from its place as a technological-centered domain. That is, by seeing it as part of larger context, BI is not relegated to being understood as just a set of interrelated technologies and analytics. This contextualization of BI is important if it is to be understood as an integral element in the creation of value for a firm. If seen as just a set of technologies and statistical techniques, BI will never be able to live up to its promise as a vehicle for improving sensemaking. Said in another way, the focus of BI must expand beyond the IT-driven initiative where the focus is on the technical aspects of delivering information to the BI user community. Nor can it be viewed as simply a suite of analytical tools that yield optimized mathematical decisions. BI is a process that includes these elements, but the larger organizational framework in which it is performed affects its understanding and valuation.

BI does not exist in isolation. BI manipulates explicit data in the search for data patterns or trends. From these patterns, analysts seek to identify correlations or causality between variables and then to understand what they mean and why they might exist. These patterns may be used to influence or to make decisions that lead to action. However, these decisions usually occur in some context where the identification of potential business value for the organization must be placed within a larger framework where other customer, supply chain, organizational, or industry knowledge are considered. Hence KM informs BI and decisions and actions taken by the firm will create new knowledge that may in due course change the very nature of the firm's processes, products, and services (Choo, 1998; Nonaka and Takeuchi, 1995).

3 The BI Product

BI is oftentimes sold as a set of technologies that can enable more efficient and effective decisions. This is the "plug-and-play" product view of BI, typically marketed to organizations by software vendors. This is problematic as it oversimplifies a more complex process. It suggests that intellectual capital is embedded in the product and not derived form the organization's explicit and tacit knowledge that are exercised in decision-making processes.

Williams and Williams (2003) state that it is common for BI vendor value propositions to emphasize business benefits such as agility, responsiveness, customer intimacy, information sharing, flexibility, and collaboration. However, they note that investing in BI to achieve such business benefits may actually destroy business value unless those attributes can be defined in operational terms and realized through business processes that affect revenues and costs. To illustrate this point, Williams and Williams point out that many companies use BI to improve customer segmentation, customer acquisition, and customer retention. These improvements can be traced to reduced customer acquisition costs, increased revenues, and customer lifetime value, which translate to increased after-tax flows. On the other hand, a BI investment that improves demand forecasting will not deliver business value unless the forecasts are actually incorporated into operational business processes that then deliver reduced inventory, reduced order expediting costs, or some other tangible benefit. In other words, Williams and Williams state that the business benefit of "improved forecasting" is useless unless it somehow is converted into incremental after-tax cash flow. In so doing, the BI activity then realizes value by contributing to the positive enhancement of a KM asset: the business process. This example illustrates that how BI affects firm performance depends upon how the firm contextualizes and interprets BI information and then how it then uses this knowledge to make decisions.

In broad terms, delivering business value via BI can be seen as a matter of determining how to increase revenues or reduce costs by

- Improving management processes: such as planning, controlling, measuring, monitoring, and/or changing.
- Improving operational processes: such as fraud detection, sales campaign execution, customer order processing, purchasing, and/or accounts payable.

In other words, the business value of BI rests in its use within cyclical management feedback processes that impact operational processes that grow revenue or reduce costs (or in its use within operational processes themselves). The revision of business processes is an expression of the firm's knowledge management activities wherein the firm gains new intellectual capital through learning.

To better understand the role of BI in enhancing the intellectual capital of the firm, it is important to review KM and how organizational learning occurs.

4 KM and BI: Knowledge Creation and Organizational Learning

Knowledge management technologies are often defined in terms of their ability to help process and organize textual content and data so as to enhance search capabilities and to garner meaning and assess relevance so as to help answer questions, realize new opportunities, and solve current problems. In most larger firms, there is a vast accumulation of documents and data, including business documents, forms, data bases, spreadsheets, e-mail, news and press articles, technical journals and reports, contracts, and web documents. Knowledge and content management applications and technologies are used to search, organize and extract value from these information sources and they are the focus of significant research and development activities.

In knowledge management, however, new knowledge is created through the synergistic relationship and interplay between tacit and explicit knowledge through a four-step process of socialization, externalization, combination, and internalization – the SECI model (see Fig. 1). Nemati et al. (2002) discuss how this is accomplished.

Socialization is the process of sharing with others the experiences, technical skills, mental models, and other forms of tacit knowledge. For example, apprentices learn a craft not through language, but by working with their masters; i.e., observing, imitating and practicing under the master's tutelage. On-the-job-training (OJT) provides this mode of sharing tacit knowledge in the business world. OJT is complemented with explicit film clips of the expert performing the task, virtual reality representations, and kinematic analysis (from the field of robotics).

Externalization is the process of converting tacit knowledge to explicit knowledge. In the decision making process, externalization may include, but is not limited to, one or more of the following:

1. Specifying the purpose of the decision; e.g., to understand how the number and locations of warehouses influence supply costs in a new marketing area
2. Articulating parameters, objective functions, relationships, etc., in a BI mathematical model (i.e., building a model)

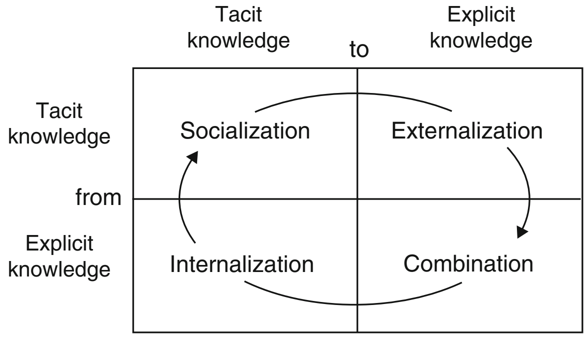

Fig. 1: The SECI Model (Nonaka and Takeuchi, 1995)

3. Articulating "what-if" model cases that reflect existing and potential decision making situations
4. Evaluating the decision alternatives, given the uncertainty in the decision making environment

In other situations (e.g., those requiring the analysis of complicated physical movements), externalization may take the form of kinematic analysis; i.e., attaching sensors to various key appendages and then digitizing and recording the movements of interest. Externalization may also include knowledge extraction in expert systems, determination of causal maps, brainstorming, etc.

Combination is the process of combining several types of explicit knowledge into new patterns and new relations, as is frequently done in BI modeling. The Gestalt theory of learning literature (e.g., Perkins, 1986) states that all problems with which we may be confronted, and also the solutions of such problems, are matters of relations. Not only does our understanding of the problem demand our awareness of certain relations, but also we cannot solve the problem without discovering certain new relations. One potentially productive integration of explicit knowledge is the analysis of multiple, related "what-if" cases of a mathematical model to find new relationships, or metamodels, that determine the key factors of the model and show how these key factors interact to influence the decision.

Internalization is the process of testing and validating the new relationships in the proper context, thereby converting them into new tacit knowledge. Perkins's theory of understanding, from the theory of learning literature, suggests that understanding involves the knowledge of three things: the purpose of the analysis (i.e., what the decision maker wants to understand), a set of relations or models of the process/system to be understood, and arguments about why the relations/models serve the purpose. Internalization is the process of using the new patterns and relations, together with the arguments of why they fit the purpose, to update and/or extend the decision maker's own tacit knowledge base, thus creating a spiral of learning and knowledge that begins and ends with the individual.

Seen in this context, BI is intended to contribute to organizational understanding leading to changes in how the organization chooses to express itself via its processes, products, and services. It also implies that effective BI behavior should become routinized. That is, effective BI should become inculcated in organizational behavior if its analytical activities are to yield demonstrable value creation.

5 Knowledge Transfer: Sharing BI in the Enterprise

One important way of leveraging existing knowledge is through the transfer and reuse of existing firm-specific knowledge among different individuals or groups integral to the firm. These constituencies can include employees, business partners, value chain partners, customers, or solicited (or unsolicited) commentary from members of the public domain in which the firm operates. Knowledge transfer is motivated by the desire to acquire, exploit, and maintain intellectual capital. It is a fundamental issue for firms. Knowledge transfer deals with moving knowledge from one part of the organization to other parts of the organization. It takes place whenever the discoveries or expertise of knowledgeable agents are disseminated more widely. Knowledge transfer is complex because (1) knowledge resides in organizational members, tools, tasks, and their subnetworks (Argote and Ingram, 2000) and (2) much knowledge in organizations is tacit or hard to articulate (Nonaka and Takeuchi, 1995).

Argote and Ingram (2000) define knowledge transfer as a process through which one unit (e.g., group, department, or division) is affected by the experience of another. They point out the transfer of organizational knowledge (e.g., routine or best practices) can be observed through changes in the knowledge or performance of recipient units.

Argote (2005) contends that while there has been some theory on the issue of knowledge transfer (e.g., Argote and Ingram, 2000; Teece et al., 1997), there has been little empirical analysis to support it. However, Watson and Hewett (2006) did conduct such research using a multi-theoretical model. They used social exchange theory to develop a set of hypotheses regarding the factors that influence the frequency with which individuals contribute their knowledge to a knowledge management system. They also employed expectancy theory and the technology acceptance model to generate a model of the factors that lead individuals to access and use knowledge from a knowledge management system, with particular emphasis on how companies can increase the extent to which individuals within the firm reuse knowledge.

Social exchange theory (Tiwana and Bush, 2001; Bock and Young-Gul, 2002) has been used to examine the behavior of individuals in distributed web communities to discover factors that impede and facilitate knowledge sharing. Social factors are seen as important predictors of knowledge sharing behaviors. Social exchange theory provides a useful theoretical lens for examining knowledge sharing because it was developed to explain why individuals engage in cooperative behaviors that are not formally rewarded by the organization. Social exchange theory is used to understand why individuals would contribute their knowledge for the benefit of others.

Knowledge reuse is a way for an individual to obtain the knowledge necessary to work better or more efficiently. The issue becomes the motivational factors that lead individuals to choose knowledge reuse over other methods of obtaining the necessary knowledge. Expectancy theory, a theory of motivation, can be used to explain this behavior and it can be linked to the issue of technology acceptance. Expectancy theory argues that an individual's motivations to use and share knowledge are influenced by the expected outcomes of using that knowledge (Bock and Young-Gul, 2002). The underlying motivations for the two different acts, knowledge contribution and knowledge reuse are quite different. Watson and Hewett argue that they are best explained by different theories. Hence in their model, knowledge flows both *into* the system from individuals, and *out of* the system to other individuals. The effectiveness of a firm's knowledge transfer system is dependent on the flow of knowledge in *both* directions.

By employing the simultaneous application of social exchange theory and expectancy theory to the knowledge transfer process, Watson and Hewett found that knowledge contribution depends upon frequency of knowledge reuse, organizational tenure, and advancement within the organization. Knowledge access, training, and the perceived value of knowledge are significant predictors of knowledge reuse.

For BI, the implication of this research on knowledge transfer is that an important way of leveraging BI is via the availability, understanding, appreciation of the value created through BI analytics by individuals or groups within or allied with the firm. Davenport et al. (2008) note that for BI to be valued, however, three critical components must exist:

1. High quality data
2. A capable technology environment
3. Quantitative expertise

High quality data is important if analytics and key performance indicators are to yield meaningful and useful results. This data must be processed in a timely and effective matter, so there must be sufficient processing power. It must be in a form that invites analysis and compels decision-making (Few, 2006). The talent and expertise to make sense of this output and transfer the meaning and value of this knowledge to others in the organization must exist. Davenport et al. (2008) state that firms tend to be good at either qualitative knowledge management or quantitative knowledge management, but rarely both. How well BI techniques are adopted, utilized, and transferred will depend then upon the nature of the intellectual capital that the organization possesses.

Davenport, Cohen, and Jacobson do note that in the case of Proctor and Gamble, for example, the firm is able to meld together both qualitative and quantitative approaches. They document how BI techniques are blended with ethnographic and psychographic analyses to better understand their customers. In this way, the BI knowledge transfer process is modified to suit organizational preferences for a triangulated form of analytical assessment.

Technology is also able to affect the viability of BI knowledge transfer. To be credible, Davenport, Cohen, and Jacobson point out that the BI tools must have good data that can be processed quickly and the BI tools should be seen as well integrated and easy to use. To facilitate knowledge transfer with technology-based BI, the BI tools should provide ease of analysis, reporting, and data visualization.

The quantitative expertise employed by the firm must be able to affect knowledge transfer and usage of the intelligence outputs. Davenport, Cohen, and Jacobson note that a BI statistics expert must be familiar with the business processes and problems in the function and the industry in which the analyses are conducted. Moreover, in many instances, knowledge transfer between analyst and decision maker will depend upon the amount of trust and closeness between these partners. Hence, for effective BI knowledge transfer to occur the BI analyst should understand the business in general and the particular needs of a specific decision maker. This implies that the effective BI analyst can best affect useful BI knowledge transfer if, in addition to their quantitative skills, they are personable, effective communicators who can speak the language of the business and market the value of their work to their clients.

All of this said, Davenport, Cohen, and Jacobson (as well as Bier, 2003 and Loshin, 2003) note that use of BI and BI-derived knowledge transfer depend upon BI's general acceptance by senior executives in the organization. Lack of demand from top-level senior executives is seen as the single greatest barrier to the firm's engaging in BI-based knowledge generation and transfer. In these instances, the executives are more comfortable with intuitive decisions. In firms where the primary mover for BI-based analytics executives is a senior executive, BI analytical demand, usage, knowledge transfer, and usage in decision-making are more pronounced. The conclusion is that culture has an impact on BI acceptance.

6 BI, Culture, and Sensemaking

Culture does play a critical role in sensemaking activities (Hasanali, 2004). Both KM and BI are deeply influenced by the culture of the organization via the actions of its leadership and though their expressed values (Herschel and Jones, 2005). Culture contributes to knowledge and behavior by helping to construct what one knows, what one does, how one does it, what one verbalizes about what one knows, and how one demonstrates what they know. It creates tangible evidence of what actually exists and what happens. Schein (2004) states that culture dictates underlying assumptions, espoused values, and artifacts that together influence knowledge and how it is shared.

For example, Thong's (1999) study of technology adoption in small businesses showed that the CEO's views on innovativeness and the value of technology affected the nature of a firms technology adoption decisions. Also, Scheraga (1998) found that unless a company encourages its workforce to contribute to knowledge-to-knowledge exchange and decision-making processes, putting knowledge management or BI solutions in place could prove useless. He notes that workers are often reluctant to share information or to articulate their decision-making schemas if businesses reward people based upon what they know and others do not know.

Reisenberger (1999) found employee resistance to sharing knowledge in cultures where most people have gotten ahead by keeping knowledge to themselves. He suggests that this can cause managers to adopt and maintain their use of flawed heuristics and decision models that fail to encompass new realities. To change this, he sees the need for top management to develop new reward systems that recognize and promote new learning behaviors. Moreover, he states that management should endorse, participate in, and lead knowledge sharing activities that challenge the *status quo*. He stresses that top leaders must become change agents within the organization who model knowledge sharing, fostering a culture of continuous learning and improvement to enable successful KM and BI. Confirming Reisenberger's findings is a paper by Elliott and O'Dell (1999) that cited APQC's (American Productivity and Quality Center) conclusions. The APQC found that it is critical to fit KM and BI approaches to the culture and to tie them strongly to the organization's core values, rather than expecting knowledge-sharing initiatives and BI activities to change the culture.

Pan and Scarbrough (1999) found that within the context of organizational culture, trust must be one of the company's core values. Trust is reflected in employee willingness to exchange knowledge to solve company problems. Barker and Camarata (1998) also assert that the preconditions necessary for a learning organization that shares knowledge includes the elements of trust, commitment, and perceived organizational support. They found that using positive reinforcement techniques rather than punishment proved to be an effective technique in a change effort to a knowledge sharing, learning organization. When employees felt trusted, empowered, and free from the fear of negative consequences associated with sharing their knowledge and decision-making, the attitudes and cultures within those organizations slowly changed to enable open discourse and acceptance of other techniques for decision-making.

In McGee's (1999) research on Proctor and Gamble, she found that their cultural change required not only a shift in internal values, but also changes in attitudes about external beliefs as well. She notes that Proctor and Gamble was pursuing aggressive use of KM and BI technology in its supply chain. To be successful, McGee says that the organization must change their cultural beliefs about sharing information and decision-making techniques with outsiders. That is, the company must change its relationships with its suppliers and with its customers, from one of passive market acceptance to one of proactive knowledge and data sharing.

Another dimension to culture and its relationship to information and knowledge sharing is group dynamics. Okhuysen and Eisenhardt (2002) contend that while knowledge is "owned" at the individual level, the integration of this knowledge at a collective level is also necessary. Knowledge is often the most important strategic resource within organizations and yet knowledge usually resides with individuals (Nonaka, 1994). This implies that knowledge disclosure and integration are critical components by which firms enhance the potential utility and benefits from KM and BI efforts. They note that simple formal interventions by management can improve knowledge integration within groups with specialized knowledge by helping group members to self-organize attempts at improving their information exchange processes and to pace those attempts with task execution.

Okhuysen and Eisenhardt state that formal interventions that focus on the improvement of group processes potentially achieve superior knowledge integration and improved KM and BI results. These formal interventions provide explicit instructions for the group to follow and help guide the discussion among members.

7 Integrating BI and KM: Knowledge Exchange Protocols

Herschel et al. (2001, 2003) describe a KM-based information sharing process called *knowledge exchange protocols* that can be employed to effectively structure BI efforts. Herschel et al. describe knowledge exchange protocols as a process for structuring problem solving wherein stakeholders can understand the various components of the decision making process in a meaningful and relevant context. The goal is for the knowledge providers and the knowledge recipients to see the logic and relevance of quantitative and qualitative elements to a decision-making process. The impact of this process for BI is that it serves to legitimize it as a critical and valued component in decision-making activities.

Herschel et al. demonstrate knowledge exchange protocols by an example from the medical community. SOAP is a *knowledge exchange protocol* used to structure and document situation-oriented, physician/patient clinical encounters. SOAP (Subjective, Objective, Assessment, Plan) provides a framework for:

- Structuring clinician–patient narratives
- Understanding the clinician's thinking about perceived problems and issues
- Learning about techniques and tests employed by the clinician in the knowledge creation process
- Sharing the clinician's reasons for actions taken to address patient issues

The SOAP process provides a consistent mechanism for documenting:

- What the physician understands about their patient's situation (sense making activities)
- How the physician closes gaps in their understanding about the patient's situation (knowledge creation)
- What actions the physician takes relative to treatments (decision making)

In the *subjective* phase, the patient describes the problem to the physician (the reason for their visit). In the *objective* phase, the physician conducts objective tests (e.g., X-ray, EKG, CBC, etc.). Based on the patient's complaints and the test results, the physician makes an *assessment* (diagnosis) leading to a *plan* of the action (more tests, prescriptions, nothing, etc.).

Knowledge exchange protocols make the decision-making process and its outcomes valid to all parties involved. Table 1 illustrates the medical SOAP protocol and how it can be transferred to BI-related activities. While not understanding the tests themselves, the patient (client) appreciates the relevance of analytics recommended by the physician (analyst), whose judgment they typically trust. Hence, in medicine, BI-type analytics are seen as appropriately applicable and useful to learning and problem solving.

Patel et al. (1999) have studied how experienced physicians have evolved specific heuristics that can be conveyed to medical trainees through effective clinical teaching. Medical students'

Table 1: Comparing Medical Practice and Business Intelligence as Knowledge Exchange Protocols

	Medical practice	Business intelligence
Subjective	Patient observes symptoms of declining health	Manager uses performance dashboard to identify disturbing trends
Objective	Physician orders tests to identify diagnosis alternatives	Analyst uses OLAP techniques to drill down to operational problems
Assessment	Test results are examined to assess most likely diagnosis and treatment options	Analyst forecasts or models problems to determine tactical or strategic implications
Plan	Physician and patient select course of action most likely to bring desired result	Decision maker with support of manager and analyst determines corrective or other action

learning the SOAP protocol is one important component of this clinical teaching process. Not only is SOAP used to structure the clinician–patient encounter, but also the resultant documentation in the patient's medical record (where the clinician's tacit knowledge is made explicit). This record can then be used to assess how clinician tacit knowledge is deployed. For example, analyses of SOAPs by agencies such as the Joint Commission on the Accreditation of Hospitals (JCAH) have been used to gain an overall impression of the nature and quality of patient care at various medical institutions. Put in a business intelligence perspective, the SOAPs can be analyzed to gain knowledge about how clinician/patient perceptions are created and justified and how analytics are used to justify decision-making and actions. In the medical field, formal medical review processes do in practice use SOAP documentation to evaluate clinician assumptions underlying action which has the unique benefit of helping to bring into focal awareness and scrutiny how the physicians' tacit knowledge of cause–effect contributes to their decision making and actions.

The discussion of the SOAP example suggests not just the appropriateness of incorporating BI in knowledge-driven decision-making processes, but the value of clearly delineating a contextual process wherein the utility of BI analytics makes sense to stakeholders, even if only an expert can interpret their meaning. Incorporating *knowledge exchange protocols* in BI efforts provides a cultural and functional legitimacy to a knowledge transfer process where the analytics are imputed with both relevance and credence. Moreover, placing BI in the *knowledge exchange protocol* framework enables the potential for observing how BI analytics can affect tacit behavior over time. Because the BI analysts tacit knowledge is made explicit relative to its use and valuing in the decision making process, documentation of decision making activities can then be used to assess how effectively BI analysts' knowledge is employed in various problem solving domains over time, especially when the decision making schema employed is consistent.

8 Conclusion

Just as knowledge management is not simply document management systems, databases, or storytelling, BI is not simply data sets interpreted by analytics. They are both complex phenomena. BI depends on knowledge gleaned from transactional information to inform problem solving or opportunity identification. However, culture, context, and knowledge management practices affect how BI will be employed in decision-making processes, how its analytical offerings are interpreted and valued in decision-making activities, and what the organization learns from its BI efforts. Applying KM practices can help to contextualize BI efforts so that other organizational constituencies appreciate them, even if they do not understand what BI is or its analytics. KM knowledge transfer also informs BI experts as to how to help other organizational members understand what is being learned and contributed by BI. Effective communication, trust, and a common understanding of process contexts between BI and stakeholders affect the collective perception of BI, determining its legitimacy and value to the organization.

Intelligence involves the ability to think rationally, to act purposefully, and to deal effectively with the environment. KM provides business intelligence with a broader purpose and an understanding of context. Having the right technology, the right intellectual talent and process knowledge, and insuring that context and culture facilitate and legitimize BI efforts are all critical issues. To pull all of these factors together is not, however, the domain of BI, but knowledge management. Both tacit and explicit knowledge are required for sensemaking. Moreover, knowledge management affects the extent to which BI efforts are organized, implemented, understood, shared, and utilized in the organizations decision-making processes.

Organizational knowledge involves all of the information that is of significance to the organization and this information includes the experience and understanding that the organization retains over time. It includes information in context with respect to understanding what is relevant and significant to business issues. It is analysis, reflection, and synthesis about what information means to the business and how it can be used to its advantage. It is the ability to learn, understand and deal with new and trying situations. Organizational knowledge management affects how situations are assessed, what information is gathered, how problems are analyzed, and how BI results are valued, shared, and interpreted. Knowledge management is an unequivocal and essential component of BI.

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Antecedents of Procedural Governance in Knowledge-Sharing Alliances

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Abstract. This chapter provides a better understanding of effective multi-directional knowledge flows between alliance partners, facilitated by procedural governance. We propose that procedural governance is positively related to knowledge sharing in alliances, and argue that antecedents of procedural governance are either individual or organizational in nature. Procedural governance is formed by the interplay between strategic and structural resources at the organizational level and willingness and abilities at the individual level. We develop a theoretical model for explaining the mediating role of procedural governance in the relationship between individual and organizational level antecedents. Our model leads to a series of propositions and we conclude by offering managerial implications and future research directions.

Keywords: Procedural Governance, Contractual Governance, Knowledge Sharing, Alliance, Multi-level.

1 Introduction

Inter-organizational collaboration is an organizational form that is used by an increasing number of firms to meet a wide range of organizational aims (Hagedoorn, 2002; Narula, 2004). Inter-organizational alliances are a preferred way of sourcing a variety of resources (Eisenhardt and Schoonhoven, 1996; Gulati, 1999), and a prominent view of the strategic alliance literature suggests that inter-firm collaboration has a special strength in serving as a mechanism by which a firm can leverage its skills, acquire new competencies, and learn (e.g., Kogut, 1989; Larsson et al., 1998). As firms collaborate at an increasing rate (Khanna et al., 1998) it becomes still more important to understand how these firms can be instrumental in organizing and governing the various collaborative knowledge processes that take place in alliances.

In their quest to better understand the dynamics of strategic alliances, researchers have relied on numerous theories, including transaction cost economics, organizational learning, strategic behavior, options theory, resource-based view, social exchange theory, institutional economics,

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and agency theory. Common for most of this research, however, very little attention has been directed to understanding how exactly firms may differ in their ability to succeed at collaborating. Although some researchers have pointed to the importance of prior experience (e.g., Lei and Slocum, 1992), in general, and collaborative know-how in particular (e.g., Simonin, 1997, 2002), very little is known about the individual level preconditions of successful knowledge exchange in strategic alliances. Indeed, while Simonin's (1997, 2002) important work on collaborative know-how is among the most comprehensive attempts to isolate the knowledge and learning components linked to collaboration [see also Lyles (1988) and Pisano (1988)], the focus is exclusively on identifying, mapping, and measuring firm level collaborative know-how.

In this article we argue that in order to provide a better understanding of how valuable knowledge is successfully shared between alliance partners specific focus must be devoted to the role of procedural governance. Procedural governance refers to the structuring of the mutual knowledge flows between the partners in a given alliance. As such, procedural governance pertains to frequency, timing, directionality and means of knowledge flows *ex post* alliance formation and is concerned with how joint problem-solving is carried out. Previous research has distinguished between procedural and contractual inter-organizational coordination mechanisms [for a review, see Sobrero and Schrader (1998)]. Contractual governance is concerned with the distribution of rights. The main vehicle for this kind of control is the alliance contract, which seeks to minimize disputes among partners and resolve these when they arise. The threat of legal recourse encourages parties to an alliance to perform their promises with a minimum of prompting and prodding, in order to avoid the costs of litigation or other modes of dispute resolution. As such, contractual governance is the essence of formal alliance formation as it defines the legal boundaries within which joint problem-solving activities will occur. However, as noted by Kanter (2002), alliances "cannot be 'controlled' by formal systems but require a dense web of interpersonal connections and internal infrastructures that enhance learning" (Kanter, 2002, p. 100). This underlines the importance of continuous coordination of processes among parties, typically accomplished via mutual exchange and embeddedness of knowledge (Nielsen, 2005) through which the partners learn to adjust their activities to each other (Sobrero and Schrader, 1998, p. 590–591). This focus on effective multi-directional knowledge flows between partners is the essence of procedural governance.

We contribute to research on effective management of knowledge in alliances by proposing that (1) procedural governance is positively related to knowledge sharing in alliances, and (2) antecedents of procedural governance are either individual or organizational in nature. Our main contention is that some of the core mechanisms fostering successful procedural governance may be individually held while others may be organizational in form. As Friedman and Podolny (1992) note, boundary spanners are more closely involved in the inter-organizational relationship than other members of the organization, and tend to interact with their counterparts to a greater extent. Hence, when examining the characteristics of an inter-organizational relationship, we need to study the individual and organizational levels simultaneously (Rousseau, 1985). In the eyes of some scholars, theory-driven research on multilevel phenomena is what "sets [this] field apart from its parent disciplines in that most of what we study in and about organizations are phenomena that are intrinsically mixed-level" (Rousseau, 1985, p. 2). In Gulati and Gargiulo's view (1999), the social structure of interorganizational relations as a "macro" phenomenon emerges out of the "micro" decisions of organizations seeking to gain access to resources and to minimize the uncertainty associated with choosing alliance partners.

It is worth noting that the majority of strategic alliance research is employing quantitative methods with a strong deterministic bias (Parkhe, 1993; Doz, 1996). Assuming that alliances correspond to the implementation of clear-cut strategic objectives to be carried out via the alliance, most studies consider initial alliance conditions and partner characteristics as determinants of outcome [see Nielsen (2007) for a review]. However, it is likely that the requirements and antecedents of performance observed at one level of analysis (for instance the firm-level) are not consistent with those observed at other levels of analysis (for instance the individual or dyadic level). Hence, a more fruitful avenue for future strategic alliance research warrants an investigation of the nature and form of these cross-level interactions. Yet before we turn to the analysis of how the antecedents of procedural governance mechanisms span analytical levels we outline key characteristics of the core activity that is at stake in this study, namely knowledge sharing in alliances.

2 Sharing Knowledge: Creating Value Through Alliances

Knowledge sharing is understood as "a process in which an organization recreates and maintains a complex, causally ambiguous set of routines in a new setting" (Szulanski, 2000, p. 10). According to various scholars knowledge sharing has become a core activity in many firms as it contributes substantially to various desirable organizational outcomes, such as new product development or dissemination of best practices across business units (Hansen, 1999; Szulanski, 1996). The ability to share knowledge is often considered a source of competitive advantage for organizations (Kogut and Zander, 1996). Hence, inter-organizational relationships have increasingly become a core component of strategy as they provide access to capabilities and resources that may otherwise be unavailable. The underlying logic for this argument lies in the view that organizations are heterogeneous entities that are differentially endowed with capabilities and important resources (Wernerfelt, 1984). Finding that a firm's critical resources may span firm boundaries and may be embedded in inter-firm resources and routines, Dyer and Singh (1998, 2004) developed a relational view of competitive advantage. They proposed the idea of relational rent, which is "…a supernormal profit jointly generated in an exchange relationship that cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners" (Dyer and Singh, 2004, p. 351–352). Relational rents are determined by; inter alia, the degree of knowledge sharing between two firms.

The literature has produced an impressive list of reasons for why organizations enter into an alliance, including categorizations such as "X form" and "Y form" coalitions (Porter and Fuller, 1986), "scale" and "link" alliances (Hennart, 1988). Another general classification is "learning alliances," where the objective is to learn and acquire from each other products, skills, and knowledge (Lei and Slocum, 1992) and "business alliances," intending to maximize the utilization of complementary assets (Harrigan, 1985). A review of this literature shows a strong similarity in the motives identified, ranging from risk/cost sharing via shaping of competition to institutional concerns with attaining legitimacy from the external environment [for a review, see Nielsen, 2009]. In relation to knowledge some authors argue that an alternative to the firm specific view of strategic renewal is to acquire new knowledge-related capabilities through strategic integration and mobilize it vis-à-vis the existing knowledge developing activities (e.g., Jemison, 1988). The strategic behavior perspective recognizes that sourcing knowledge externally is driven by long term competitive considerations and not only by minimization of transaction costs (Tidd and Trewhella, 1997). In addition scholars point to the fact that collaborative R&D projects are often set up with the aim of learning rather than minimizing cost (Hamel, 1991; Kogut, 1988; Grant, 1996). This illustrates that the acquisition of external knowledge or technology *complements* internal R&D rather than servings as a *substitute* for it (Tidd and Trewhella, 1997). Additionally, it highlights the importance of building and maintaining fruitful relations to core partners via close relations. In fact, supply chain management, an integrated approach to the planning and control of materials, services and knowledge flows from suppliers through factories to the end customer, represents one of the most significant paradigm shifts of modern business management by recognizing that individual businesses no longer compete as solely autonomous units, but rather as collaborative supply chains (Chen and Paulraj, 2004).

In this vein, Dyer and Singh (1998) has convincingly emphasized the importance of a firm's investment in relation specific assets, their ability to engage in substantial knowledge exchange as well as the process of combining complementary but scarce resources. They also provide evidence for the importance of firms employing effective governance mechanisms that lower transaction costs in their quest for gaining relational rents. One of the specific factors that is leading to relational rents is the development of knowledge sharing routines, defined as "a regular pattern of inter firm interactions that permits the transfer, recombination, or creation of specialized knowledge" (Grant, 1996). These routines are institutionalized inter-firm processes that are purposefully designed to facilitate knowledge exchange between alliance partners (Dyer and Singh, 1998), and the existence of knowledge sharing routines is suggested to be the factor that divides the successful collaborations from the less successful (Dyer and Hatch, 2006). The development and employment of these routines constitute a firm's dynamic capabilities that is the ability to "integrate, build and reconfigure internal and external competencies" in rapidly changing environments (Teece et al., 1997), where the use of knowledge resources are especially critical.

The character of the knowledge at stake in a given collaboration is very influential on a firm's ability to make use of the knowledge (Dyer and Singh, 1998). A characteristic of knowledge is fostered by its degree of transferability: explicit knowledge can easily be communicated and hence is easily transferred between individuals, across space and time (Grant, 1996, p. 111). Tacit knowledge, on the other hand, is not articulated (codified) and thus more difficult to transfer. Tacit knowledge transfers more slowly across organizational borders than codified knowledge (Zander and Kogut, 1995). As allying is a preferred way of acquiring and creating knowledge in many firms (Ring and Van de Ven, 1994; Powell et al., 1996) a focus on inter-organizational knowledge sharing mechanisms supporting for example knowledge diffusion, information retrieval or shared problem solving, has proliferated in theory as well as praxis.

Regardless of whether the motive for entering into a collaborative relationship is cost related, based on a wish for sharing resources, a need to learn new competences, or a combination, the success of the alliance relies on the ability to share knowledge across organizational borders and contribute to new either local or joint knowledge production. However, inter-organizational knowledge sharing activities create various strategic issues to be handled (Contractor and Ra, 2002). The dilemma of how much knowledge to disclose in the project (Carter, 1989), the difficulty of codifying and valuing knowledge (Tsoukas and Mylonopoulos, 2004), and the existence of various knowledge related asymmetries between partners (Dussauge and Garrette, 1995), are examples of challenges that meet a focal firm when entering into an inter-organizational collaborative project. This points to the importance of deploying deliberate governance mechanisms related to knowledge sharing in the alliance. Yet, contractual governance of knowledge sharing activities in an alliance is a less fertile approach to mitigate these challenges. This is due to the often asymmetric distribution of knowledge combined with the tacitness of knowledge that prevents other individuals than those who possess the knowledge (that is the core employees, not the top managers) from taking part in the exchange. It is therefore important to ensure that the managers involved in the actual knowledge sharing activities are engaged in the contractual processes in order to ensure that the procedural governance mechanisms are not neglected. Additionally, contractual governance mechanisms are often only applied in the *ex ante* negotiation stages of the alliance formation process. Yet, in the later stages of alliance relationship development, *ex post* alliance formation, the need for explicit attention to design and implementation of procedural governance mechanisms pertaining to knowledge sharing arise. In order to avoid a disconnect between the *ex ante* alliance contractual negotiations and the *ex post* alliance coordination activities, these governance processes must be seen as two interrelated parts of the knowledge sharing activities. Furthermore, it is important to perceive the knowledge sharing activities as ongoing through the entire alliance relationship that is knowledge sharing is not only to be seen as an end product. As a result, procedural governance mechanisms are highly important during all phases of interfirm collaborative relationships and may serve as complements to more formal control systems, such as contracts.

3 The Importance of Procedural Governance for Knowledge Sharing

Contractual coordination mechanisms provide institutions for achieving the alignment of incentives among the partners. However, from the availability of these institutions, it is impossible to deduce how they are actually employed to coordinate the activities of the partners during the evolution of the relationship. Even if two organizations have contractually agreed on governing institutions for coordination at the outset of the alliance, it does not imply that these necessarily do coordinate their actions as the relationship matures (Sobrero and Schrader, 1998). Hence, a recurring criticism of the transaction cost literature as it has been applied to strategic alliance governance choice is that it fails to acknowledge the role that non-transactional attributes play in influencing the choice of governance mode. In particular, relational capital is suggested to be an important determinant of strategic alliance governance, where relational capital has been defined as encompassing mutual trust, respect, understanding and friendship between individuals in a business relationship (Thuy and Truong Quang, 2005). Consistent, Doz and Hamel (1989, p. 136) argue that the *actual* coordination is not achieved through contractual mechanisms but, rather, is realized by the day-to-day interaction of the employees involved in the activities of the relationship: “Top management puts together strategic alliances and sets the legal parameters for exchange. But what actually gets traded is determined by day-to-day interactions of engineers, marketers, and product developers.”

The study of strategic alliances has emphasized the use of transaction cost economics and resource dependence theories to explain the governance structure of alliances (Kogut, 1988;

Contractor and Lorange, 1988). These theoretical formulations do not explicitly address the issue of new knowledge created in an alliance as they view alliances as just another form of organizing exchange. Other research has pointed out that effective alliance governance can significantly enhance firms' joint learning and knowledge creation (e.g., Dutta and Weiss, 1997; Larsson et al., 1998). From a learning perspective, equity joint ventures are considered to be better suited than alternative governance mechanisms to the transfer and learning of tacit and embedded know-how because they align incentives for cooperation, permit a replication of the organizations themselves and provide prolonged and intense social interaction that facilitates the replication of organizational routines (Dutta and Weiss, 1997). Moreover, equity participation generates a governance structure in which companies can monitor the activities of the alliance as they are represented on the board of directors. Equity sharing might also align the motivation of the partners, thereby creating mutual interests that reduce the likelihood of opportunistic behavior by partners (Oxley, 1997; Pisano, 1989).

Mjoen and Tallman (1997), on the other hand, argue that the relative degree of control of partners in a joint venture is determined by a bargaining process based on the importance of the resources that each partner contributes, rather than ownership level. Poppo and Zenger (2002) argue that the "right" mix of trust and formal contracting enhances cooperative interactions; however, they fail to specify precisely how this right mix is attained. To this end, some studies show that more complex alliances tend to be governed through more hierarchical forms, with the nature of complexity being identified by various measures including number of partners, scope of product and/or technology, nature of functional activities covered by the alliance, and technological intensity of industries (e.g., Oxley, 1997; Hagedoorn and Narula, 1996). Hence, while promising, research in this area has not sufficiently demonstrated that alliances influence the development of new knowledge-related resources nor has it identified the conditions under which such development occurs.

Network theory argues that embeddedness shifts actor's motivation away from the narrow pursuit of immediate economic gains toward the enrichment of relationships through trust and reciprocity (Powell, 1990; Smitka, 1991). According to Uzzi (1999), governance arrangements of social embeddedness appear to come before, rather than follow from, the attributes of transactions. Following this, embeddedness is not a result of an exchange relationship; rather it preexists and shapes exchange relationships. This indicates the existence of an important underlying latent construct, procedural governance, which needs to be explicitly recognized and integrated in the explanation of knowledge sharing in strategic alliances.

Decisions on the frequency, timing and directionality of knowledge flows, as well as the means through which these flows occur (e.g., cross-functional team, alliance unit or simply a knowledge management system), identify the operational dimensions of procedural coordination mechanisms. The purpose of procedural coordination is that actors exchange sufficient information so that they can adjust their mutual behavior in a meaningful way for any given associated distribution of rights among the partners. The degree to which parties can achieve procedural coordination will influence the patterns of knowledge exchange between partners to an alliance. It is likely that the nature of the tasks to be carried out during the alliance relationship will influence the expected outcome. Furthermore, the nature of tasks is likely to change constantly during the course of the alliance relationship and thus procedural coordination mechanisms will have to be adjusted accordingly. Maintaining the relational quality after the contract has been signed is an important activity positively related to performance (Büchel and Killing, 2002). Above all it is important to constantly consider how the procedural coordination mechanisms need to be adjusted in order to facilitate the knowledge sharing activities of the alliance. Notwithstanding, the level and quality of procedural governance in collaborative exchange relations is likely to influence the degree of knowledge sharing among alliance partners in the following general way:

Proposition 0. Procedural governance is positively related to knowledge sharing in strategic alliances.

Multiple factors determine the level and quality of procedural governance in strategic alliance relationships. As postulated in Fig. 1 below, several capability factors at different analytical levels are hypothesized to affect the level and quality of procedural governance in an alliance. At the organizational level, variables associated with strategy and processes are likely to influence the way the alliance is procedurally governed. At the individual level, variables associated with willingness and skills among employees involved in the exchange relationship are of primary importance. While the individual importance of most of these variables has long been recognized in both strategic alliance and social exchange literatures, their simultaneous effects have thus far been ignored. As noted by Inkpen (2002), now that a solid base of antecedent research exists, the next step is theoretical and empirical work that integrates the diverse categories[1] and establishes some causal links across the variables. In line with this observation, we go one step further and introduce cross-level effects in order to fully account for the complexity of knowledge sharing in strategic alliances. Thus, the aim of this paper is to identify the multi-level determinants of procedural governance, and how they relate to knowledge sharing, in strategic alliances, and derive a series of testable propositions to guide future empirical investigation.

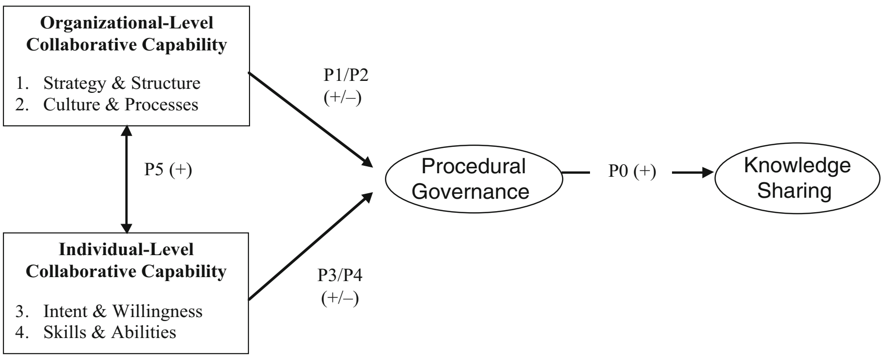

Fig. 1: Theoretical Model

[1] According to Inkpen (2002), antecedents of alliance learning can be classified into five categories: (1) learning partner characteristics, (2) teaching partner characteristics, (3) knowledge characteristics, (4) relationship factors, and (5) alliance form. In the model presented in this article, category 1 and 2 are collapsed and included together with 3 and 4. Alliance form is considered a control variable for testing purposes.

4 Antecedents of Procedural Governance

We have indicated that the antecedents are either organizational or individual in nature. A central reason for the importance of dealing with the individual-level antecedents of procedural governance mechanisms is that they are necessary for providing a complete understanding of the organizational-level phenomenon that we study, i.e., procedural governance (Coleman, 1990; Abell et al., 2008). Adding individual-level antecedents to the organizational level antecedents accomplishes at least three things: First of all, it enables us to delineate the various alternative individual-level explanations that can not be disentangled in an organizational-level explanation. Second, it provides an opportunity to be precise about prospective managerial interventions as we deal with the need for interventions at the level where they ought to be directed that is at the level of individual action. Third, since the phenomena we study are likely to be an outcome of the action of their components (for example the behavior of individuals of a given strategic alliance), knowledge of how the actions of these parts combine to produce the collective level outcome can be expected to give greater predictability than will aggregate relations of surface characteristics of the system. In other words, "an explanation based on internal analysis of system behavior in terms of actions and orientations of lower level units is likely to be more stable and general than an explanation which remains at the system level" (Coleman, 1990, p. 3). In this context, it is particularly important to note that it is not the explanations of the individual level antecedents as such that interest us; rather it is the understanding of the interaction between the individual and the organizational level antecedents which is essential. This interaction, being for example the way that individual alliance capabilities support organizational level collaborative initiatives, must be brought into focus as it will assist in providing both a better theoretical understanding of the construct of procedural governance and a productive ground for outlining potential managerial implications.

4.1 Organizational Level Antecedents of Procedural Governance

The relational capability of a firm – i.e. its capability to interact with other companies – may increase its access to external knowledge and potentially increase knowledge transfer (Lorenzoni and Lipparini, 1999). Both transaction and production costs can be lowered through multiple, repeated, trust-based relationships, and well managed alliances are likely to support a firm's access to complementary capabilities and specialized knowledge (Lorenzoni and Lipparini, 1999). At the organizational level it is important that the organizational strategy supports the development of procedural governance mechanisms. The strategic antecedents of procedural governance mechanisms are associated with anchoring the alliance strategy within the overall organizational strategy, for example, by fostering routines that assess the task-related and partner-related fit (Geringer, 1991) in relation to the strategic objectives. Other examples are post-alliance formation routines pertaining to speed of knowledge transfer and development of effective ways to capture synergies among complex, dispersed knowledge-related resources (e.g., via rotation of scientists or joint reward systems).

At the same time some structural elements are likely to affect procedural governance. These structural elements pertain to developing effective practices for procedures that allow for standardization of knowledge sharing, such as designing IT infrastructures and setting up communication channels for the interaction between partners. Another example is the establishment of an alliance unit that facilitates the technical aspects of the interaction, which may significantly reduce the cost of setting up, monitoring and managing an alliance (Simonin, 1997, 2002). By the same token, the important role of the alliance manager as a coordinating devise in collaborative relationships is widely accepted (Spekman et al., 1998). For instance, Draulans et al. (2003) found that organizations with a specialist, positioned at middle-to lower levels of management, are considerably more successful with alliances than those lacking one. Moreover, the design of a specific knowledge management system, organized around the content and complexity of knowledge to be shared in conjunction with organizational structural characteristics (Nielsen and Michailova, 2007), ensures effective knowledge sharing across organizational boundaries. Hence, to the extent that the organizational strategy-structure configuration is aligned with knowledge sharing intent, we would expect the following:

Proposition 1. Strategies and structures that are aligned with knowledge sharing intent are positively related to procedural governance in strategic alliances.

The organizational level governance mechanisms are often closely related or formed by the culture or climate of the organization. Organizational culture is believed to be the most significant input to effective knowledge management and organizational learning. Corporate culture determines values, beliefs, and ultimately work systems that may encourage or impede coordination of knowledge sharing efforts (Leonard-Barton, 1995). The importance of a knowledge-centered organizational culture which supports knowledge exchange and accessibility is evident. Nevertheless, within the field of knowledge management, relatively little research has been conceptually and empirically conducted that seeks to identify what constitutes a knowledge-centered culture – that is which key organizational characteristics encourage and facilitate both the creation and dissemination of knowledge. Moreover, although the importance of socialization, face-to-face relationships, embeddedness, and cooperative interaction among *individuals* for the purpose of knowledge sharing is well established (e.g., Nonaka and Takeuchi, 1995; Senge, 1990), relatively little is known about the influence of a collaborative climate on knowledge management in strategic alliances.

A collaborative climate is best defined as the observable behavior in regards to collaboration in a given group; or put more colloquially it can be said to be "what people do around here" (Sveiby and Simons, 2002, p. 421). On the basis of a large scale study, Sveiby and Simons (2002) developed a categorization of how the composition of collaborate climate can be understood. Three of the components are organizational level issues; such as fostering *employee collaborative attitude*; *work group knowledge sharing support*; and *organizational culture*, relating to the leadership factors outside the specific alliance group. We propose that collaborative climate is an important prerequisite to drive a propensity for high knowledge sharing because such a climate form the organization's retentive and nurturing capacity. Organizations with a collaborative climate are typically equipped with an extensive set of routines and learning competencies designed to retain and nurture knowledge transferred from an alliance partner. This is consistent with (inter)organizational learning theory (Huber, 1991), which is preoccupied with how learning processes can be structured or enabled, given the nature of the knowledge to be learned. The process approach to corporate coherence allows firms to solve the coordination of knowledge dispersal "by various means, such as command, management information systems, routines and shared cognitive constructs" (Foss and Christensen, 2001, p. 222). Hence, collaborate climate and development of (inter)organizational learning processes are likely to be conducive to coordination of alliance knowledge management activities and thus constitute the very bedrock upon which governance rests. Hence:

Proposition 2. A collaborate climate and organizational learning processes are positively related to procedural governance in strategic alliances.

4.2 Individual Level Antecedents of Procedural Governance

Discussions in existing organizational literatures lack attention to levels in general and micro-foundations in particular (for a discussion see Felin and Foss, 2005; Dansereau et al., 1999). Despite the growing use of collaborative alliances in a wide variety of settings, much of the organizational literature still treats the organization as the centerpiece of theorizing. Various studies have examined the acquisition of capabilities and knowledge through alliances (e.g., Inkpen and Dinur, 1998). However, the vast majority of these studies have the organization or the alliance (dyad) as the unit of analysis, thereby lacking attention to individual level antecedents of knowledge sharing. The application of diverse theoretical approaches, such as resource dependence theory, micro-economics and strategic management, identify specific (industry or firm-level) preconditions for collaboration and use these to predict organizational outcomes, however, without regard to the underlying, individual level mechanisms that conditions these outcomes. Although studies have recognized the importance of individuals for alliances and learning more generally, few studies have incorporated the role of individuals into explanations for knowledge sharing in alliances. Research has found that the bonds between key individuals are central mechanisms that initiate alliance formation (e.g., Larson, 1992) and sustain inter-firm relationships (Seabright et al., 1992). Individuals also embody the knowledge-based resources that evoke problem solving and learning and contribute the most to a firm's ability to utilize information. Moreover, the primary basis of the firm's ability to capitalize on external information rests on the ability of individuals to access, assimilate and utilize information (Cohen and Levinthal, 1990, p. 131). Despite these insights, researchers of strategic alliances have placed much greater emphasis on environmental conditions, and organizational level resources, practices and tendencies than individual level mechanisms as explanations for knowledge sharing in alliances.

We argue that by redirecting the focus towards the individual level mechanisms that condition knowledge sharing we provide a more solid analysis based on knowledge about how the actions and abilities of the individuals impinge on organizational level outcome. We concur with Leung and White who state that, "so much is at stake in an alliance, as reflected by the voluminous firm-level research on this topic, but we know so little about the relevant people issues that make or break alliances" (Leung and White, 2006, p. 203). Challenges may arise due to conflicting ideas about how and when to collaborate or because the individuals' abilities do not match the task. Other challenges may stem from in-group favoritism (Salk and Shenkar, 2001) or divergent perception of group members (Leung and White, 2006).

Realizing the importance of the individual's knowledge sharing behavior we turn towards the issue of work motivation, which can be defined as the set of psychological processes that initiate work related behavior and determines its form, direction, intensity, arousal, and duration (Latham and Pinder, 2005). Motivation is an invisible, internal, hypothetical construct (Ambrose and Kulik, 1999) which is affected by external factors such as rewards, punishment, rules, norms etc. and internal factors such as needs, values, cognition etc. Whether employees are willing to engage in collaborative projects is an outcome of their motivational orientation; they may collaborate because they are rewarded for this specific effort or they may collaborate when the opportunity arises because they find collaborative activities more interesting than the ordinary tasks they otherwise would have done – or as a mix of the two. People that are intrinsically motivated to engage in collaboration (due to, e.g., personal beliefs or traits) may be specifically chosen to be a part of a given collaborative project. In this way the manager can design a group of people for a given collaborative project that are especially keen on collaborating.

It is especially important to focus on the employees' *willingness* to collaborate as not all employees see the potential gains of collaboration at first sight. Certain individuals may be opposed to collaboration for numerous reasons which may give rise to an attitude mirrored in the "not invented here" (NIH) syndrome. According to the NIH syndrome, employees traditionally resist accepting knowledge produced externally, and favor internal solutions to a given problem even though external solutions do exist (Katz and Allen, 1982). Various kinds of knowledge hoarding behaviors may lead to rejection of knowledge sharing. The term "hoarding" suggests a premeditated attempt to hide something away for own future use, yet a hoarding behavior may also be the result of an unconscious attitude. Conscious or unconscious, people hold back their knowledge if they anticipate being punished for sharing it, one way or another. An employee may, by way of example, fear to be blamed if she shares knowledge with a partner and what is shared is misused by the partner. Additionally, she may be anxious about loosing her status; if she shares her knowledge there will be no need for her expertise any longer and she may not even be recognized for her contribution. These factors may all lead to behavioral barriers to collaboration. Thus, to the extent individuals are motivated and willing to collaborate, coordination of knowledge related activities in strategic alliances is likely to improve:

Proposition 3. Individual collaborative intent/willingness is positively related to procedural governance in strategic alliances.

Whereas behavioral barriers to collaboration may be rooted in lack of motivation, cognitive barriers are typically related to the absence of *ability* to share or collaborate. For instance, lack of ability to articulate the required knowledge or incapability of understanding the context in which the knowledge is to be applied may constitute cognitive barriers to coordination and transfer of knowledge. An employee's wide range of abilities is a very important condition for his or her behavior in a collaborative project. The most central abilities that are needed in a given collaborative project are, naturally, the ones related to the task that is to be carried out in the collaborative project. The extent to which an individual understands a specific domain of knowledge defines whether he is an expert in this area. Individuals with a high level of expertise are better at understanding the laws, logic and rationales underlying the function or processes of a specific knowledge domain. This understanding provides the individual with the ability to identify critical configurations or complexes that contains several pieces of information such as information about the solution in a complex situation. Individuals who are experts are better at integrating new knowledge in existing domains than individual without expertise, and as a consequence individuals with high level of expertise are more likely to learn from collaborative activities. Thus, by way of example, a project about developing answers to challenges in the field of cancer research will be better off if a number of oncologists are core members of the collaborative group. In staffing collaborative projects the manager needs to keep the central knowledge in focus and assign employees that hold the right expertise. Still, employees with other professional profiles will also be needed. For instance, a collaborative project will most often need a legal officer (or a patent worker) closely connected to the project as well as inclusion of employees from other functional areas, such as business development or marketing.

In addition to possessing the proper disciplinary skills, employees may benefit from additional skills that are directed towards the specific challenges pertaining to collaborating as such. An ability to designate and understand the various phases of a collaborative project and to spot the potential problems that may occur at a given time in the project may be beneficial to employees engaged in alliances. Firms that collaborate frequently tend to make this kind of knowledge explicit in manuals or a codex that can guide the employees through the phases of the project. Still, the ability to maneuver skillfully is often a question of experience and may thus be a personally held ability. Abilities that relate to understanding and aligning to the partner's goals or being good at working in trans-disciplinary teams are often gained through experience. This goes for many of the individual capabilities which can be characterized as collaborative capabilities, such as interpersonal communication skills. An important ability in regards to procedural governance is the ability to absorb external knowledge. In fact, one of the most important learning processes in collaborations is the process of *recognizing* the value of new, external information, *assimilating* it and *applying* it to commercial ends in the firm. Essentially, the skills and abilities associated with appropriation and utilization of external knowledge are central individual capabilities for employees engaged in collaborative projects.

Proposition 4. Individual collaborative skills/abilities are positively related to procedural governance in strategic alliances.

5 Conclusion: The Interaction of Organizational and Individual Level Antecedents

The dominant rationale behind the increase in strategic interfirm collaboration is that firms engaged in alliances can enjoy synergistic effects by combining knowledge resources and related capabilities (Doz and Hamel, 1989; Ring and Van de Ven, 1994), and that they additionally can foster opportunities to learn, and to access knowledge that can be shared and used to create innovative solutions (Grant and Baden-Fuller, 2004). Yet, as we have argued, knowledge sharing must be supported by the implementation of procedural governance mechanisms that are directed towards the structuring of mutual knowledge flows. We have shown that procedural governance in strategic alliances is positively affected by a number of factors of which some are organizational and some are individual in nature. Although the identification and specification of these factors are important, it is the interaction between levels that exposes the true complexity of knowledge sharing and governance in strategic alliances. Only by studying the combined effects of organizational and individual level antecedents of procedural governance can we arrive at an understanding of how to facilitate more effective interorganizational knowledge sharing.

Since knowledge ultimately resides within the individual and collaboration is a result of inter-personal socialized interaction, we argue that a strategic view on collaborations needs to be accompanied by a more fine-grained analysis of the individual-level perceptions and behaviors that affect the various collaborative activities of a given firm. As is clear from the above discussion, organizational strategies and structures, as well as cultural processes, form the preconditions for procedural governance and interorganizational knowledge sharing. However, organizational conditional factors, such as for instance governing policies for knowledge transfer or application of incentive systems designed to encourage collaborative behaviors, do not ensure effective coordination of knowledge related activities in strategic alliances. The extent to which such organizational level collaborative capabilities enhance procedural governance, and ultimately collaborative knowledge sharing, is likely to vary widely with the behavioral and cognitive characteristics of the individuals involved in a collaborative agreement:

Proposition 5. Organizational-level and individual-level antecedents exhibit interactive effects on procedural governance in strategic alliances.

In this paper we have argued that procedural governance is formed by the interplay between strategic and structural resources at the organizational level *and* willingness and abilities at the individual level. This puts a premium on studies that distinguish between factors at the organizational and individual level which may influence procedural governance, as well as the potential moderating effects of one level on the other. The proposed framework leads to several propositions that may guide future research in the pursuit of a more complete understanding of the interdependent roles of organizational-level and individual-level antecedents of procedural governance in strategic alliances. It may also provide strategic decision makers with a better framework for evaluating the potential tradeoff or substitution effects of different types of coordinating mechanisms.

In many organizations, the group initiating inter-firm relationships and involved in the drafting of the original contracts is quite different from the group in charge of the implementation of the agreement. The contractual coordination mechanisms are frequently negotiated by top management and a group of lawyers, while the setting up of procedural coordination is left to business-unit managers, who have usually been involved in similar alliances in the past. Whenever such functional separation is not carefully bridged, however, the negotiation and the implementation aspects of inter-firm relations are de facto detached, increasing the chances that the relationship will fail. Hence, from a managerial perspective, it is important to recognize the interactive effects of organizational strategic policies and individual level human resource management issues. For instance, organizations that engage frequently in collaborative projects and where a large part of company revenues accrues from strategic alliances should invest resources not only in building organizational structures and processes that may facilitate more effective collaboration and knowledge sharing, but also devote adequate attention to hiring and further training individuals with behavioral and cognitive characteristics conducive to interfirm knowledge sharing.

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Enterprise-Wide Management of Intellectual Property

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Abstract. To make continuous development of enterprise-wide Intellectual Property (IP) part of the enterprise's strategic goals, employees and external partners need to believe that ideas matter and the enterprise will create value from them. To create this value, enterprises need to integrate all of the stages of IP management into their information technology architecture to facilitate development of unique and original innovations. To integrate IP, the enterprise needs to transform its knowledge development processes from capturing & reusing information to one of developing & revising its knowledge base.

Keywors: Intellectual Property, Enterprise Architecture, Innovation, Unique Knowledge

1 Introduction

This chapter advocates for the integration of intellectual property (IP) management into enterprise-wide knowledge management systems. The chapter also presents an argument for knowledge management systems to evolve from their singular emphasis on reuse of information to the inclusion of means to create and commercialize unique ideas. The creation of unique ideas is the bedrock for successful IP. IP is the unique assets within a firm's broader intellectual assets having the potential to be or are legally protected (Rivette and Kilne, 2000). Legal protection gives IP the capability to be "crucial to the bottom line ….for all companies" (Corporate Legal Times Roundtable, 2000).

Intellectual assets are integral to the products/services marketed by enterprises, and within the processes to make and create these products and/or services. A large body of literature [for an overview see, e.g., Boisot (1998)] points to the important conclusion that the extent to which an enterprise can generate and exploit economically useful knowledge depends on its management processes. Creation of unique IP independent of current production processes and products/services is essential to business knowledge development. IP management has four basic stages: creative idea generation, unique product adaptation, application replication, and continuous alertness. Within each of these four stages an enterprise's information technology (IT) architecture should automate and specify processes to extract value from the enterprise's IP by (1) protecting IP, (2) creating the ability of the enterprise to analyze IP at each stage and develop the market value of unique IP, (3) improving the enterprise's internal and partnering processes to develop its IP and to produce products and services utilizing the enterprise's, its partners' and third parties' IP, (3) capitalizing on the value of IP through the implementation of strategic IP initiatives, and (4) creating portfolios and records at each stage of IP management. As integral as IP is to the global success of the enterprise, IP management cannot be left to the oversight of technology managers and/or corporate legal staff (Sterling and Murray, 2007).

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2 IP and Global Forces

There are three major forces that are influencing the world's preoccupation with IP in enterprises and markets: globalization, digitalization, and emerging markets. Each of these three forces offers significant opportunities for revenue growth from IP. Yet, each pose significant challenges to establishing and maintaining IP management processes. Globalization has opened the world markets to the rapid availability of commodities and technologies for complementary application possibilities never before available to inventors and innovative enterprises. The universally accepted digital technology base has given developers and customers instantaneous entry into all areas of the globe. Digitalization of many products (e.g media, software) has reduced or even eliminated industry boundaries giving developers greater access to a wider scope of customers. As digitalization and globalization has put innovations at the doorstep of the global consumer they have given opportunities for those in emerging markets to benefit even though their lands lack communication infrastructures (e.g., cell phones). The future implications of these forces present burgeoning opportunities for IP of individual inventors, enterprises and nations.

Yet, these forces have also opened up the potential for counterfeiting and piracy of goods on a massive global scale. Estimates place the global trade in fake products at costly the US economy over $250 billion per year (National Association of Manufacturers, 2008). Products from clothes to cigarettes, drugs to computers and media to software are being copied and sold illegally. The Business Software Alliance (2007) estimates that for every $2 of software sold legally another $1 will be sold illegally, and of the 1 billion PCs in the world close to half have unlicensed software on them.

Economic, legal, and business literature indicates that as globalization and digitalization has opened the markets to new uses of IP the complexity of the development and manufacture of many products has increased. For example, within semiconductors and their manufacture are embedded thousands of IP patented inventions. From these numerous patents, manufactures and developers now have a greater potential at being a target for holdup from legitimate innovators and "patent sharks" (Henkel and Reitzig, 2008). A new method of managing IP is needed to protect the large and small innovating enterprises and insure that the process of creating new innovations is not hindered.

IP and the rights that can be allotted have been the subject of rich theoretical, empirical and practitioner study by multiple disciplines. Although these studies offer many important openings for discussion and investigation this chapter assumes that patents will continue and that all parties benefit from managing intellectual resources and assets. This chapter directs its discussions to the creation of the most effective combination of IP and information/knowledge management practices to prosper in global markets.

3 IP Roles in Enterprises and Economies

In recent years, the primary locus of value for many corporations has been found in their intellectual assets (Davis and Harrison, 2001). By one informed estimate from the late 1990s, almost three-quarters of the Fortune 100's market capitalization has been represented by IP, as patents, copyrights and trademarks (Reitzig, 2004). In 2008, IP is estimated to be valued at $5 trillion or 45% of the US GDP (National Association of Manufacturers, 2008). Little of the writing on the subject of IP, however, has been directed at the management of the process; instead research has frequently been focused on the role specialists, e.g., attorneys or scientists have in the process.

Unfortunately, IP is not a universally recognized accounting or economic term nor is it considered in analytical calculations by either discipline. Nor has the use of the term improved the novelty of the knowledge created. This chapter emphasizes the enterprise-wide creation and capturing of novel ideas and the development of them into commercial prototypes. This unique IP strategy requires intra and interenterprise processes including the creation, evaluation, management, exploitation, revenue/profit measurement and valuation of the total impact of IP to the enterprise.

Enterprises in all industries and of all sizes are rapidly learning that IP can be a tool for generating income and investment in all markets. While the significance of IP in the technology sector cannot be denied, the importance of IP is certainly not limited to companies in a single sector of the economy. Even companies engaged in traditional “bricks and mortar” endeavors own and rely upon IP as an integral revenue generating function of their business. Examples range from the ingredients and recipe for Coke’s beverage syrup, a closely guarded trade secret, to domestic and international trademarks owned by multinational corporations such as Sony, Nike, GE, Ralph Lauren, etc.

4 IP and Patent Law

Patent law affects all facets of the management of IP as it is the basis for the determination of what IP an enterprise owns. For enterprises the knowledge of their IP should be collected from the initial stages of a commercial idea’s creation. Enterprise policies and procedures should identify vulnerable patent applications proactively and develop alternative patent strategies for protecting innovative products. Once a product is launched, or even offered for sale, the opportunity to obtain patent protection may be significantly damaged especially in countries other than the US. As such, managers cannot afford to sit back and wait for their legal department to take action. The earlier in the product development process that patentable processes or components are identified, the more likely that patent protection can be established that will maintain the competitive advantage created by the company’s valuable innovations.

Patent protection includes the potential to protect your invention with a patent infringement lawsuit. In 2007, the number of cases in patent litigation more than doubled over the previous year, yet even these were only approximately 10,000. This may be due to the high cost of patent infringement litigation (upwards to $2 million). On the other hand, the potential for large dollar amount of damages from a patent infringement is high, because of a long list of potential claims. These two combined factors make negotiations between parties the most probable outcome. An enterprise may consider insurance against claims, but the best policy is to have procedures to continuously investigate the potential of using another’s patent before you engineer the prototype and to apply for a patent early as your process of innovation is initiated.

Bessen and Hunt (2007) found that over 20,000 software patents are awarded each year and that this is less than 15% of all patents. In 2007, 467,000 applications for patents were filed with the US Patent Office and the office awarded and registered over 180,000 patents and another

100,000 trademarks. Of the number of patents awarded approximately half were to residents of foreign countries. Obviously, throughout the world a US patent is considered as having value.

5 IP's Legal Definition

One recent US Supreme Court decision addresses one the basic arguments of this chapter: "Where does the value of intellectual assets come from and how best should enterprises expend their resources to maximize benefit?" In 2007, the Supreme Court unanimously reversed a judgment of a lower court that U.S. patent law says: you can't patent an invention that is "obvious." Case KSR International Co. v. Teleflex Inc. et al., the Supreme Court raised the standard for showing that an invention is not obvious and is therefore worthy of a patent. Justice Kennedy in his opinion (October Term, 2006) stated that: "We build and create by bringing to the tangible and palpable reality around us new works based on instinct, simple logic, ordinary inferences, extraordinary ideas, and sometimes even genius. These advances, once part of our shared knowledge, define a new threshold from which innovation starts once more. And as progress beginning from higher levels of achievement is expected in the normal course, the results of ordinary innovation are not the subject of exclusive rights under the patent laws."

The important item for our chapter is "ordinary innovation." The court in its unanimous decision points out the need within the awarding of patents process: to balance the need for protection with the need for allowing the growth of the knowledge through continues innovation. Therefore, *ordinary innovation* from normal improvements to solve a problem is not subject to the protection of exclusive patents. Therefore, to have the benefit of a patent monopoly, unique and non-obvious inventions are necessary.

As a result, many enterprise's innovations will not be patentable and many others will lose their existing US patents. Jaffe and Lerner (2004) contend that "in the space of less than a decade, we converted the weapon that a patent represents from something like a handgun or a pocket knife into a bazooka, and then started handing out the bazookas to pretty much anyone who asked for one." KSR v. Teleflex is a corrective measure within the global economy for creative ideas that are not "ordinary inventions."

The Supreme Court KSR v. Telefex ruling emphasizes the importance of unique innovations to obtaining patent protection. This should make managers and executives more aware that it is the "invention" not the "user" who creates IP knowledge. Enterprises should develop within themselves the ability to foster growth and profitability from *creative* generation of IP having unique and original characteristics.

6 Intellectual Property and "Ordinary Inventions"

The heritage of IP was born in early France as intellectuals were those of independent thinking. From these, early inventors of the industrial revolution created their IP from free and independent thought rather than enterprises' institutionalized research and development. Unlike this traditional perspective, most enterprises today fail to develop the concept of independent thinking. Only recently has IP become associated with systematic research efforts inside modern enterprises.

Yet, in these modern enterprises the most frequent reason for seeking legal protection of their IP is not for proactive development of revenues, but for defensive strategies (Cohen et al., 2002). Enterprises use IP to gain and retain control in their marketplace. Their IP is created as barriers to thwart their competition. IP is proprietary and primarily viewed for uses within an enterprise and from a relative narrow perspective: the creation of power in the marketplace. In this context, IP in the main is not considered knowledge from which the entire enterprise may benefit from sharing in the marketplace. Rather than seeing benefits from technological advancement in general, enterprises hold their inventions to themselves. Unlike in today's knowledge model (King, 2008), where knowledge is used, licensed, bartered in the marketplace with little regard of market power. Enterprises see benefit from all market participants' (suppliers, competitors, complementors, etc.) contributions to the market's knowledge bases. Knowledge in the marketplace today is expansive with limited life so potential usages are maximized soon after development.

Yet, enterprises do not manage IP as they manage information and knowledge within their business. Nor do most enterprises manage the IP process like they manage other profit-generating processes. At best, IP is left to the patent attorney whose primary focus is legal considerations rather than those of commercial and global strategic benefits to the broader enterprise. Legal staff has a habit of focusing their interests on the enterprise's R&D endeavors. Not only does this promulgate the seeing value in incremental inventions but also this has a negative organizational impact by creating a "silo affect" separating IP from the remainder of the enterprise.

As the KSR case emphasizes, gone are the days when companies could count on patenting countless incremental improvements. Gone are the days when patenting in order to extend the time during which their independently developed unique products are developed. Many of these incremental improvements may be deemed obvious and those industries that are dependent on the information economy, e.g., software, e-commerce, pharmaceuticals maybe the ones most harshly affected. Therefore, enterprises need to readdress their IP focus to truly novel innovations and inventions. To this end most enterprises, post KSR ruling, are going to have to learn how to foster creativity within their entire enterprise rather than just from a few research specialists or within a specific project team.

7 Creativity

Creativity is more often viewed at the individual and team level. Whereas in this chapter, I address the much under researched organizational level of creativity. At all levels of research the role of creativity is one of increasing importance. As we have discussed above, creativity is necessary to obtain the uniqueness test for IP patent protection. As an executive, of a German manufacturing enterprise, noted in an interview in reference to the enterprise's technological capabilities,: "we do not seek patent protection, because the process exposes our secrets to our competition to copy and/or alter and they quickly catch up to us." Even if an enterprises adopts this "hide and make it difficult to seek" strategy, the role of creativity is vital. Enterprises rely on their accelerated creativity to maintain a pace of improvements to keep their innovations competitively ahead of their competitors.

Enterprises must become masters at achieving both creativity and innovation. Creativity is seen as the production of new, novel and useful ideas (generating value and being seen as valuable); whereas, innovation is seen as the implementation of these creative ideas (Mumford et al., 1997; Amabile et al., 1996). An enterprise's creativity is demonstrated through the development of new products, services, technologies and work processes from original unique ideas. In an enterprise, creativity is the capability to develop components that are both novel (meaning original or unexpected) and appropriate (meaning useful) (Sternberg and Lubart, 1999). The development of the enterprise's unique ideas requires the commitment of organizational resources against an unknown outcome. The development and production of unique ideas with commercial potential involves numerous trials and errors and considerable risks, all at the expense allocated to unknown outcomes. Therefore, the enterprise must trust its employee's intellectual creative potential and the enterprise's innovation capabilities while developing supportive systems with non-accounting controls (Chenhall, 2003). The IT architecture provides the platform, but the enterprise needs to provide the inventor with motivation (compensation and status), organizational culture (trust), privacy (especially at initial stages of envisioning), and resources (human, intangible, and tangible).

Creativity is vital to organizational success. In this chapter, the creativity literature and much of the management oriented IT literature will be explored to suggest that IT needs to plays an integral role in the creative process within enterprises. As enterprises encounter the need to develop systems for novel business applications (e.g., knowledge management, peer-to-peer collaboration) and new problem domains (e.g., reverse logistics in supply chains), the need for creativity as a valued enterprise characteristic in their information systems is increasingly important.

8 Information Technology and Intellectual Property

Information technologies (IT) have increasingly become a major influence on process efficiency and effectiveness in enterprises. This focus has created IT's role in enterprises as primarily a productivity not a creativity one. The main objective of this chapter is to develop IT to support creativity in all functional aspects of enterprises. While enterprise-wide IT systems, e.g., ERP, support manufacturing from raw material purchases, to component manufacturing, to final assembly, and for customer logistics and channel delivery to purchasing. Our proposed IP enterprise system will support creative development which will rely on resource allocation, strategic measurement, outsourcing and partnering decisions. Specifically, a primary benefit that IT now affords enterprise-wide creativity is the potential exploitation of low cost communications and information processing capabilities. Additionally enterprises need to nurture their exploration for unique knowledge. To accomplish this, enterprises need to apply IT to the requirements for creative knowledge production, to automate the stages of the individual creative process, to improve effectiveness process of organizational learning as related to creativity, and to support the creative process within large-scale project-based collaboration.

A review of over two decades of literature (1981–2003) reveals few studies that combine IT and organizational creativity (a review in Tiwana and McLean, 2005). Business processes and practices are restructured to conform and best of all complement the information system parameters (Laughlin, 1999). Individual creativity is confined by the limits of the system. Both factors restrict the value placed on individual differences, diverse behaviors and person-to-person sharing usually present in a creative process. Whereas, enterprise-wide systems such as ERP are more likely to produce an enterprise focused on efficiently managing various factors of production than an enterprise that emphasizes unique idea development and promotes changes in behavior that advocates new insights. Therefore, ERP systems tend to eliminate the seeds of individual and enterprise creativity.

Unique ideas originate from bright and knowledgeable individuals placed where new knowledge is produced (Venkataraman, 2003). Unique ideas are generated from continued collaborations with experts around the enterprise. From these collaborations, unique products are created and then produced. The literature describes that to develop ideas within an enterprise into useful and appropriate inventions; group processes are more effective at supporting creativity (Hargadon and Bechky, 2006). Group processes provide the inventor's idea refinement from interaction enabled by the diversity of the group members (Feist, 1999).

Creativity research in the sciences and management domains focuses on the benefits that come from the group process including benefits of challenges (Jehn, 1997), interplay of divergent and convergent thinking (Nyström, 1993), trust and uninhibited exchanges (Farrell, 2001) and sharing same goals (West, 2003). In the IT discipline creativity has been studied in the Human Computer Interaction (Nardi, 1996) and Computer Supported Cooperative Work literature (Wilson, 1991). Development of creativity supported by IT has focused on the toolkits (von Hippel, 2005) and information system design rules (Farooq et al., 2007).

In the context of the enterprise, groups which have the ability to function in variety of configurations and are provided a variety of collaboration tools seemed to achieve more creative results (Streitz et al., 1997). Therefore the degree of flexibility provided a group offers the group better collaborative results. Nambisan et al. (1999) findings imply that IT systems that are familiar or easy to learn for the individual, while offering the group the ability to locate knowledge, accompanied with individual motivation will significantly improve the systems knowledge creation potential.

In interviews with several enterprises involved in creative projects both process and product development, I found their persistent use of Wiki-based information technology tools greatly assists their creativity in group projects. The users and their supervisors of these IT wikis were satisfied with the creativity and resulting innovations. But, individuals and supervisors were also quick to point out that organizational factors supporting long-term collaboration contributed greatly to the success of creativity developed. These enterprises provide a working atmosphere which promotes sharing and divergent contribution.

9 Fostering Creativity in an Enterprise

For the last 20 years IT systems and knowledge management have focused on reuse of captured information. This chapter views the message sent enterprises by the KSR ruling is: to become more efficient and effective enterprise-wide at creating and capitalizing of novel and unique IP.

In the future, enterprises will find it is vital not only to secure means to utilize existing knowledge, but also to systematically and persistently identify and develop new and novel knowledge throughout the enterprise by more effectively integrating and using IT. This trend will develop a new horizon for knowledge management.

Research in knowledge management and intellectual capital informs organizational learning, but to date it does not capture the ongoing cycle of action taking and knowledge acquisition found in the commercialization process of unique ideas. Researchers and practitioners to date have not accepted the holistic transformation necessary to support enterprise-wide unique IP management. To be considered as organizational, unique IP needs to be not only part of the enterprise's market strategy, scientists, and patent attorneys, but also integrated in the enterprise's vision, strategy and processes.

IP needs to be considered as a resource whose major consideration is creating and sustaining competitive advantages. Quinn (1992, p. 216) suggests that "looking beyond mere product lines to a strategy built around core intellectual or service competencies provides both a rigorously maintainable strategic focus and long-term flexibility". While Drucker (1998) predicts that enterprise able to develop and implement new information and communication technology will increasingly shift toward more efficient organizational structures, e.g., flatter, less hierarchical. These enterprises are better designed to reuse information and can more easily apply technology solutions to achieve creation of unique IP as an achievable goal.

In doing this an enterprise will first need to achieve the first stage of IP management: Identifying new and unique IP. To achieve this, knowledge needs to be identified as IP and then be evaluated in terms of its potential value: organizational, market, and/or strategic. Similar organizational processes underlie other transformational business trends such as business process redesign, the emergence of "high performance work systems" and the shift from "mass production" style manufacturing to flexible "manufacturing" now enterprise processes need to be developed with IP management transformation as their objective. Enterprise IP transformations that exploit low cost communications and information processing capabilities created by IT will have the best opportunity to integrate knowledge exchanges throughout the entire enterprise. To be effective IP management needs to be enterprise-wide processes. To achieve this organizational transformation, the inclusion on IP management into the enterprise's IT architecture is necessary.

10 Implementing Enterprise-Wide IP Architecture

The concept of architecture is fundamental for the enterprise to adapt an enterprise-wide unique IP strategy. Enterprise architecture is positioned to link IP strategy and execution through its focus on social and technology systems. Obviously, these systems need to maintain operational conditions with a high level of reliability, availability, resilience, and efficiency. Primarily, the effectiveness of the architecture needs to focus on how the system is to be designed in regards to the organizational behavior, performance and interface characteristics of IP development within the enterprise. Implementing an enterprise-wide IP strategy entails change throughout the enterprise as knowledge systems are built upon and within the interdependent functions of the enterprise (Kaplan and Norton, 2001). Integration also improves knowledge innovation efficiency which is found to be lacking in most enterprises as Feldman (2003) reports that a knowledge worker may spend up to 35% of their time looking for information. Failure to properly establish integrated architecture has also been noted in enterprises to cause disruption in the formation of information sharing communities (Holtshouse, 2006). Therefore, new investigations need to be conducted whose purpose is the establishment of an integrated enterprise-wide IP architecture.

As the enterprise transforms its knowledge management architecture to include a creation IP business model, key decisions determining the relationships established in a knowledge-intensive market include (1) develop or sell decisions (if developed can we do it in the existing enterprise of is it best in a new business venture), (2) organizational partnership or isolation, (3) rapid or paced innovation of the adaptation of new technology, (4) the protection or exploitation through external partnerships; (5) public or private research funding, (6) safeguarding or sharing of IP, and (7) pioneering advantages or disadvantages and the development of the organization's metrics, assigning responsibility, and establishing goals (Borg, 2001).

11 Enterprise Creation of IP

Innovation can no longer be limited to internal creation, because of rapid and powerful development capabilities located around the globe in both developed and emergent economies. In today's dynamic business environment innovation may come about by the interplay of two distinct but related trends: the first may be considered as internal organizational trends, as endogenous R&D and/or spontaneous human initiatives. Internal organizational trends are supported by enterprise cultures. The cultures support the creating, interpreting, and alteration of existing knowledge into new inventions and applications. The second is as external organizational trend of exogenous acquisition of knowledge.

IP literature has rather neglected the innovative development of IP within strategic alliances. A small number of intellectual asset articles have shown that strategic alliances do indeed contribute significantly to the innovative performance of companies (for an overview on innovation literature; see e.g. Duysters and Hagedoorn (2000). The ability for enterprises to sense the most appropriate combination of internal and external information to create profit generating processes and products is crucial for the enterprise. It is often noted that an enterprise's capability to absorb externally generated knowledge by means of strategic alliances is to a large degree dependent on the openness and dynamic capabilities of an enterprise (McEvily and Marcus, 2005). Therefore, IP managers need to understand intellectual assets major elements consistent with their enterprise's collective responsibilities. Finding ways to extract value from both external knowledge generators and the enterprise's intellectual potential "knowledge that can be converted into profit" is a very important component in IP management. Therefore, the process of combining information is of major concern for the enterprise, and IT systems can play a vital part in the process. IT systems are not only extremely adaptable to storing relevant information, but also are capable of processing new trends into the prototyping and simulation of knowledge creation.

Such questions as: What will the marketplace want from our products in the future? and How will our competitors development progress? are potential questions that IT capabilities can assist an enterprise in answering. IT capabilities can aid in the developing of prototypes and engaging in simulations of scenarios to assist in determining potential goals for IP management.

12 IP and Unique Knowledge Procedures

While operational capabilities to develop ideas are vital; an enterprise and its management can not forget that the entire IP process is fundamentally both a national and an international legal undertaking. Differences in national laws and exact procedures with unforgiving outcomes and penalties require the establishment of processes that support and impose strict adherence to rules established by qualified patent attorneys. Failure to adhere to these procedures, e.g., complete disclosure, can make the patent invalid losing any potential monopoly power after full disclosure of the technology to the world. Therefore IP procedures need to be a component in the architecture from its very design and integrated into the idea development from idea creation till its obsolescence. The architecture must combine business and legal contributors to manage the processes of creating innovation and inventions.

Unlike the present knowledge management systems that are focused on universal reuse of information in enterprises a unique IP system's primary purpose is not just to transfer knowledge to reuse existing information and practices, but it is to create new knowledge and thus *new* revenue, reduced costs, and/or increased power in the marketplace. These systems need to be integrated in the enterprise architecture. These systems need to be integrated in such a manner not only to achieve improvements in organizational knowledge development productivity, but also to establish a platform that supports the creation of unique solutions from initial inventor's idea and/or concept. Therefore, a key component in an IP management program is a creativity strategy relying more on collaboration not to relearn/reapply but to evolve/revolutionize anew.

The proposed IP management program is an on going collaborative knowledge exchange and development program. Nonaka and Takeuchi (1997) emphasize that the transfer of knowledge especially tacit knowledge between individuals from different functional domains and with different capabilities is a critical process. Yet, communiqués, especially external ones, poses significant risks for the IP protection process. Thus, the enterprise architecture while supporting these transfers and will also have to be capable of legally protecting the transfer of IP potential knowledge between external partners.

13 IP Integration and Risks

One might say that a portion of operating all business systems is the assumption and management of risks. As we discussed above with IP there are disastrous potential if procedures are not followed as variations in national and international regulations complicate the establishment and operation of an enterprise-wide program. Therefore the architecture design needs to include how IP protection risks intersect with the collaboration creativity processes. For example, at the design stage attorneys along with successful inventors need to understand each others requirements and processes. The delivery of business benefits should be extended to assist in preventing potential theft, fraud, and costly mistakes. In this manner the technology may be designed to assist in the risk management.

As the information that is being stored and processed within the IP systems represent the heart of the enterprise's future, business risks are strategically significant. The ability to circumvent the controls has to be limited. Security to insure that the right people are engaged in their proper activities is absolutely necessary. Therefore, a separation of power capability is necessary as is segregation and role-based security processes. IP within an enterprise is basically a "bottom–up" system therefore preventive and detective controls will be necessary to track loggings and event engines to test for exceptions.

The enterprise architecture should provide a platform for the easing of procedural requirements of the enterprise's employees. These need to include check-off sheets for the signing of assignment of rights and daily records especially those that support the original inventor's claim. The database, redundancy potential, and enterprise-wide process capabilities of the architecture will allow real-time "due diligence" audits to aid valuation estimates and market strategy development for the entire enterprise.

14 IP as a Profit Center

IP should be viewed as a product/service in itself for it is and has always had the potential to be a profit-center (Berman, 2006). To be an enterprise-wide profit-center, IP architecture needs to include information technology elements which will synchronize the IP rate of activity to those of the enterprise's changing business models. As such an enterprise needs to set goals not only for the profit levels and number of inventions, but also of potential input to market strategies. As Thomas Edison set his IP strategic goals for so many small inventions per week and a significant invention every ten days so to should an enterprise develop its IP goals. An enterprise needs both inventions and innovations so the contributions to capitalize both in the marketplace, plant, and office can be maximized. Included in this is the proper allocation of ownership between inventor, contributors and the enterprise. As the inventor needs and uses enterprise assets their own ownership percentage is reduced and given as an exchange to the enterprise for committed resources. As such the architecture needs to represent the business models of the enterprise's IP and the business processes necessary to be performed to achieve individual, operational, tactical, and strategic IP goals. The interests and concerns are both financial and motivational for the inventor's and enterprise's needs and as such, should be integrated into the architecture.

Since the enterprise architecture is facilitating information transfer and creative knowledge development inside an enterprise, the architecture needs to recognize and overcome organizational barriers which potentially will hamper the process. Literature has offered that knowledge management systems that support the reuse of information need to address three dozen technological barriers (Riege, 2005). I am sure that a system whose objectives to support and foster the creation of unique and novel inventions will face as many barriers.

15 Setting Strategic IP Objectives

The increasing corporate value of IP has a consequence for senior leaders: They must not leave IP-related questions to functional management levels alone. Instead, they must take a strategic approach to the IP issue. The key lies in treating IP as they would any other strategic issue facing their enterprises. By thinking through their strategies about obtaining competitive advantage, industry structure, entry barriers, competitors, suppliers and enterprise – they can make IP a strategic profit generating or market barrier weapon in their enterprise.

The management of IP proposed by this chapter has a more process approach rather than relying on the picking of winners. We propose the fostering of ideas throughout the enterprise. The enterprise supports employee's investigations, but does not initially totally finance them. The aim of creating an enterprise's IP measurement is to mobilize an enterprise's IP as a priority in their employees' thinking, talking and doing something about contributing to IP as a driver of an enterprise's strategic initiatives.

As a strategic initiative, leaders must attempt to tie and bundle together various forms of capital and assets to support existing and create new competitive advantages. Management is concerned with bringing and comparing the development of their internal intellectual capital together by technologies, procedures, and systems with external trends and strategies all the while adding value for customers and overcoming potential competitive forces with improvements achieved with interfirm partners.

A question each employee needs to address is: what ideas are important to our enterprise's success? To set strategic direction and then initiatives, enterprises need to evaluate their industry's rate of knowledge obsolescence. From this exercise the enterprise can estimate their IP renewal, reject, and/or recreate strategies. These strategies should develop objectives and outcomes for their IP policies. The rate of obsolescence of knowledge may be estimated from a simple patent renewal schedule. These estimates provide enterprises the lifespan of the output of their present IP in all aspects of the enterprise (market & processes). Then the estimates of enterprise needs are compared to market and internal generation of means to satisfy needs.

At this stage both technical and business interests are engaged to establish best policies for enterprise IP profit center contribution to the overall value of the enterprise. For instance, would specific inventions create a market monopoly if patented? Then this inventor would receive a higher priority than an inventor of dubious benefit. Inventors and potential partners would receive higher ownership shares for inventions with higher priorities. These estimates, together with mean R&D gestation lags, are then used to correct previous estimates of the private excess rate of return to investment in research (Pakes and Schankerman, 1979). Enterprises engaged in IP management have much to gain from their strategic initiatives, yet, they also face significant challenges. The first realization of an IP management is that: Ideas matter.

16 Conclusion

Today, enterprises need to view IP as a strategic initiative capable of generating profits in global markets from the commercialization of their legally protected unique ideas. As such, enterprises should be developing unique ideas throughout their enterprise, managing them strategically including within market and inter-firm relationship strategies, and aggressively protecting them even after receiving legal protection. Poor IP policies that result in expensive development efforts yielding products that can be freely copied by competitors are failures of the enterprise's IP management. Effectively managing IP requires the implementation of a comprehensive asset and business IP management strategic plan. In the past, many enterprises viewed the protection of IP as a cost of doing business. This chapter is a venture into addressing the needs of IP management as a profit-making function throughout an enterprise. The means to achieve this, initiates with the enterprise, changing their dependence on R&D departments, generating ideas and developing systems and processes to commercialize unique innovations enterprise wide. This chapter has highlighted how enterprise-wide IP management can create the strategic initiative that *ideas matter* and how enterprises make them matter.

One of the major internal problems enterprises face with IP creation is the cross functional decisions and responsibilities, e.g., developing or selling needed to successfully develop IP. Enterprises need to have input from marketing, operations, procurement, R&D, etc. into their idea development decisions. These are difficult and complex processes when the prime characteristic of the enterprise's IP is its uniqueness. Uniqueness is a function of the ability to maximize its creativity.

In order for enterprises to effectively create and discover novel concepts, fully exploit commercially their newly generated ideas, and optimize the earnings potential of all of the enterprise's IP, organizational processes and systems to monitor, record, and measure need to be integrated within its IT architecture. The enterprise also needs to integrate IP into business and corporate strategy decision-making. Capturing value from new and unique intellectual capital and knowledge-based assets has become the new mantra. The organizational choirs need to include IT and knowledge management processes to transform organizations from primarily utilizing known information for the control across functions, to the future of creating the most dynamic of all strategic assets: "IP innovations."

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Virtual Worlds as Platforms for Communities of Practice

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Abstract. The problem of effective tacit knowledge transfer has long been identified and studied in the field of knowledge management. Communities of practice have been proposed as one way to facilitate tacit knowledge exchange. In this chapter, we propose virtual worlds, or computer simulated 3D environments, as potential platforms that can be used to facilitate communities of practice. We differentiate virtual worlds from other Web based communication technologies, and discuss four unique affordances, namely self-expression, co-creation, co-experience and crowd sourcing, as enablers of attributes of communities of practice.

Keywors: Virtual Words, Communities of Practice, Co-experience, Co-creation, Knowledge Transfer

1 Introduction

Firms today have been described as learning organizations with the ability to acquire, develop and exploit knowledge, and to support the learning process within the organization that is vital to their survival (Huber, 1991). Often, organizations are analyzed from a knowledge-based perspective (Grant, 1996; Kogut and Zander, 1992) and their employees are referred to as knowledge workers (Blackler, 1995). In order to conceptualize and integrate knowledge into organizational processes as well as to facilitate continuous organizational learning, organizations employ knowledge management systems (KMS) (Alavi and Leidner, 2001; Davenport, 2005; Gupta and Govindarajan, 2000).

The distinction between explicit knowledge, which can be communicated easily, and tacit knowledge, which is revealed through application and acquired through practice (Polanyi, 1967; Ryle, 1949/1984), has been well documented in the knowledge management literature. Being able to deliberately leverage tacit knowledge possessed by experts is hypothesized to be a core capability that generates value (Alavi and Leidner, 2001; Davenport et al., 1998) and that can provide strategic differentiation for a company (Glasser, 1999). Due to the uneven distribution of expertise, the task of managing tacit knowledge is especially essential for global organizations (Bender and Fish, 2000; Subramaniam and Venkatraman, 2001).

However, approximately 70% of knowledge management initiatives are deemed as unsuccessful (Akhavan et al., 2005; Hammer et al., 2004) and only few have achieved success (Alavi and Leidner, 1999; Davenport et al., 1998; Huber, 1991; Pellegrino, 2001; Wasko and Faraj, 2005). In 2005, IDC (http://www.idc.com) estimated expenditures on knowledge management

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initiatives at USD 12.7 billion worldwide. Estimates for 2007–2008 of USD 73 billion show that organizations continue to spend resources towards trying to manage knowledge (Murphy and Hackbush, 2007). Hence, while the success of knowledge management programs is important to organizations, the problem of successfully facilitating tacit knowledge exchange through appropriate technologies is one that management is still struggling with.

One potential solution is facilitating communities of practice, which are gaining attention as vehicles to share tacit, practice-related knowledge in an informal, interactive, group-based form. Knowledge management practitioners and researchers recognize the importance of communities that foster collaborative learning in organizations (Pan and Leidner, 2003) and almost all knowledge management systems have a network component that facilitates connecting people in communities of practice (Goel and Mousavidin, 2008). Since real life communities of practice are impractical in large geographically distributed organizations, learning systems simulate communities of practice by having virtual forums. These have been referred to as networks of practice (Brown and Duguid, 2000; Wasko et al., 2004), virtual communities of practice (Ardichvili et al., 2003; Dube et al., 2006), or online communities of practice (Sharratt and Usoro, 2003), all of which share the same essential characteristics. Evidence demonstrates that such communities have been a key element in knowledge management systems of many companies, including Xerox PARC, British Petroleum Co., Shell Oil Company, Halliburton, IBM, Proctor and Gamble, and Hewlett Packard (Brown and Gray, 1995; Cohen, 2006; Cross et al., 2006; McDermott, 1999a,b). Most of the companies that used IBM's first Web-based knowledge management system organized their activities around such communities, an element that IBM had not deliberately implemented in the system initially (McDermott, 1999b).

In this chapter, we propose that the latest technological phenomenon, virtual worlds, will play a significant role as platforms for tacit knowledge exchange as they support the requirements of communities of practice in an ideal manner. Given the rapid changes in technologies used for collaboration and the emergence of new learning styles of a maturing high tech generation, we believe this to be an opportune time for research that investigates the affordances, or enablers, of virtual worlds for learning. We analyze technological features of virtual worlds and frame four affordances – self-expression, co-experience, co-creation, and crowd-sourcing – that support attributes of communities of practice for tacit knowledge exchange. Hence our objective in this chapter is to examine virtual worlds as facilitators of communities of practice.

The chapter is structured as follows. We first present the driving forces behind virtual worlds and differentiate between their unique characteristics and those of other Web-based technologies that are currently used for communication and learning. We then present four affordances of virtual worlds based on these characteristics. Next, we discuss communities of practice and their attributes. Finally, by juxtaposing the technological affordances of virtual worlds and the attributes of communities of practice, we illustrate the value of virtual worlds as learning platforms and then discuss areas of research opportunities.

2 Virtual Worlds: Characteristics and Affordances

Virtual worlds are computer-based simulated environments inhabited by "avatars", or 3D representations of users. While virtual worlds are usually associated with virtual reality games, this perspective has changed dramatically lately with the availability of open Web-based applications such as Second Life, There, and Active Worlds. The applications of these virtual worlds have grown beyond gaming and 3D modeling to include pedagogical, commercial and business applications. Many universities (such as Harvard, Virginia Tech, Drexel and Emory) use Second Life, an Internet-based persistent 3D world, as a platform for teaching and providing information about their academic programs. IBM has set up "islands" in Second Life exclusively for the purpose of providing a virtual meeting place for its employees to interact.[1] Toyota and Reebok, amongst others, use Second Life to collect customer preference information (Goel and Prokopec, 2008). Sun Microsystems' intranet-based virtual world, MPK20, provides a virtual office for Sun's over 50% remote workforce.[2] Hence, businesses are beginning to see virtual worlds as a platform for intra-firm collaboration as well as a new vehicle for reaching out to customers and business partners (Goel and Mousavidin, 2007).

For this chapter, we solely focus on non-gaming virtual worlds that carry the following set of characteristics: they are Web-based, and hence enjoy the benefits of the Internet, such as global reach and 24/7 availability; they are persistent, which means that changes in the environment persist whether or not a user is logged in; they allow user-generated content in the form of virtual artifacts; they facilitate many-to-many synchronous interactions for those that are logged in concurrently; and finally, they allow for informal communication due to the fact that meetings of users can be happenstance rather than pre-arranged. In short, virtual worlds portrayed in this chapter are those that are not game-driven, but instead provide open, three-dimensional, Web-based platforms for user-generated content, such as the one provided through Second Life.

From an organizational learning perspective, communities of practice supported by information systems have long been an object of interest (Andreu and Ciborra, 1996; Whelan, 2007). The growth in popularity and functionality of virtual worlds suggests that they, like the wikis and blogs that preceded them, might provide a powerful new platform for learning and supporting virtual communities. There are good reasons for anticipating this. One reason is the relentless technological advances that are fueling the increased interest in virtual worlds. Information technologies continue to increase in power and decrease in cost (Kanellos, 2003; Twist, 2005). The past 5 years have similarly seen an exponential growth in the processing capacity of mobile devices, such as laptops and handhelds (Soh and Tan, 2008). Correspondingly, forms of information representation are changing from basic text to richer, more intuitive forms that involve sound, motion, and touch. Besides hardware and software improvements, connectivity to Web applications has also increased (Krill, 2008). The trend toward ubiquitous access can be seen in the increasing number of hotspots available at public places (The Economist, 2008). Wireless mesh network initiatives in several areas offer citywide Internet access. The Internet is even more pervasive than it was predicted to be, and this pervasiveness is only growing (Lyytinen and Gregory, 2003). The growth of virtual worlds would not have been possible without the recent technological advances in hardware, including graphics cards and processors, software, and the pervasiveness of the Web. These developments allow for the unique characteristics of virtual worlds: 3D user representations, persistence of user-generated content, support of multiple formats of content, such as text, audio, video, and 3D artifacts, and synchronous many-to-many interactions.

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[1] http://www.ibm.com/virtualworlds/businesscenter/
[2] http://research.sun.com/projects/mc/mpk20.html

Another contributor to the uptake of virtual worlds is demographic forces. The "millennials," the generation born after 1980, have grown up with digital media during their formative years; they are accustomed to visual and auditory channels, including high-definition television, podcasts, surround-sound systems, e-books, e-mail, and instant messaging, and social applications, such as MySpace and FaceBook. And, they are often observed using them almost simultaneously. This generation will be, and many already are, comfortable using virtual platforms for social networking, education, business transactions, and telework (Dede, 2005). Moreover, the age at which individuals are exposed to technologies, such as the Internet and social networking, keeps decreasing. Disney's Toontown, Barbie Girls, Whyville, and Club Penguin are among examples of the many virtual worlds that are available for pre-teens. There are specific virtual worlds geared for children of different ages. By the time they are in high school, most youngsters in the U.S. are very comfortable with navigating the Web using rich interfaces to communicate and conduct transactions.

There are three technological complementarities that will shape how people learn (Dede, 2005): an individual's familiarity with the "world-to-the-desktop" notion providing access to people and information around the world via the Internet; an individual's familiarity with multi-user virtual environments (MUVEs) due to his/her exposure to gaming and social interaction through these interfaces; and an individual's familiarity with ubiquitous computing such that he/she increasingly uses mobile devices (e.g., PDAs and media players like iPods) that allow infusion of virtual resources into his day-to-day real life. As the millennial generation gets assimilated into the future workforce, successful uses of technology for learning and communication will reflect their needs (Junglas et al., 2007). We see already an increasing use of wikis and forum-oriented platforms in the workplace today (Majchrzak et al., 2006).

The globalization of the business landscape also pushes us towards virtualization. As geographic and temporal barriers become less salient, businesses increasingly find themselves competing against, or threatened by, global competitors. A growing percentage of companies have some global footprint, if not in the form of physical presence, then through its international suppliers, consumers, offshore vendors, or business partners (Jensen et al., 2005). Worldwide networks help such organizations conduct business anytime, anywhere. Distributed teams that only interact virtually are now commonplace.

Simultaneously, there is an increased demand for Web-based learning and virtual courses in educational institutions (Piccoli et al., 2001); there is a constant pressure for increasing the richness of this virtual interaction and maximizing the cues and bandwidth of the communication. While other forms of Web-based environments only provide minimal immersiveness and social presence, virtual worlds support rich interactions. We summarize how virtual worlds differ from other Web-based communication media along different attributes in Table 1.

Due to their technological characteristics, virtual worlds hold unique affordances, i.e., perceived or actual properties of an object or environment that allow an individual to perform certain actions (Gibson, 1977). Zammuto et al. (2007) drawing on Gibson (1977, 1979) advocate the analytic lens of affordances in studying technology and define an affordance perspective as one that "recognizes how the materiality of an object favors, shapes, or invites, and at the same time constrains, a set of specific uses". From the definition, the affordance perspective is not restricted to the fixed characteristics of a technology, but incorporates the appropriation of those characteristics

Table 1: Comparison of Web-Based Communication Media

Medium	Reach[a]	Synchronicity[b]	Informality[c]	Primary Format of Content[d]	User Representation[e]	Immersion[f]	User Influence on Persistent Content[g]
E-mail, newsletters	Low	Low	Medium	Text	1D (screen name)	Low	Low
Instant messaging	Low	Medium	High	Text	1D/2D (image)	Low	Low
Newsgroups	Medium	Low	Medium	Text	1D	Low	Medium
Bulletin boards	Medium	Low	Medium	Text	1D	Low	Medium
Web sites	High	Low	Low	Text/images	1D/2D	Low	Medium
Weblogs, wikis	High	Low	High	Text/images/video	1D/2D	Low	High
Video-conferencing	Low	High	Low	Voice	3D (real)	Low	Low
Social networking sites[h]	High	Low	High	Text/images/video	1D/2D	Low	High
Virtual worlds	High	High	High	Text/voice/images/virtual artifacts	3D (virtual)	High	High

[a]The number of unspecified recipients that the communication can reach
[b]The ability to participate in communication in real time
[c]The ability to communicate in an informal manner
[d]The main format of information representation
[e]The manner in which a user is represented to others in the communication
[f]Immersion is defined as the subjective perception of an individual that an experience is real life-like
[g]The extent to which a user can effect change in the content of the environment that remains whether or not the user is logged in
[h]For example Facebook, MySpace

by users. In the case of virtual worlds, it is not the materiality of one object, but rather that of the simulated environment enabled by virtual worlds, that is appropriated by its users.

These affordances are relevant for learning within communities of practice. In the following, we discuss four primary affordances of virtual worlds: self-expression, co-experience, co-creation, and crowd-sourcing. These affordances can change the way we use information technology to support knowledge management and organizational learning practices so as to better achieve situated learning in communities of practice. We draw on relevant literature and examples from practice that help inform us on the capacity of virtual worlds as platforms for learning in communities of practice.

2.1 Self-expression

In understanding the relationship between an individual's 3D virtual avatar and his real self, the social-psychological phenomenon of self-expression becomes important. The "use of on-line persona can serve a useful purpose for expressing and understanding our 'core' selves unfettered by shyness, social anxiety and physical states" (Joinson and Dietz-Uhler, 2002, p. 291). Social psychologists argue that in real life people feel the need to present a self that is approvable to the society and the social groups they belong to (Olson and Johnson, 2001). However, in virtual interactions they do not need to worry about barriers, such as age, status, gender or the stereotypical notions they face in real life (Miller and Arnold, 2001). In a series of experiments through computer-mediated interactions, researchers have found that the *true* self of respondents was heightened (Joinson and Dietz-Uhler, 2002). Others have found that participating in online communication gives people the opportunity of "disclosing a long secret part of one's self" (McKenna and Bargh, 1998, p. 179). In the same vein, it has been argued that on the Internet "people loosen up, feel less restrained, and express themselves more openly" (Suler, 2004, p. 321). This stream of research does not discount the possibility of deceit where individuals pretend to be different from their real life selves. However, social psychologists argue that this deceit reflects what individuals desire to be and would like to be perceived as. Some view presented self in a cyber world as an extension of an individual's real life self. This can be seen in the following quote from an individual with a virtual persona:

> I also play female characters, despite being male…I don't give my real gender to people very often… I'm exploring aspects of human interactions that are denied to me in real life because I am male (Reid, 1995, p. 180).

Virtual Worlds present an interesting environment for self-expression because they not only facilitate anonymity, they also provide individuals with more tools for self-expression. Anonymity has been studied extensively in the group decision support literature and has been found to foster creativity (e.g., Jessup et al., 1990). 3D user representation in the form of avatars and the ability of users to influence persistent content enables self-expression in virtual worlds. Individuals can customize their avatars along multiple dimensions, including appearance, clothing, accessories, and possessions. Individuals can also interact with richer representations of products as compared to other Internet-based media used for the same purposes (Sawhney et al., 2005) and even customize their avatars and virtual world environments according to their aesthetic preferences.

Moreover, for some individuals it is more advantageous to express themselves through non-verbal cues. This group could include individuals with or without specific disabilities, or individuals that are introverted or hold a minority opinion. Therefore, it is possible to learn with individuals who would have not been otherwise included in traditional settings.

2.2 Co-experience

Global reach, synchronicity, 3D user representation, and immersion allow individuals to co-experience by sharing the same virtual space with other avatars. Technical aspects of the virtual environment, such degrees of freedom of movement, and the types of information formats supported influence the degree of immersion experienced by an individual in that environment. Prior research has found a positive relationship between the level of immersion offered by the environment and the degree of social presence experienced (Sadowski and Stanney, 2002). Also, virtual environments present an egocentric frame of reference as opposed to an exocentric one. Egocentric frames provide the view of an object, space, or phenomenon from within rather than from outside (viz. exocentric). The difference between an exocentric and egocentric frame of reference is analogous to viewing a dollhouse from the outside as a human versus viewing it from the eyes of a doll living in it (Salzman et al., 1999).

Egocentric frames of reference have also been hypothesized to enhance participants' social presence (Dede, 2005). An enhanced level of social presence makes the experience interactive, dynamic, and hence closer to real life than other virtual platforms. Social presence refers to the salience of the interactions of an individual with others in the medium and the degree to which these interactions feel like real life. Social presence goes beyond perception of the location of others in the medium – it also includes perception of their behaviors and an insight into their actions. Hence through co-experience, an individual is more engaged with others that share the same virtual space.

2.3 Co-creation

Besides being able to co-experience with other individuals, users of virtual worlds have the ability to create and modify persistent content and to work on 3D virtual artifacts simultaneously. This allows individuals to collaborate with one another and to co-create products and experiences. Hence they are not merely consumers of knowledge or information, but are equal participants in the production function of learning. Co-creating learning experiences also enhances the effects of the impact one learner has on the learning experience of others. Creating, and being able to own persistent virtual artifacts, can be hypothesized to instill a sense of "embeddedness" in this environment, which in turn creates social communities (Granovetter, 1973).

Additional support for co-creation in virtual worlds stems from the knowledge management literature that identifies the central role of boundary objects in effective situated learning contexts (Star and Griesemer, 1989). Boundary objects are artifacts that enable communication between members within and between different communities of practice (Carlile, 2002). While literature in IS underscores the role played by IT personnel in communities of practice as boundary spanners and gatekeepers (e.g., Pawlowski and Robey, 2004; Boland and Tenkasi, 1995), the role of boundary objects conceptualized as IT artifacts that help share meanings, has received less attention. Virtual worlds allow avatars to work on these boundary objects, or virtual artifacts, at the same time, providing a powerful and rich representation of the object of interest. For example, when designing a structure together in a virtual world, avatars can see changes and make modifications to the same virtual artifact, thus learning through interacting with each other. The common artifact serves as a boundary object that helps share a common meaning for all individuals who work together using the boundary object. To this extent, we believe that virtual worlds are unique among other Web-based communication media.

2.4 Crowd-Sourcing

Crowd-sourcing is a term employed for leveraging the collective potential of an undefined group of people, usually connected to the Internet, to pool resources, such as information, images, or videos (Howe, 2006). For example, the Wikipedia relies on crowd-sourcing for its articles. YouTube has user-generated content in the form of videos. Most news-blogs, such as Slashdot and MetaFilter, are also crowd-sourced and, in some cases, are more popular than corporate news Web sites (Silva et al., 2006).

Virtual worlds can be seen as crowd-sourcing platforms in which organizations have the possibility to reach out to the collective pool of avatars for sourcing of ideas and virtual artifacts. Reebok and Scion, for example, provide customizable virtual shoes and cars in Second Life for avatars in-world. They are able to collect customer information based on these customizations and hence leverage their virtual world presence to crowd-source customer preferences. Ducati Motor Holding builds brand loyalty and pools customer insights into designing motorcycles through Ducati.com. The ability of users to create persistent content further enables “building-on” or pooling ideas together.

3 Communities of Practice

While explicit knowledge is relatively easy to manage, it is the transfer of tacit knowledge that has proven to be far more difficult (Szulanski, 1996; Hippel, 1994). Tacit knowledge, such as experiences and contextual insights, has been traditionally transferred through methods such as story telling (Brown and Duguid, 2000), sense making (Wenger, 1998), or through conversations in informal social networks. The community perspective of knowledge management, which acknowledges the importance of informal networks and emphasizes collaboration, started in the late 1990s (Cross et al., 2006). Communities of practice are informal networks of like-minded individuals, where the process of learning and transfer of tacit knowledge is essentially social and involves a deepening process of participation (Lave and Wenger, 1991). Specifically, a community of practice has been defined by Brown and Duguid (1998) as:

> A group across which know-how and sensemaking are shared… which needs to work together for its dispositional know-how to be put into practice… (Brown and Duguid, 1998, p.96).

Tacit knowledge is implicit (Nonaka, 1994), sticky (Szulanski, 1996) and situated (Tyre and Hippel, 1997) in social interactions which are embedded in communities of practice (Wenger, 1998). Participation as well as interaction inside these communities of practice is essential for the exchange of tacit knowledge (Nonaka, 1994; Polanyi, 1967), which ultimately leads to the emergence of learning (Brown and Duguid, 1991). The "situatedness" comes from the belief that knowledge is situated in specific social contexts and practice (Brown and Duguid, 1991). Through participation and interaction, each community of practice develops a shared knowledge base, values, meanings, assumptions, beliefs, and practices. Research shows that in the absence of decisive first-hand knowledge, an individual looks at successful decisions made by other like-minded, similarly situated people as filters or guides to identify potentially good choices (Hill et al., 1995; Nidumolu et al., 2001). Prior case studies also have shown that even for individuals armed with extensive explicit knowledge, collective know-how (i.e., tacit knowledge) can be highly significant (Orr, 1989).

In conceptualizing communities of practice, Brown and Duguid (2000) identify key attributes that define a community of practice.

Common shared interest: Communities of practice start with a group of like-minded people who have the desire to share common interests. The common interest that binds the group is primarily intrinsic in nature and transcends extrinsic goals (Wenger, 1999).

Synergistic potential: Communities of practice learn and grow as the level of interaction and participation of their members' increases. Hence learning in communities of practice does not come from impersonal sources of information, but rather through an interaction with people through conversation and mutual engagement. The synergistic nature fosters continuous or organic sharing of knowledge and ideas as opposed to pre-arranged or structured communication. Communication is such that "changes can propagate easily, coordination is tight and ideas and knowledge may be distributed across the group, not held individually" (Brown and Duguid, 2000, p. 143). Knowledge, in communities of practice, is hence shared by the group rather than held by an individual.

Informality: Another key attribute of a community of practice is that its members interact casually. Informality comes from opportunistic and spontaneous communication that is not scheduled or intended, but happens by chance (Kraut et al., 1990). The level of interaction grows in an atmosphere of informality that facilitates story-telling and collective sense making.

Reach and reciprocity: Since a community of practice often starts in a spontaneous manner, it is necessary to have a medium in which like-minded people are able to reach one another across geographic, temporal, organizational, or cultural boundaries. Such reach needs to be bi-directional, where all individuals that are part of the community can "see" and interact with each other in a reciprocal manner and are "able to affect one another and the group as a whole directly" (Brown and Duguid, 2000, p. 143).

These attributes of communities of practice are not unassociated, but rather highly meshed with each other. In some cases, the presence of one attribute necessitates the presence of another. However, we believe they are valuable in providing a theoretical lens of enquiry to discuss virtual worlds as platforms for communities of practice.

4 Virtual Worlds as Platforms for Communities of Practice

Current, non-3D Web-based technologies are limited in the way they support communities of practice (Kimble and Hildreth, 2004). Media, such as e-mail, video conferencing, or instant messaging, typically facilitate either one-to-one or one-to-many communications. However, they do not support collective or synergistic needs as they are not necessarily the most appropriate media for sharing group interests dynamically and in an interactive way. Rather, they are static since they do not allow a dialogical way of communication or a dynamic conversational exchange (Schroeder, 2002). Also, most of these groups are moderated and have a formal tone in their communications. This formality, demanded for example by media such as bulletin boards and e-newsletters, thwarts attempts at creating an informal atmosphere (Silva et al., 2006). Further, traditional platforms used for communities of practice such as virtual forums, while having global reach, do not support bi-directional reciprocity. In the same vein, media such as video conferencing have high reciprocity, but low reach. Due to their affordances, these media are inflexible in structure, thus limiting the level of interaction, interactivity, and participation needed in communities of practice (Silva et al., 2006).

Virtual worlds, on the other hand, have the potential to facilitate such interaction. They are able to support the collective participation needed for communities of practices, their synergistic potential, informality, reach and reciprocity. Based on our literature review of communities of practice and our discussion on the unique affordance of virtual worlds, we posit that virtual worlds have the potential to be valuable platforms for communities of practice as they support their needs in an idealistic manner.

Virtual worlds support *sharing common interests* among a like-minded group through self-expression as users are able to represent their interests through non-verbal cues in a 3D format; through co-experience as users are able to communicate in a synchronous and immersive medium; through co-creation as users are able to work on boundary objects simultaneously; and through crowd-sourcing, which allows a community to reach out to a global audience for individuals with similar interests. Self-expression allows individuals to reify their experiences in communities of practice, by "producing objects that congeal this experience into thingness" (Wenger, 1998, p. 58). For example, the "Shakespeare Company" performed Hamlet in April 2008 in Second Life. Avatars, dressed up as characters from the play, logged in from around the world, only having previously met "in-world" for rehearsals. Other events, such as ballet shows and art exhibitions, are held routinely in Second Life. In September 2006, IBM hosted a version of Innovation Jam, an online brainstorming event, where employees from 70 countries could interact, see exhibits, try out math puzzles, get free t-shirts, and be tossed out of canons. Thus, the medium allowed for like-minded people to demonstrate and share their interests.

Virtual worlds facilitate *synergy* through the self-expression of users who can represent ideas and suggestions in a 3D format; through co-experience, which allows for synchronous and continual dialogical interchanges; through co-creation where boundary objects can be collectively modified to represent evolving ideas; and through crowd-sourcing, which allows for pooling of ideas from a large audience. For example, a group of people interested in the design of a new structure can meet in Second Life and collectively work on a virtual version of the building by modifying it in real time to incorporate evolving ideas. Starwood Hotels, for instance, used

Second Life as a platform to develop and design a new real-world site. A 3D blueprint of the new hotel was laid on a virtual floor with avatars of clients, architects, interior designers, and engineers were able to walk on the blueprint and to contribute ideas. Any avatar in Second Life was invited to make changes to the virtual hotel. Hence, the medium allowed people to pool their ideas and build a collective knowledge base.

By allowing for multiple modes of communication, virtual worlds facilitate *informality*. An individual can choose to talk to all avatars around him/her through chat or voice. He or she can also use instant messaging to limit his conversation to a particular avatar, even those in other parts of the virtual world. Non-verbal communication is possible through boundary objects in the shared virtual space. The ability to easily change the environment further allows for spontaneity. However, the most important factor contributing to the informality of communication in virtual worlds is the opportunistic and spontaneous interactions as avatars can meet through "happenstance" if they log in at the same time. For example, employees in different geographic locations who happen to be online in their company's virtual world (such as Sun's MPK20) may start talking and sharing experiences – which they would be unable to do through usual organizational communications channels.

While all Web-based applications enable global *reach*, they are limited in the *reciprocity* they permit. Brown and Duguid (2000) observe that online networks of practice, while allowing for efficient communication of information of a shared practice to a large number of members, are limited in their ability to support bi-directional communication. Hence, while information is easily disseminated, there is little chance of action being taken or knowledge being produced as a consequence of the existence of the network. In a virtual world, bi-directional interaction is in real time. Individuals can react to, and act on, the information they receive instantaneously, increasing the reciprocity within the community. For example, the American Cancer Society staged a virtual "Relay for Life" event where avatars participated in a walk on a virtual course, lit virtual luminaries, and raised virtual money, which was fully convertible to real money subsequently donated to the organizations. Hence collective action was enabled based on the information that the organization disseminated in the virtual platform.

Table 2 summarizes of how we think each attribute of a community of practice is facilitated by the affordances of virtual worlds in tabular format.

5 Discussion

In this chapter, we seek to contribute to research that investigates the role of information systems in knowledge management and organizational learning. Managing a firm's knowledge resources is crucial in today's global business landscape. However, current technologies that are used to facilitate knowledge management are limited in their ability to support communities of practice. We believe that virtual worlds, through their unique affordances of self-expression, co-experience, co-creation, and crowd-sourcing, have the potential to be valuable platforms for communities of practice.

However, the technology of virtual worlds is still evolving. While virtual worlds are now more common as proprietary software (such as Second Life by Linden Labs) or intra-firm applications

Table 2: Affordances of Virtual Worlds as Facilitators of Attributes of Communities of Practice

Communities of Practice Require	Virtual Worlds Provide			
	Self-expression	Co-experience	Co-creation	Crowd-Sourcing
Common shared interest	3D format of content and user representation allow articulation of interests through non-verbal cues	Synchronicity and immersion enable shared representation and perception of boundary objects	Users' ability to collectively create and modify persistent boundary objects facilitate rich interactions	Open nature of platform and ability to create persistent content allows for attracting individuals with similar interests
Synergistic potential	3D format of content and user representation allow articulation of ideas and abstract concepts	Synchronicity allows for continuous, dialogical exchanges	Users' ability to collectively create and modify persistent boundary objects facilitates representation of evolving of ideas in real-time	Open nature of platform allows for incorporation of higher number of ideas
Informality	Ability to customize virtual personas and the environment allows for informality	Synchronicity, immersion, and customized user representation facilitates informality	The dynamic nature of content allows for informality	Ability for greater number of individuals to collaboratively build and modify boundary objects enhances informality
Reach and reciprocity	Ability to customize persistent virtual content in an open platform increases reach and reciprocity	Synchronicity and immersion enhance reciprocity	Users' ability to collectively create and modify persistent boundary objects facilitates reciprocity	Open nature of platform allows for inclusion of individuals with access to the Internet in the environment

(such as Sun Microsystem's MPK20), there is a possibility that more open-platform virtual worlds will emerge.[3] In this chapter, we summarized the current technological characteristics of virtual worlds, drew on the theory of communities of practice, and presented a framework of how affordances of virtual worlds can facilitate each attribute of communities of practice. However, further research is required that traces the technological evolution of virtual worlds in relation to knowledge management and organizational learning. For example, in their current form, most virtual worlds provide minimal support for asynchronous communication and archiving. Both these features are found beneficial to facilitating explicit knowledge exchange, as highlighted by the success of blogs and wikis (Cayzer, 2004; Grudin, 2006). Hence these are limitations of the current form of virtual worlds. This chapter provides a starting point for a discussion that calls for a strong research agenda investigating the implications of the technology of virtual worlds in knowledge management and organizational learning.

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[3] http://www.businessweek.com/magazine/content/07_33/b4046064.htm. Efforts for developing open-platform virtual worlds are already underway. For example, see http://www.nmc.org/news/nmc/nmc-launches-open-virtual-worlds-project.

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Open Innovation Through Online Communities

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Abstract. Researchers have recently advocated the use of open innovation models to capitalize on new sources of innovation. One such promising source of new innovations comes from the actual end users of an organization's products and services. However, many organizations have difficulty absorbing these innovations due to a fear over losing control of the innovation process, and a lack of absorptive capacity to understand and assimilate end user ideas. The purpose of this chapter is to review the currently espoused strategies for integrating end users into an organization's innovation process: incorporating user toolkits, strategic positioning of personnel, engaging lead users, and implementing user innovation communities. These strategies were identified in a time when interactions between an organization and its end users interacted through face to face communications. We extend this prior work by examining the implementation and management of online user innovation communities, drawing upon our research of the Dell IdeaStorm web site. We conclude the chapter with areas in need of future research.

1 Introduction

The ability to identify and capture new sources of innovation is essential for sustaining competitive advantage. Recently, the term open innovation has become synonymous with organizational strategies that recognize the potential opportunities and advantages gained from leveraging knowledge and innovations found outside an organization's formal boundaries (Chesbrough, 2003a, b). When an organization opens its boundaries to external sources of innovation, it increases its potential for gaining competitive advantage through expanding its ability to develop creative product solutions (von Hippel et al., 1999), increasing the pool of potential ideas and innovations in its product and service portfolio (von Hippel, 1988, 2005), and developing its capabilities in terms of its innovation processes (Chesbrough, 2003a; von Hippel and Katz, 2002).

Maintaining competitive advantage through open innovation creates new challenges in terms of absorptive capacity and organizational control over the innovation process. Absorptive capacity is defined as the firm's ability to identify, evaluate, and integrate new knowledge into existing business operations (Cohen and Levinthal, 1990). Innovations from external sources can potentially contradict or disrupt an organization's current innovation processes, and exceed its absorptive capacity. When an organization lacks absorptive capacity, it is costly to assimilate new innovations due to the tacitness of the knowledge about the innovation (Nonaka and Takeuchi,

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1995; Polanyi, 1966). Additionally, open innovation introduces new participants in the innovation process (Dahlander and Wallin, 2006; von Hippel, 1988). An organization must surrender some control over the innovation and decision-making process itself to external sources. When external sources participate in the innovation process, an organization must balance its innovation needs with those of its partner/source. To deal with the challenges of absorbing and controlling open innovations, organizations must develop strategies that bridge the knowledge gap and balance control over the open innovation process.

Research has focused on two models of open innovation – formal (Chesbrough, 2003a) and informal (von Hippel, 1988, 2005). Open innovation using formal models focuses on three strategies: integrating external research and development (R&D) efforts through mergers and acquisitions, giving away internally developed intellectual property to create new business opportunities, and creating spin-off organizations based on internal R&D efforts (Chesbrough, 2003a). Informal open innovation models seek sources of innovation from non-traditional and unexpected sources, redefining who participates in an organization's innovation process and how an organization absorbs new ideas.

Research in this area has focused on leveraging the end users of an organization's products and services (von Hippel, 1988, 2001, 2005). End users have the most experience actually using a firm's products, and are at the intersection of a product's expected use and its actual use. When a product or service no longer meets the demands of end users, end users innovate by experimenting with the product to meet changing demands. In this way, end users have the potential to become an extension of the firm's research and development efforts, which increases the potential number of ideas and/or innovations.

For the purposes of this chapter we focus on the informal model of open innovation and end user innovation. Recent advances in information and communication technologies (ICTs) have created new opportunities for organizations to connect with end users, regardless of geographic boundaries, temporal considerations, or organizational affiliation (Constant et al., 1996; Dahlander and Wallin, 2006; von Hippel, 2005). ICTs provide the communication mechanisms for individuals to share ideas and innovations with a sponsor organization through online user innovation communities. User innovation communities are "distributed groups of individuals focused on solving a general problem and/or developing a new solution supported by computer mediated communication" (Dahlander and Wallin, 2006, p. 1246).

The general challenges of open innovation – absorptive capacity and control – are potentially exacerbated by integrating a large population of end users. ICT environments create the possibility for a volunteer workforce of unknown size to participate in an organization's innovation process. As a result, the organization has little control over the sheer quantity of end user ideas and/or innovations that are contributed, and is likely to have difficulty sifting through the ideas to identify those of particular relevance or quality. Thus, an organization's absorptive capacity can be exceeded simply by the number of ideas and/or innovations contributed by end users. Additionally, as end users become integral to an organization's innovation process, control over which ideas or innovations an organization should incorporate into its product and service portfolio is shared. If an idea is extremely popular among the user innovation community but not adopted by the organization, this has the potential to do irreparable harm to the organization's reputation among the most valuable stakeholder group available: the actual consumers.

Instead of the unidirectional model of producer innovation to consumer consumption, end user innovation depends upon the active engagement of “prosumers” – producers who are also consumers (Bandulet and Morasch, 2005; Tapscott and Williams, 2006; Yamaguchi, 1990). End user innovation alters the traditional roles of an organization and its end users by redefining who can be a source of innovation and who can consume the innovation. The organization and end users alike become both the producers and consumers of innovations. For example, Dell IdeaStorm is a user innovation community that integrates Dell’s end users into the innovation process. The goal of the user innovation community is to improve Dell’s existing products and services as well as offer ideas on new market opportunities. In a traditional producer-consumer model, Dell produces its innovations from its R&D department and its customers consume those innovations. IdeaStorm, however, incorporates a more open prosumer model where Dell and its end users are both the producers and consumers of innovations. As a result, Dell relies on its end users for producing and consuming some of its products and services. The extended role that end users occupy in such an open innovation model explicitly stresses the importance of external sources of innovations for Dell to develop and maintain competitive advantage over its rivals. Consequently, control over the innovation process requires that more authority be placed in the hands of the end users when deciding which products and services should be adopted.

The purpose of this chapter is to examine the role of end users in open innovation models and how ICTs bridge the gap between new sources of innovation and traditional organizational boundaries. To do this, we present results from a series of studies that examine the two main dilemmas associated with open innovation: control over the innovation process and the ability of the organization to absorb the innovation. This chapter is divided into three main sections. First, we review current research on end user innovation strategies. Second, we discuss our research, which examines Dell’s IdeaStorm user innovation community. We examine how Dell balances the control over the innovation process and effectively absorbs ideas from the community. Our first study examines why certain ideas are adopted. Our second study examines the role of “lead users” in the community and adoption process using social network theories and techniques. Third, we discuss the general theoretical and practical implications of these studies for open innovation and identify several questions remaining at the intersection of open innovation and information systems.

2 End User Innovation

End users have been found to provide significant value to an organization’s innovation process. For example, end users routinely participate in focus groups to provide feedback on an organization’s new or existing products and services. Von Hippel (1988) describes the development of several scientific instruments, such as the gas chromatograph and transmission electron microscope, and suggests that users can be a source of both minor and major innovations. These end user innovations evolved into the present-day versions of these scientific instruments. In fact, von Hippel (1988) found that nearly 80% of the improvements to several scientific instruments were created by end users. Interestingly, the percentage of user innovations categorized as minor and major were relatively equal, indicating that users can provide an organization with both incremental and radical innovations.

While end users present an important source for new ideas and innovations, actually absorbing these innovations and turning them into viable new products and services is tremendously difficult. When an organization seeks ideas from end users, it faces the significant challenge of working with a volunteer workforce that may hold different views on how and what an organization should incorporate into its product and service portfolio. Moreover, absorbing the ideas of end users opens the boundaries of the firm, substantially increasing the number of potential ideas the organization must consider as potentially new innovations. As a result, this volunteer workforce may exceed the existing capabilities of corporate research and development teams in terms of identifying, developing, and absorbing user-driven innovations.

Prior research on organizations that have successfully incorporated end user innovations suggests four strategies for bridging the end user-corporate divide, presented in Fig. 1. The strategies are categorized based on two dimensions: source of the innovation (individual innovator or user innovation community) and control over the process (end user control or organizational control). These strategies are used to help overcome the traditional open innovation dilemmas of control and absorptive capacity. The first dimension is control over the innovation process. Control over the process can be directed by the end user or the organization. Organization-controlled innovations are innovations developed specifically for an organization, while user-controlled innovations are innovations derived from end users independent of an organization's participation.

The second dimension concerns the source of the innovation. Individual innovator innovations are created by individuals. To absorb these innovations, an organization provides users with toolkits, both physical and virtual, to develop and absorb organization-controlled user innovations (Franke and von Hippel, 2003; von Hippel and Katz, 2002). Additionally, an organization can engage specific end users based upon reputation factors and internalize these users into its innovation process to efficiently absorb user-controlled user innovations (Franke et al., 2006; Lilien et al., 2002; von Hippel, 1988).

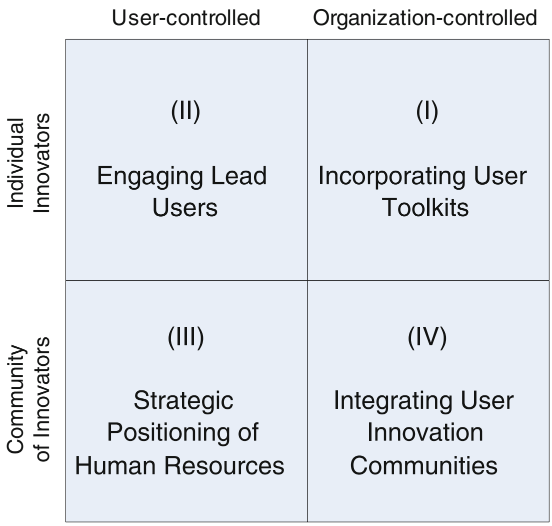

Fig. 1: End user innovation strategies

Community innovations are end user innovations designed and developed by a group of users. An organization can internalize user communities within its organizational boundary to provide a continuous source of organization-controlled ideas and/or innovations (Di Gangi, 2008; Di Gangi and Wasko, 2009). In addition, an organization can strategically embed human resources in user communities to identify and absorb user-controlled innovations developed by groups of end users (Dahlander and Wallin, 2006).

2.1 Incorporating User Toolkits

An organization can develop user toolkits as part of its innovation process to better absorb user innovations. User toolkits are "integrated sets of product-design, prototyping, and design-testing tools intended for use by end users." (von Hippel, 2005, p. 147). Research on user toolkits has primarily been conducted by von Hippel and his colleagues (e.g., Franke and von Hippel, 2003; von Hippel, 2005; von Hippel and Katz, 2002). For example, von Hippel (2005) described how Nestlé incorporated a user toolkit composed of pre-processed ingredients for restaurant chefs to use when developing new recipes for their restaurants. The chefs would create recipes with the ingredients that were already being manufactured at the Nestlé production facility, minimizing the need for reconfiguring its production facility to meet the chefs' needs (von Hippel, 2005).

In terms of absorptive capacity, user toolkits are designed to essentially create innovation opportunities within an organization's existing production capacity. User toolkits are designed to complement an organization's existing processes and capabilities, focusing on the creation of incremental innovations based on recombinations of existing products and services. However, while user toolkits ensure that an organization has the absorptive capacity to assimilate the innovation, predesigned toolkits limit the potential scope of new innovations. Users that innovate using toolkits do not have an opportunity to introduce radical innovations or incremental innovations that exceed the current production capabilities of the organization. Organizations wishing to absorb radical innovations that extend beyond their existing capabilities must seek alternative strategies for leveraging end users as a source of innovation, such as engaging lead users, strategically embedding human resources in external environments, and implementing user innovation communities.

2.2 Engaging Lead Users

Von Hippel and his colleagues extended their research on user-driven innovation processes to determine whether particular types of users can be better sources of innovation. This research suggests that organizations could engage "lead users" when leveraging end users as sources of innovation (Lilien et al., 2002; von Hippel, 1988). Lead users are typically end users that have unique needs for product innovations that are "months or years in the future" of general consumers (von Hippel, 1988). Early research on lead users has consistently cited Roger's (2003) diffusion of innovations research to suggest that lead users are individuals that possess unique knowledge and play an early role in the development of an innovation. Specifically, lead users typically are "early knowers" or the innovators themselves (Rogers, 2003; von Hippel, 1988). Early knowers maintain diverse information channels and possess significant human capital for identifying potential innovations (Lüthje, 2004; Rogers, 2003). Identifying and engaging lead users is based upon a "pyramiding" process (von Hippel et al., 1999) which is an iterative external search for lead users based on reputation factors (a continuous cycle of identifying leaders within specific expertise domains) who can be incorporated into an organization's innovation process.

For example, when 3M began developing its surgical drapings products to reduce infection rates in emergency rooms, it sought out the advice of third-world hospital staff to gain a greater understanding of the causes of infections (von Hippel et al., 1999). 3M had already identified an area in which it wanted to innovate (infectious disease control) and proceeded to identify lead users that would help define the requirements of a new product (surgical drapings). While engaging lead users can provide an organization with substantial support for creating new, radical innovations, an organization must absorb considerable costs to identify, integrate, and engage lead users in its innovation process. These costs include the search process itself, time delays for identifying and integrating lead users into the R&D efforts, and transaction costs associated with coordinating with individuals from outside the organization's boundaries. Additionally, the organization maintains control over the innovation process by engaging lead users in pre-specified areas of interest to the organization. Essentially, lead users are incorporated into the R&D team after a specific area of innovation has been identified by the organization, limiting the potential scope of innovation for an organization.

In summary, the open innovation strategies based on incorporating user toolkits and engaging lead users focus on how an organization can leverage individual innovators in the research and development process. The two strategies are differentiated by the control over the innovation process – user-controlled or organization-controlled. User toolkits give an organization greater control, while engaging lead users focuses on identifying individuals within a specific domain of expertise giving end users greater control over the innovation process. These lead users provide the organization with the necessary information for developing new innovations.

2.3 Strategic Positioning of Human Resources

The third strategy strategically positions an organization's human resources within user innovation communities to capture knowledge about an innovation (Dahlander and Wallin, 2006). User innovation communities can be divided along the control dimension. User-controlled innovation communities are communities that form around a central interest or hobby, such as sports hobbyist groups (Franke and Shah, 2003; von Hippel, 2001), and typically develop non-organization specific innovations. Franke and Shah (2003) examined sports communities and found end users were able to identify and develop innovations based upon their unique knowledge to enhance user experiences. For example, von Hippel (2001) describes the innovation process for a windsurfing community (Franke and Shah, 2003), and suggests that complex products can be developed by users with limited manufacturer involvement. These innovations are designed based on the community's interests and require an organization to reconfigure or tailor the user innovation to match its overall business strategy.

An organization assigns and positions human resources in user innovation communities to capture the information flowing within the community and to influence the direction of the community's development efforts. Similar to Burt's theory on structural holes maintaining advantageous positions within a social structure (Burt, 1992), strategic positioning helps capture the innovations being exchanged among end users and enables identification of key end users to engage when attempting to capture the knowledge necessary to create new innovations.

While this approach creates the ability for organizations to passively capture user innovations, an absorption problem still exists. The positioned employees act as third-party innovation translators that pull the user-controlled innovation from the community and transfer the tacit knowledge to the organization's R&D team. The innovation is user-controlled because the community is external to the organization and does not develop organization-specific innovations. Additionally, the positioning of human resources in one community limits the ability for the organization to target alternative communities that may be a source of additional innovations. Thus, resource constraints become an important factor in the effectiveness of strategic positioning to capture user innovations.

2.4 Internalizing User Innovation Communities

The final strategy is based upon organizational implementation of user innovation communities. Organization-controlled user innovation communities operate within the formal boundaries of the firm, with the pre-specified goal of developing organization-specific innovations (Di Gangi and Wasko, 2009). User innovation communities become a geographically distributed volunteer workforce of end users. End users contribute ideas and innovations based upon an organization's existing products and services and identify potentially new innovations that an organization can develop as part of its product and service portfolio. However, there are two important challenges with implementing this strategy. First, this strategy has the greatest potential to exceed an organization's absorptive capacity, due to the complexity of the innovations being proposed and the quantity of ideas that need consideration (Di Gangi and Wasko, 2009). Additionally, there are challenges with publicly inviting users to participate in the innovation process and sharing control of research and development efforts. Organizations have to balance between selecting innovations that ensure high market returns against implementing the innovations that are popular in the community.

In summary, research on open innovation has identified four strategies for leveraging end user innovations. However, each of these strategies has limitations. Strategies that facilitate knowledge sharing and absorptive capacity have the potential to limit the scope of innovations. Strategies that enable greater organizational control over the innovation are resource intensive and run the risk of backfiring – doing more to ostracize than engage end users. Organization-controlled innovation strategies such as user toolkits support incremental innovations based on existing production capabilities rather than radical innovations. User-controlled innovation strategies create the additional challenge of absorbing innovations that were originally not designed to be organization-specific. User innovation communities enable organizational control, and have the potential to reach thousands of volunteer innovators. However, the key questions remaining regarding user innovation communities are (1) how to share control over the innovation process, and (2) how to effectively and efficiently absorb innovations from the community.

3 Generating Value from User Innovation Communities

One of the limitations of the open innovation literature to date is that the studies have focused predominately on interpersonal, face to face physical strategies, such as Nestlé's recipe toolkit and wind-surfing communities. Advanced ICTs based on Web 2.0 technologies, such as discussion groups, individual profiles, and social network sites, improve interactions with an organization's end users and have been touted by the popular press as essential for the future of organizational success. Terms such as "crowd-sourcing" and "viral loops" have become common to describe the role of online communities of customers discussing ideas and issues related to an organization's products and services. The theory is that there is "wisdom" embedded in a crowd of individuals that exceeds any one individual or small group (Surowiecki, 2005). The belief is that a crowd is able to identify the best idea among a large pool of potential innovations. Nonetheless, the wisdom of crowds is reliant upon the aggregation of diverse opinions, independent judgments, and localized and specialized knowledge in order to not crowd out their potential wisdom.

To examine the challenges of how to harness the power of customer-driven innovations while ensuring that the capabilities of corporate research and development departments are not exceeded by the influx of external innovative ideas, we have performed a series of studies on one highly successful and popular user innovation community – Dell's IdeaStorm. IdeaStorm is an online user innovation community created by Dell, introduced in early February 2007.

Since its inception, nearly 10,000 ideas have been contributed by end users with nearly 80,000 comments to define and clarify the user ideas (as of September 2008). Dell introduced IdeaStorm to Dell customers with the explicit statement that IdeaStorm was a place "*where your ideas reign*." Customers create usernames and post their innovative ideas on how Dell can improve existing products and services and suggest new ideas. In addition, users can post comments about an idea, promote or demote posted ideas and edit their own ideas. When users wish to submit an idea, they provide a title and a description of their idea. Additionally, users have the option to classify their idea from over thirty categories (e.g., Linux, Desktops, and Sales Strategies). This allows other users searching the web site to view ideas based upon a specific category. Once posted, users are able to promote or demote (e.g., vote on) an idea based upon whether they feel it should be adopted by Dell.

When users promote an idea, points are awarded that can potentially elevate the idea to most popular status, which is shown on the front page of IdeaStorm. Demoted ideas or ideas that are no longer receiving votes are automatically pulled from the popular ideas page after a specified period of time, determined by Dell. Consequently, Dell can highlight ideas which it believes are potentially more significant to IdeaStorm users. Additionally, Dell provides mechanisms for alerting users to the status of ideas. First, IdeaStorm moderators can append status tags to ideas (Under Review, Reviewed, In Progress, Coming Soon, Implemented, and Partially Implemented). Second, IdeaStorm uses an *Ideas in Action* page which provides detailed information of the status of ideas Dell has decided to adopt. Since its inception, Dell has adopted 35 ideas from a wide variety of areas, ranging from pre-installed Linux operating system to introducing a new Tablet PC.

In June 2007, we conducted a five-month study of the initial interactions between Dell and the IdeaStorm community. The purpose of this first study was to investigate why certain ideas and not others were adopted by Dell. We hypothesized that Dell was faced with competing adoption decisions: adopt innovations based on the potential market returns to Dell, or adopt innovations due to community pressure (Di Gangi and Wasko, 2009).

We gathered objective and subjective data from twenty-one user innovations to determine which factors potentially influenced Dell's adoption decision (the 11 adopted ideas compared to the 10 most popular, but not adopted ideas in the community). To assess community pressure, objective data was collected that focused on the characteristics of the user ideas: the number of votes, the number of comments, the age of the idea, and the number of unique users posting comments about the idea. To assess the potential market returns of the idea, business professionals rated subjective data in the IT industry along five dimensions: market value, return on investment, appropriability, the extent to which Dell possesses complementary assets, and the potential of the idea to generate new dynamic capabilities for Dell.

We compared the eleven adopted user innovations and ten not-adopted, but most popular ideas within the community, and found that no significant factors, except community age ($p = 0.045$), predicted the adoption of user ideas. Surprisingly, Dell was no more likely to adopt ideas that were the most profitable or the most popular. Therefore, we conducted qualitative case analyses on two user ideas, Pre-installed Linux OS which was adopted, and Pre-installed OpenOffice which was not adopted. The data for the case studies compared approximately 1,865 user comments. We focused on how the comments made by end users had the potential to influence Dell and other members of the community to support the idea.

Our qualitative analysis suggests that the key factor underlying adoption was Dell's ability to understand what the community was proposing (absorptive capacity). Users participating in the discussion of the pre-installed Linux idea were able to refine and describe the idea to Dell and come to consensus about how to implement the idea. Another interesting finding of this study relates to the idea of "viral loop". We found that in order to promote the Linux idea, users posted links to the idea in external user groups (e.g., Digg.com) to raise awareness of the idea and promote its popularity. Additionally, users assumed responsibility for creating consensus, defining the idea requirements, and summarizing these points to aide Dell in its adoption decision. Moreover, Dell utilized an online survey to create formal consensus in the adopted idea community.

The online survey supported Dell's ability to bridge the knowledge gap between the idea community and the organization by identifying the central points of the idea to evaluate for adoption. This study yielded three important practical implications for organizations pursuing ideas through user innovation communities. First, organizations must be prepared to handle thousands of ideas from end users. Second, organizations could enhance absorptive capacity by implementing user toolkits, such as templates for defining and describing ideas and online survey techniques for users to further refine and define the idea for the host organization. Finally, in order to not disenfranchise end users, organizations need to communicate and actively participate in the user innovation community (strategic positioning), and keep innovators informed about the status of their innovations.

4 Following the Leaders

While identifying the community development factors that influenced Dell's decision to adopt user ideas, the size of an online user innovation community can still exceed an organization's absorptive capacity. Without control over the number of contributors and quality of the ideas provided by end users, an organization must absorb considerable costs to evaluate each user idea.

Our second study focused on the strategy of engaging lead users and examining how organizations can identify a subset of lead users within online user innovation communities (Di Gangi, 2008). Using social capital theory, we suggest that lead users can be identified by how they accumulate three important forms of structural social capital – idea specialized, domain specialized, and community generalized. By identifying the users that are central in these three different types of networks, organizations may be better able to identify relevant innovations by following these leaders.

Social capital theory rests upon the central assumption that networks of relationships provide individuals additional benefits, such as access to key resources, early notification of information, and influence over others in a social environment (Burt, 1987; Granovetter, 1973, 1995; Nahapiet and Ghoshal, 1998). Social capital is generally defined as "any aspect of social structure that creates value and facilitates the actions of the individuals within that social structure." (Coleman, 1990; Seibert et al., 2001, p. 220). An individual's relationships can be used as proxy mechanisms for identifying individuals possessing social capital (Brass, 1984; Nahapiet and Ghoshal, 1998; Seibert et al., 2001). Early research on engaging lead users suggested a "pyramiding" process based upon reputation factors for identifying lead users. This process identifies lead users by searching the relationship networks of individuals within specific domains of expertise that may provide information or advice to develop new innovations.

In online user innovation communities, several types of relationship networks are potentially available to identify lead users. First, idea specialized social capital may exist which focuses on lead users possessing strong ties to specific idea communities which may aide an organization in the development, clarification, and refinement of a user idea. Second, domain specialized social capital examines the weak tie relationships lead users possess in specific categories or areas of expertise. Similar to von Hippel's (1988) lead user theory, lead users with this type of social capital aide organizations in identifying relevant user ideas within a subset of the community by creating an artificial boundary around the ideas within a specific domain. Finally, community generalized lead users possess a vision advantage (Burt, 2005) providing organizations with an overall view of potentially relevant and adoptable user ideas.

We conducted a nine-month study using three-month time periods and user affiliation networks to identify lead users within an online user innovation community – IdeaStorm. Affiliation networks are social networks of relationships between individuals based upon a common affiliation or experience. Users participating in the same idea community are considered to be related through their mutual affiliation with the idea community. We created affiliation networks based upon an ego-centric network design. An ego-centric network is a network created from an initial list of users which expands to a larger network based upon affiliations with the initial users. Using the adopted idea communities in each time period to identify the initial list of users, we identified lead users based on the varying types of social capital. We conducted correlation analyses across the three time periods in order to determine whether identified lead users can aide an organization in identifying relevant user ideas.

Using social network analysis, we used three centrality measures – eigenvector, closeness, and degree – to identify lead users across the time periods (Wasserman and Faust, 1994). Initial results suggest lead users with domain specialized and community generalized social capital are significantly correlated with user ideas adopted in the subsequent adopted idea time periods. Interestingly, virtually none of the idea owners or innovators (Rogers, 2003), were found to be central within the adopted ideas across multiple time periods.

Based on these findings, we suggest that a lead user, in addition to being ahead of market trends and active within the community, possesses significant levels of social capital in online user innovation communities (Di Gangi, 2008). Furthermore, von Hippel's (1988) depiction of lead users consisting of both innovators and early knowers (Rogers, 2003; von Hippel, 1988) can be refined to early knowers rather than innovators in online user innovation communities. Lead users in online user innovation communities participated in adopted ideas prior to adoption by Dell and typically were not the original idea owner.

In summary, ongoing research on open innovation strategies that incorporate end users into the innovation process examines how online user innovation communities can capture user ideas and innovations. The absorptive capacity issue remains an open question for future scholars to examine. Identifying a subset of lead users an organization can follow suggests an organization does not need to follow every idea. Rather, an organization can focus its R&D efforts and absorptive capacity on absorbing ideas identified by the lead users within the community. Additionally, ICTs play a role in bridging the knowledge gap between end users and an organization to maintain absorptive capacity by creating consensus within the communities. However, several questions are in need of further research. The next section points to future directions as open innovation becomes more widespread.

5 Questions for MIS Researchers

Research to date has shown that an organization is not the only source of innovation; rather end users themselves can potentially provide innovative ideas and innovations. However, concerns over organizational control and absorptive capacity arise when implementing open innovation strategies. Our review suggests that these issues are compounded when online user innovation communities are incorporated into the innovation process. As a result, we believe that further research is needed to investigate the impact of ICTs on how an organization incorporates end users, implements open innovation strategies, and addresses organizational control and absorptive capacity issues.

First, as ICTs become an integral component of the innovation process, research on the decision-making process must be examined. Based on the prior literature, open innovation has been found to create new business markets and alter how organizations develop competitive advantage (Chesbrough, 2003a). Research examining organizational characteristics that influence the likelihood of adopting a specific open innovation strategy is needed. To incorporate open innovation strategies with ICT components, organizations with strong technology capabilities may be more successful at adopting open innovation for maintaining competitive advantage. The results are likely to suggest different open innovation strategies benefit some organizations over others; however, research is needed to identify these factors.

Second, with the advancement of open innovation as a competitive strategy, what are the implications for controlling the innovation process and managing a volunteer workforce? For instance, our study focused on the first five months of IdeaStorm and examined both organizational and community factors that influenced Dell's decision to adopt user innovations. At several points in the innovation process, users expressed anger at Dell's delayed responses, inaction to popular ideas, and slow implementation of adopted user ideas. Organizations that incorporate end users into their business operations face the potential of customer revolt or loss of a potential source of innovation.

For example, Digg.com is a social news aggregation organization in which its success is built upon the satisfaction of its customers in terms of how it controls the news articles that become popular and are displayed on its homepage. Digg.com recently experienced the downsides to an organization that fails to surrender some control over its content to its end users when it unilaterally removed user content from its site concerning HD-DVD and Blu-ray discs and piracy protection (Claburn, 2007; Havenstein, 2007). Consequently, Digg.com was forced to acquiesce to its end users' demands in order to sustain its competitive position as a news aggregation service provider (Rose, 2007).

Central to this story are the control issues facing an organization that chooses to implement open innovation models. Moreover, the managerial considerations that must be taken into account when incorporating end users as integral sources of innovation in the innovation process remain unanswered. Research examining how an organization should manage a volunteer workforce of end users and negotiate control over its innovation decision is needed in order to maintain a sustainable source of end user innovations. For example, can organizations negotiate control over the innovation process by engaging lead users with significant social capital? Social capital theory suggests that these lead users would possess significant influence over their social environments which may provide organizations with an alternative to relinquishing full control of its innovation process to the general community.

Furthermore, how can an organization sustain these sources of innovation beyond initial popularity to establish long-term advantages? For example, IdeaStorm faced a significant challenge eight months into its initial launch with some lead users leaving the user innovation community over a lack of organizational response from Dell. Given the nature of electronic community membership to be volatile over time, is turnover healthy or should an organization develop mechanisms to retain these lead users?

Third, the existing literature on open innovation and ICT environments is limited. Much of it is based on user innovation communities based on physical interactions, such as wind-surfing and bicyclist communities. With the exception of research on open-source software communities, our study of IdeaStorm appears to be one of the first studies examining online user innovation communities. However, several organizations have recently introduced online user innovation communities; such as, Starbucks, Ubuntu, Fiat, and IBM, to solicit innovations from their end users. Research on how online user innovation communities differ from their physical counterparts is needed in order to distinguish key characteristics that influence how organizations can implement open innovation strategies. For example, user toolkits can harness the capabilities of web technologies that support refining, clarifying, and describing user ideas clearly to the organization. IdeaStorm uses a basic user comment system that does not allow comment chaining and user ratings of comments, forcing Dell to assume each comment is equally valued by the community. By incorporating similar comment systems that social media sites use (e.g., Digg.com), community members can provide Dell with the ability to identify highly valued comments which may provide additional clarification on how to implement a user idea. However, research examining the impact of web technologies on the innovation process is lacking. How can information systems professionals and academics incorporate technology components into open innovation strategies? Are there differences between online and physical user innovation communities and how can an organization create mechanisms to ensure the effective assimilation of valuable user innovations?

Finally, ICTs introduce the potential to overlap several open innovation strategies concurrently. Based upon our initial study of IdeaStorm, we created guidelines for organizations seeking to build online user innovation communities for their business (Di Gangi and Wasko, 2009). Three of our recommendations focused on integrating prior research findings into the online user innovation community design. We suggest modifying user toolkits for online social environments, engaging community lead users, and strategically embedding human resources within internalized user innovation communities to interact directly with end users. However, research is needed to determine whether concurrent open innovation strategies provide organizations a method to absorb relevant user innovations and/or ideas or further compounds absorptive capacity issues.

In summary, several directions are in need of further research to determine how organizations and end users react to open innovation using ICT environments. Our intention in this chapter is to present a general review of the current research to identify potential opportunities that MIS scholars can examine in the open innovation area. As open innovation becomes more common, additional research opportunities will become apparent which suggests this area of research is potentially valuable to the MIS field.

6 Conclusion

Organizations have begun to embrace the ideology that by increasing the sources of innovation, an organization can continuously replenish its idea pool and maintain competitive advantage. In doing so, open innovation research has focused on redefining the traditional view that organizations produce and customers consume innovations. An open innovation approach focuses on how organizations and customers alike produce and consume innovations. However, open innovation models present significant challenges to an organization in terms of absorptive capacity and control over the innovation process as end users play an increasingly vital role within the innovation process.

The purpose of this chapter is to briefly review open innovation research and identify the key questions in need of further examination. Accordingly, several researchers have examined different open innovation strategies for integrating end users into the innovation process (e.g., Dahlander and Wallin, 2006; Franke et al., 2006; von Hippel and Katz, 2002; von Hippel et al., 1999). In each instance, absorptive capacity is central to the types of user innovations absorbed and how an organization incorporates end users into the innovation process. Based on our discussion, we suggest that open innovation strategies designed to capture user innovations can be described along two dimensions – control (user vs. organization) and orientation (individual vs. community). Within each of these dimensions the four open innovation strategies we discussed create opportunities and limitations to leveraging end users.

Our approach has demonstrated the need for further research to examine ICT effects on open innovation and the resultant absorptive capacity issue. When incorporating an unknown number of end users into an organization's innovation process, an organization must develop strategies for managing a volunteer workforce. Furthermore, an organization must develop technical strategies for transferring the tacit knowledge concerning the user innovation to the organization. Additionally, as end users play an increasingly crucial role in an organization's innovation process, control over the innovation process will become a decidedly important component of open innovation model effectiveness.

We conclude this chapter with a call for research within the MIS field on open innovation strategies. As organizations begin to integrate end users into their innovation processes, ICTs will play a larger role in bridging the knowledge gap between the end user and organization. Research on this integral role and the resulting effects on an organization's decision-making process, competitive advantage, and absorptive capacity are needed to further advance our knowledge in this emerging area of interest.

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Knowledge Networking to Overcome the Digital Divide

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Abstract. As organizations become increasingly extended across global boundaries, their reliance on information and communication technologies (ICTs) to support their processes increases. The use of ICTs to activate dispersed knowledge within complex webs of human networks can enable the gap between the information rich and information poor to be overcome. This paper develops a new concept called knowledge networking and investigates how this process enables the digital divide to be overcome. Following a phenomenological analysis of knowledge networking using a selection of vignettes, this paper provides a conceptual model describing the ways in which knowledge networking enables the digital divide to be overcome.

Keywords: Knowledge networking, knowledge activation, digital divide, information and communication technologies, talent pools.

1 Introduction

Traditional notions of knowledge management do not always address the ways in which knowledge is shared and used across organizational and national boundaries. It appears that the rise of distributed processes among people and organizations in different parts of the world are providing new challenges for decision makers (Qureshi et al., 2006). The notion that organizations have become extended across geographical boundaries has meant that decision making processes are dependent upon information and communication technology (ICT) to offer an environment that provides reliable and timely task-related information sharing and support for rapid decision-making (Zigurs and Qureshi, 2001; Baker, 2002). While organizational processes are becoming increasingly dispersed, notions of knowledge management continue to focus on the generation, representation, storage, transfer, transformation, application, embedding, and protecting of organizational knowledge (Schultze and Leidner, 2002; Hedlund, 1994; Alavi and Leidner, 2001). In organizations today, knowledge management practices and technologies are being implemented and incorporated on the commonly held assumption that it will help bring about improved effectiveness, efficiency, and competitiveness. The underlying assumption is that knowledge management processes are always beneficial and that there are no negative consequences.

These notions of knowledge management fall short of enabling knowledge to be found and used. Duffy (2001) asserts that KM tools having the capability to mine complex and rich knowledge (both explicit and tacit knowledge) should be able to support KM activities within organizations as well as between geographically dispersed communities. But unfortunately, in reality Duffy's (2001) assertion falls short. Reasons for doing so have to do with but are not limited

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to the existence of multiple nomenclatures for the same term (Qureshi et al., 2006). Issues relating to widespread adoption of a KM tool or technology (Venkatesh et al., 2003) by knowledge workers are another consideration that plagues the KM field. An effective KM process or strategy should bring about shared understanding of both explicit as well as tacit knowledge. But a study by Cramton (2001) of collaboration among geographically dispersed people highlighted five types of problems for the failure of mutual knowledge (knowledge that people share and know that they share). The first problem is the failure to communicate and retain contextual information. Second, is the issue of unevenly distributed information. Third, is difficulty in understanding and sharing the salience of information. Fourth, are differences in speed of access to information and last but not the least, difficulty in interpreting the meaning of silence.

Keen and Tan (2006) define knowledge mobilization as the necessary extension of knowledge management. Qureshi and Keen (2005) highlight knowledge activation as a key component of such mobilization. Knowledge networking is the core set of processes that achieves this activation and mobilization. This definition will be used in the chapter to describe this ubiquitous but ill-understood concept. By contrast, knowledge management tends to focus on the supply side of the equation: infrastructure plus information. These are needed for large-scale mobilization but need to be explicitly deigned with that goal in mind. Hanna (2006), a leader in many World Bank ICT initiatives for development highlights inattention to the nature of effective use by communities as a continued weakness in their planning and design. To bring about development there is a need to have access to information and expertise. ICT can enable development processes to be achieved (Qureshi, 2005).

In order to develop an understanding of how knowledge networking takes place, an activation perspective is necessary in that it enables knowledge to be brought into action. Knowledge networking creates information and its exchange among talent pools. Qureshi and Keen (2005) suggest that knowledge activation is the "conversion of knowledge to action." This is central to the networking of knowledge between disparate groups and individuals. The main idea behind knowledge activation is the process of discovering people with pertinent knowledge and utilizing it effectively through their keenness to provide, access, and share it when the need arises.

This chapter draws upon the Qureshi and Keen (2005) study which has implications for knowledge networking as the notion of knowledge activation through knowledge identities in a networked environment. Knowledge activation thus enables improved knowledge networking among geographically dispersed communities and attempts to reduce the gap between the information- and expertise-rich communities and those that are and poor in these resources. In this chapter the concept of knowledge networking is developed and through the analysis of a selection of vignettes, it offers evidence as to how knowledge networking is enabling the digital divide to be overcome. This analysis uses the data reported in Qureshi et al. (2007) and offers a conceptual model through which further studies into knowledge networking can be informed.

2 Knowledge Networking

There is a sense that inter-organizational learning is needed for the transfer of knowledge. Churchman's (1971) concept of inquiring systems implies that in order for actions of an organization to result in the creation of knowledge, learning needs to take place with other organizations and even countries. Courtney et al. (1998) mention that through sharing associations, cognitive systems, and memories, organizational learning can take place. This notion signifies a heavy reliance on people and groups as enabling actors for knowledge transfer. In this, the need to network knowledge is important. A common trend in conducting business today has been in forming inter-organizational networks and a shift has occurred more toward the exchange of knowledge rather than tangible goods. In the process of such knowledge exchange there is a need for shared understanding between parties in the transaction. Swan et al. (2000) mention that Heath's (1994) "zones of meaning" can be seen to exist among corporate communities. These zones of meaning can be considered as mental models that organizations share amongst one another. In addition to this, the authors point out that there is also a need to consider differences in the network structure in terms of cultural knowledge between the different zones of meaning.

As much as knowledge creation is important, so is the issue of networking knowledge across organizational boundaries. A study by Boschma and Wal (2007) investigated a cluster of firms in the foot-ware district in the south of Italy, and showed that having strong ties to both local as well as non-local organizations is important for obtaining the necessary knowledge – both managerial as well as technical knowledge – to improve firm performance. The study's findings are interesting in that it disproves the traditional notion that an organization being simply geographically co-located within the same district as other firms will enable it to benefit from knowledge externalities. Boschma and Wal's (2007) study emphasizes the importance of building networks to facilitate knowledge transfer and highlights the importance of building non-local ties to improve overall business firm performance.

Cultural differences play an important part in knowledge networking. There are four institutional types with varying degrees of cultural knowledge embodiment as outlined by Boisot (1998). They are Bureaucracies, Markets, Clans, and Fiefs. According to the properties of each of these institutional types, Boisot (1998) highlights that the high degree of cultural knowledge sharing within clans and fiefs assists in exchanging knowledge between zones of meaning. Thus, it enables a corporation to "develop an organizational capacity that reaches beyond its corporate boundary" (Boisot, 1998). Swan et al. (2000) performed a case study on an inter-organizational network that was a mix of the clan and fief structures. Zones of meaning were not consciously developed but rather they cropped up as a product of discourse and repeated exchanges among the network participants leading to an understanding of shared context. The shared context gave way to activities to produce specific knowledge deliverables and so reinforcing the zones of meaning and enhancing network processes. The study performed by Swan et al. (2000) allows the possibility of viewing a corporate community as a knowledge network but it does not specify the enabling factors to extract both tacit and explicit knowledge from the network participants.

Schultze and Leidner (2002) investigated both the positive and negative consequences of knowledge management by extracting published research on this topic in six different IS journals within a span of 10 years and categorizing them into diverse theoretical lens or discourses such as normative, interpretive, critical, and dialogic. The findings from the study show that each of the four theoretical perspectives focuses on different aspects of knowledge management. Specifically, the normative discourse appears well suited to studying technology solutions to knowledge management problems. On the other hand, the interpretive discourse looks to understand the implementation and the organizational implications of knowledge management initiatives and technologies. The critical discourse views knowledge with respect to highlighting the social inequities underlying organizational stratifications. And last but not least, the dialogic discourse lends itself well to the examination of the contradictions in managing knowledge.

While a core process in the knowledge management field involves the creation of knowledge, the concept of knowledge networking enables the knowledge creation cycles to be activated. According to Nonaka and Konno (1998) new knowledge is created through the interaction between explicit (knowledge that can be expressed in words and numbers and shared in the form of data) and tacit (knowledge that is highly personal and hard to formalize, making it difficult to share with others) knowledge. Nonaka and Konno (1998) explain that there is a spiraling process that takes place as tacit and explicit knowledge interact, which gives rise to four knowledge conversion phases within an organization. The first phase is that of *Socialization*, which involves the sharing of tacit knowledge between individuals through joint activities such as simply being together, spending time and living in the same environment. The second phase is that of *Externalization*, which involves expressing tacit knowledge and its translations into comprehensible forms that can be understood by others. The next phase is that of *Combination*, which involves the conversion of explicit knowledge into more complex sets of explicit knowledge. In this phase, the core issues are communication and diffusion processes and the systemization of knowledge. The final phase is that of *Internalization*, where the internalization of newly created knowledge is the conversion of explicit knowledge into the organization's tacit knowledge. It is important to emphasize that the four phases mentioned above have a cyclical/spiral relationship and that they allow us to understand the "actualization of knowledge within social institutions" (Nonaka and Konno, 1998).

3 Overcoming the Digital Divide

The concept of the digital divide has been particularly pervasive in recent years because there is a sense that there is a gap between people who have access to ICTs and those who do not. There are various definitions to depict this divide. Servon (2002) points out that the Digital Divide is not simply a problem of access and that access is just one of the issues involved. Equally important aspects are those of IT literacy and content. The ability to use IT for a range of purposes and the knowledge of how and why IT can be used as a key resource is important in bridging the Digital Divide. In the same vein, content that meets the needs and demands of disenfranchised groups and content that is created by these groups are important considerations in narrowing the digital gap. Norris (2001) also describes the concept of the digital divide as a multidimensional phenomenon comprising of three distinct aspects. The *global divide* refers to the divergence of Internet access between industrialized and developing societies. The *social divide* concerns the gap between information rich and poor in each nation. And finally within the online community, the *democratic divide* signifies the difference between those who do, and do not, use the panoply of digital resources to engage, mobilize, and participate in public life. It appears that these global, social, and democratic gaps affect development. Traditional development literature suggests that there is a direct link between literacy, tertiary education enrollment, availability of personal computers and the digital divide (OECD, 2001).

However, a recent global study of the digital divide has illustrated that the gap is rapidly decreasing. The Sciadas reports (2003) studied the Digital Divide using three indicators, infodensity, info-use, and infostate. Infodensity refers to the portion of a country's overall capital and labor stocks, which are ICT capital and ICT labor stocks and indicative of productive capacity and is operationalized in the study through the measurements of available infrastructure/networks and ICT skills. Info-use refers to the consumption flows of ICTs and is operationalized through ICT uptake (uptake corresponds to ICT goods) and ICT intensity of use (intensity of use corresponds to ICT services). The third and final indicator is infostate, which is the aggregate of infodensity and info-use and is considered to be the degree of a country's "ICT-ization".

The report defines the Digital Divide as the relative difference in infostates among countries. The study utilized existing data on 192 countries for the measurements of networks (covering 99% of the population of the planet), 153 countries in skills and therefore Infodensity (covering 98% of the population), and 143 countries in Info-use and 139 in overall Infostate (covering more than 95% of the global population). Results from the extensive statistical analysis performed reveal that, as much as Infodensity and Info-use accounted almost equally for the existence of the Digital Divide, they also accounted almost equally for its closing. The numbers showed that on average, between 1996 and 2001, Infodensity increased approximately by 74% and Info-use by 87%. Additionally it was observed that ICT networks and uptake accounted for most of the growth and that mobile networks and the Internet were attributed to most of the gains.

This trend was more evident in the have-not countries than in the countries with higher Infostates. The core finding of the Sciadas study gives empirical evidence of the gradual progression of countries in closing the Digital Divide. Figure 1 below shows how individual factors contribute to the closing of the Digital Divide. The 192 countries in the study were categorized into five groups (A–E) and compared with a hypothetical country (Hypothetica) which recorded the average values for each of the indicators. It is clear from the chart that, much of the upward movement is accounted for by the use of the Internet, followed by mobile phones and Internet networks. The same factors that account the most for the Digital Divide are also the ones that move more in the direction of alleviating it. Another interesting finding – that contradicts so

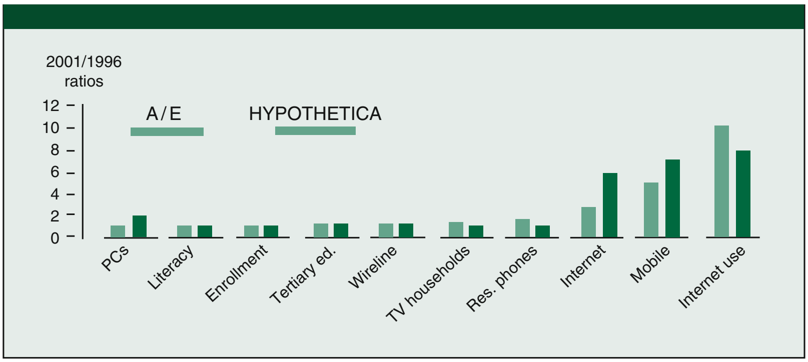

Fig. 1: Factors Contributing to the Closing the Digital Divide (Source: Sciadas Report, 2003)

many of conjectures in earlier Digital Divide studies – is that number of PCs and literacy do not play any significant role in contributing to the closing of the divide.

This suggests that there is a more powerful force affecting the ways in which the information highway is being used to bridge the development divide. Qureshi (2005) in an interpretive study of multiple cases investigated the relationships that might be in play as we talk about IT and its impact on development. Qureshi (2005) points out that positive cycles of development come about when the effects from ICT implementations with the help of better tools and techniques will result in increased human development as well as improved macro-economic growth. It is seen that this also results in increased per capital income which then creates a ripple effect for improved social and economic development. Warschauer (2003) provides a rather different focus on the interplay between ICTs and the development divide by examining the ways in which varying access to technology contributes to social and economic inclusion. This focus on social inclusion shifts the discussion of the Digital Divide from gaps to be overcome by providing equipment to social development challenges to be addressed through the effective integration of technology into communities, institutions, and societies. Warschauer (2003) thus emphasizes that what is most important is not so much the physical availability of computers and the Internet but rather people's ability to make use of technologies to engage in meaningful social practices.

It appears that the key challenge faced by knowledge networking processes is not so much the digital divide but the social divide. International development agencies have come to recognize and show concern of a social divide – digital divide within societies. The Internet has become increasingly central to life, work, and play by providing job opportunities, strengthening community networks and facilitating educational advancement. This suggests that the exclusion of certain groups and areas such as poorer neighborhoods, working-class households, or rural communities are more important than ever. According to Norris (2001), the social divide has a number of components. Norris (2001) identifies household income, occupation, education, gender, and generational differences to be the key factors in play when talking about the social divide in Internet access. She mentions that the heart of the problem of the social divide in Internet access "lies in broader patterns of socioeconomic stratification that influence the distribution of household consumer durables and participation in other common forms of ICTs, as well as in the digital world." Norris (2001) also goes onto say that it is not necessarily true that all dimensions of the social divide will automatically close as Internet access becomes more ubiquitous. Norris provides evidence from countries such as Sweden & the Netherlands where widespread new technologies exist but the gaps by education, income, and occupation still remain substantial.

A key component of the social divide is the development and access to social capital. Literature in the area of social capital has investigated the effects that it has on various segments of business activities and in the overall economy of communities. Some of the popular and widely used definitions in use today have been adapted from Bourdieu (1983) who refers to social capital as "the sum of the resources, actual or virtual, that accrue to an individual or a group of people by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition." Working off Bourdieu's definition of social capital, Coleman (1988) provides his perspective to the term by stating that "Social capital is defined by its function. It is not a single entity, but a variety of different entities, with two elements in common: they all consist in some aspect of social structures, and they facilitate certain actions of actors within the structure." Lin (2001) provides a definition for social capital which states that "social capital is the investment in social relations with expected returns in the marketplace."

It is evident from these different definitions that social capital refers to the characteristic of social interactions and networks that can provide value added resources to a society. Impacts of social capital can be broadly classified as (1) Getting information (Granovetter and Mark, 1973); (2) Transfer of knowledge, innovation, and diffusion of technology or practices (Ahuja, 2000; Brown and Duguid, 1991); (3) Combining complementary knowledge and helping solve problems (Greve and Salaff, 2001; Von Hippel, 1988); and (4) Brokerage (Burt, 2005).

In the context of world development, increasing importance of social capital is being recognized as a key component affecting the increase in incomes. Acknowledgement of its importance has also come from the Organization for Economic Co-operation & Development (OECD) and the World Bank: "Trust [social capital] has a role in facilitating productivity…when embodied in the organizational culture of firms…and may lead to larger and more effective production units…as well as enhanced co-operation within firms. Social capital can facilitate regional systems of innovation…helps people to find jobs" (OECD, 2001). Serageldin and Grootaert (2000) mention that, at any given time, every country has appropriate levels of social capital. And that over time the total composition of social capital should increase through accumulation. Steinmueller (2004) mentions that computer-mediated-communication and information and communications technologies may help communities of practice to have enhanced capabilities of global sourcing of knowledge and problem-solving activities resulting in greater social capital. Steinmuller goes on to say that the social networks of communities of practice, help extend knowledge markets. In addition he states that changes in communities of practice impacted by ICTs may have implications for growth, competitiveness, and employment. The paper by Steinmueller (2004) lays out a number of potential policy suggestions of how communities of practice may improve economic growth for regions. Gaved and Anderson (2006) in a similar study looked at the role of local ICT initiatives on networked communities in several countries in the European Union (EU). One of the key recommendations that come out from their study is the issue that the local ICT initiatives need to "go up the citizens' value chain" i.e., the chosen technology needs to address a community purpose in order for citizens within that community to utilize it. It is evident from the social capital literature that ICTs have a role to play in enhancing and promoting social capital within communities.

Knowledge networking brings about development by enabling people to connect using digital media. In order to develop an understanding of how knowledge networking takes place, an activation perspective is necessary in that it enables knowledge to be brought into action. Knowledge networking creates information and its exchange among talent pools. Qureshi and Keen (2005) suggest that knowledge activation is the "conversion of knowledge to action." This is central to the networking of knowledge between disparate groups and individuals. The main idea behind knowledge activation is the process of discovering people with pertinent knowledge and utilizing it effectively through their keenness to provide, access, and share it when the need arises. This requires collaboration among people in different parts of the world. The Qureshi and Keen (2005) study has important implications for knowledge networking as the notion of knowledge activation through knowledge identities in a networked environment will enable individual's knowledge to be brought into the collaborative arena. Knowledge activation thus enables improved knowledge networking among geographically dispersed communities and attempts to reduce the gap between the information- and expertise-rich communities and those that are poor in these resources. These processes are not only distributed, they are collaborative and are activated through a demand for action.

In addition, Queau (2002) argues that a new culture is emerging of ‘information literacy’ through online interactions comprised of visual representations and mental images that can potentially increase the disparities between people who are part of this culture in industrialized countries and those who are not, as well as within societies themselves. This has implications for the level of civic engagement and level of participation in knowledge networking (Norris, 2001; Giddens, 2003). And so there is a dire need to come up with ways that would help reduce the knowledge disparities among communities within and among developing and developed countries. International development agencies recognize that in order to bridge this divide between the information rich and information poor, knowledge networking needs to take place. Keen (2007) states that knowledge networking strategy is “one of accelerated development through pragmatic opportunism: its priority is to network two distinct groups: those looking for talent and aiming to source capabilities or products and services that their organizations need and those with talent looking for opportunities to find new spaces to apply their skills, build up their businesses and enrich their communities.” In Sect. 4 a methodology is developed to enable the key components of knowledge networking to be identified as they enable the digital divide to be overcome.

4 Methodology

In order to investigate knowledge networking, this chapter follows a phenomenological approach. This enables us to extract the key elements of knowledge networking from interactions carried out using electronic collaboration. This process involves the collection of vignettes and blogs from the Internet. This data represents the creation of shared understanding through inter-subjectivity. According to Weick, inter-subjectivity has two defining characteristics (1) it emerges from the interchange and synthesis of meanings among two or more communicating people and (2) the subject gets transformed during interaction such that a joint or merged subjectivity develops (Weick, 2001). The creation of the life world through processes of inter-subjectivity enable us to identify and explain certain behaviors, norms, and traditions that develop in the distributed work environments we investigate. When the social construction of reality governed by inter-subjectivity is controlled by language, according to Searle (1995), language is seen to be a tool of accessing each other’s life-world.

The selection of vignettes and blogs for this study was based on the following categorizations (1) impact on development, (2) conceptually relevant, (3) empirically predictive, and (4) having empirical coherence. In order to illustrate the effects of knowledge networking, vignettes were taken from articles and reports published on the World Wide Web and in books and articles. They reflect peoples’ experiences in very different sets of knowledge networking and development spirals. Popular search engines such as Google and Yahoo were utilized. Keywords used included, “knowledge networking,” “knowledge activation,” “impact of cell phones,” “poverty reduction,” “knowledge networking for development,” “Internet cafes,” “digital divide,” "developing countries," "African villages," and other terms relevant to the geography, demographics, and occupations of the target topic areas.

While the same criteria applied to blog selection. Relevant topics were selected from projects listed on the WSIS stock taking database to reflect knowledge networking aspects. These results are analyzed using a selection of transcripts that reflect comments, or vignettes from people interacting on the selected blogs. For each blog, the comments were then grouped into the basis of their comments as they related to the exchange of information, expertise and ideas. The vignettes and blogs are anecdotal and not part of any systematic survey or large-scale sampling. They do represent contours of a phenomenon that is increasingly ubiquitous but ill-understood.

5 Results and Analysis

Qureshi (2005) suggests that development activities are able to benefit from ICT implementations through (1) better access to information and expertise, (2) increased competitiveness and access to new markets including global markets, (3) administrative efficiencies from low transaction costs, (4) increase in labor productivity through learning, and (5) direct reduction in poverty. The analysis presented in this paper extends these factors to more explicitly address the payoffs from communication and conversation captured in the vignettes. These are the ICT effects on development.

Sustained economic growth helps break the shackles of poverty by first increasing average household incomes and second increasing income from individual and business tax revenues, which may lead to the provision of better services for the poor Qureshi (2005). When households below the poverty line share in the average rise in national income, the extent of extreme income poverty (that is, the share of people surviving on $1 a day) is directly reduced (UNDP, 2003). Such an upward spiral can also stimulate additional growth through factors such as foreign direct investments in factors of production. These are the positive effects on the cyclical process through which development can take place.

The following subsections illustrate the process of bringing distributed knowledge into action. This takes place through use of ICT to access information and expertise which brings about additional opportunities for development.

6 Knowledge Activation

Knowledge Activation is the enactment of an individual's expertise by bringing it into social interaction with other people (Qureshi and Keen, 2005). There is a sense that while the causes of the digital divide is not limited to access to technology, the real cause of this gap has to do with the concept of social inclusion or exclusion (Warschauer, 2003; Castells, 2000). According to Warschauer (2003), social inclusion refers to the extent that individuals, families and communities are able to fully participate in society and control their own destinies. Social inclusion is enabled by the existence of demand for knowledge that can be activated through knowledge networking. Communities on the Internet enable social inclusion to be achieved and sustained through the creation of social capital.

Transcript 1 illustrates the existence of social capital among the members of this village. The concept that the Internet can promote social capital has been shown to bring about more extensive social networks of support within and outside the geographic areas in which the participants reside (Warschauer, 2003).

Transcript 1: Seeking Travel Advice

> *dear fellows, i'm kind in need for information about life in nigeria in particular kano especially for lebanese living there or moving there on work purpose i need to know as much as u can on political situation, security, medical situation, insects and malaria, water, food, places to go to and anything u can do to support me.*

With the existence of high social capital, demand for knowledge can be activated spontaneously by people in the knowledge network. People in the community in Transcript 2 feel free to say and do as they wish; participants share and access information they need instantaneously and appear to have greater control of their lives. In her study of civic engagement on the Internet, Norris (2001) suggests that digital politics serves to engage the engaged.

Transcript 2: Bank Warning

> *I would like to tell u all that everyone has an account in saradar bank under 5000$ or under 5000000 l.l.... they r going to take 15000 l.l. or 10$ everymonth without knowledge...so please pay attention and let everybody know this message ....coz if u r not putting money in ur account...it will disappear....*

This is a "Virtual Village" in Lebanon ripe with discussions on politics (the cedar revolution), health, facts and personal discussions. Participants of this virtual village are members of the general public who access information and expertise on a range of subjects instantaneously.

Transcript 3 illustrates the different opportunities these virtual gatherings bring about. This has the potential for new opportunities to achieve growth in per capita incomes – as opportunities such as the one illustrated in transcript 3 come to fruition.

Transcript 3: Potential Employment Opportunities

> *I'm working on a project that could make job vacancies for about 25 mechanical engineers, here in lebanon, and anything with that result couldn't be nicer to do, anyway, among the info i need is the salaries of mechanical engineers, according to their experience in here, ….This project might be moved to INDIA, so wish me, and us all luck !!!! D.P*

Within this positive spiral of Internet use, this community portrays a clear sense of mutual support. This form of knowledge activation enables knowledge networking to become more pervasive and drive social and human development processes. Once initiated, this positive spiral enables income opportunities to be generated and thus economic development.

7 Information Literacy

A view from the human development world provides insight into how people experience ICTs and whether there is a negative spiral that is affecting their lives. A selection of transcripts from a number of blogs connected to Blog Africa give a sense of this human experience with ICTs in

Africa. Transcript 4 illustrates the stark reality of what is faced by an aid worker trying to educate orphans in Sudan.

Transcript 4: Part of Email from an Aid Worker in Darfur

The answers from the children living in Fata Borno were for me – very powerful. I asked them "if you had a million dinars what would you do with it?" they all said "buy food" – an uncomplicated, unselfish, very basic need. I asked "what do they think is the solution(s) to the problems in Darfur" – they said "collect and take away all of the guns" - precise, unpolitical, and astute. And, I asked them, "If I could deliver to the world a message from you – what would it be?" they said "that there is a camp in Fata Borno – we are here, do not forget us ..."

Many writers propose theories of how literacy can bridge the digital divides and have research to support this claimed link (Norris, 2001; Servon, 2002; Warschauer, 2003). However, when people are not free from poverty and do not have the opportunity to get out of it, implementation of ICTs may worsen the plight of the most disenfranchised. Information literacy appears to be developing but in the majority of the blogs viewed, the language and tone was not very conducive to the development of a community. The blogger in Transcript 5 is clearly frustrated by this development.

Transcript 5: Explosion of "Net Fanatics"

The explosion of local .Net fanatics continues but have you noticed the trend at dotnet.org.za of new bloggers not introducing themselves and instead just jumping headfirst into their first blog entry? Whats next? Elbows on the table? ;-) Welcome to the ZA blogging scene in any case :-D

Warschauer (2003) suggests that the value of information literacy stems not just from the use of a computer and the Internet but also from a broader information society, its ethics and norms.

8 Knowledge Networking of Talent Pools

The vignettes presented this far suggest that the key factors affecting the success of knowledge networking is the use of low cost technologies for conversation and communication. These technologies enable talent pools of comprising of experts, entrepreneurs, farmers and business people to be accessed and activated through communication. In particular, mobile phones enable these talent pools to be activated towards joint effect. The following Vignette 6 illustrates the activation of talent pools through knowledge networking.

Vignette 6: Benefits of Mobile Phones in Developing Countries

Some of the biggest benefits of cell phone use are going to the world's very poorest people, who cannot even afford to buy their own phone handset. A lively rental market is flourishing across the developing world. For instance, Grameen Phone now boasts more than 100,000 "phone ladies", who buy a handset (often with the help of a loan from a micro-finance institution such as Grameen Bank) and then rent out airtime. These women are forming an increasingly influential army of micro-entrepreneurs, a new focus of business activity in their villages. And they are providing potentially global connectivity to some of the world's least connected people. There are other benefits, and potential benefits, that may not be fully captured by GDP statistics. There is the psychological benefit of being able to talk to relatives living far away, for example. And there is enormous potential for mobile telephones to transform the efficiency of healthcare provision in poor countries. In Kenya and Tanzania, the African Medical and Research Foundation (AMREF) is using phones to allow patients in remote areas to be diagnosed by specialist doctors far away in AMREF's headquarters. Another *project has built a management structure based on mobile phones to enable doctors in AIDS clinics to monitor patients far away to ensure they are taking their drugs* (Source: "Access to mobile phones is rocketing, along with its impact on poverty", International Development Magazine. http://www.developments.org.uk/data/issue31/loose-talk.htm)

This shows talent pools at work. In many small villages, the inestimable phone ladies are well-known and are entrepreneurs with the micro-finance loans as venture capital. The lesson here that is mobile technology has changed the economics and risks of innovation. A cell phone is immediately usable, with no need for training, does not involve complex installation and operation, nor purchases of software and peripherals. This contrasts with the risks and complexity of PCs and even PDAs: the frequency with which they are unused or underused, obsolescence, and high initial purchase price can be readily observed. A second lesson is that it is communication and conversation that have driven the entire consumer market: from AOL's chat rooms to SMS and now to VOIP. The economics of communication has also changed to reflect this networking of talent pools as is illustrated in Vignette 7.

Vignette 7: Increased Communication in Africa

Since the base station in Funyula started up in 2005, three entrepreneurs have started public phone booths using landline-style handsets with mobile technology. At one booth, Yuanina Juma pulled a crumpled letter from her bag and punched in her husband's number. He is away working in the capital, Nairobi. "When are you coming back?" she asked, as her one-year-old son held on to her skirt. "You have to send me money, because I am broke." At another booth beside a bus shelter, Angelina Odhuor called her son-in-law, who works in a hospital in the Rift Valley region. "My daughter needs school fees," she told him. "Can you help us?" Queueing behind her, Evelyn Anyango waited to call her uncle in Uganda: "I am calling him to come because there is a funeral. My little sister died of malaria." In a culture where people travel long distances to find work, the mobile has become the most useful and ubiquitous piece of technology since the bicycle. Just as bicycles are used in rural Africa to transport bananas or paying passengers, the mobile is changing lives in ways unimagined in the developed world. It links distant families and allows the poor to communicate. (Source: Guardian special report on Africa. http://www.guardian.co.uk/hearafrica05/story/0,15756,1569470,00.html)

Mobile payments are likely to become a massive international industry as more and more workers leave countries such as the Philippines, Indonesia, and many parts of Africa and Latin America to work in Singapore, the U.S., Dubai and elsewhere. Currently, the fees charged by currency exchange services and firms such as Western Union are high, though falling rapidly. This has meant increased work opportunities for remote businessmen as is illustrated in Vignette 8.

Vignette 8: African Businessmen Happy with Improved Work Efficiency

The new technology has had a bigger impact on shopkeepers and tradesmen, who use it to keep in touch with suppliers and customers. "Before we got a signal here, I was doing five or six jobs a week" said electrician Isaac Kamande. "Now I'm doing 20 or 30 jobs a week. Before, people had to call the landline, which was not all that reliable. On rainy days, it goes off. Maybe there would be an emergency, but customers couldn't reach me - they had to send somebody with a message." (Source: Guardian special report on Africa. http://www.guardian.co.uk/hearafrica05/story/0,15756,1569470,00.html)

Vignette 8 depicts another talent pool at work. Much of the literature on ICT and economic development speaks as if all the poor are lifeless and lazy and that they need education before they can be brought into the knowledge economy. So many of the vignettes above signal the opposite: it is not an oxymoron to speak of poor entrepreneurs.

However, should ICT implementations not be appropriate to local needs, digital divides increase, and the reverse can occur and perpetuate a downward spiral. For example, lack of access to information or expertise brought about by the lack of access to information kiosks or inappropriate support for community networking, reduces the ability of a farmer or merchant to sell goods at the most favorable price, thus reducing income generated by their efforts. Given the costs of Internet access compared to income, only a small segment of the population have access to the Internet. Warschauer (2003) notes that the Internet can lead to a narrowing of social contact as there is no assurance that people will use it for either social interaction or information.

Similarly the implementation of information systems that intend to provide better access to government services and information can bring about administrative inefficiencies by locking out citizens that have no means or ability to use the information system. In the new global electronic economy, fund managers, banks, corporations as well as millions of individual investors can transfer vast amounts of capital from one side of the world to another at the click of a mouse. As they do so, they can destabilize what might seem like rock solid economies (Giddens, 2003).

Those who are negatively affected by the information system are considered Victims in this research and may comprise people, organizations and even entire regions or countries. The ending of textile import quota by the WTO in 2005 has seen massive growth for China and India, retailers and global supply chain service providers have used ICT to streamline their entire logistics and consumers have benefited from a 40% drop in the cost of clothing. Vietnam, Honduras and other countries in which textile manufacturing was one of the largest sources of employment have seen as much as 40% of their factories close in under a year.

Only talent pools can compensate for such disruptions and only knowledge networking can fuel their innovation. From that perspective, there is much encouraging news from the vignettes and many other such examples. The talent is there. And the interest in knowledge networking infrastructures is accelerating. Africa now has 5 million Internet subscribers with Internet cafés springing up in many urban areas (Steinberg, 2003).

9 Knowledge Networking for Development

In working towards bridging the digital divide, development may take place through social and economic aspects needed within a country. Qureshi (2005) provides a socio-economic model of development. This model of development identifies social development by delineating the key areas in which its activities are most common: government, healthcare, the environment, and education. The social perspective enables development to be investigated as a product of human activity systems. The socio-economic model of development also incorporates economic development through financing in the form of loans, aid and/or trade agreements, the use of knowledge and expertise for innovation and the sourcing of raw materials, goods and services needed for production. These in turn may create an impact on public policy, education, and healthcare.

In order to for knowledge networking to enable development to take place, the knowledge needs to be activated. Activation of knowledge involves bringing knowledge into action. The knowledge activation framework proposed by Qureshi and Keen (2005) suggests that the demand for knowledge within a network is driven by knowledge "identities" that determine the willingness of people to communicate and share. They have many incentives to share their accountable knowledge, which is part of their responsibility and position. They are less likely to share their discretionary and autonomous knowledge, which is personal and in many instances carefully guarded. Knowledge networking processes are initiated through processes of collaboration (existence of shared spaces and support for the activation of accountable knowledge, reciprocity and relationship for activation of discretionary knowledge, and trust and personalization for activation of autonomous knowledge). The following Vignette 9 illustrates how this process takes place.

Vignette 9: Mobile Phones to Help Fight Poverty in Africa

> *Daniel Mashva heaves his sack of cabbages and sweet potatoes into a rickety shared taxi and travels nine hours under the scorching sun to the market in Johannesburg. By the time he arrives, half his tiny harvest is rotten and the 48-year-old father of five returns to his impoverished village just a few pennies richer. That was before new cell phone technology changed his life. Mashva now dials up to a virtual trading platform on his new high-tech phone and sells his produce direct from his small thatched hut on the fringe of the vast Kruger National Park. "I check the prices for the day on my phone and when it's a good price I sell," he told reporters from his village in the remote Northeast of South Africa. "I can even try to ask for a higher price if I see there are lots of buyers." Mashva is one of around 100 farmers in Makuleke testing cell phone technology that gives small rural farmers access to national markets via the Internet, putting them on a footing with bigger players and boosting profits by at least 30 percent.* (Source: Zee News http://www.zeenews.com/znnew/articles.asp?rep=2&aid=292033&sid=ZNS)

This behavior reinforces the points made by that what drives innovation in underdeveloped economies are talent pools – people such as Mr. Mashva who are able to make the connection between new tools at hand and their own growth via knowledge networks. Such use of mobile phones for the activation of dispersed knowledge to enable knowledge networking is bringing about economic development on a larger scale. Vignette 10 illustrates this impact.

Vignette 10: Mobile Phone Boom Spurs Bangladesh's Economic Growth

> *"The mobile phone industry in Bangladesh employs 237,900 people directly and indirectly. These are well-paid jobs with salaries many times the national average," said the study by the international consultancy firm Ovum. The study commissioned by the GSM Association (GSMA), a global industry body of 690 operators, found that the mobile services industry contributed 650 million dollars to Bangladesh's GDP annually. Analysts say the boom will continue amid falling mobile phone prices. Last year alone call charges fell by 30 percent, injecting faster growth to the industry. Over seven percent of the population now has a mobile phone, up from a mere 0.2 per cent four years ago, the study said, describing the growth as "extraordinary". Due to huge investment by operators, mobile phone coverage now has been extended to 90 percent of the country, it added.* (Source: http://news.yahoo.com/s/afp/20060510/tc_afp/bangladeshtelecomstudy)

This vignette illustrates a trend in developed nations whose implications for other nations is easy to overlook: the commoditization of what was previously "high tech" but is now consumer electronics and the corresponding commoditization of many jobs that previously were "high knowledge" in the sense that they demanded advanced levels of education and were very specialized. The more that mobile phones, PDAs, PCs and Internet-based services become commodities, the greater the expansion of their use and of the jobs that surround that use. Katmandu offers good, low cost Internet service and Bangladesh has after decades of failure to grow employment added a billion dollars a year to its economy plus several hundred thousand jobs.

In developed economies, this commoditization is very much a threat, cutting margins for companies such as Sun, Dell, Sony, and HP and leading to the outsourcing of more and more jobs to locations such as Bangladesh. Exploiting technology commoditization has added half a billion dollars to its economy and taken away far more than that from these and other firms' profits. Historically, nations have tended to assume that they should move to the high end of the knowledge economy, as Taiwan and Singapore have so successfully done. Europe and Japan launched multi-billion dollar programs with such lofty titles as The Fifth Generation and Esprit, all of which generated limited value. This vignette may be summarized as "the more you commoditize high technology, the more people who can afford it and the more the jobs that creates and the larger the knowledge network."

A very common scenario is apparent in organizations: having less time available for us to grow comfortable in our own knowledge while needing to generate more knowledge. It is becoming extremely challenging and difficult, even within narrow technical professions, to stay current and updated. For example, consider today's medical profession where, despite having formal education, doctors are frequently "taught" by their patients, who have more time to review massive amounts of data related to their specific medical concern. Even more so, as we move into a knowledge-intensive economy, only rarely does any one person have sufficient knowledge to solve increasingly ambiguous and complex problems.

The following vignette is an ideal example of circumstances frequently heard when managers and executives are asked to narrate how they obtained information critical to the success of an important project. This person was successful, not solely as a result of his own knowledge, but rather as a product of being able to find and apply relevant information efficiently. And of notable importance is the role that his network played in helping him locate knowledge in a timely fashion.

Vignette 11: How Employees obtained Information Critical to the Success of an Important Project

> *"So the call came in late on Thursday afternoon and right away, I wished I hadn't answered the phone. We had received a last-second opportunity to bid on a sizable piece of work that the partner on the other end of the line really wanted to pursue. Unfortunately, I had little experience in the subject matter but happened to be the one with availability at the time. I had no clue how to even begin looking for relevant methodologies or case examples, so my first move was to tap into my network to find some relevant info and leads to other people or databases. And in fact, I relied pretty heavily on this group of people over the next couple of days. For example, Seth was great for pointing me to other people and relevant information, Paul provided ideas on the technical content of the project while Jeff really helped in showing me how to frame the client's issues in ways that we could sell. He also helped navigate and get buy-in from the client, given his knowledge of their operations and politics. And somehow in this process, we managed to pull it off…I mean the whole game is just being the person that can get the client what they need with the company's resources behind you. This almost always seems to mean knowing who knows what and figuring out a way to bring their knowledge to bear on your client's issue. Knowing who to turn to for what is ultimately the key to doing what you need to do quickly so you can go home to your family"* (Cross et al., 2002)

It is becoming clear that we are seeing a subtle but consistent shift in how we work. This is a collaboration component that pervades knowledge networking and is a key driver for development activities. Such virtual teams have become more pervasive than ever before and enable bridges to be build across different regions. It has now become easier to communicate than to cut oneself off from such knowledge networking as that described in this example.

With knowledge networking there is a shift to an etiquette that you can contact anyone as long as there is a legitimate knowledge networking need. People do not see this as an "intrusion" and it is routine to reference a colleague in explaining the reason for making the knowledge networking request.

10 A Knowledge Networking Model

The above analysis suggests that knowledge networking enables the digital divide to be overcome by activating geographically dispersed talent pools. These talent pools benefit from the activation and enable income to be generated by enabling new markets to be accessed and administrative efficiencies to be achieved. In order for this cycle to enable knowledge networking to be effective, information literacy needs to be continuously developed. The greater the ability of individuals to communicate and understand electronic communication, the more they can engage in activating knowledge. This cycle of knowledge networking enables the digital divide to be overcome by narrowing the gap between information rich and information poor people by bringing together these dispersed knowledge resources to bear on the knowledge. The vignettes have illustrated how knowledge networking can be successful by enabling people and businesses to access new markets, use information they would otherwise not have, achieve administrative efficiencies and enable diverse talent pools to be accessed. When knowledge networking processes are able to transcend the social divide, businesses are able to make decisions relating to the sourcing of global capabilities (Keen and Qureshi 2006). This has a direct effect on the ability of these businesses to innovate, access and hire needed talent. This increases incomes and enables further sourcing of talent from these regions as is illustrated in Fig. 2.

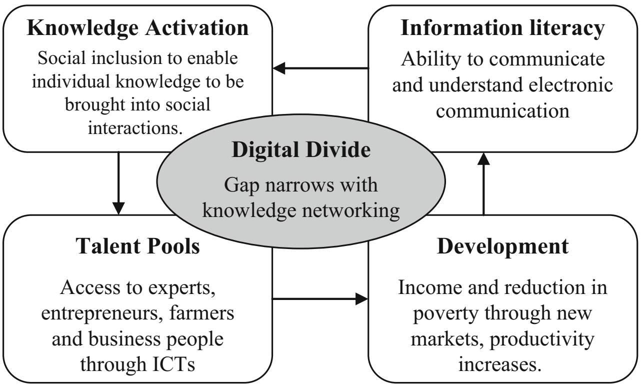

Fig. 2: Knowledge Networking Model

It appears that while the benefits of knowledge networking are many, these can be best reaped by bridging the social divides. Castells (2000) is notable in his description of globalization to be fueled by information technology in what characterizes this current technological revolution is not the centrality of knowledge and information but the application of this knowledge and information to knowledge generating and information processing devices. This forms a cumulative feedback loop between innovation and the uses of innovation. This feedback loop can enable decisions to be made that enable ICTs to be used to bring about increases in incomes and better livelihoods. The Internet can promote social capital and has been shown to bring about more extensive social networks of support within and outside the geographic areas in which the participants reside (Warschauer, 2003).

The results of this research suggest that through knowledge networking, farmers, small business entrepreneurs, students and NGOs are able to access new markets, use information that they otherwise would not have access to, access talent pools and get help with running their activities more effectively and efficiently. This form of distributed decision making has a direct effect on the ability of these people to increase their incomes. However the ability to achieve these gains through knowledge networking depends upon the social divide. The greater the social divide the more difficult it becomes to source global capabilities and participate in the industries that provide special services, assembly of low cost products, outsourcing and even creative communities. This suggests that through knowledge networking organizations are able to make decisions that enable them to source talent, goods and services from regions that provide the lowest cost burden.

11 Implications for Knowledge Networking

The discussion thus far has illustrated how knowledge networking is a process that can foster development by affecting human, social, and economic development. Through the activation of geographically dispersed knowledge, human freedoms and civil engagement, social capital and inclusion, and opportunities for sourcing expertise and innovations can be achieved. This process can lead to positive spirals that enable the digital divide to be bridged or negative spirals in which ICTs may exacerbate existing gaps in poverty, information literacy and facilitate social exclusion. This has implications for the way in which the digital divides are addressed and approaches that can be used to overcome them. These are outlined as follows:

1. Low cost communications technology, in particular, mobile phones, and payment systems enable talent pools to be activated. Information systems that address knowledge networking should address credibility, validity, accuracy, and recourse.
2. Information literacy is needed to enable people to reap the benefits of digital infrastructures. There is a demand function at work in knowledge networking whereby people with limited education, poor information literacy and in many instances isolation from the mainstream of the modern economy none the less apprehend the opportunity for themselves to make a significant improvement in their lives.
3. The collaboration component is driven by the need to access dispersed talent. This need is fueling the use of ICT for the development of virtual teamwork which spans developed and developing countries.

4. The activation of knowledge is particularly prevalent in established communities in which social capital is high. Fostering social inclusion brings about a readiness with which people share information and a sense of civic engagement. These high activation communities also generate opportunities for economic development.
5. The existence of talent pools drive networking between people and in doing so extend the reach and impact of their knowledge generation, mobilization, use, and impact. This suggests that governance mechanisms are needed to protect intellectual property and promote ethical conduct in the use of dispersed talent.
6. Information architectures are needed that foster activation of knowledge and the development of knowledge networks. In particular, semantic Web searching tools would bring knowledge in talent pools into action and mitigate the development of knowledge networks. Such architecture should address knowledge sources rather than information in databases.

The above implications point to a set of guidelines that may enable bridges to be built across the digital divide. This also suggests that further research is needed into the ways in which knowledge networking infrastructures may be developed to activate and protect dispersed talent pools.

12 Conclusions

The sourcing of knowledge and skills from developing countries has hastened the need to share dispersed knowledge. This paper has illustrated the need for knowledge networking and produced a model through which organizations in the developed world are able to source the skills they need from developing countries. Following an analysis of knowledge networking, this research has illustrated how knowledge networking can enable development to take place by bringing about positive cycles that enable the digital divide to be bridged. Knowledge networking can also reduce development by bringing about negative communication cycles. Armed with insight of knowledge networking, further research should investigate approaches for stimulating positive development cycles through knowledge networking.

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Evaluating KMS Effectiveness for Decision Support: Preliminary Results

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Abstract. This study evaluated the effectiveness of two knowledge management systems (KMS) for supporting individual decision makers in a predictive judgment task. The systems differed with respect to the way the technology was used to assist knowledge utilisation during the judgment process. The informating white-box KMS brought together relevant know-what and know-how in the form conducive to human consumption. The automating black-box KMS embedded codified knowledge within the software and automated its application. The preliminary results obtained from two contexts are mixed and suggest the contingent nature of KMS effectiveness on organisational identification.

Keywords: Knowledge Management Systems (KMS), KMS Design, KMS Effectiveness, Decision Making, Decision Support, Experiment

1 Introduction

Today organisations require improved managerial decision making capabilities more than ever before in order to meet the new challenges coming from accelerated technological development, global competition and knowledge-based economy. Knowledge management systems (KMS) are an emerging class of information systems (IS) that target managerial work by focusing on creating, transferring and applying an organisation's knowledge for decision support.

Given that KMS are the most recent organisational trend, little research and insight currently exists to guide the successful development and implementation of such systems. Some reviewers identified the existing body of knowledge on KMS as consisting primarily of general and conceptual principles and case descriptions of such systems in a handful of organisations (Alavi and Leidner, 2002). Others commented on many unresolved issues, challenges and opportunities for researchers in the domain of KMS (Sambamurthy and Subramani, 2005).

The goal of this exploratory study is to contribute an improved understanding of the value of KMS from the perspective of individual decision makers involved in time series forecasting. More specifically, the study examines empirically two KMS that use different approaches and technologies to build the system and incorporate knowledge domains, and identifies their benefits and limitations in improving the decision makers' performance. Some preliminary results are reported elsewhere (Handzic, 2007) and extended in the current report.

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The paper is organised into six sections beginning with this introduction. The next section reviews relevant literature on decision making and knowledge management (KM). It is followed by the description of two KMS under investigation. The subsequent section presents the empirical study details, while the penultimate one discusses the main findings and their implications. The final section closes the paper with the concluding comments.

2 Literature Review

The need to improve decision making is a longstanding concern in decision support research. KM is the latest management innovation promising to deliver significant benefits. This section reviews representative literature on issues and challenges facing decision makers and KM trends and solutions addressing these problems.

2.1 Decision Making

Decision making can be viewed as a dynamic and iterative process comprising: (1) identification phase, which involves decision problem recognition and diagnosis activities; (2) development phase, which concerns search and design activities; and (3) selection phase, which comprises screening, evaluation and authorisation activities (Mintzberg et al., 1976). The quality of the subsequent decisions will depend on the nature of the preceding diagnostic, design and selection activities.

There is a considerable body of evidence indicating that people systematically deviate from rational decision making. Such deviations are termed "decision biases" and are described as cognitions or mental behaviours that prejudice decision quality (Arnott, 2002). The variety of biases documented in behavioural decision literature include: memory, statistics, confidence, adjustment, presentation and situation related biases. Most decision biases tend to cause poor decision outcomes. Therefore they are of concern to designers of support systems that aim to facilitate and improve decision makers' task performance.

Of particular interest to this study are biases that people experience in combining multiple decision cues into single judgmental responses. The problem of combination could be due to misperception and/or misaggregation (Lim and O'Connor, 1996). With respect of misperception, the literature shows that people lack the ability to correctly interpret the predictive quality (weight) of the cues. Both tendencies to overestimate unimportant and underestimate important cues have been identified. With respect to misaggregation, the literature indicates that people have difficulties in performing mental calculations when combining multiple cues due to cognitive overload.

2.2 Knowledge Management

KM offers a promising new approach to reducing or eliminating biases from the cognitive strategies of a decision maker. Assuming that the decision maker is the primary source of the biased judgement (Fischhoff, 1982), our attention is focused on how to better manage the decision maker's knowledge. Two main trends are distinguishable in terms of this support. One trend prescribes a set of social and structural mechanisms to create an enabling environment for knowledge development, transfer and application (Holsapple, 2003). The other one focuses on the use of information and communication technology (ICT) as tools to facilitate management of knowledge processes (Handzic, 2004). Usually, these ICT based systems are referred to as KMS.

KMS are diverse and include a wide range of technologies coupled with methodologies that allow users to acquire, share and utilise knowledge that they can benefit from (Barnes, 2002). Popular claims for KMS include that they offer organisations the ability to be more innovative as well as improving decision making and productivity. The literature provides a considerable theoretical support for suggesting that the potential return from leveraging knowledge can be enormous - if KMS are properly designed and implemented (Alavi and Leidner, 2001). However, there is little empirical evidence regarding the actual impact of these initiatives on working knowledge and performance.

The challenging nature of the issue prompted this study to address the existing gap between theory and practice by providing some empirical evidence regarding the potential and limitations of different KMS to assist decision making in time series forecasting. It is expected that the empirical findings will lead to insights that will help guide more successful KMS initiatives in practice. In addition, it is hoped that the findings will help provide directions for further research in the area.

3 KMS Description

Various KMS implementations provide differing levels of support in locating, extracting and utilizing organisational knowledge and impose differing burdens to their users. Managers need to carefully consider choices that are available to them when selecting specific technologies for building KMS for the purpose of supporting decision making. In this section, two broad approaches to KMS are described that differ in how they deal with cognitive limitations and assist decision making of individuals.

3.1 Automating Black-Box KMS

One distinctive approach to KMS focuses on "automating" knowledge processes. Essentially, automating involves the use of "smart" systems that apply knowledge to solve problems for, and instead of, humans (Zuboff, 1988). Typically, such systems can reason in a narrow domain and in a relatively mechanistic way (Becerra-Fernandez et al., 2004). Examples of popular systems in this category include those that can facilitate activities of direction and routines. Other well known examples are knowledge based systems in the form of intelligent decision support and rule-based or case-based expert systems. These were devised as problem solving systems long before the term KM became popular (Hasan, 2003). Neural networks are another significant development by Artificial Intelligence (AI) researchers featuring the ability to learn from noisy, distorted or incomplete data (Glorfeld and Hardgrave, 1996).

Of special interest to this study is a specific form of automating KMS – knowledge aggregation tool - that mechanically combines multiple knowledge cues into a single judgemental response. Essentially, the tool embodies the optimal decision rule and automates the use of the embedded knowledge on the task. It is argued that the provision of such a tool may help alleviate or even completely eliminate negative effects of misaggregation bias. In general, computers are considered to be better than people in making complex calculations and making calculations rapidly and accurately (Stair and Reynolds, 2003). However, despite benefits offered by these systems they are not free from criticism. Some scholars warn that replacing people with machines may have important ethical implications. Most AI systems are of the "black-box" kind. This means that the tool produces conclusions without any explanation and justification of the reasons behind such conclusions. Consequently, it may have a detrimental effect on decision makers' working knowledge. In general, past surveys reveal poor corporate use of software in forecasting (Sanders and Manrodt, 2003).

In the current investigation, the representation of the automating "black-box" KMS is as a series of output forecasts from the knowledge aggregation tool shown in Fig. 1. In theory, the optimal decision rule embedded in software allows superior knowledge application of domain-specific knowledge and enables best possible decision performance. It also reduces the cognitive load of application of that knowledge. The question is whether it will be an effective strategy for assisting decision making in practice.

3.2 Informating White-Box KMS

An alternative approach to KMS focuses on "informating" and guiding rather than "automating" knowledge work. The term originally coined by Zuboff (1988) refers to organising and presenting knowledge to users in ways that would enhance their interpretation of the available knowledge and thus enable them to apply it more effectively in solving problems (O'Leary, 2003). Such an approach can be considered as a "white-box" kind of approach to managing knowledge. It may be quite relevant to practice given the identified preference of heads over models in judgment (Dalrymple, 1987). A stream of research on system explanations strongly suggests the usefulness of providing explicit terminological, tracing, control and/or justification support for the knowledge offered. Gregor and Benbasat (1999) found that suitably designed system explanations that conformed to Toulmin's model of argumentation and provided to users in an unobtrusive way resulted in improved performance, learning and positive perceptions of a system. Similarly, recent empirical studies on knowledge mapping reported beneficial effects of initiatives such as competency and procedural knowledge maps (Handzic, 2004).

The focus of this study is on yet another potentially useful informating KMS - knowledge weighting tool - that offers users an explicit analysis of decision cues weights by which they are manipulated to address the task. It is argued that the provision of such a KM tool may help alleviate negative effects of misperception bias. In addition, such a white-box approach to KMS may help increase people's "trust" and reliance on helpful decision aids. Empirical evidence from recent knowledge tagging and content rating studies (Shanks, 2001; Poston and Speier, 2005) also hints that such a tool may enhance users' working knowledge and performance.

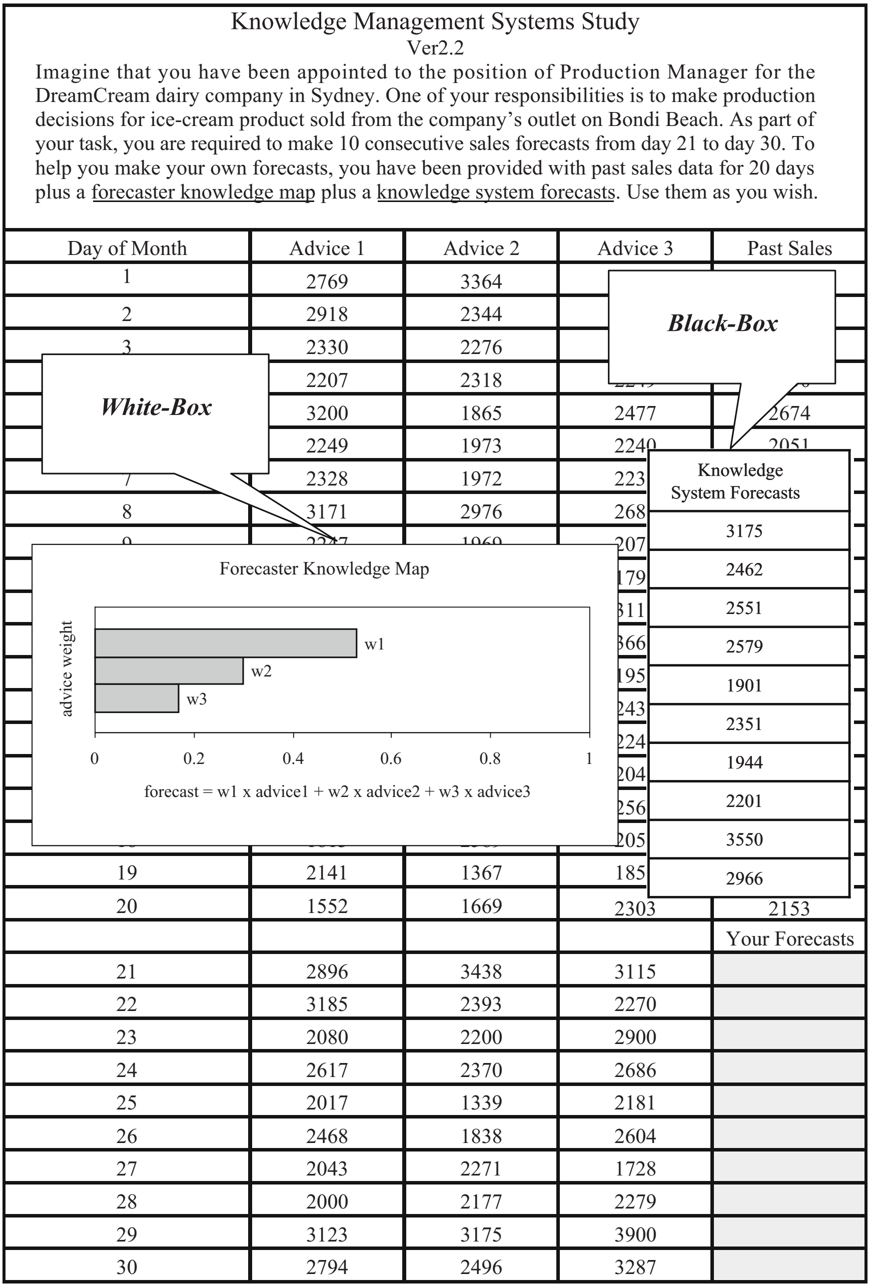

Fig. 1: A sample screen layout of the research instrument

For the purpose of the current investigation, the representation of the informating "white-box" KMS in Fig. 1 is as a graphical image incorporating a bar-chart of the relevant cues weights produced by the knowledge weighting tool and a formula for the related additive decision rule. In this way, the tool brings together all the necessary know-what and know-how which allows decision makers to construct theoretically optimal decision responses. The question is whether and how effective such support will be in debiasing their decision strategies in practice.

4 KMS Evaluation

In view of the prior findings and concerns expressed, the main objective of the current study was to determine the nature of assistance, the extent of assistance and the limitations of the above two KMS in supporting managerial decision making. In particular, the study examined: (1) whether and how much of the available KMS potential was used by decision makers and (2) whether and how it improved the quality of their decisions in a specific judgemental decision making task.

4.1 Research Instrument

For the purpose of facilitating current investigation, a simple simulation game was developed in Microsoft Excel as a multipurpose research instrument. It incorporated: (1) experimental task simulator, (2) KMS as a decision-aiding component and (3) data collection component. The screen layout of the research instrument is presented in Fig. 1.

The experimental task was a simulated production planning activity in which subjects assumed the role of Production Manager for an imaginary firm and made decisions regarding daily production of a perishable product. The company incurred equally costly losses if production was set too low (due to loss of market to the competition) or too high (by spoilage of unsold product). The participants' goal was to minimise the costs incurred by incorrect production decisions. During the experiment, participants were asked at the end of each day to set production quotas for the product to be sold the following day. Subjects were required to make ten production decisions over a period of ten consecutive simulated days.

All participants, irrespective of the KMS treatment, had access to past product demand data and advice from three different sales persons. Advice time series were artificially generated with relative weights set to 0.53, 0.30 and 0.17 to provide varying predictive power. The optimal decision strategy was derived by using a linear regression model with three cues as independent, and product demand as dependent, variables in the equation. The optimal cue weights yielded minimal expected decision errors.

The task differed with respect to the availability and form of KMS received as a decision-aiding component. One third of the subjects received no KMS support. The other third was provided with a "black-box" KMS (see Fig. 1) that automatically combined multiple cues and presented output decisions without giving users any explicit analysis of the quality of the available decision cues, or the rule applied to translate them into specific decisions. The remaining third received a "white-box" KMS (see Fig. 1) providing them with the explicit analysis of the quality of the available decision cues, and the rule applied to translate them into specific decisions.

All treatments enabled equally accurate optimal decisions. Subjects were free to use the available support as much or as little as they wished to.

In addition, task descriptions were provided to inform subjects about the task scenario and requirements. The given text differed with respect to the KMS treatment received. Performance feedback was omitted in order to increase the subjects' reliance on helpful tools as suggested by Arkes et al. (1986).

Finally, the research instrument recorded actual decisions made by individuals. However, it should be noted here that printed versions (screen shots) of the instrument were used for the experiments reported in this paper for the convenience reasons. These records were saved in separate files for each subject and treatment for later analysis. They were used as primary source for the analysis of KMS utilisation and effectiveness.

4.2 Research Design and Variables

A laboratory experiment with random assignment to treatment groups was chosen for the study due to high controllability. This made it possible to draw stronger inferences about causal relationships between variables. The experimental design was a single factor design, with KMS as the only between-subjects factor.

The manipulation of different KMS groups was achieved by changing the availability and the form of system support provided to the participants. In the "control (unaided)" group, participants were provided with the experimental task time series data only. The "black-box" group participants were provided with the additional system-recommended decisions. The intension was to create a condition for eliminating cognitive biases by reducing reliance on human judgment. The "white-box" group of subjects was provided with the additional relative importance weights of decision cues with the related integration formula. The intention here was to create a situation where knowledge is organised and presented for human consumption in a way that would help eliminate biases from the cognitive strategies of a human decision maker. In addition, the "optimal (nominal)" group was formed from imaginary decision makers who made their decisions by using optimal (linear regression) decision strategy and produced theoretically minimal decision errors.

The subjects' performance was evaluated in terms of *decision accuracy* operationalised by absolute percentage error (APE) as suggested by Makridakis (1993). APE was obtained by computing the subjects' absolute error (i.e. difference between forecasted and actual product demand), then dividing the absolute error by the corresponding actual value (i.e., actual product demand) and multiplying by 100%. In addition, ratios of optimal to subjects' scores were calculated to assess *system utilisation*, that is, how much of the maximum KMS potential was used by the experimental subjects in making their decisions.

4.3 Subjects and Procedure

The subjects were drawn from a pool of graduate students enrolled in Master or Doctoral courses in IS at two large Australian universities. Twenty-seven students from the University of New South Wales (UNSW) and eighteen students from the Australian National University (ANU) participated in two separate experiments on a voluntary basis. They had no prior knowledge of the task and received no monetary incentives for their performance. Generally, graduate students are considered to be appropriate subjects for this type of research (Ashton and Kramer, 1980; Remus, 1996; Whitecotton, 1996).

The experiments were conducted as part of the author's guest lecture and workshop on KM at these two universities. The same procedure was followed in both sessions. Subjects were assigned randomly to one of the three treatment groups by picking up an appropriate version of the research instrument to be used. Subjects were briefed about the purpose of the study, read the case descriptions and then performed ten decision tasks each. In this way, 90 decisions per group were collected at UNSW and 60 at ANU for the analysis purposes. Each session lasted about half an hour.

The collected data was analysed statistically using a series of t-tests to examine the effects of two different KMS on subjects' decision accuracy, and to compare it with that of their unsupported and nominal optimal counterparts. Since four groups in each experiment were equal in size there was no need to perform any normality test on data (Huck et al., 1974).

5 Results and Discussion

The expectation was that KMS would have positive effects on subjects' decision accuracy in the predictive decision making task performed. It was believed that the white-box and the black-box system would help reduce decision biases of misperception and misaggregation and improve performance. The summary results of two experiments presented in Tables 1 and 2 provide mixed support for such contention.

Table 1: Summary results of *t* tests for absolute percentage error (APE)

	UNSW			ANU		
Score	df	*t*	Sig.	df	*t*	Sig.
Black-box vs. control	178	0.674	0.501	118	−2.232	**0.027**
White-box vs. control	178	−1.998	**0.047**	118	−1.101	0.273
Black-box vs. white-box	–	–	–	118	−2.185	**0.031**
White-box vs. black-box	178	−2.382	**0.018**	–	–	–
Black-box vs. optimal	–	–	–	118	1.033	0.304
White-box vs. optimal	178	2.400	**0.017**	–	–	–

Boldface indicates significant differences between groups at 0.05 level

Table 2: Means (and standard deviations) of APE (in %) by treatment groups

	UNSW			ANU		
Group	*N*	Mean	(Std. dev)	*N*	Mean	(Std. dev)
Control (unaided)	90	9.82	(7.99)	60	12.96	(20.29)
Black-box	90	10.76	(10.48)	60	6.84	(6.35)
White-box	90	7.70	(6.09)	60	9.76	(8.26)
Optimal (nominal)	90	5.81	(4.35)	60	5.81	(4.35)

5.1 UNSW Results

In the case of UNSW, the results in Table 1 show no significant change in decision accuracy due to the black-box type of KMS. The subjects provided with the black-box system made similarly high decision errors as those without any system support (10.76 vs. 9.82, ns). Similar errors suggest low (if any) reliance and use of the available system. In contrast, the mean error of the subjects supported with the white-box system was significantly smaller than that of their unsupported counterparts (7.70 vs. 9.82, $p<0.05$). Smaller errors indicated that the "opening" of the black box had a significant positive effect on the decision makers' reliance and use of the system support provided.

As visible from Fig. 2, the white-box subjects managed to utilise about three quarters (75%) of their system's maximum potential to improve performance. This is compared to only about one half (54%) for the black-box subjects. Higher levels of system utilisation resulted in significantly smaller errors made by the white-box subjects than by their black-box counterparts (7.70 vs. 10.76, $p<0.05$). However, the results show that these subjects failed to reach optimal decision performance. The mean error of the white-box subjects was significantly higher than that of their nominal optimal counterparts (7.70 vs. 5.81, $p<0.05$). This indicates a lot of room for further improvement.

5.2 ANU Results

With respect to ANU, the results of the analyses performed portray a very different picture. As shown in Table 1, no significant change was found in subjects' performance due to the white-box system, but instead there was a highly positive impact of the black-box system. The subjects provided with the white-box system made similarly high decision errors as those without any KMS support (9.76 vs. 12.96, ns). Such result is consistent with low reliance and use of the available system. Contrary to this, the mean error of the subjects supported with the black-box system was

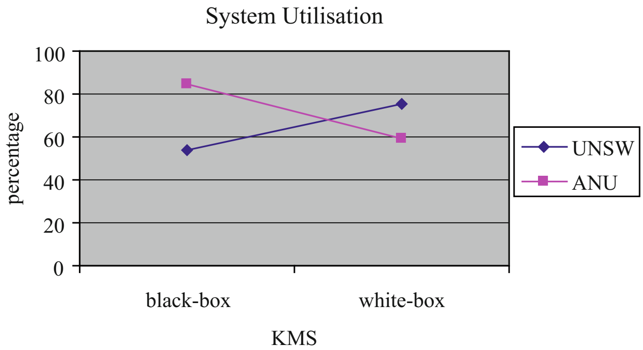

Fig. 2: Summary results for system utilisation by context

significantly smaller than that of their unaided counterparts (6.84 vs. 12.96, $p<0.05$). Smaller errors indicated that trusting of the smart system had a significant positive effect on the subjects' reliance and use of the system support provided.

Figure 2 shows that the black-box subjects utilised almost all (85%) of their system's potential, compared to only about one half (59%) in the case of their white-box counterparts. As a result, they made significantly smaller decision errors (6.84 vs. 9.76, $p<0.05$). More importantly, they also managed to achieve optimal performance. The mean error of the subjects supported by the black-box KMS was slightly but not significantly higher than that of their nominal optimal counterparts (6.84 vs. 5.81, ns).

5.3 Discussion of Main Findings

In summary, the main findings of the study indicate different patterns of utilisation and performance for two KMS (white-box and black-box) in two contexts (UNSW and ANU). The white-box system was found to be more beneficial to UNSW participants and the black-box system appeared to be more useful to ANU subjects. This suggests the contingency nature of KMS effectiveness upon context. This is consistent with the proposition of the Handzic's (2004) integrated KM framework that various task, environment and person related factors influence the choices of KM solutions. One possible contextual factor, namely "organisational identification", could potentially explain differences found in the current study.

Organisational identification refers to the degree to which members define themselves by the same attributes that they believe define their organisation's identity (Ravishankar and Pan, 2008). Based on the author's own observations, two schools of IS that participated in this study have very different academic identities. The UNSW school has been recognised worldwide for its long established expertise in human judgment. This knowledge and positive academic attitudes towards judgment have been firmly incorporated into the school's graduate programmes. On the other hand, the ANU school represents a more recent establishment, founded and led by an academic recognised for her expertise in intelligent systems.

It is speculated here that these academic influences could have affected subjects' attitudes towards different KMS and resulted in different patterns of system utilisation and performance. Prior research highlights the high value people attach to their organisational identity (Ravishankar and Pan, 2008). In accordance with prior research, the results of this study indicate that UNSW subjects largely tended to adopt the white-box system and reject black-box one, while ANU subjects exhibited the opposite tendencies to adopt the black-box and ignore white-box type. Such choices are consistent with their respective school identities.

The fact that UNSW participants with the white-box system support performed better than those with the black-box one further indicates that they were able to understand and use well the knowledge available from their system. They were given a small number of relevant cues in a meaningful task, graphical presentation of cue weights to provide clues to causal relationships, and forecast values to suggest future behaviour. The graphical design facilitated interpretation and enabled the subjects to better judge the right size of future changes. As a result, they tended to achieve substantial improvement in their subsequent performance. In real terms, decision errors dropped by 22%.

Such findings seem to contradict the overly pessimistic picture of human ability to utilise explicit knowledge painted by earlier laboratory research in judgement and decision making (e.g. Andreassen, 1991; Harvey et al., 1994). However, while the "opening" of the black-box KMS was helpful in improving UNSW subjects' decision accuracy, performance gains were less than theoretically possible. The failure to achieve optimal performance resulted mainly from the participants' insufficient use of the available knowledge. Further analysis revealed that, on average, they tended to effectively use 75% of the explicit knowledge provided to them. While this is better than the ability of unaided decision makers who use between 40% and 60% (Handzic and Bewsell, 2005) it is not enough for top performance.

A potential explanation for the observed suboptimal performance may be the lack of vital knowledge regarding tool reliability. Subjects in the current research were not given any explicit analysis of the quality of their tool's past performance. As a result, they tended to place less reliance than they should have on the seemingly helpful decision aid. Earlier studies on learning from feedback in multivariate tasks reported improved performance due to task and cognitive feedback (Remus et al., 1996). Another potential explanation for the observed suboptimal performance may be the lack of opportunity to learn from one's own experience through task repetition. Earlier studies on learning (for review see Klayman, 1988) indicate that people can learn multivariate tasks reasonably well over a large number of trials. However, it seems that the period of ten trials was too short to induce effective learning.

The superior performance of ANU subjects provided with the black-box KMS indicates that they had no difficulties in trusting the decisions produced by a smart system. Such subjects' attitude may be attributed to their strong sense of "oneness" with their academic school. It could have been influenced by their perceptions of and identification with the school's central and distinctive expertise in intelligent systems. Prior field research found that the members' organisational identification influenced their compliance with KM initiatives (Ravishankar and Pan, 2008).

Trusting the black-box KMS was beneficial to the quality of ANU subjects' decision performance. In real terms, their decision errors dropped by 47%. More importantly, heavy reliance on the system-recommended decisions enabled them to reach optimal performance without the need to exert too much cognitive effort. From a solely performance perspective, the current results are in favour of technology deployment to automate rather than informate decision making process in a predictive judgment task. However, they also raise a deeper ethical question of whether technology should be deployed to replace (or inform) human work. It is argued here that a balanced approach to KMS design is needed that would encompass organisational, human and technological aspects of KM.

5.4 Limitations and Implications

While the current study provides a number of interesting findings, some caution is necessary regarding their generalisation due to a number of limiting aspects. One of the limitations refers to the use of a laboratory experiment that may compromise the external validity of research. Another limitation relates to artificial generation of time series data that may not reflect the true nature of real business. The subjects chosen for the study were students and not real life decision makers. The fact that they were mature graduates may mitigate the potential differences. No incentives were offered to the subjects for their effort in the study. Consequently, they may have found the study unimportant and not approached it seriously enough. Most decisions in real business settings have significant consequences. Further research is necessary that would extend the study to other subjects and environmental conditions in order to ensure the applicability of the present findings.

Although limited, the findings of the current study have some important implications for the effective design and use of KMS. They suggest that adopting either a solely white-box (informating) or a solely black-box (automating) approach to KMS may not be sufficient for management decision making. The value of the informating (actor focused) approach is limited because it does not acknowledge the full potential of technology. Similarly, the automating (codification orientated) model overlooks the role of tacit knowledge and cultural aspects of KM (Moteleb and Woodman, 2007). These may be crucial for accommodating the dynamic and unpredictable nature of complex decision making problems.

There is now a recognition of the need and a desire to learn more about how to blend human judgment with technology to get the most beneficial outcome (Lawrence et al., 2006) Understanding these issues will require more systematic empirical research addressing the relationships between social and technological aspects of KM. One useful line of enquiry would consider systems with more meaningful analysis, task/performance feedback and learning histories that might potentially help such workers better understand what works when and why (Kleiner and Roth, 1998). This, in turn, may result in better performance. Alternatively, organisations may employ trustworthy specialists trained in analytical and statistical reasoning who would perform a knowledge filtering process for professional and managerial knowledge workers (Godbout, 1999).

Initiatives aimed at creating working environments that encourage communication and culture of knowledge sharing may also potentially have a beneficial effect on enhancing decision makers' working knowledge and performance. Organisations have come to realise that a large proportion of knowledge needed by the business is not captured on hard drives or contained in filing cabinets, but kept in the heads of people. Sources report that between 40% (AAOTE, 1998) and 90% (Hewson, 1999) of the needed knowledge is (in the lingo of the business) tacit. The spiral knowledge model postulates that the processes of sharing will result in the amplification and exponential growth of working knowledge (Nonaka and Takeuchi, 1995; Nonaka, 1998). Yet, little is known of the ways in which tacit knowledge is actually shared, conditions under which this sharing occurs, and the impact it has on performance.

Finally, by combining and integrating various socio-technical KM initiatives organisations may potentially create synergy effects that would lead to even higher levels of knowledge and performance. According to Davenport and Prusak (1997) only by taking a holistic approach to management may it be possible to realise the full power of knowledge ecology. Further research may look at some of these initiatives and approaches.

6 Conclusion

The main concern of this study was KMS effectiveness for decision support. Technology has dual potential to automate and informate knowledge work. The primary objective of this study was to determine which approach to KMS would be more beneficial in improving task performance of the decision makers involved.

The findings indicate the contingent nature of KMS effectiveness upon organisational identification. The patterns of subjects' utilisation and performance with two KMS (informating white-box and automating black box) were consistent with their academic schools identities (human judgment and intelligent systems). However, the adopters of the automating black-box KMS performed relatively better and succeeded in reaching optimal performance in the current predictive judgment task.

This work has some important implications for KM practice and research. From the organisational performance perspective, the current results favour technology deployment to automate rather than informate decision making process. However, they raise an important ethical dilemma of choosing between "working for a smart machine or having smart people around the machine" (Zuboff, 1988). The right way forward may be to build on the current desire to learn how to blend the two. Rather than making an either or choice, the organisations should strike the right balance between automating and informating for any particular task.

Finally, a word of caution is in order that these findings and recommendations are qualified by the number of study limitations. Due to these limitations, the present study should be considered exploratory and its conclusion tentative. Further research is recommended to address inherent restrictions and explore current and other KMS issues in different tasks and contexts and among different users, in order to generalise and expand these findings.

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Organizational Knowledge, Cognitively Plausible Actors, and Multi-Actor Systems

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Abstract. Organizational knowledge and knowledge management can only be studied successfully if two basic requirements are fulfilled: (1) determination of what knowledge is about and which carriers of knowledge are allowed and (2) the mechanisms that provide the interaction between the carriers (actors and software agents). We therefore have to step down to a lower level of aggregation, that is to say, to actors, to (shared) mental models, to agents and to the interaction between them. In order to guide the study of these constituting elements we formulate two questions. (A) What is the difference between information and knowledge and what consequences does this difference have for corporate and organizational issues? (B) If the human individual is one kind of actor, what other kind of actors (or agents) can we discern, what characteristics do the various actors have and what mechanisms are used to collaborate in Multi-Actor Systems (MAS)?

Insights from cognitive science, artificial intelligence and knowledge technology are used to answer the questions. We see knowledge as interpreted information. For the time being only human actors can entertain knowledge, because they have representations. Taking into account other components of (intelligent) actors, such as perception and interaction, other kinds of actors (and agents) can be defined. Various kinds of actors (and agents) may work together in an organization, which we call a Multi-Actor System. The "glue" that keeps such a system together is called: coordination mechanism. Various kinds of coordination mechanisms exist such as standardization, authority, and mutual adjustment. This also depends on the characteristics of the involved actors. The perspective of cognitive science combined with the assumption that organizations are a MAS make "organizational knowledge" and "organization" operational, measurable and quantifiable. Especially the focus on actor characteristics and as a result the actor/agent taxonomy being combined in a multi-actor system with various coordination mechanisms, makes it a better framework for an easy and smooth inclusion of and integration with (software) agents.

Keywords: Cognition, Actor and Agent, Coordination Mechanism, Organization

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1 Introduction and Research Questions

In many situations, the term "organizational knowledge" is very useful as a short description of what organizations know. "Organizational knowledge" is also the basis for "organizational learning" (OL). One can only learn if one knows already something. In this article, we argue that this organizational perspective can only be studied fruitfully if two basic requirements are fulfilled: (1) a determination of what knowledge is and is about and which carriers of knowledge should be taken into account and (2) a determination of the mechanisms that provide the interaction between actors and possibly software agents.

We first state that the term "organizational knowledge" is a metaphor, a way of speaking. Organizations literally do not have knowledge. Human individuals, or to be more precise, the brains/minds of humans have knowledge. With this knowledge, humans work with each other and with other kinds of actors (software agents), such as (advanced) information systems. For reasons of clarity, we prefer to use the term actor for humans and the term agent for software entities. Similarly, "organizational memory" and OL are metaphors. They are useful, but bounded and limited. Their usefulness lies in the fact that with these terms we can describe complex artifacts and constructs in a ready-made and short-handed way. However, their limitations are also clear, namely that you easily borrow properties or attributes from the one field and apply or ascribe them to the other. For example, talking about a diploma given to employees for following courses (an indicator of individual knowledge) and stating that the whole group has "corporate knowledge" is strange. Alternatively, talking about the speed of "corporate memory", which characteristic is relevant in computers and human memory, is at least quite beside the intention of using the metaphor. Metaphors are therefore inspiring, but on the other hand persuasive and occasionally wrong.

Although discussions about knowledge (and learning) are very prominent in management and organization studies (Dalkir, 2005; McElroy, 2003), we also believe that often knowledge (and learning) are not made operational, quantifiable and measurable. As we said, a term like "organizational knowledge" is a metaphor and "measuring" properties of metaphorical entities is often misleading. Two directions can then be chosen. The first is that one forgets about making the concepts operational, that is to say that one is satisfied with qualitative instead of quantitative observations, often at an abstract level. The second is that one tries to redefine the concept of e.g., organizational knowledge into concepts at lower levels of aggregation and thereby tries to change a metaphorical into a more literal description. This requires assessing the constituting elements of organizations, that is to say human individuals (actors), computer systems (agents) and the adaptive processes of them, individually as well as collectively. By presenting a framework and its constituting elements, we show that the second route is rewarding.

To make various aspects of knowledge operational and quantifiable, we will step down to lower levels of aggregation, that is to say to characteristics of actors, to (shared) mental models, to agents and the interaction between actors and agents. This does not imply that organizations are not relevant any more. On the contrary. Organizations are combinations of actors, more and more integrated with agents. We call them Multi-Actor Systems (MAS), in which the "multitude" exists in the various kinds of actors (and agents) with knowledge involved and in the coordination mechanisms that make the multi-actor system function.

In our view, knowledge – and consequently learning, which we only discus as far as it is relevant for our focus on knowledge – is something human actors have, respectively do. This knowledge is based on information. However, information is different from knowledge and a human actor is different from an organization or from complicated (software) agents. Although literature discusses the levels distinction in organization and individual, we believe that a real cognitively plausible perspective on human actors as information processing systems is missing and that consequently the treatment of actors (and agents) in KM literature is superficial and not very operational. What often remains is "lip service" to real humans in organizations, where in fact one discusses empty, or at best, very simple actors. We claim to present a framework taking into account intra- and inter-individual mechanisms based on cognitive science, artificial intelligence and organizational semiotics (Helmhout, 2006). To structure our analysis of the observable, empirical and measurable constituting elements, we formulate two questions:

1. What is the difference between information and knowledge and what consequences does this difference have for corporate and organizational knowledge issues? The determination of knowledge implies a further distinction in the content and the form or presentation of knowledge.
2. If a human individual is one kind of actor, what other kind of actors (or agents) can we discern, what characteristics do the various actors have and what mechanisms are used to collaborate in a MAS? We start our discussion about knowledge and actors in Sect. 2 with a review of the literature within knowledge management (KM) (and organizational knowledge). We will then answer the first question about knowledge in Sect. 3 and the second question about the characteristics of actors, their interaction and coordination mechanisms in Sect. 4. In Sect. 5, we give conclusions and some reflections on future research.

2 Issues in Organizational Knowledge and Knowledge Management

2.1 Carriers of Knowledge and Coordination Mechanisms

According to McElroy (2003), the discipline of KM evolved from the fields of OL and ICT (see for instance Firestone and McElroy, 2003). According to McElroy (2003, p. 82), the field of information technology unjustly claims that KM is nothing more than the application of information technology. ICT forms the technological side of most KM approaches (Alvesson and Karreman, 2001). The field of OL concerns how learning by organizations takes shape (Argyris and Schon, 1978), and sets out the human-side of KM approaches. OL is described in terms of single-loop – learning within the boundaries of assumptions that apply within the organizational context -, and double-loop learning – learning by questioning the boundaries of the assumptions and changing them.

For long, learning by individuals has not been addressed within OL (e.g., Kim, 1993). Kim (1993) bridges the gap between learning at the organizational and individual levels. He presents the OADI-SMM model, combining insight from OL and Kofman's (1992) view on individual learning. OL and individual learning are linked through the notion of shared mental models (SMM), a notion that is similar to Helmhout's concept of social construct, which we will discuss in Sect. 4. Antonacopoulou (2006) empirically explored the link between individual and OL.

Although Kim (1993) presents a comprehensive model that convincingly links the two levels of learning, we argue that two issues are missing in his approach. The first concerns the identification of the carrier of knowledge. Because knowledge cannot exist without someone keeping it in existence, we argue that a theory that deals with knowledge (and learning) should specify a cognitively plausible carrier. Although Kim (1993) touches upon this topic, in his model he does not refer to humans as cognitive, information processing entities. He starts from the position that the carriers of knowledge are human beings, but other carriers are storage facilities within an organizational context (e.g., paper, or computer systems), initially perceiving these carriers as equal. When discussing the likelihood for an organization to survive a total disintegration of all computer systems and paper material versus a complete replacement of employees, Kim favors the former situation. In other words, computer systems and human beings are not equal carriers of knowledge. This is true, but what do the differences consist of?

The second element that lacks from Kim's model is the notion of coordination mechanisms between individuals who learn. Kim identifies organizational structure and size as the distinctive element between individual and OL. He argues that within small groups the two levels of learning are indistinguishable because of little structure (Kim, 1993, p. 40). As the group or organization grows, structure becomes more apparent, and organization and individual learning become distinctive realms. In essence, we agree with this position. What Kim, however, hardly discusses is that there is no learning without knowledge and that this knowledge implies knowing how to function and act organizationally in a firm. Knowledge about the organization in which an actor operates implies a discussion about coordination mechanisms. As we will discuss later, the use of a coordination mechanisms stands apart from an organizational structure. Additionally, the concept of coordination mechanism links directly to the levels of individual and OL and therefore knowledge. We will explain this in more detail in Sect. 4.

2.2 First-Generation Knowledge Management: Knowledge Distribution and Use

KM is a relatively young discipline in both research and practice (Dalkir, 2005). From the start, the main objective of KM has been to get the right information to the right people at the right time in the right quality, in the right shape, against the lowest costs (Schreiber et al., 2000; McElroy, 2003). According to McElroy (2003), KM was highly technocratic in the beginning. Information technological applications dominated KM practice from the start (Ruggles, 1998). This is understandable, for KM has been perceived as nothing more then the distribution, delivery and transformation of information. McElroy calls this kind of KM, first generation KM. Now, this approach within KM does not suffice anymore. KM, in its present second generation, has become much more than just delivering and transforming information and using information technology. It is now also about knowledge creation and production (Sect. 2.3).

Based on McElroy (2003), we first give a general picture of knowledge and KM (first generation) in organizations (see Fig. 1). In the figure, real world or environment is external. Within the environment, there is a system or organization, with business processes (BP), with subjective and objective, coded and theoretical knowledge in what we call the distributed organization knowledge base (DOKB), governed partly by KM. It should be noted that we are describing the system here at a higher level of aggregation than just the human individual (the actor).

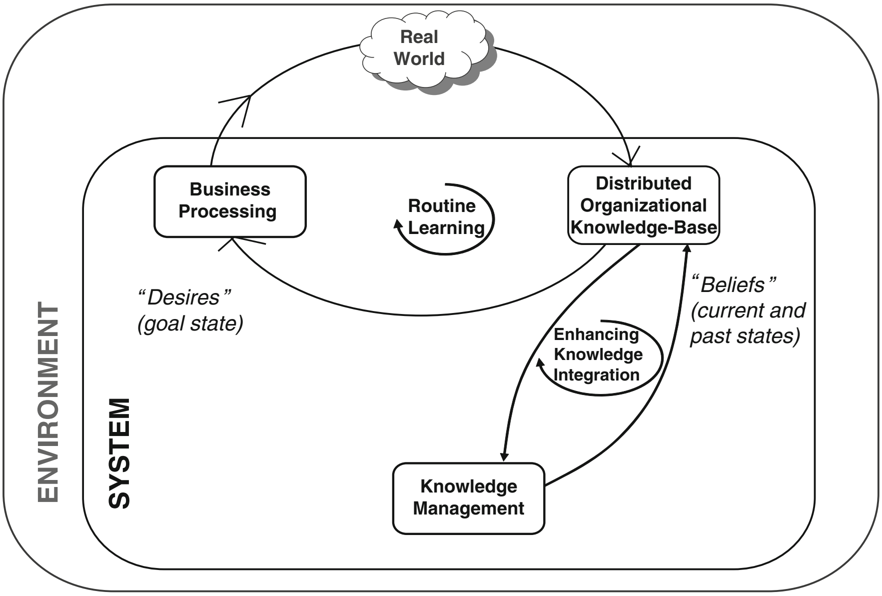

Fig. 1: First-generation knowledge management

Also in the perspective of McElroy, knowledge is not integrated with cognitively plausible actors. Furthermore, the system or organization consists of a multitude of various kinds of actors, what we call a MAS.

McElroy (2003) states that KM starts from two assumptions that, he says, do not align with reality. The first assumption is that knowledge that is needed by individuals to perform a certain task is already there. It exists. From this assumption, the need arises to capture and codify knowledge to make it easy to handle, to transform it into manageable pieces of information that can be easily transported. The choice for information technology as an instrument for KM is logical, for it brings forth tools that realize the fast transport of information and in this way, it contributes to the realization of organizational efficiency. From the first assumption, McElroy derives a second assumption that underlies KM: the equivalence of information and knowledge. Knowledge not solely depends on humans as carriers or social processes as distributors. McElroy concludes that within an organization one presupposes that just feeding humans with the information they need, will result in desired outcomes, and will make organizations perform better.

The two assumptions lead to two consequences for KM. First, because knowledge exists already by definition, one only has to focus on the transfer of knowledge. Just making sure that the right information reaches an individual at the right time, in the right shape and quality is sufficient from this KM perspective. Second, information technology is the key technology within KM. Therefore, KM is all about information transfer against the lowest costs. Information technology enables a fast transfer and transformation of all kinds of information against relatively low costs. In other words, information technology is KM's "silver bullet."

The codified perspective of information management resulting in KM, presupposes that human actors are controllable and predictable. It, therefore, suffices to prescribe behavior they are allowed to display in rules and policies. Furthermore, the controllability of humans enforces the use of information technology. Because humans will behave as predicted, the inflexibility that often characterizes information technology does not stand in the way of efficient organizational behavior. If the two assumptions hold, KM should pursue the mentioned objective making strong use of information technology. Meeting the objective then should result in the functioning of organizations as if they were well-oiled machines (another metaphor).

Problems of course arise when one or both of the assumptions do not hold. What should be done in case not all knowledge already exists and that therefore knowledge transfer is insufficient? Alternatively, what should be done if human interactive behavior as such does matter regarding knowledge and KM?

Several authors have abandoned the assumption that knowledge already exists. They suggested that KM theories need a broader basis (Nonaka and Takeuchi, 1995; McElroy, 2003; Jorna, 2007). If all knowledge would exist, innovations would not be necessary anymore. The focus on information systems in first generation KM has resulted in a neglect of knowledge creation and production within KM. McElroy and others suggested broadening and transforming the "old KM school" with structures to cover the creation of knowledge.

The second assumption underlying KM – the similarity of information and knowledge – contrasts with our notion of knowledge in which only humans are carriers. Knowledge is something human actors posses and use, also in social interactions. McElroy (2003) concludes that, in addition to including a structure for knowledge creation, a theory of KM should focus on humans and social processes.

2.3 Second-Generation Knowledge Management: Knowledge Creation

Dalkir (2005) provides an overview of KM theories that all describe some structures of knowledge *creation*. She presents theories by Meyer and Zack (1996), Bukowitz and Williams (1999), McElroy (2003), and Wiig (1993). Here, we adopt McElroy's (2003) approach towards the creation of knowledge, a process he labels as "knowledge production". We already mentioned that he labels the earlier theories of KM, in which information technology prevails and knowledge is assumed to exist as "first generation KM". In contrast, when KM theory incorporates knowledge production – leading to knowledge processes – McElroy speaks of "second generation KM". Humans and social processes form the centre of his notion of second generation KM (see Fig. 2).

The difference between Figs. 1 and 2 concerns the emphasized aspect of knowledge processing that is closely related to creative learning. KM should provide the policy to enable or endorse these processes. Regarding knowledge creation, McElroy (2003) speaks in terms of knowledge claims, a concept that links to the well-known concept of hypothesis in scientific research. The process of knowledge production builds upon these knowledge claims. Knowledge production roughly consists of the sub-processes of knowledge claim formulation and knowledge claim evaluation. In the former, individuals collaboratively formulate a testable knowledge claim. Through information gathering and discussion about this information, knowledge claims are formulated. Both information

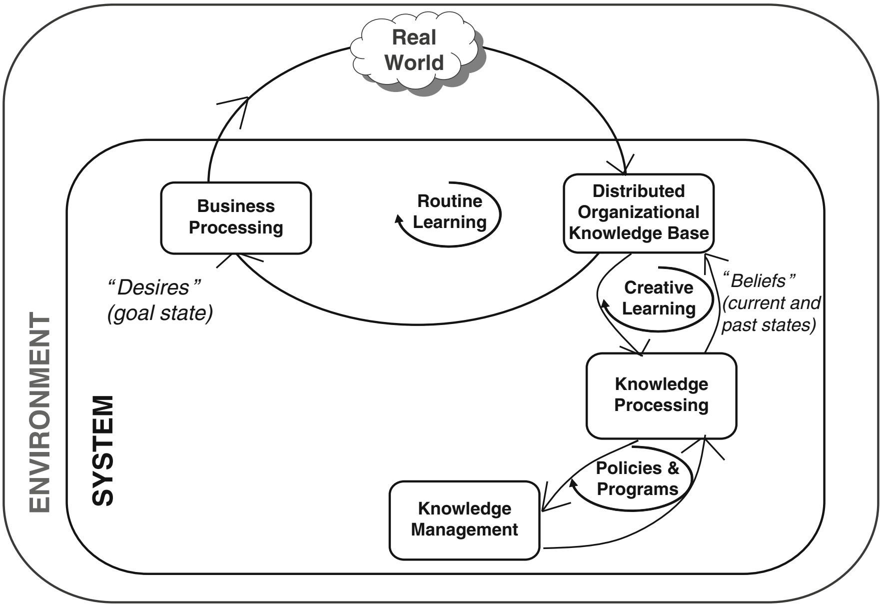

Fig. 2: Second-generation knowledge management

gathering and discussion rely on human involvement and social interaction. Formulated knowledge claims are subsequently tested in the sub-process of knowledge claim evaluation. Peters et al. (2008) identify various types of evaluative mechanism that can be used to evaluate knowledge claims. An evaluated knowledge claim will become part of the overall "organizational" knowledge and will be integrated and so the knowledge processing continues.

In summary, the incorporation of knowledge production processes in KM theory emphasizes the role of humans concerning knowledge processes and the importance of "inside knowledge", i.e., the knowledge held by human actors within the organization (Fearon and Cavaleri, 2006). The next step is to determine the ways to manage the process of knowledge production. First generation KM relied strongly on the use of information technology. As indicated, this was possible because the role of human actors was largely ignored. In contrast, human and social processes reside at the core of second generation KM, and the use of information technology is not that straightforward anymore. We are talking here about information technology from the late 90s. However, the role of information technology has changed since then. The developments and possibilities of new software tools have dramatically increased the last ten years. Until now, we humans are the only syntactic, semantic and pragmatic intelligent machines. Our digital "companions" (agents) are mainly syntactic machines and as far as they are semantically and pragmatically sound, it is because we humans provide the interface(s). We belief this might change within the next twenty years (see also Harper et al, 2008). This brings us to the significant part concerning actors.

Currently, our artificial actors are mainly assistants and companions. What characteristics – also with regard to knowledge – are required to be an actor and what are its implications for MAS? We, therefore, change our focus. We direct our attention to actors, the basic elements within any organization.

3 Information, Knowledge, Cognition, and Human Actors

We see data, information and knowledge as parts of a three-stage rocket (Jorna and Simons, 1992; Schreiber et al., 2000). Knowledge assumes information, and information in turn assumes data. The bottom layer is formed by data. Data are the noises, scratches, images and other unstructured elements, out there in reality. If the data are interpreted explicitly, we speak of information. If this information is used by people in reasoning or in performing actions – i.e., if it is interpreted – we have knowledge. This means that going from data, via information to knowledge, degrees of freedom increase. The same data can be interpreted in many different ways to serve as information. In a similar way, information can be interpreted in many different ways to serve as knowledge. Someone receives data and information, and with the aid of knowledge the person already possesses, information becomes knowledge, which, in turn, can consequently complement or change a person's current knowledge. The crucial difference between information and knowledge is interpretation and this interpretation is done with the human mind. It implies a cognitive perspective on knowledge. Presently, humans are the only carriers of knowledge. They are goal-oriented sign or symbol processing systems (Jorna, 1990; Newell, 1990). What is exclusive for humans as carriers of knowledge, here, is different for information and data. In that situation, not only humans, but also other kinds of actors (software agents) are involved.

With respect to the knowledge actors have, various divisions can be made. The most important one is the distinction in knowledge content and knowledge type. Knowledge content concerns what knowledge is about: about cars, about physics, about making coffee, about computers or about coordination mechanisms. Domains, fields and disciplines are examples of knowledge content. Postrel (2002) calls a knowledge domain a "singularly-linked cluster", also named "discipline". Scientific fields are good examples of knowledge domains, for example medical science, biology, chemistry or sociology.

Knowledge according to content can often easily be covered by the question "what" and occasionally by the question "how". After determining knowledge content, it is very important to take into account the various forms of knowledge; the knowledge types (Polanyi, 1967; Pylyshyn, 1984; Boisot, 1995, 1998; Jorna, 2007). Leaving aside the many distinctions that can be found in literature (Cijsouw and Jorna, 2003), we suggest three knowledge types, classified along three non-orthogonal axes: sensory (ranging from rough to detailed), coded (from weak to strong), and theoretical (from concrete to abstract) knowledge. Together the types of knowledge can be depicted in a knowledge space (see Figs. 3a, b).

Sensory knowledge forms the first dimension in the knowledge space. Sensory knowledge is the knowledge a person obtains using sensory organs. The knowledge is as concrete as the event that is interpreted. It is behavior. Examples of such knowledge are the knowledge of somebody's face, the knowledge of bird songs or the skills and procedures one demonstrates in labor and performance. This dimension ranges from rough to detailed sensory knowledge. In detailed sensory knowledge, more fine-grained and specific sensory or behavioral aspects are present and relevant.

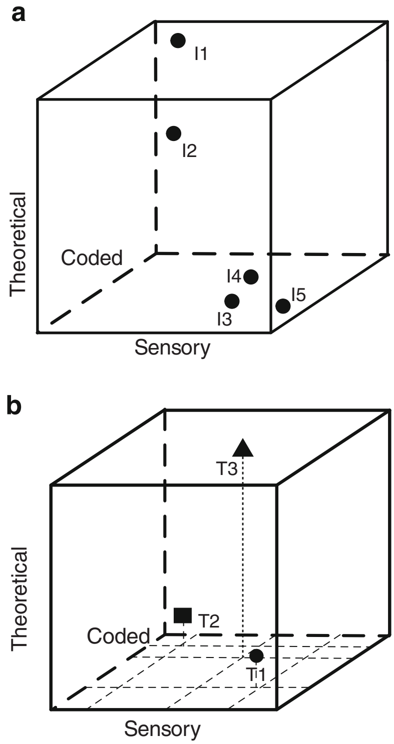

Fig. 3: (**a**) The knowledge space: Five individuals (I1 to 5) on knowledge domain D at time T. (**b**) One individual's knowledge types on knowledge domain D moving through time from T_1 to T_3

Coded knowledge is the second dimension in the knowledge space. Coded knowledge is the category that is formed on top of the knowledge of a concrete event (sensory knowledge). Coded knowledge means using signs. Words, diagrams, formulas and pictograms are all examples of codes. Coded knowledge forms a dimension that ranges from weak (icon or picture) to strong (mathematical formula) (Goodman, 1981/1968; Jorna, 1990). The dimension from weak to strong is indicated based on decreasing ambiguity: the stronger the code, the less ambiguous the transferred knowledge is.

Theoretical knowledge is the structure that can be formed on top of sensory and coded knowledge. All knowledge that reflects a structure, method, or pattern is theoretical. For example, natural laws and behavioral norms are theoretical knowledge, but ideological or religious coherent structures are theoretical knowledge as well. Theoretical knowledge can be made visible in asking and answering "why" questions. This third dimension in the knowledge space ranges from concrete to abstract theoretical knowledge; concrete theoretical knowledge consists of small "why-chains", whereas abstract theoretical knowledge consists of long and complex chains. Note that theoretical knowledge is not used before coded knowledge has been acquired and that coded knowledge builds upon sensory knowledge in this structuring of knowledge types.

Just as information and data can be made operational and quantifiable in terms of databases or in conceptual mathematical structures (i.e., Shannon and Weaver, 1963), so can knowledge in this way be made operational (by using questionnaires to asses the types) in a knowledge space. Figure 3a depicts an example of the use of a knowledge space. It is an example of a static situation. In this knowledge space – a snapshot at time T – the individuals (I_1 to I_5), who are involved in a similar knowledge domain D, are positioned according to the knowledge types they use. Individual I_1 has knowledge type: highly theoretical, strongly coded and roughly sensory, whereas I_5 has the knowledge type: low theoretical, weakly coded and detailed sensory. Accordingly, "corporate knowledge" can be depicted (not depicted in Fig. 3) involving a higher level of aggregation combining individual actors, knowledge content and knowledge types. In this way, given a knowledge content, we can make a snapshot of the organizational knowledge of company A.

It is also possible to depict individual (or organizational) development within the knowledge space, provided one makes various consecutive snapshots in time (see Fig. 3b). One individual develops knowledge from low theoretical and weakly coded at T_1 into highly theoretical and strongly coded at T_3.

Determining a specific knowledge content domain (e.g., glassblowing, car production or childcare), the knowledge space makes it possible to assess and compare which individuals have which type of knowledge. It is also possible to accumulate the individual knowledge into a dominant knowledge type of an organization. The knowledge space can therefore be used as a measuring tool to assess the knowledge "state" of an individual, but also of a group or organization. In this way, we can operationalize organizational knowledge. The assessment may then result in an organizational debate about knowledge use, knowledge distribution, knowledge storage and knowledge accessibility. In combination with ICT, this is what McElroy (2003) called: first generation KM. Nevertheless, we still have to go into more details of the carriers of knowledge: what does our cognitively oriented view on actors (and agents) mean?

4 Knowledge Carriers, Various Kinds of Actors, and Coordination Mechanisms

4.1 Characteristics of Cognitive and Other Kinds of Actors (Agents)

We already said that "actor" is the general term to talk about carriers of knowledge. Our focus is first on the individual cognitive actor. In Sect. 4.2, we focus on multiple actors.

Within cognitive science, cognition of an actor consists of three essential characteristics: (a) a cognitive architecture, (b) representations and (c) computations or operations on representations. Newell and Simon (1972) stated that human thinking and reasoning consist of the manipulation of (internal) symbols (physical symbol system hypothesis). Symbols are the basic constituents of our thoughts. They are the functional constituents of representations. They have a material carrier. For humans: their brain.

A cognitive architecture implements the design and organization of the human mind. It presents various functions and properties of the mind and their interrelations. This concerns characteristics of functional components, such as memory, processing capacity, perception, motor systems and various kinds of central processors (Posner, 1989). An architecture without content is empty. Representations are the content, the substantial knowledge in our cognitive system. They refer to books we have read, movies we have seen or experiences with our relatives and friends. All this knowledge and information exists in our memory in the form of representations: stories, icons, images, propositions, semantic nets and scripts (Jorna, 1990). Operations on these representations are activities of symbol manipulation, such as combining them, forgetting, abstracting from and restructuring them. This general cognitive perspective of actors is implicitly present in our perspective on KM.

Putting aside for a moment the general cognitive structure, we consider an actor to be a coherent whole, consisting of several components. Within cognitive science, Posner (1989) formulated an extensive list of (cognitive) actor components. They include (a) *perception*, (b) *interaction* (including learning in the sense of habit formation), (c) *representation and interpretation* (including learning in the sense of (mental) knowledge formation and integration) and (d) *autonomy and self-consciousness* (Gazendam, 1993; Gazendam and Jorna, 1998).

With *perception,* a system must be able to accept input in a general sense. This input may include visible, audible and tangible stimuli and the accepting system may vary from a lobster, a human being to a software agent.

Interaction is the process by which a system has contact with its environment. Stimuli as input in the system lead to output in the sense of responses. The reaction patterns of the system may result in learned behavior, that is to say that habits are formed.

Representations and interpretation are necessary for a system that internally symbolizes the environment (Newell and Simon, 1972; Jorna, 1990). Based on representations and interpretations the system also learns. Examples of representations are words, pictures, semantic nets, propositions and temporal strings (Kosslyn, 1980; Anderson, 1983).

A system is *autonomous, self-organized or self-conscious* if it is able to have a representation of its own (physical and conceptual) position in the environment. This means that the system has self-representation. An autonomous system has reconstructing representational interaction patterns.

In Fig. 4, taken over from the work of Helmhout (2006), we depict a situation where two actors (having all the components) are interacting. Actor X and actor Y are examples of human actors.

Various combinations of aspects result in an actor hierarchy. An actor that only has perception is at the lowest level and cannot be called an intelligent actor, whereas an actor with self-organization, including perception, interaction and representations, is at the highest level. This last form is what we regularly call an actor that is reflective, intelligent and thoughtful. Human beings are presently the only instantiations of intelligent actors. It is debatable whether software agents at this moment have representations, but they certainly do not have self-organization, at least not the next years. (We are aware of the fact that we are mixing up our earlier distinction in actor and (software) agent, but the fields of AI, cognitive science, computer science and economy are not consistent and constantly developing. In the remainder, we use as general term: actor.

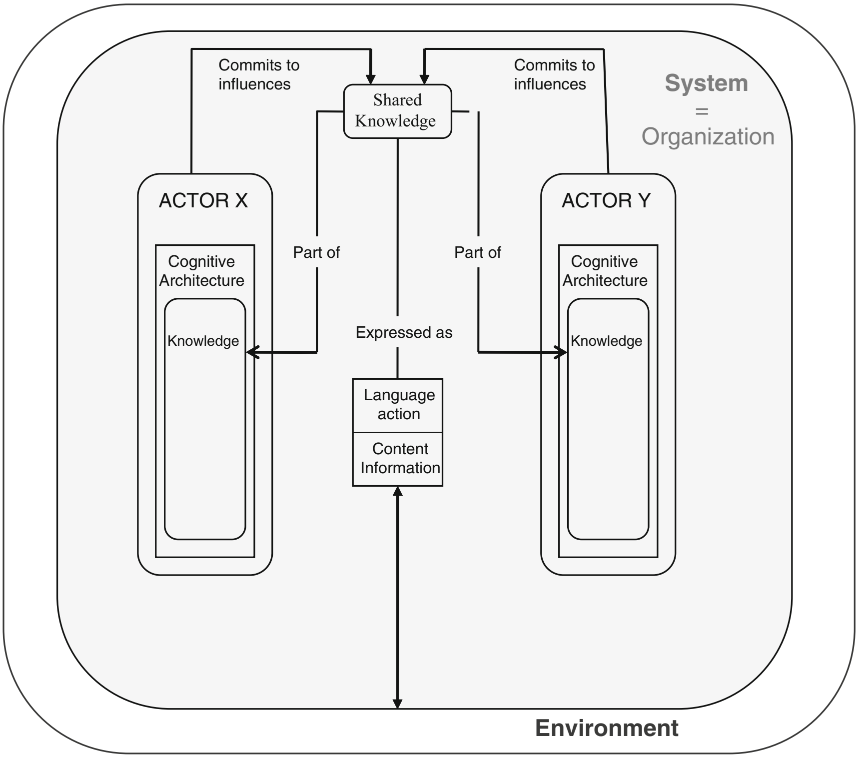

Fig. 4: Actors, properties and multi-actor systems (from Helmhout, 2006)

The above described classification in perception, interaction, representation and autonomy can be used to qualify various kinds of actors. We start with a cohesive, structured and organized entity. In a sense this entity is an actor, because it is self-contained, strives toward continuation and, looking at the actor characteristics, it has perception and interaction including the possibility of learning in the sense of habit formation. We emphasize that this actor does not have internal representations. Its cognitive domain is absent or empty. We call this actor a Response Function system (RF-system), or Actor I (first square in Fig. 5). We can compare it with the ant in the sand (Simon, 1998/1969). In discussing complex behavior of systems, Simon stated that the behavior of an ant on the sand could be called complex, not intelligent, because its behavior is a function of the complexity of the irregular environment that the ant has to cross.

In the second place, we can define an actor that we call a Representational system (R-system). This actor has representations and is able to depict external events internally into its cognitive domain. We call this Actor II (second square in Fig. 5). This representational system has representation, to a certain extent autonomy and perception. Interaction as we humans use it, is absent, that is to say that there is no device that semantically interprets causal inputs and outputs. Most present work in Artificial Intelligence, Knowledge Technology and Decision Support

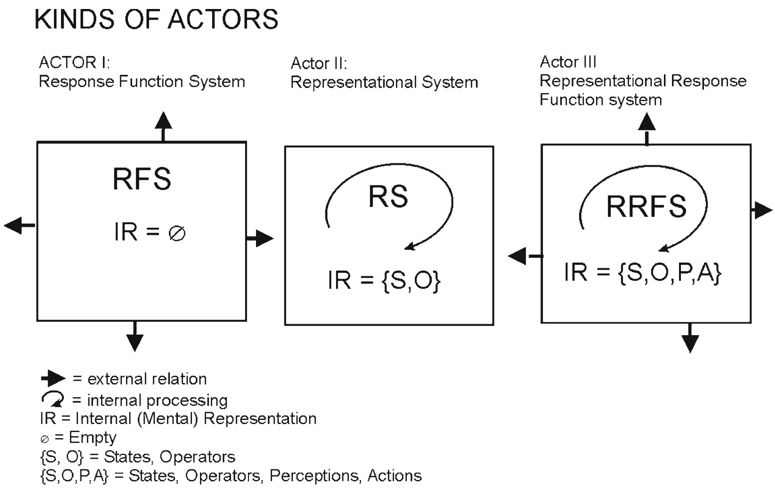

Fig. 5: Three kinds of actors

Systems concern Actor II implementations, for example, ACT-R or SOAR. The focus here is mainly on the internal functioning of an "intelligent" system and very little on the interaction between this system and its environment.

The third possible interpretation of an actor is the Representational Response Function actor (RRF-system). This actor incorporates a really intelligent, interactive and cognitive system. We call this Actor III (third square in Fig. 5). This actor is able to perceive, to interact, to represent and to be autonomous. RRF-systems behave on the knowledge level, as Newell called it. "*There exists a distinct (computer) systems level, lying immediately above the symbol level, which is characterized by knowledge as the medium and the principle of rationality as the law of behavior.*" (Newell, 1982, p. 99) Newell is proposing this knowledge level for natural (humans) as well as in the future for artificial (computers) intelligent systems. Actors equipped with the integration of representations and responses have knowledge. "*Knowledge*", says Newell, "*is whatever can be ascribed to an actor, such that its behavior can be computed according to the principle of rationality.*" (Newell, 1982, p. 105). We believe that it will not take a century before actors and agents are equivalent. Hopefully, this explains our confounded use of the terms actor and agent.

4.2 Multi-Actor Systems and Coordination Mechanisms

The hierarchy of single actors returns in the composition of a MAS. In a first multi-actor system, all actors are RF-systems ("empty actors"; see Fig. 6).

All actors have perception and interaction. To take up the example of Simon's ant we are talking here about a group of ants perceiving and interacting with each other. Coordination is only defined in terms of reactions to the behavior of other actors.

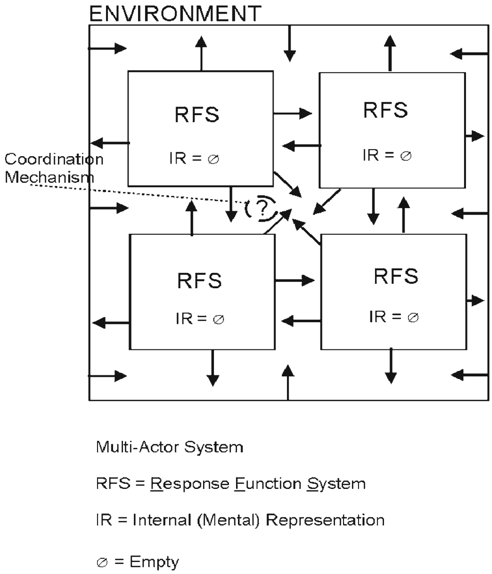

Fig. 6: RFS (multi-actor system)

In the second place, we have a multi-actor system consisting of only representational systems (Actor II). Every actor has internal representations in the sense of symbol structures and operations. Interaction is nearly absent for this kind of actors and if it exists it is of course not semantically or pragmatically meaningful (Fig. 7).

In the third place, we may have representational response function systems in a multi-actor situation. The actors perceive each other and react to each other in a semantically and pragmatically rich and intelligent way (see Fig. 8).

Each actor has perception, interaction, representation and autonomy and manages to integrate this into the organization as a multi-actor system. A collection of human cognitive systems in a multi-actor perspective is an example of multiple representational response function systems. This is the situation of (human) organizations in practice. They consist of actors in the sense of actor III.

In the fourth place, a combination of several kinds of actors is possible. Various MAS's can be considered consisting of actors I and III, of actors II and III, and actors I, II and III. A combination of actors I and II seems difficult because we believe that at least one of the actors in a multi-actor system should have autonomy and self-organization. Under the influence of developments in ICT more and more artificial actors (agents) will behave as actors III (see Fig. 9), which to many people now seems horrifying.

A multi-actor system necessarily requires a coordination mechanism to align, combine or integrate the various actors. We already indicated that for the moment we believe that for any

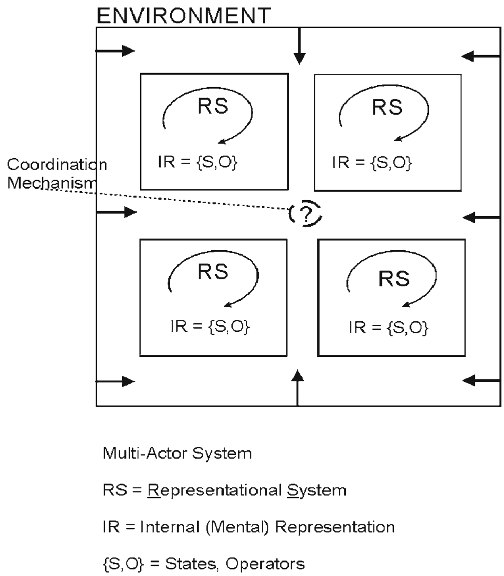

Fig. 7: RS (multi-actor system)

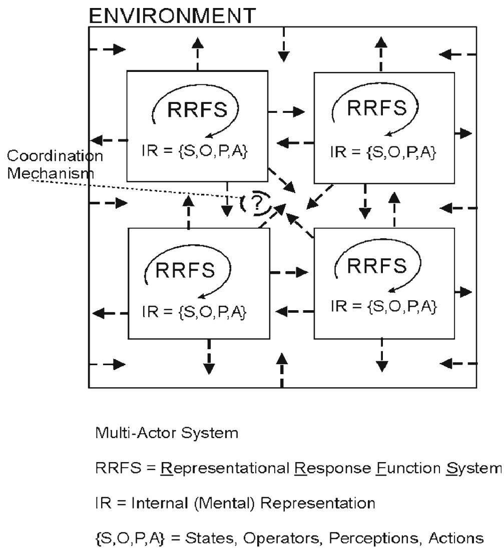

Fig. 8: RRFS (multi-actor system)

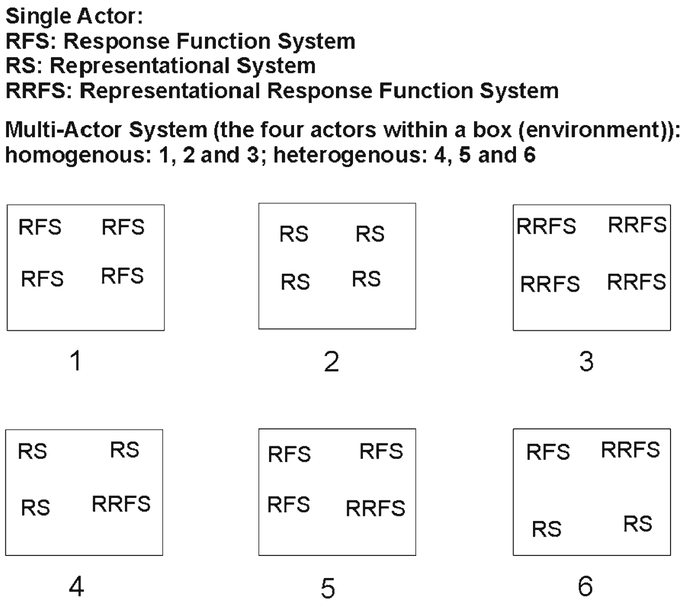

Fig. 9: Homogeneous and heterogeneous multi-actor systems

such intelligently behaving MA-system at least one RRF-entity, an actor III, is necessary. This actor is the incorporation of a normal intelligent cognitive system. That being said, many MAS realizations can be made, depending on the used coordination mechanism.

Before discussing coordination mechanisms, we have to make a distinction between this mechanism and an organizational form. An organizational form is a consistent structure of the cooperation (togetherness) of various actors (and agents). Examples of these forms are bureaucracies (professional or machine), networks (including webs and markets), clans and fiefs (Boisot, 1995). The reason why these forms exist and work is the coordination mechanism within these forms that makes the organization function. In any organizational form, the actors have to understand the coordination mechanism, that is to say they need shared representations. For example in a bureaucracy, everybody has to understand and follow rules, procedures or norms. Moreover, in case of a clan, the members have to understand that there is one very important person who is in charge and has the authority; in most clans, based on family ties. However, family ties are not necessary. Clans are also found in R&D departments, where the authority is based on someone's expertise and creativity.

Thompson (1967) distinguishes three major coordination mechanisms in MAS: standardization, planning and mutual adjustment. In using these mechanisms, a balance has to be struck between autonomous action and concerted action in order to gain an optimal performance (risk control, flexibility, learning) of the multi-actor system. Mintzberg (1983) distinguishes five coordination mechanisms that are used in five different types of organizations, i.e. simple structure, machine bureaucracy, professional bureaucracy, divisional structure, and adhocracy. In a simple structure, direct supervision is used as coordination mechanism, whereas in the machine bureaucracy standardization (rules or procedures) of work processes is the coordination mechanism. Standardization of skills is the coordination mechanism used in professional bureaucracies. In a divisional structure, standardization of output is the main coordination mechanism used, and finally, people working in an adhocracy use mutual adjustment as coordination mechanism.

If we look at Thompson's, Mintzberg's and many other distinctions in terms of knowledge, we can discern three basic coordination mechanisms. The first is standardization, which presupposes that every actor knows the rule, procedure or norm and is able or obliged to act accordingly. The second is authority that can be based on age, expertise, official position or on family structures, like being a (god)father. In terms of knowledge, this requires that if one actor is the expert, the other actors acknowledge this and see themselves as having less expertise or authority. The third is mutual adjustment, meaning that beforehand no rule or authority does exist and that the actors have to negotiate or adjust in order to make the MAS function. This requires knowledge of goals, preferences and constraints of the various actors. All these coordination mechanism and organizational forms are constructs. They are human made artifacts; they are social constructs that exist only because of our knowledge.

Looking at the basic coordination mechanisms, it is evident that knowledge of what actors do and understand is essential in any multi-actor system. We also argued that knowledge can only be used meaningfully if at least one actor is a cognitively plausible system. This has consequences for the allowed combination of actors in a MAS. If knowledge is involved, we can think of two basic structures that are possible and two others that are impossible.

At the moment, the most frequent MAS is one consisting of only humans (actor III). We will not repeat the various coordination mechanisms and organizational forms (also see Sorge and Warner, 2001). They are obvious. The second MAS that already occurs very often, is a combination of humans (actor III) and (software) agents (actor I or actor II). In the case of classical information systems, they function at the level of actor I and in combination with the authority of humans, we see them all around us. In the case of actor II, we are talking about software agents that may reason, analyze or solve problems, but under the guidance or control of humans, at least in principle. Examples of such systems are expert and knowledge systems, advanced or dedicated decision support systems or other implementations of artificial intelligence systems. These MAS's in whatever organizational form, use coordination mechanism such as rules, procedures and authority based on expertise, function or power. Whether the coordination mechanism of mutual adjustment also works here, if many actors are software agents, is debatable. If software agents have self-representation and autonomy, it might be possible in the future. At the moment, it does not work.

We also have two impossible basic structures of MAS's, now. The first one only consisting of actors I and the second one consisting of actors II, in which some actors I may be involved. There is a very simple reason for this impossibility. A MAS consisting of actors I is just a behavioral system, without reasoning and representations, whereas a MAS consisting of actors II is lacking interaction possibilities and autonomy. Actors II, consisting of AI-systems, knowledge technology and robots, require the presence of an actor III to be fully "cognitively plausible" and realistic. Without the inclusion of humans, the composition of such a MAS does not function.

The various kinds of actors (and agents) and various organizational forms and coordination mechanisms all presuppose the availability and accessibility of knowledge. As cognitive science already demonstrated, intelligence and rationality being present in reasoning, thinking, decision making and problem solving, presuppose that we humans are cognitive systems. We have and manipulate representations consisting of signs and symbols. We do this internally, but we also use signs and symbols in our external interaction. Intra-individually as well as inter-individually, we are sign and symbol systems. In our minds, we use and work with sign and symbols, but also in our interaction, cooperation and communication we work with signs and symbols. The interesting point is that agents, software entities, are also sign and symbol using and interpreting systems (Newell and Simon, 1972). Without starting a new conceptual discussion, we can say that covering the field of information systems, organizational structures and cognitive plausible actors, the term organizational semiotics was coined (Stamper, 1973; Liu, 2000). Semiotics, as the study of sign systems and sign interpretation in general, is thereby used to apply an existing conceptual framework to study MAS (Helmhout, 2006, Helmhout et al. (2009)

5 Conclusions and Future Directions

The concept of "organizational knowledge" is important. The concept is used in intra- and inter-organizational analyses and studies. By using the concept, an organization values its own and other organizations' possibilities for development, innovation and cooperation. However, because it is so important we wondered why so few quantifiable and measurable indicators of "organizational knowledge" have been developed. The same can be said for the KM issues in organizations. We believe that two important reasons exist for this situation. The first is that too much a top-down approach, from departments and processes to tasks and actors in KM, is practiced. The second is that as for actors and agents too little use is made of the availability of concepts and operational tools within cognitive science and artificial intelligence.

For both shortcomings, we opened up the literature and suggested alternatives. Instead of a top-down approach, we sketched a bottom-up approach, starting with actors having various kinds of knowledge in their minds and we end with processes and organizations as MAS. Within this perspective, it is possible to measure and to quantify knowledge. Because knowledge is something until now only human actors have, we can study this knowledge by using mental maps, knowledge types in "knowledge spaces" and reasoning patterns of actors. Mental maps of the content of actors show what similarities and differences in knowledge various actors in organizations have. Use of the knowledge space makes explicit whether actors use sensory, coded and theoretical knowledge and how the distribution of the various types is for the various actors with regard to specific domains. Studying reasoning patterns of actors makes accessible what they do in decision making, problem solving or planning. These tools and instruments can not only be used with regard to the primary or main processes in organizations (the processes expressing why organizations exist (making cars, teaching or curing)), but also with regard to the organizational, executive or secondary processes.

We showed the availability of concepts and tools of cognitive science (CS) and artificial intelligence (AI) in the description of various characteristics of actors and as a consequence the variation in kinds of actors. Within CS and AI, we find extended discussions of components of actors, varying from perception and interaction to mental representations and reasoning. If actors do not have mental worlds at their disposal, they are empty actors. They do behave, but do not think or reason. We showed that the sophisticated concepts and tools of CS and AI can be used when we discuss actors as the building stones of organizations. Again, we argue that in this way we are able to measure and quantify the carriers of information and especially knowledge. Organizations without human actors do not exist, as much as one human does not exist without the interaction with another human. This situation requires coordination and organization, not only as a leading principle, but also as an abstract entity and as a social construct. "Organization" as a structuring principle can be found in many coordination mechanism that we use. "Organization", as an abstract entity, embodies a social construct and emphasizes the fact that as such an organization can only exist if we humans think about it. When the university as an organization closes down during the night and opens again in the morning, it does not mean that it did not exist in the night. It exists as buildings and other artifacts, but especially because during the night it exists in the minds of their members, whether they have it unconsciously, consciously or in their nightmares.

The perspective of cognitive science combined with the assumption that organizations are MAS's make "organizational knowledge" and "organization" operational, measurable and quantifiable. Especially the focus on actor characteristics and as a result the actor/agent taxonomy being combined in a multi-actor system with various coordination mechanisms, makes it a suitable framework for the inclusion of (software) agents. Our future organizations in terms of hardware will consist more and more of combinations of brains, neural nets and electronic circuits, separated in different physical entities. In terms of functional structures, or if one wants to call it that way: of software, we will more and more be interwoven and connected. That this functional structure does not have to be a vague, imprecise and abstract notion, we hope we showed in this article. In any case, artificial intelligent systems (agents) are here to stay and they will be more and more integrated with human cognitive systems. The big challenge for the future is to make them semantically and pragmatically more adaptable to us, so they can help us in sustaining a human future (Harper et al, 2008).

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On Using Organizational Knowledge Capabilities to Assist Organizational Learning

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Abstract. Knowledge management (KM) and organizational learning (OL) are attracting increasing attention from both academics and practitioners in the knowledge economy era. Recognizing the dynamics of KM research, organizational knowledge from a capability-based perspective is advocated as an essential force to aid a firm's growth. Learning embedded in organizational activities is viewed as a knowledge process that facilitates innovation. In this study, we take organizational knowledge capability (OKC) and process-oriented OL as the two primary research variables. Additionally, we consider OKC as a socio-technical system and divide it into social-based OKC and technical-based OKC, which tries to assist the development of process-oriented OL. Our objective is to construct a relationship between OKC and OL. Specifically, we propose a conceptual model that shows the KM–OL link, and advance research propositions for future empirical testing.

Keywords: Organizational knowledge capability, Process-oriented organizational learning, Socio-technical system

1 Introduction

In efforts to deal with an increasingly dynamic business environment, many organizations are striving to improve their efficiency and effectiveness by implementing knowledge management (KM) and organizational learning (OL). KM and OL are widely accepted and related concepts that are already adopted in a variety of organizations. KM can be seen as an organization's ability to share and retain the knowledge resources of the firm for sustained competitive advantage (Chuang, 2004; Gold et al., 2001). Meanwhile, OL can be considered as the process of improving business practices through better knowledge and understanding (Fiol and Lyles, 1985). More specifically, OL emphasizes how the learning process can create new knowledge for developing business practices in a changing environment (Drejer, 2000). The process of capturing, diffusing, transferring, and using organizational knowledge, which tries to foster innovation, is essential for managing knowledge and enabling learning within a firm. To be successful, a firm needs to create an organizational context that integrates OL with KM to facilitate knowledge sharing and learning. The objective of OL and KM is to build a work environment that supports employees in the creation, acquisition, capture,

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and use of organizational knowledge, and thereby ensure the firm's success. The development of KM and OL has thus attracted a great deal of attention from both academics and practitioners.

In general, OL is complementary to KM (Dimovski et al., 2008; King et al., 2008). With the emphasis on knowledge-based firms, OL as a critical business activity is the process that creates new knowledge (Bergman et al., 2004). On the other hand, the formation of learning organization requires a firm that has the capabilities to learn and communicate the firm's knowledge effectively to reflect changes in the external environment (King, 2001). In recent years, increasing attention has been paid to knowledge assets as critical features of a firm, and to the way firms develop and sustain the knowledge-based capability to gain a competitive advantage. Organizational knowledge capabilities (OKCs), which are the focus of a firm's strategy to deploy resources effectively, are developed to implement knowledge processes more efficiently so as to achieve knowledge sharing (Yang and Chen, 2007), a competitive advantage (Chuang, 2004), and organizational success (Dawson, 2000; Gold et al., 2001). However, there has been little research on the relationship between OKCs and OL.

In this paper, we propose a general framework for interpreting the KM–OL link from a capability-based perspective, and consider the effects of OKCs on OL. Additionally, OKCs composed of people, culture, structure, and infrastructure where the first three are categorized as social while the infrastructure is considered as technical (Chuang, 2004; Gold et al., 2001; Pemberton and Stonehouse, 2000). Therefore, we consider a firm's OKC as a socio-technical system and divide it into social-based OKC (SOKC) and technical-based OKC (TOKC), which tries to assist the development of OL. Our objective is to determine the knowledge capabilities a firm should have and examine how those capabilities should be used to influence learning processes.

The remainder of this paper is organized as follows. In the next section we discuss the three core concepts, namely, the socio-technical perspective of KM, OKCs, and OL. In Sect. 3, we propose our research framework and related propositions among different variables. Then, in Sect. 4, we summarize our conclusions and consider future research directions.

2 Research Background

In this section, we discuss our three core concepts and consider their significance for the development of OKC-OL. The concepts are the socio-technical view of KM, OKCs, and OL.

2.1 Socio-Technical Perspective of KM

Generally, KM refers to all efforts to increase the value of organizational knowledge, and is considered essential to sustaining a firm's competitive advantage and success. KM research focuses on managing knowledge assets effectively, which means identifying the potential strategic value of each knowledge resource of a firm. KM strategies are used to identify how a firm implements knowledge activities and where knowledge resources are located in a firm.

According to Mason and Pauleen (2003), two broad approaches (hard and soft) are considered when a firm implements KM. The hard approach focuses on the management of information objects through the development of appropriate technology, and the soft approach focuses on the transformation of knowledge into corporate assets through the management of people and processes. Hansen et al. (1999) defined two types of KM strategy: codification and personalization, which are hard and soft approaches respectively. Codification concentrates on the reuse of codified knowledge by an information system (IS), and personalization focuses on communicating individuals' tacit knowledge via organizational knowledge networks. Both strategies are consistent with the socio-technical perspective of the KM field.

The socio-technical perspective considers the organizational interrelatedness of social and technological subsystems (Bhatt, 2001). It has been widely applied in studies of KM (Coakes, 2002). The socio-technical view of KM focuses on a firm's strategy for harmonizing KM activities with technological drivers and social enablers to achieve its business objectives. A firm needs to consider KM in the context of a technical and social system (Bhatt, 2001; Prieto and Easterby-Smith, 2006). In a knowledge-intensive organization, technical-based KM focuses on seeking and capturing knowledge so that it can be codified, organized, stored, and accessed by effective information and communication technologies (ICT). In contrast to technical-based KM, social-based KM emphasizes knowledge that can be acquired and shared via a socially interactive process (e.g., through experienced and skilled people, trust, and reciprocal relationships among employees) to support KM activities.

Information technology (IT) is an effective infrastructure for transforming data into information. Transforming information into knowledge requires interacting with others (Bhatt, 2001). To reap the benefits of organizational knowledge, a firm should adopt the socio-technical view, which combines a firm's infrastructure, corporate culture, knowledge, and people with technology as the sources of strategic assets when developing, implementing, and managing its KM system (Meso and Smith, 2000). Pan and Scarbrough (1998) described a KM case in Buckman Laboratories, where an effective knowledge network system called K'Netix® was established to share knowledge and experience. The system is based on the socio-technical perspective and provides a KM environment to support communications among the firm's employees. Microsoft has also developed a successful KM system based on the socio-technical approach to help maintain the company's competitiveness (Meso and Smith, 2000). The technological infrastructure facilitates a rich knowledge sharing environment to support Microsoft's researchers in the R&D of software products. A knowledge friendly culture is a strategic asset that facilitates a positive relationship with knowledge activities when employees participate in knowledge exchange.

Consequently, by adopting the socio-technical perspective, organizations can use social and technical resources effectively and manage knowledge processes efficiently. Technology can increase the efficiency of information flows and social factors can improve the comprehension of knowledge assets; thus, a company needs to find an optimal balance between technical and social systems.

2.2 Organizational Knowledge Capabilities

Recently, scholars have paid more attention to the knowledge-based view (KBV) of a firm (Gold et al., 2001; Grant, 1996). According to the KBV perspective, organizational knowledge is considered the most valuable resource, and the capability to manage that knowledge is the most significant driver of competitive advantage.

What are the knowledge capabilities of an organization? Dutta et al. (2005) suggested that knowledge capabilities refer to how a firm deploys its resources to generate value and achieve organizational objectives. Recently, based on the theory of KBV, organizational capability has been explored as the outcome of knowledge integration (e.g., efficiency, scope, and flexibility) (Gold et al., 2001; Grant, 1996). In addition, Drejer (2000) defined organizational capability as the way a firm's systems synthesize a variety of elements, such as technology, human resources, company culture, and their interaction. As King (1995) noted "organizational capability is an internally consistent combination of skills, processes, procedures, organizational structures, physical systems, ISs, and incentive systems."

Knowledge is regarded as the potential capability to affect a particular task and action (Alavi and Leidner, 2001; Dawson, 2000). OKCs are developed to perform knowledge processes (i.e., generating, capturing, sharing, and applying knowledge) more efficiently so as to achieve organizational success (Dawson, 2000). In other words, OKCs enable firms to mobilize and deploy knowledge resources in combination with other resources and capabilities in order to perform knowledge activities (Yang and Chen, 2007). Gold et al. (2001) argued that infrastructural knowledge capabilities are comprised of three dimensions, namely technical, cultural, and structural knowledge capabilities. Alavi and Leidner (1999) considered that information, technological, and cultural knowledge capabilities provide the three principal perspectives of a firm's KM capability. The development of OKCs is a necessary feature of the learning organizations (Pemberton and Stonehouse, 2000).

Bhatt (2001) suggested using two primary perspectives (SOKCs and TOKCs) to measure OKCs. Subsequently, Prieto and Easterby-Smith (2006) considered examples of the management of organizational knowledge from technical and social perspectives, which appear to contribute to a firm's dynamic capabilities. The technical aspect focuses on using ICT to manage task-related knowledge, while the social perspective stresses the importance of the non-technical resources deployed in a knowledge-based firm.

2.2.1 Social-Based Organizational Knowledge Capabilities

Organizational contexts play a vital role in providing the environment needed to support a firm's knowledge and learning activities. The development of knowledge processes requires a social-based organizational context that can enrich the maintenance and innovation of knowledge assets, which in turn increase organizational benefits. When asked what social contexts are related to KM, executives tend to focus on people, culture, and structure (Drejer, 2000; Pemberton and Stonehouse, 2000). Many studies have noted the importance of contextual factors, such as a friendly knowledge culture (Davenport et al., 1998), a reasonable incentive system (Hall, 2001), and an effective interpersonal network (Yang and Chen, 2007) in the successful implementation of KM and OL programs. A firm needs to create a social-based context that maximizes the organizational capability for improving learning activities over time (Thomas et al., 2001).

SOKC – the ability to link and leverage non-technical knowledge resources (Yang and Chen, 2007) – can provide the bulk of added value in knowledge processes needed to maintain a competitive advantage. Knowledge embedded in organizational practices, values, and processes is socially constructed as a context-dependent resource (Lang, 2001). Hence, in this study, it is essential that we consider SOKC as a part of a firm's capabilities. Based on the work of Chuang (2004) and Yang and Chen (2007), we characterize a firm's SOKCs, including structural, cultural, and human knowledge capabilities, as measurable variables to describe the fundamental capability for maximizing social capital in an organization. Social capital is typically defined as "resources embedded in a social structure that are accessed and/or mobilized in purposive action" (Lin, 2001, p. 29)

2.2.2 Technical-Based Organizational Knowledge Capabilities

A firm's technical infrastructure is an important factor that can affect KM activity substantially. Davenport and Prusak (1998) emphasized that the value of IT in a KM project has to focus on the link between technology and people, rather than the technology itself. In other words, although an IS is a useful platform/tool for storing and distributing organizational knowledge, if the organization lacks the ability to operate this platform/tool, then the value of the technical infrastructure will be lost. Bhatt and Grover (2005) argued that the technical infrastructure alone is not a direct source of differentiation in a firm, but the ability to effectively leverage that infrastructure is. Therefore, aligning different technological resources to support knowledge and learning activities is a key firm capability in a knowledge-based organization (Bharadwaj, 2000; Chuang, 2004; Gold et al., 2001). That is, technological capability is regarded as the ability to leverage and deploy organizational knowledge by using the functionalities of technological resources effectively (Pavlou and El Sawy, 2006; Tippins and Sohi, 2003).

TOKCs can enable firms to implement organizational knowledge processes rapidly, map internal or external knowledge sources effectively, and create new knowledge by applying existing information effectively (Chuang, 2004; Gold et al., 2001). We develop the construct of TOKC by drawing on the aspect of IT capability, which determines a firm's ability to convert IT assets and services into strategic applications (Bharadwaj, 2000). TOKCs affect a firm's ability to perform technological operations efficiently and reconfigure existing technical capability (Pavlou and El Sawy, 2006). King (2002) suggested some guidelines for practitioners to emphasize the importance of developing explicit IT capabilities, such as hardware, software, shared services, and technical and managerial skills. Synthesizing the literature on IT capability, Pavlou and El Sawy (2006) defined three aspects of technological capability: the acquisition of IT resources, the development of IT-business relationships, and the leverage of IT resources and skills. Bharadwaj (2000) also reported three dimensions of IT-based resources and capabilities: tangible resources (e.g., the physical infrastructure), human IT resources (e.g., IT skills), and intangible IT-enabled resources (e.g., knowledge assets). Tippins and Sohi (2003) considered similar constructs (IT objects, IT operations, and IT knowledge). Based on those constructs, in this study, we define TOKC as a measurable variable that shows the extent to which a firm is acquainted with IT and employs IT resources effectively to manage organizational knowledge.

2.3 Organizational Learning

OL, a practical field that combines knowledge with organizational theory, derives mainly from the model of single- versus double-loop learning. The model describes a set of actions within an organization that are intended to detect and correct errors (Argyris and Schön, 1978). With the highly unstable business environment, OL is receiving increasing attention from KM scholars and business practitioners (Fiol and Lyles, 1985; Huber, 1991; King, 2001; Wang and Ahmed, 2003). OL tries to create new knowledge for adapting organizational change (Templeton et al., 2002) and emphasizes how a corporation maintains and utilizes its organizational knowledge to improve its performance (King et al., 2008).

OL, which is strategically valuable to firms, is the ability to manage knowledge in order to acquire, share use, and create information (Bergman et al., 2004; Templeton et al., 2002). The most important learning tasks in an organization involve disseminating valuable knowledge resources and using them effectively (López et al., 2004). Recently, some researchers have also suggested that OL can be described as a production process whereby a firm's knowledge is generated (Huber, 1991; López et al., 2004; Tippins and Sohi, 2003; Wang and Ahmed, 2003).

Specifically, OL is a set of dynamic processes that move knowledge from individuals to firms based on organizational information activities (Real et al., 2006; Ruiz-Mercader et al., 2006). The process-oriented OL stresses the importance of facilitators for OL and it should transform information into knowledge (Dimovski et al., 2008) through better awareness (Fiol and Lyles, 1985). Four features are defined as the essential characteristics of process-oriented OL (López et al., 2004): (1) a transformational process that creates and recreates knowledge continuously; (2) a cumulative process that acquires a large mount of knowledge; (3) an improvement process that tries to achieve the goal of organizational development effectively; and (4) a system process that impacts the whole of the organization. Huber (1991) divided OL into four subprocesses: knowledge acquisition, information distribution, information interpretation, and organizational memory. Huber's model provides a comprehensive perspective of process-oriented OL and many researchers have conducted related studies (Lopez et al., López et al., 2004; Slater and Narver, 1995; Tippins and Sohi, 2003). Figure 1 summarizes the concepts of process-

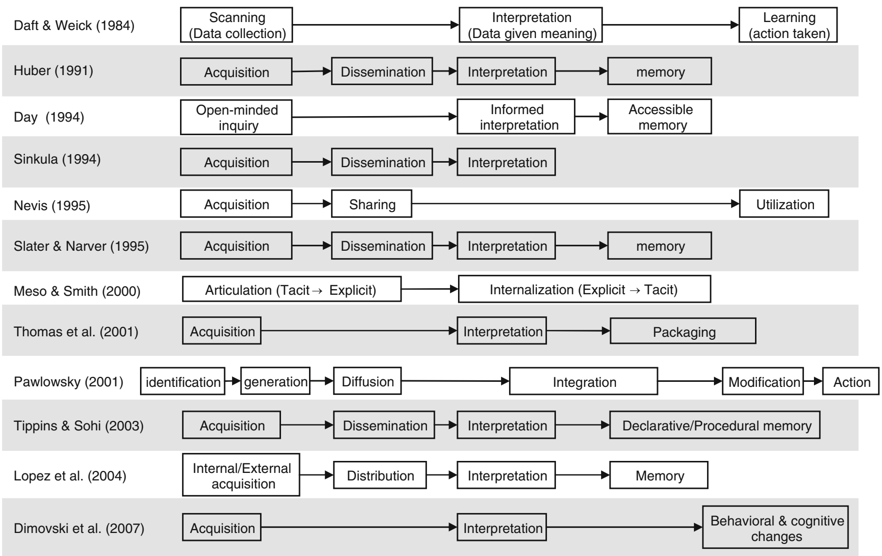

Fig. 1: Process-oriented organizational learning

oriented OL reported in the literature. These OL processes can effectively leverage information/ knowledge cycles to improve specific learning activities.

Most scholars agree that information generation, capture, or acquisition from a variety of sources is the first phase of increasing the volume of task-related knowledge for learning. The next step involves disseminating, sharing, or diffusing information through the firm's network in order to expand the breadth of usable knowledge. Then the acquired knowledge should be interpreted by shared terminologies. Finally, the shared knowledge is stored in the organizational memory in various forms and is accessible to employees of the organization. All the process-oriented learning activities are designed to modify, use, and create knowledge, which in turn drive behavioral changes.

We adopt the concept of process orientation to examine the construct of OL, which is defined as the extent which a firm acquires, disseminates, interprets, and memorizes organizational information/knowledge efficiently to manage learning activities within the firm.

3 Conceptual Framework and Development of Research Propositions

In this section, we introduce the proposed framework, describe the constructs, and explain the relationships between the constructs.

3.1 The Two Dimensions of OKCs and Their Relationship with OL

KM and OL, which are used interchangeably in many studies, are important strategic perspectives for developing and implementing learning in an organization (King, 2001). Effective KM is essential if a firm wishes to implement OL activities to create and sustain a competitive advantage (Meso and Smith, 2000). OL is described as changes in the state of knowledge and involves diverse knowledge activities (Wang and Ahmed, 2003). Two perspectives for exploring the relationship between KM and OL were discussed by King et al. (2008). One considers OL as a process-oriented knowledge activity and KM as a content-based program. The other views KM as the means of accomplishing the goals of OL. In this section we explain the relationship between KM and OL in terms of an integrated aspect; that is, OL is regarded as a knowledge-based process and as the goal of KM development.

The features and characteristics of OL are influenced by a firm's structure, infrastructure, and culture (Pemberton et al., 2001). Research on the alignment of KM and OL based on the socio-technical view is the new focus of management science and information development (Meso and Smith, 2000). Chou (2003) developed an extended framework, which follows the concept of Huber's (1991) research, to examine the relationships between OL processes, computer systems, and organizational contexts The author claimed that IT and contextual variables as enablers are helpful for the process-oriented OL. Meso and Smith (2000) observed that many firms invest heavily in the development of organizational KM systems (OKMS) based on a socio-technical perspective. The objective is to construct a strategic system to assist knowledge workers and enhance OL.

To invest in capabilities that enhance KM and establish processes that facilitate OL, a firm needs to adopt flexible and innovative strategies (Bergman et al., 2004). Alavi and Leidner (2001) suggested that KM is a set of systems that help develop organizational capability and understanding of strategic know-how. Yang and Chen (2007) examined how organizational capabilities affect knowledge sharing, which is attributed to a sub-process of OL (Nevis et al., 1995). Exploration of how a firm's knowledge capability can be used to facilitate OL is therefore suggested as an important issue that is worthy of further research.

Hence, in this study, we consider KM as aspects of knowledge capability (KC) from a socio-technical perspective to impact OL processes. Hypothetically, a strong link exists between OKCs and OL processes. The proposed framework is shown in Fig. 2.

As mentioned previously, process-oriented OL is viewed as a progressive knowledge activity that involves acquiring/capturing, distributing/sharing, interpreting/integrating, and retaining/applying organizational knowledge. Therefore, process-oriented OL, a dependent variable in this study, consists of the following four processes: knowledge acquisition, knowledge dissemination, knowledge interpretation, and organizational memory (Huber, 1991; López et al., 2004; Slater and Narver, 1995; Tippins and Sohi, 2003). First, knowledge acquisition is identified and acquired as the beginning of OL. Acquired knowledge comes from distinct sources, including direct individual experience, the experiences of others, and organizational memory. Second, knowledge

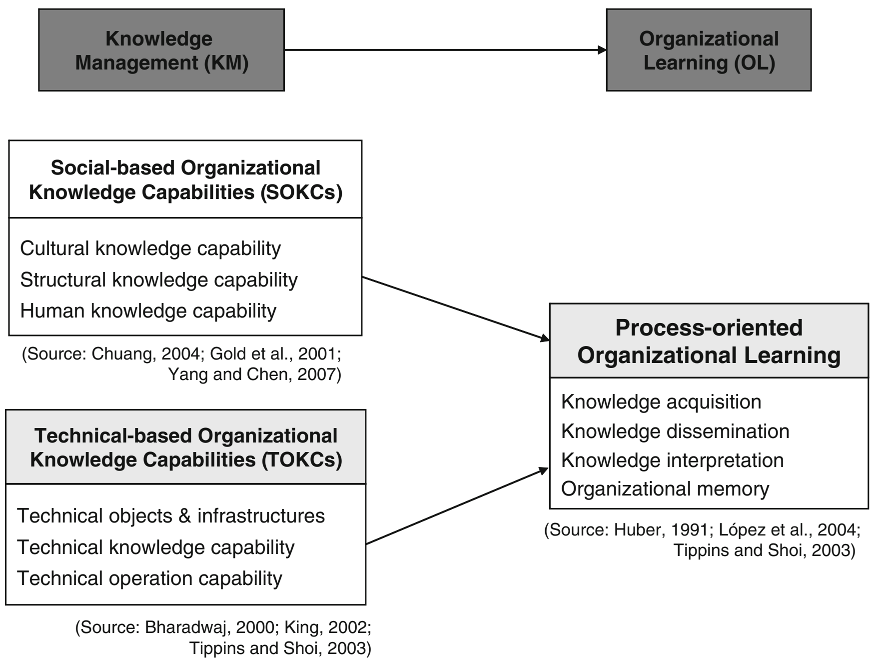

Fig. 2: A conceptual research framework

dissemination is a critical learning process that enables a shared context between its functional units by formal and informal channels. Third, knowledge interpretation process facilitates the interaction required for learning and innovation. Shared interpretation plays a key role in clarifying how information may contain similar semantic concepts. Fourth, organizational memory process provides the basis for knowledge accumulation and creation. It also reflects an organization's ability to absorb and store knowledge.

The objective is to use OKCs to perform knowledge and learning activities effectively within a firm. Therefore, we assume there is a positive relationship between OKCs and OL s and the effect of OKCs on OL is significant. We divide OKCs into SOKC and TOKC based on the social-technical view. Next, we elaborate on each of these constructs and develop our propositions.

3.2 Social-Based OKCs and Process-Oriented OL

The proposed model describes a SOKC as the ability to link and deploy non-technical knowledge resources effectively in order to achieve a learning advantage. The social dimension of OL can be better understood as a cognitive activity whereby an organization's members participate in the learning process (Bogenrieder, 2002), and as a relational-oriented view that explores a variety of social resources and contexts to facilitate OL (Chiva-Gomez, 2003). According to King (2001) "learning by social systems" may be considered as a knowledge strategy that aims to create social capital.

Social-based knowledge resources, including a firm's culture, leadership, incentive system, managerial policies, and co-workers' interactions, are driving forces that encourage employees to participate in OL (Pemberton et al., 2001). A firm needs to build organizational capabilities by using social-based knowledge resources effectively, which in turn affects learning activities (Thomas et al., 2001). Based on a personalization-oriented knowledge strategy, Janz and Prasarnphanich (2003) defined OL as a variety of activities that focus on discovering and transferring a firm's knowledge through the collaboration and interaction of experts or group participants. The enhancement of social-based resources and capabilities will provide positive and obvious benefits to the learning and innovation of organizational knowledge. Thus, we propose the following proposition:

Proposition 1

The higher SOKCs are within a firm, the better the effect they will have on process-oriented OL.

3.2.1 Cultural Knowledge Capability

Establishing a learning culture is one of the most challenging tasks in a knowledge-based firm. Culture – the collective perceptions, beliefs, norms, and values of employees in the workplace (Debowski, 2006) – is usually considered as a factor in the success of KM and OL. Based on a clear and shared vision, a knowledge-centered culture is one of the major antecedents of OL (Janz and Prasarnphanich, 2003), and a learning culture is a key factor that enables a firm to achieve the objectives of OL (Pemberton et al., 2001). Therefore, a firm should nurture the development of a learning culture to accelerate OL processes (Drejer, 2000; López et al., 2004; Slater and Narver, 1995).

Knowledge capability is a culture-based feature that facilitates continuous collective learning. The culture-based view of KM considers that teamwork, practical guidelines, and knowledge sharing are important organizational contexts that encourage learning behavior (Alavi and Leidner, 1999). The cultural knowledge capability (CKC), which exists within a learning context, stresses building an atmosphere of trust to support individuals in experimenting with new ideas in business (Pemberton and Stonehouse, 2000). In addition, CKC is viewed as a supportive capability that values the importance of organizational knowledge and develops an ambience of collaboration to transfer knowledge (Yang and Chen, 2007). In general, the alignment of core values within an organization, including collaboration, communication, and interaction, contributes to a positive and effective CKC (Debowski, 2006), and the capability affects the probability that learning will occur (Fiol and Lyles, 1985). Thus, we propose the following:

Proposition 2

Cultural knowledge capability is positively related to process-oriented OL.

3.2.2 Structural Knowledge Capability

Organizations need to motivate individuals to contribute their knowledge to a learning system. This is an important factor for any firm that wishes to retain intellectual assets and organizational memory (King, 2002). When a firm implements a new activity or system, structural factors are frequently mentioned as an effective means of motivating the people participating in it. López et al. (2004) suggested that organizational structure might be an interesting variable that influences learning activities. These structural enablers include tangible or intangible resources and capabilities. For example, Hall (2001) posited that reward, career advancement, and learning opportunities are important means of motivating people to participate in knowledge and learning activities. That is, knowledge is more likely to be learned effectively when appropriate incentives are in place. The mechanism of political directives (e.g., management principles) is another means of portraying the effect of structural factors on knowledge processes within a firm (Yang and Chen, 2007).

SKC – assessing the extent to which an organization integrates structural resources – attempts to create new knowledge through external encouragement for organizational creativity and innovation (Yang and Chen, 2007). Structural resources and capabilities play critical roles in determining process-oriented learning activities (Chiva-Gomez, 2003; Fiol and Lyles, 1985; Pemberton et al., 2001). SKC guides process-oriented OL via a number of mechanisms, including formal planning and control, reward systems, and the allocation of responsibility (Drejer, 2000). Therefore, we propose the following proposition:

Proposition 3

Structural knowledge capability is positively related to process-oriented OL.

3.2.3 Human Knowledge Capability

To develop better OKCs in the social dimension, the people factor is considered an important driver of organizational knowledge and learning activities (Smith and McLaughlin, 2004).

Relationships and organizational networks are two significant elements frequently mentioned as the factors used to transfer business practices effectively (O'Dell et al., 1999). Interpersonal relationships could improve the reliability of a firm's employees and may further motivate the employees to become involved in organizational systems; that is, the more friendly the relationships among colleagues, the more they will be prepared to contribute their knowledge.

An interpersonal network enables individuals to exchange their knowledge about values, assumptions, insights, and cognition (Inkpen and Tsang, 2005). More frequent interactions among employees result in a better organizational network.

We conceptualize human knowledge capability (HKC) as the relationship between interpersonal understanding and the extent of interaction among a firm's members in order to create a valuable knowledge network in an organization (Chuang, 2004; Yang and Chen, 2007). The reliability of participants influences learning behavior, and the knowledge network of a firm fosters learning processes (Bogenrieder, 2002). Organizations that foster learning thus place great emphasis on the human element (Drejer, 2000). This leads to the following proposition:

Proposition 4

Human knowledge capability is positively related to process-oriented OL.

3.3 Technical-Based OKCs and Process-Oriented OL

The value of technological resources and capabilities in organizations is, by most indications, growing in importance. A firm's technology plays a fundamental role in KM programs and it has the potential to support OL through the acquisition, representation, distribution, storage, and retrieval of organizational knowledge. Technological assets or capital facilitate OL activities (Real et al., 2006); however, administrators should place greater emphasis on the development of IT capabilities (Chou, 2003; King, 2002. An organization needs to invest in the IT resources and capabilities if it wishes to control, distribute and share knowledge assets. In this study we adopt TOKCs as important technological capabilities for developing knowledge activities and facilitating learning processes.

It is important for businesses to develop technological capabilities by acquiring external knowledge, and then diffusing, communicating, sharing, and assimilating these capabilities into their organizations. Although it has been shown that IT capability is associated with increased productivity (Bharadwaj, 2000; Gold et al., 2001), research on whether technological capability affects the activities of an organization to learn from internal/external knowledge sources is in its infancy. Based on the theory of RBV, Tippins and Sohi (2003) found out that the enhancement of a firm's IT capability can improve its ability to acquire and disseminate information efficiently, interpret shared knowledge easily, and store the information in the firm's memory conveniently. The technological capability is important for a firm to drive the OL processes (Ruiz-Mercader et al., 2006; Yang and Chen, 2007). Accordingly, the learning activities of a firm should be enhanced through TOKC. Thus, put forward the following proposition:

Proposition 5

The higher TOKCs are within a firm, the better the effect they will have on process-oriented OL.

3.3.1 Technical Objects and Infrastructures

IT is an effective infrastructure for creating, accumulating, and sharing organizational knowledge (Alavi and Leidner, 2001). That is, the deployment of technological resources is based on a key dimension of TOKC upon which the entire business depends (Pavlou and El Sawy, 2006; Tippins and Sohi, 2003). The technical infrastructure, which is similar to the technical object discussed in Tippins and Sohi's (2003) work, is regarded as a set of technological assets that includes computer-based hardware, software, and applications. To manage information and knowledge effectively, organizations need to employ appropriate technical assets and schemes that ensure the efficiency of information processes and organizational activities.

In this study, we assume that technical objects and infrastructures can improve learning processes. IT can be used as an important tool for knowledge transformation (e.g., from tacit to explicit knowledge). It can also be used as a critical instrument for information functionalities (e.g., information codification and diffusion) in creating and supporting a firm's capability, which in turn improves OL processes (Pemberton and Stonehouse, 2000; Ruiz-Mercader et al., 2006).

The link between technical objects and infrastructures and OL is well established (Chou, 2003; Real et al., 2006). As IT becomes more widespread, technical assets can increase the learning activities of individuals and teams who acquire task-related information and contribute their knowledge to the firm's memory. Thus, the following proposition is set forth:

Proposition 6

Technical objects and infrastructures are positively related to process-oriented OL.

3.3.2 Technical Knowledge

Knowledge is described as a belief that improves an entity's capacity for action effectively (Alavi and Leidner, 2001). A rapid advance in the development of IT means that individuals need to enhance their technological capabilities to discover task-related knowledge in order to solve problems and improve the effectiveness of their work. Technological knowledge is conceptualized as a firm's ability to understand the concepts of computer hardware, software, and procedures to design, develop, and maintain specific applications for task-related activities. That is, technical knowledge refers to the knowledge a firm possesses about technical objects and infrastructures (Tippins and Sohi, 2003) and how well employees understand fundamental IT concepts (Bassellier et al., 2003). This implies that technical knowledge is a part of IT capabilities.

Technical knowledge is comprised of three components: the application of IT, the effect of IT on management, and the acceptance of state-of-the-art technology within the firm (Ghingold and Johnson, 1997). The diversity of technical knowledge and activities should also facilitate OL. Tippins and Sohi (2003) posited that technical know-how based on contextual factors is an essential component of learning processes. Managers with higher levels of technical knowledge are helpful for information acquisition and decision making (Ghingold and Johnson, 1997). Organizational IT knowledge can enhance the technical ability of employees to use an information platform to learn task-related knowledge. If employees understand more technical knowledge, it is easier to acquire, distribute, interpret, and accumulate further knowledge. Technical knowledge is therefore a critical factor in promoting learning activities within a firm. Thus, we put forward the following proposition:

Proposition 7

Technical knowledge is positively related to process-oriented OL.

3.3.3 Technical Operations

Technical operations consist of activities that are performed to achieve a particular purpose (Tippins and Sohi, 2003). Tippins and Sohi (2003) consider two implications of technical operations. First, technical operations represent a deep understanding of a particular knowledge domain. Second, technical operations reflect an ability to extend the knowledge to other operations. Technical operations are defined as the individual's ability to use IT to organize task-related knowledge effectively (Bharadwaj, 2000; Chuang, 2004). The ability is viewed as a method, skill or process for dealing with the organizational knowledge activities through IT infrastructure (Tippins and Sohi, 2003). Technical operations, or IT skills, are therefore considered components of IT capability.

IT is widely employed to connect people to improve OL and acquire task-related skills for solving problems (Ruiz-Mercader et al., 2006). In other words, diverse technical skills for operating IT systems make learning processes more efficient. As a result, practitioners have focused on enhancing technical operations to assist OL. Thus, the following proposition is set forth:

Proposition 8

IT operations are positively related to process-oriented OL.

4 Summary and Recommendations for Further Study

The proposed framework is derived from the existing literature on KM and OL. Recognizing the dynamics and complexity of KM research, a capability-based model of organizational knowledge, called organizational knowledge capability (OKC), is proposed. OKCs, as the foundation of a firm's success, must be enhanced continually to ensure organizational development. We also introduce a socio-technical perspective of knowledge capability, which integrates the technological and the social sides of OKC to distinguish the dimensions of capability-based organizational knowledge. SOKC, including the aspects of cultural, structural, and human resources and capabilities, is viewed as a facilitator that encourages employees to participate in a firm's activities. TOKC, including the aspects of technical infrastructure, applicable knowledge, and practical techniques, facilitates the movement of organizational knowledge efficiently. Both dimensions (social and technical) are necessary for developing knowledge capabilities and linking the behavior of OL. In a firm, learning is often embedded in organizational activities that are performed and accumulated through a knowledge process. Process-orientated OL, including knowledge acquisition, dissemination, interpretation, and storage, is therefore an appropriate perspective for exploring how a firm accomplishes its learning goals.

This study deals with the link between capability-based organizational knowledge and processed-oriented OL by providing synthesis of these closely related concepts. We suggest that TOKC has a significant effect on OL, and we put forward a number of postpositions about the importance of technological resources and capabilities for learning processes. TOKCs assist OL in capturing, acquiring, sharing, and reusing task-related information by ICT resources effectively. They also build shared meanings to help personnel understand and interpret the semantics of task-related knowledge. At Buckman Laboratories, knowledge suppliers and users are connected through the K'Netix® system, which reduces the cost of communications and improves collaboration among employees (Pan and Scarbrough, 1998). The practitioners at Buckman Laboratories achieve the learning effect by employing IT assets and improving IT capabilities.

The propositions about SOKCs suggest that the collective and separate effects have a positive influence on OL. In order to improve the learning capability of an organization, a corporate should use its non-technical resources well. To maximize the effects of process-oriented OL, a Connecticut-based steel manufacturer – Nucor Corporation illustrates how a social system can improve knowledge flows within a firm (Gupta and Govindarajan, 2000). The firm has developed a variety of transmission channels, such as face-to-face communication and a community network, to facilitate the transfer and sharing of tacit knowledge held by individuals. Nucor also utilizes various social mechanisms, such as effective incentives (e.g., rewards, bonuses) and techniques of empowerment (e.g., fault tolerance, accountability); to tap workers' diverse abilities and help they discover new knowledge. Thus, by investing more in incentives and empowerment, a firm can generate new products and services to sustain its competitive advantage. The practitioners of the Nucor cooperation accomplish the learning process by the development of organizational resources and the implementation of social-based capabilities.

In short, firms should invest in developing knowledge resources and capabilities to create new products and services. Managers must turn their attention to the development of capability-based OKCs from a socio-technical perspective to enable OL processes.

The findings to date are valuable, but they need to be corroborated by further empirical evidence. Relatively limited studies have provided empirical insights into the effect of capability-based organizational knowledge on process-oriented OL. The framework and propositions presented in this study require further empirical testing before managerial implications can be derived. This suggests a critical study for future work, with the opportunity to examine the relationships in the proposed framework. Accordingly, we briefly introduce a few notions about how the proposed framework is measured empirically. First, most of the instruments of the proposed constructs are available in the related literature; however, we should use them very carefully to explore the proposed relationships. With regard to TOKC, the measures proposed by Tippins and Sohi (2003) might be appropriate for testing our research propositions. Second, further research should investigate the relationship between OKCs and OL, with a variety of samplings. For example, the investigation of various industries might result in the different findings. Additionally, the model can be expanded in either forward from OL or backward from OKC. OL might act as a mediator that leads to better performance (King et al., 2008) or OL is a mediator that influences the innovation of product and service. On the other hand, the antecedents of OKCs might be identified and explored.

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Organizational Learning and Performance in Two National Cultures: A Multi-group Structural Equation Modeling Approach

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Abstract. This chapter examines the impact of organizational learning on organizational performance in two countries. Using a multi-group structural equation modeling approach on data from 203 Slovenian and 202 Croatian companies, it tests the impact of the organizational learning process on financial and non-financial performance (NFP). The results show consistent findings between both countries under investigation (which vary only in terms of effect strength). First, the organizational learning process connects information processing with behavioral and cognitive changes. Second, organizational learning has a very strong direct impact on NFP (reflecting performance from employee, supplier, and customer points of view). Third, the effect of organizational learning on financial performance (measured in terms of return on assets and value added per employee) is also positive and strong, but indirect and exhibited through NFP. Finally, no direct effect on financial performance has been observed in any of the two cases. This paper advances the theory and practice of organizational learning by uncovering one specific aspect of the context in which organizational learning processes occur. It is the first of its kind to control for the contextual variables of national culture and economic development regarding the organizational learning – performance link.

Keywords: Organizational learning, Organizational performance, Multi-group structural equation modeling, Slovenia, Croatia

1 Introduction

Organizational learning is one of the most important sources of sustainable competitive advantage that companies have (de Geus, 1988), as well as an important driver of corporate performance (Stata, 1989). Constant learning is a key driver of an organization's ability to remain adaptive and flexible – that is, to survive and effectively compete. This is especially the case in turbulent and volatile business environments (Sorenson, 2003; Tucker et al., 2007). Hence, it is crucial to manage organizational learning processes within these organizations in order to successfully compete.

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The literature on organizational learning is vast and growing at an intense rate. Organizational learning has emerged as one of the most researched phenomena in the organizational sciences (Argote et al., 1990; Argyris and Schön, 1978; Bapuji and Crossan, 2004; Beckman and Haunschield, 2002; Bogenrieder and Noteboom, 2004; Borgatti and Cross, 2003; Brown and Duguid, 1991; Cohen and Levinthal, 1990; Davis and Luthans, 1980; Dimovski et al., 2008; Easterby-Smith, 1997; Fiol, 1994; Fiol and Lyles, 1985; Huber, 1991; Kane and Alavi, 2007; Kang et al., 2007; Lankau and Scandura, 2002; Lave and Wenger, 1991; Lazega et al., 2006; Liebeskind et al., 1996; Liebowitz et al., 2007; Levin, 2000; March, 1991; Pisano et al., 2001; Shrivastava, 1983; Sorenson, 2003; Škerlavaj et al., 2007; Visser, 2007).

The concept of organizational learning is embedded in different scholarly literatures, including management science (Argyris and Schön, 1978; March, 1991; Huber, 1991; Nonaka, 1994; Senge, 1990) strategic management (Andreu and Ciborra, 1996; Dodgson, 1993; Vera and Crossan, 2004), psychology and organizational development (Brown and Starkey, 2000; Dixon, 1994; Kolb et al., 1981; Nonaka and Takeuchi, 1995), information systems (Robey et al., 1995; Tippins and Sohi, 2003), system dynamics (Lomi et al., 1997), production management (Argote et al., 1990; Adler and Cole, 1993), cultural anthropology (Raz and Fadlon, 2006), sociology (Brown and Duguid, 1991; Lave and Wenger, 1991; Lazega et al., 2006), and organizational theory (Cyert and March, 1963; March and Simon, 1958; Shrivastava, 1983). As such, it comes as no surprise that the concept of organizational learning is founded on a wide assortment of theoretical assumptions which should be viewed as complementary to each other in an understanding of the organizational learning field (Dodgson, 1993; Easterby-Smith, 1997; Shrivastava, 1983).

In their review of the literature on organizational learning and performance, Dimovski and Škerlavaj (2008) found 20 works of empirical literature that examine this link. While the literature on organizational learning is noteworthy, to date most of the research on organizational learning and performance has been limited to one setting (country) at a time. This contribution begins to address this gap by simultaneously testing the impact of organizational learning on performance in two different countries. Hence, it controls for the contextual factor of national culture and tests the invariance of the organizational learning-performance link. This study aims to explore whether the previously established positive link between organizational learning and performance varies according to different national culture contexts. For this project, it uses data collected in companies in two countries, Slovenia and Croatia, and the advanced methodology of multi-group structural equation modeling (SEM). The overall research objective was to assess whether the organizational learning-performance link is culturally invariant or not.

This paper is organized as follows. We begin by presenting the theoretical foundations of organizational learning and performance. Following this, we present our research hypotheses regarding the impact of organizational learning and performance, and its cultural invariance. Next, we present the methodological framework, company, and sample profile, and data collection procedures. This is followed by a presentation of the results of the multi-group SEM. We then discuss the results and their implications, expose some limitations, and suggest future research opportunities.

2 Theoretical Framework

2.1 Organizational Learning

Organizational learning is a process that concerns transforming information into knowledge and knowledge into action (Argyris and Schön, 1978; Crossan et al., 1995; Day, 1994; Fiol and Lyles, 1985; Huber, 1991), which is then reflected in accompanying behavioral and cognitive changes (BCC) (Crossan et al., 1995; Kim, 1993).

Despite and maybe even because of its importance, organizational learning has numerous definitions and there are many perspectives in the field. This is consistent with the findings of the few early authors. According to Shrivastava (1983), the vast majority of research in the area has been fragmentary and incomplete. To present just few of them, Senge (1990) defines organizational learning as "a continuous testing of experience and its transformation into knowledge available to the whole organization and relevant to their mission", while Huber (1991) sees it as a combination of four processes: information acquisition, information distribution, information interpretation (INFINT), and organizational memory. Argyris and Schön (1978) are even less restrictive in their definition, declaring that organizational learning emerges when organizations acquire information (knowledge, understanding, know-how, techniques, and procedures) of any kind by any means.

Given the multidisciplinarity of the field, it is no surprise to see the variety of definitions (Table 1). The common trait of the majority of the definitions is that they consider organizational learning as a process that involves transforming information into knowledge (Argyris and Schön, 1978; Crossan et al., 1995; Day, 1994; Dimovski, 1994; Fiol and Lyles, 1985; Huber, 1991; Lee et al., 1992). Definitions differ in the way they extend (or not) information processing (information acquisition, interpretation, and storage in the organizational memory) to BCC (Crossan et al., 1995; Dimovski, 1994; Kim, 1993; Slater and Narver, 1995). One could call the tradition that understands organizational learning as the process of information acquisition, information distribution, INFINT, and BCC, Huber's tradition of information processing upgraded with the action perspective. In addition, there is another tradition, more recently emerged, and that can be labeled the Canadian school of thought (Bontis et al., 2002), which differentiates between knowledge stocks and learning flows, and does so by looking at individual, group, and organizational-level knowledge stock and feed-forward as well as feed-back learning flows. These two traditions differ also in the way they operationalize the organizational learning concept as shown in the overview of the previous research (Dimovski and Škerlavaj, 2008). Huber's tradition is based on information processing and BCC as operationalized in e.g. the OLIMP (Organizational Learning and Information Management Processes) questionnaire (Dimovski, 1994; Škerlavaj et al., 2007; Dimovski et al., 2008), while the Canadian school uses the SLAM questionnaire (Strategic Learning Assessment Map).

2.2 Modern Concepts of Organizational Performance Assessment

The conceptualization and measurement of organizational performance is a problematic concept in strategy research (Venkatraman and Prescott, 1990), with many different variables being used. Nevertheless, there seems to be a few trends evident in the assessment of organizational performance

Table 1: Definitions of Organizational Learning

Author(s)	Definition
Argyris and Schön (1978)	Organizational learning is a process of detecting and correcting errors.
Crossan et al. (1995)	Learning is a process of change in cognition and behavior, and it does not necessarily follow that these changes will directly enhance performance.
Daft and Weick (1984)	Organizational learning is knowledge about the interrelationships between the organization's action and the environment.
Dimovski (1994)	Organizational learning is a process of information acquisition, information interpretation, and resulting behavioral and cognitive changes, which should in turn have an impact on organizational performance.
Fiol and Lyles (1985)	Organizational learning means the process of improving actions through better knowledge and understanding.
Huber (1991)	An entity learns if through its processing of information the range of its potential behaviors is changed.
Kim (1993)	Organizational learning is defined as increasing an organization's capacity to take effective action.
Levinthal and March (1993)	Organizational learning copes with the problem of balancing the competing goals of developing new knowledge (exploration) and exploiting current competencies (exploitation) in the face of dynamic tendencies to emphasize one or another.
Schwandt and Marquardt (2000)	Organizational learning represents a complex interrelationship between people, their actions, symbols, and processes within the organization.
Slater and Narver (1995)	At its most basic definition, organizational learning is the development of new knowledge or insights that have the potential to influence behavior.
Stata (1989)	Organizational learning is the principal process by which innovation occurs. (In fact, I would argue that the rate at which individuals and organizations learn may become the only sustainable competitive advantage, especially in knowledge-intensive industries.)

Sources: Adapted from Bontis et al. (2002), Dimovski (1994), and Shrivastava (1983)

(1) moving away from purely financial to non-financial indicators as well, (2) broadening the emphasis from shareholders to other stakeholder groups, and (3) investing efforts to evaluating also present and future performance as opposed to past performance alone. The reason for these trends lies in the fact that a modern business environment demands a multi-goal orientation, which is something that most previous research on organizational learning and performance has neglected. Profit theory (Cyert and March, 1963) is, alone, no longer a valid basis for organizational performance. The same goes for other approaches that are only concerned with the interests of the shareholders of a company. Today's business environment is characterized by the increased importance of customers, employees, and society in general. It has become obvious that all

stakeholders need to be taken into account in an assessment of a modern company's performance (Freeman, 1984, 1994).

The behavioral theory of a company (Cyert and March, 1963) already recognized the company as a coalition of individuals or groups of individuals such as management, employees, customers, owners, and government. Stemming from these origins, financial performance along with non-financial performance (NFP) must be assessed in order to evaluate the overall organizational performance of a modern company (Tekavčič, 1998; Tekavčič and Peljhan, 2002). Several approaches to selecting non-financial indicators exist, the most established and widespread of which is the Balanced Scorecard – BSC (Kaplan and Norton, 1992, 1993, 1996). Its extension represents the so-called Dynamic Multi-Dimensional Performance (DMP) framework (Maltz et al., 2003), which extends the BSC to also include the people development dimension (besides financial, customer, process, and future dimensions). Interestingly, research among 180 US top managers demonstrated that the most important indicator of business success is the retention of key employees, followed by sales and customer satisfaction (Maltz et al., 2003). Indeed, Agrell et al. state that "although a profit maximizing behavior may be induced by profit-sharing schemes, such contracts may easily lead to sub-optimal levels of organizational training, innovation, and knowledge transfer" (Agrell et al., 2002, p. 1). Today's business environment is characterized by the increasing importance and strength of various stakeholder groups.

It has become quite obvious that all stakeholders need to be taken into account when assessing a modern company's performance. This is the main idea of Freeman's Stakeholder theory (Freeman, 1984, 1994). The stakeholder view maintains that firms have stakeholders rather than just shareholders to account for. The view that the corporation has obligations only to its stockholders is replaced by the notion that there are other groups to whom the firm is also responsible. Groups with a "stake" in the firm include shareholders, employees, customers, suppliers, lenders, the government, and society (Berman et al., 1999; Harrison and Freeman, 1999; Hillman and Keim, 2001). Emerging management paradigms emphasize a stakeholder perspective (Atkinson et al., 1997; Berman et al., 1999; Harrison and Freeman, 1999; Hillman and Keim, 2001; Sirgy, 2002; Tangem, 2004).

One important notion revealed in many studies is that building better relations with primary stakeholders like employees, customers, and suppliers could lead to increased shareholder wealth. A sustainable organizational advantage may be built with tacit assets that derive from developing relationships with key stakeholders (Hillman and Keim, 2001). When studying the relationship between stakeholder management and a firm's financial performance, Berman et al. (1999) found that fostering positive connections with key stakeholders (customers and employees) can help a firm's profitability.

Due to the significance of various stakeholders, organizational performance should not be solely assessed by financial indicators. There are several approaches (Tangem, 2004) to organizational performance measurement that encompass different stakeholders' perspectives. The Balanced Scorecard – BSC (Kaplan and Norton, 1992, 1993, 1996) is the most established and most commonly used (Neely, 2005), but by far not the only one. The multi-model performance framework (MMPF) model by Weerakoon (1996) is also very interesting and has four dimensions, comprising employee motivation, market performance, productivity performance, and societal impact, and covers the satisfaction of various stakeholders, such as customers, investors, employees, suppliers, and society. A more recently developed conceptual framework is the performance prism, which suggests that a performance measurement system should be organized around five distinct but linked perspectives of performance (Tangem, 2004, p. 733). Either way, it is important to include non-financial indicators of performance of various stakeholder groups to arrive at a more valid picture of a company's success or failure.

3 Research Hypotheses and Model

The impact of organizational learning on organizational performance has been of high interest in empirical research since the 1990s. Jones (2000) emphasizes the importance of organizational learning for organizational performance, defining it as "a process through which managers try to increase organizational members' capabilities in order to better understand and manage the organization and its environment to accept decisions that increase organizational performance on a continuous basis" (Jones, 2000, p.472). In line with this thinking, Dimovski and Škerlavaj (2008) conducted a systematic overview of the empirical literature for the period 1990–2006 on the impact of organizational learning on performance. Using content and meta-analysis of the Web of Science, Proquest, and Emerald databases, they identified 20 units of empirical literature that explicitly examine this link.

Four empirical pieces emerged in 1990s (Darr et al., 1995; Dimovski, 1994; Lam, 1998; Simonin, 1997). Dimovski (1994) demonstrated the positive impact of organizational learning on financial performance using a one-industry research design and a stratified sample of 200 credit unions in Ohio. Using a 39-item questionnaire based on Huber's (1991) definition of organizational learning upgraded with BCC, and 16 traditional financial items to evaluate organizational performance, he established positive relationships between organizational learning and performance (via LOGIT regression). Darr et al. (1995) used a different approach – learning curves. They examined the acquisition, depreciation, and transfer of knowledge acquired through learning by doing in a service organization and found evidence of learning; as the organizations gain experience in production, the unit cost of production declines significantly. As such, they rely upon the specific, indirectly and objectively measurable evidence of learning by doing (and not many other kinds of learning).

Simonin (1997) was the first to expand the notion of organizational performance in the organizational learning literature to also include non-financial indicators. He found strong effects of learning on financial and NFP in the context of strategic alliances. Specifically, he tested the influence of collaborative know-how on tangible as well as intangible collaborative benefits. Tangible benefits are strategic and financial: generating additional profits, improving market share, and sustaining a competitive advantage. From a methodological standpoint, he was also the first to use SEM in this respect. Lam (1998) was the first author to sway the focus of research away from the United States to Hong Kong. By investigating 95 sales people in eight organizations and using Kolb's (1985) Learning Style Inventory, he focused on individual learning level and found that accommodators significantly outperformed assimilators, convergers, and divergers in terms of their sales revenues.

By the end of 2006, 16 more empirical studies on organizational learning and performance were published. Only two of them followed the tradition of relying upon the objective measures of performance and use learning curves (Arthur and Huntley, 2005; Pisano et al., 2001). Pisano et al. (2001) examined learning curves in a health care setting and determined that organizations achieve performance improvements (improved work processes – reduced procedure times, hence increased efficiency) from their cumulative experience at different rates. Similarly, Arthur and Huntley (2005) observed learning curves for cost-reduction ideas in an automotive company in the USA and established that the cumulative number of employee suggestions actually implemented significantly contributed to lower production costs (with the additional assumption that an employee gain-sharing program has been introduced).

Rowden and Ahmed (2000) and Rowden (2002) addressed the issue of workplace learning (formal, informal, and incidental) and its impact on employee job satisfaction (one of the specific elements of NFP) in Malaysian and US small to mid-size companies (up to 200 employees). Their results for 12 US-based companies and 794 employees showed a statistically significant and high correlation between informal and incidental learning with job satisfaction. The correlation between formal workplace learning and overall employee job satisfaction was still statistically significant and positive, but moderate in size. This distinction can be used to neutralize the conventional wisdom that small and medium-sized companies do not have the time or money to deal with the development of their human resources (Rowden, 2002) and organizational learning. The opposite seems to be true (along with this important notion that they tend to use less formal forms than large companies).

Sloan et al. (2002) studied the impact of workforce knowledge and skills on price and lead time in an aerospace supplier and stressed the importance of knowledge and learning as the ultimate response to low-price competition. Figueireido (2003) used a comparative longitudinal case study in two large steel companies in Brazil to show the positive impact of well-thought out and systematic approaches toward knowledge-acquisition and knowledge-conversion processes on technological capability accumulation and operational performance.

While few studies have used methodologies such as the cross-sectional case study (Sloan et al., 2002), comparative and longitudinal case studies (Figueireido, 2003), and correlations (Rowden and Ahmed, 2000, Rowden, 2002), the vast majority of empirical studies since the year 2002 have acknowledged the fact that organizational learning is a latent construct (or even a second-order construct or process). Hence, a very popular methodological framework for studying the organizational learning-performance link is SEM. Within the studies that use SEM, two approaches toward operationalizations of organizational learning emerge. Dimovski and Škerlavaj (2008) name one *Huber's tradition of information processing* and the second one *the Canadian school of organizational learning*.

3.1 Huber's Tradition of Information Processing

This stream (Dimovski and Škerlavaj, 2005; Llorens-Montes et al., 2005; Real et al., 2006; Llorens-Montes et al., 2005; Santos-Vijande et al., 2005) builds upon Huber's (1991) definition of organizational learning with various sets of operationalization items that range from four to 37 items.

Based on empirical research among 220 Slovenian companies, Dimovski and Škerlavaj (2005) and Škerlavaj et al. (2007) use the OLIMP questionnaire and demonstrate a statistically significant positive and strong impact of organizational learning on both financial and non-financial organizational performance. Companies that have managed to develop organizational learning of a higher level have gained in terms of higher profits and value added per employee relative to their competitors. Besides the improved financial status of the company, higher-level organizational learning results in better relationships with employees, customers and suppliers.

Jashapara (2003) studied 181 UK construction companies and tested a model interrelating cooperative organizational culture, single- and double-loop learning, and organizational performance. His results also support the underlying assumption in the organizational learning literature (de Geus, 1988; Stata, 1989) that organizational learning powerfully contributes to organizational performance. Organizational learning in the form of double-loop learning does induce increased organizational performance. To be more precise, "it is the cognitive dimension of the double-loop learning that will aid organizations in sustaining competitive advantage rather than the behavioral dimensions of single-loop learning" (Jashapara, 2003, p. 45). Perez-Lopez et al. (2005) tested the influence of organizational learning on organizational performance for 195 Spanish firms with more than 200 employees. Their definition and operationalization of the organizational learning process included four stages (1) knowledge acquisition; (2) distribution; (3) interpretation; and (4) organizational memory. While one might argue that organizational memory is more a stock than a flow and can be considered a consequence of the process of organizational learning itself, it is certain that in order for organizational learning to actually happen, behavioral (Fiol and Lyles, 1985; Garvin, 1993; Lei et al., 1999; Senge, 1990; Simon, 1969) and cognitive changes are needed (Dimovski, 1994; Dimovski and Škerlavaj, 2005). Additionally, they (Dimovski, 1994; Dimovski and Škerlavaj, 2005) also build upon the somewhat too narrow understanding of the concept of organizational performance, which does not seem to cover the non-financial aspect adequately. Either way, the results of the Spanish study support the view that organizational learning contributes positively to both innovation and competitiveness and to economic/financial results.

Santos-Vijande et al. (2005) scrutinized the relationship between market orientation and organizational learning and their impact on mainly the financial aspects of business performance. Santos-Vijande et al.'s (2005) notion and operationalization of the organizational learning construct is even narrower than that in the research of Real et al. (2006) and also confuses the idea of organizational learning with the idea of the learning organization; however they use a 13-item scale to measure learning using the following three dimensions: commitment to learning, open-mindedness, and shared vision, which are all generally accepted elements of the learning organization model according to Senge (1990). For a sample of 272 Spanish industrial companies from seven selected industries (Standard Industry code 32-38) they came to the conclusion that a learning orientation does not exhibit a direct relationship with a firm's business results, but it does so through the firm's market orientation as a moderating variable, and they also showed the statistically significant impact of the firm's learning orientation on the firm's trust in a strategic customer.

Llorens-Montes et al. (2005) empirically examined the influence of support leadership and teamwork cohesion on organizational learning, innovation, and financial and operational performance. The organizational learning construct in their case is based on the work of Edmondson (1999) and Kale et al. (2000) and comprises four items (1) quantity of new and relevant knowledge acquired by the organization in the last 3 years; (2) critical capacities and skills acquired by members of the organization; (3) impact of learning acquired on the company's performance; and (4) the extent to which quality managers perceive their organization as a learning organization. Organizational performance consists of (1) economic profitability; (2) financial profitability; (3) percentage of profits over the total revenues; and (4) sales growth. Drawing from a sample of quality managers of 202 Spanish firms, they tested two structural models: one for administrative and the other for technical innovation. In both cases, they reached the conclusion that organizational learning (directly and indirectly – through innovation) positively affects financial and operational performance.

Using the same measurement instrument, Garcia-Morales et al. (2006) examined 406 Spanish organizations in four industrial sectors (food-farming, manufacturing, construction, and services) and found that organizational learning contributes to financial and operational performance. Their research is also interesting because they controlled for company size (the number of employees) and compared "intellectual" (software companies and biotech firms) to other organizations, and in both cases found no statistically significant differences.

Jiménez-Jiménez and Cegarra-Navarro (2007) used the organizational learning scale developed by Perez-Lopez et al. (2005) based on Huber's (1991) definition. They used a sample of 451 south-eastern Spanish companies with more than 15 employees in order to test a model relating market orientation and organizational learning to organizational performance. Their results suggest that the influence of market orientation on performance is only significant when mediated by organizational learning. Their results also show that organizational learning has a positive and strong effect on performance measured using the human relations model, the open/internal system model, and the rational goal model. Ruiz-Mercader et al. (2006) examined the impact of information technologies and organizational learning on organizational performance in small Spanish businesses (in the region of Murcia) from the IT sector. Their results show that organizational learning is a mediating variable from IT to organizational performance. Both individual learning and learning at the organizational level demonstrated a positive impact on performance.

3.2 The Canadian School of Organizational Learning

Crossan et al. (1999) developed a 4I framework which relates organizational learning to the perspective of strategic renewal. They build upon four key elements (1) the tension between exploration and exploitation of knowledge; (2) multiple levels of organizational learning (individual, group, and organizational); (3) the association between the levels and four categories of social and psychological processes (intuiting, interpreting, integrating, and institutionalizing – 4Is); and (4) belief that cognition and action are mutually dependent. The SLAM framework (Crossan and Hulland, 1997) simplifies the 4I framework by focusing on the relationships between the three levels of learning. It offers five theoretical constructs: three learning stocks – individual, group, and organization (to represent the learning that resides within the level) and two learning flows – feed-forward and feed-back (the flow of learning across levels).

Bontis et al. (2002) operationalize the SLAM framework and apply it to a sample of the Canadian mutual fund industry. Their research design is somewhat specific but they managed to attract 32 out of 64 companies to participate in a survey where 15 employees from each firm filled in the questionnaire. Their results show that learning at individual, group, and organizational levels is all positively associated with business performance.

The strongest predictor of performance is learning at the organizational level. Besides, the misalignment of stock and flows has negative effects on performance. One important implication of their work is that companies can often improve this misalignment if they improve flows, as opposed to the common view that only additional investments in stock can bring about results. Nevertheless, there is one evident methodological shortfall in their research. Namely, they neglected one key assumption when collecting the data – the independence of observed units. Their data clearly show a hierarchy and should as such be treated with a more suitable tool (e.g., hierarchical linear modeling).

Real et al. (2006) examined the role of organizational learning on business performance on a set of 140 Spanish companies with more than ten employees coming from selected innovative sectors. They use the Strategic Learning Assessment Map (Bontis et al., 2002). This study has a relatively innovative operationalization of business performance that measures perceived performance at individual, group, and organizational levels. They intentionally selected only innovative industries, which might be considered a source of bias within the sample itself.

Another downside is that they limited their understanding of organizational learning to knowledge creation, while neglecting its transformation into action via cognitive and behavioral changes. They used a partial least squares methodology. Among other relationships related to in-formation technologies, technologically distinctive capabilities, organizational learning, and business performance, they found a statistically significant, positive, and strong impact of organizational learning on business performance.

The latest study relating organizational learning to organizational performance within the "Spanish stream" of research is that published by Prieto and Revilla (2006). Instead of the term organizational learning, they use the term learning capability, which in their operationalization involves (1) knowledge stocks: individual, group, and organizational-level knowledge; and (2) leaning flows: exploration and exploitation (Bontis et al. (2002) SLAM scale). Business performance is measured using (1) financial performance (return on assets, sales growth, profitability, improvement in work productivity, and improvement in production costs) and (2) NFP (customer satisfaction, growth in the number of customers, employee satisfaction, quality of products and services, and organizational reputation). Prieto and Revilla (2006) gathered data from 111 Spanish companies ranging from 50 employees up to 2,500 employees and found that learning capability shows an indirect effect on financial performance via NFP. While no direct effect of learning capability on financial performance is observed, there is a strong indirect one (through NFP).

Irrespective of the manner of operationalizing organizational learning, the vast majority of studies evidence a positive impact of organizational learning on performance. For this study, we follow Huber's tradition of information processing (Huber, 1991) and upgrade it with contributions from the Canadian school (Crossan et al., 1995) as well as Dimovski (1994) regarding the concept that learning needs to be reflected in BCC. With regard to organizational performance, the modern literature uses both financial as well as non-financial indicators and so does this study. In addition, the purpose of this study is to add to the generalizability of these research findings by developing, operationalizing, and testing a multi-group structural equation model of organizational learning and its impact on financial and NFP. We hypothesize that the information processing part of organizational learning will a have strong and positive impact on BCC, yet they will involve two distinct constructs (both forming the organizational learning process). Thus, we propose the following set of hypotheses:

H_1. Information processing (INFOPROC) induces BCC.
H_2. BCC lead to improved financial performance (FP).
H_3. BCC lead to improved NFP from the perspectives of employees, customers and suppliers.
H_4. NFP leads to improved performance in financial terms (FP).

On the methodological level, we benefit from multi-group SEM in two ways. First, it allows us to test the impact of the organizational learning process simultaneously on both financial and non-financial performance. Second, we can test the invariance of research findings across several sample groups. In our case, this will be two countries: Slovenia and Croatia. Given the fact these are two neighboring countries with a different level of economic development, different yet related languages, and a relatively similar structure of economic activities (Appendix A), it is not fully evident whether we can expect that the structural coefficients within both models will be similar or not. Hence, we decided to start from a negative hypothesis and on this basis to test various forms of invariances. Either way, based on the literature review within the Science Direct, ProQuest, and Emerald databases for the period 1990–2006, this is the first research study to address the question of organizational learning and performance simultaneously on a set of companies from two countries simultaneously. Hence, hypothesis 5 is proposed in order to begin to address this gap in the literature:

H_5. Country context will not moderate the relationships posited in H1-H4, thereby suggesting that the relationships for Slovenian firms will be invariant from Croatian companies.

4 Method

This methodological framework section presents the development of the research instrument, data collection, and sample description, together with the procedures for validity and reliability assessments. It also introduces a multi-group structural equation model that seeks to test the impact of organizational learning on organizational performance.

4.1 Development of the Research Instrument

The questionnaire used (OLIMP) has been undergoing constant development and validation for more than 10 years. Dimovski (1994) used it on a sample of Ohio credit unions in order to measure the organizational learning process as a source of competitive advantage. It had 14 items to measure information acquisition, 10 items for INFINT, 15 for BCC, and 16 credit-union specific financial performance measures. Škerlavaj (2003) upgraded it to include three measures of NFP, while he replaced industry-specific measures of financial performance with two measures valid for all companies and applied it to a sample of Slovenian companies with more than 100 employees in 2003. Dimovski and Škerlavaj (2005) improved the operationalization of all three constructs involved and tested its psychometric properties on a sample of Slovenian firms with more than 100 employees in 2004.

The measurement instrument used in this study has 24 items for the Information Processing construct, 14 for BCC, two items for Financial Performance, and 17 for NFP. Pre-testing procedures were conducted in the form of interviews and pilot studies with managers and focus groups with academic colleagues. When translating the instrument from and to the English, Slovenian, and Croatian languages, a back-translation procedure was applied. In autumn 2005, the study was expanded to include companies with more than 50 employees in Slovenia as well as in Croatia. The reason to include smaller companies is to improve the generalizability of the research findings. Having enlarged the sample and included several new items and translated it into the Croatian language, the need emerged once again to test for the validity and reliability of the research instrument and findings. Prior to addressing these issues, the data collection and sampling procedures are described.

Several researchers (Spector and Davidsen, 2006; Templeton and Snyder, 2000) agree that organizational learning is difficult to measure due to the complexity and dynamics of the situations and problems due to the difficulty and costs of data collection. Table 2 presents the operationalization

Table 2: Operationalization of the Organizational Learning Construct

Measurement Variables	**Items**
Information processing –Information acquisition (INFOACQ)	Employees are an extremely important source of information (INFOACQ1).
	Previous decisions important for current decisions (INFOACQ2).
	New business methods and services are always worth trying even if they may prove risky (INFOACQ3).
	Reports prepared by external experts are an extremely important source of information (INFOACQ4).
	Clippings service (INFOACQ5).
	Competitors are an extremely important source for learning new methods and services (INFOACQ6).
	Expertise about the industry, products, and services is an extremely important criterion for hiring a new employee (INFOACQ7).
	Joint tasks and mergers contribute a great deal of knowledge about the industry and the economic environment, new methods, and services/ products (INFOACQ8).
	Top managers making any important decision seek information or advice from the board of directors or owners (INFOACQ9).
	Top managers making any important decision seek information or advice from sources outside the company (hiring experts, contacting top managers of other companies, etc.) – (INFOACQ10).
	Our organization has employees whose job is related to searching for external information (INFOACQ11).
	External sources (reports, consultants, newsletters, etc.) are extremely important for the operations of our organization (INFOACQ12).
	In our organization we explicitly reward employees who are a source of quality information (INFOACQ13).

(continued)

Table 2: (continued)

Measurement Variables	Items
Information processing-Information interpretation (INFOINT)	Personal contacts – (INFOINT1)
	Team meetings – (INFOINT2)
	Committees as decision-makers – (INFOINT3)
	Telephone contacts – (INFOINT4)
	Written memos, notes, letters, etc. – (INFOINT5)
	Special reports – (INFOINT6)
	Formal chain of command reporting – (INFOINT7)
	The company's intranet as a mean of information interpretation – (INFOINT8)
	Forums (e-chatting, e-debates) – (INFOINT9)
	The more information the subordinate has the better he/she will perform – (INFOINT10).
	Information to a subordinate must always be simple and concise – (INFOINT11).
Behavioral and cognitive changes (BCC)	Adaptability to environmental pressures – (BCC1)
	Quality of products/services – (BCC2)
	Number of products/services offered – (BCC3)
	Technology of operations – (BCC4)
	Speed of operations – (BCC5)
	Introduction of new marketing approaches – (BCC6)
	Average productivity of employees – (BCC7)
	Satisfaction of employees – (BCC8)
	Overall atmosphere – (BCC9)
	Personal communication between top managers and employees – (BCC10)
	Team meetings' efficiency – (BCC11)
	Employees' level of understanding of the company's strategic orientation – (BCC12)
	Employee's level of understanding of major problems in the company – (BCC13)
	Efficiency of information systems within the company – (BCC14)

Sources: Argyris and Schön (1978), Crossan (1995), Daft and Weick (1984), Daft and Lengel (1986), Dimovski (1994), Dimovski and Škerlavaj (2005), Eppler (2003), Fiol and Lyles (1985), Huber (1991), Martello (1993), Škerlavaj (2003), and Zahra and Covin (1993)

of the organizational learning process. Each item used was measured on a 1–5 point Likert scale. When measuring Information Acquisition (INFOACQ), INFOINT10, and INFOINT11 we asked the respondents about their degree of dis/agreement with a certain statement. When measuring INFOINT1–9, we measured perceived importance and, with BCC items, the respondents were asked about changes in the last three years in 14 selected items in terms of their increase or decrease.

Table 3: Operationalization of the Non-Financial Performance (NFP) Construct

Measurement Variables	Items
Non-financial performance from the employee perspective (NEFEMP)	The net fluctuation of employees (number of staff replaced due to dissatisfaction with pay, relationships in the workplace, and chances for career advancement, etc. – internal reasons) – (NEFEMP1)
	Productivity of employees relative to the industry average – (NEFEMP2)
	Employees' trust in the leadership – (NEFEMP3)
	Trust among employees – (NEFEMP4)
	Efficiency of the work organization – (NEFEMP5)
	Employees' level of commitment to the organization – (NEFEMP6)
	Employees' preparedness to go the extra mile for the company – (NEFEMP7)
	Work costs per employee relative to the industry average – (NEFEMP8)
	Absenteeism in the company (relative to the competition) – (NEFEMP9)
	Employees' level of satisfaction with the situation in the company – (NEFEMP10)
	Learning ability and adaptability of the employees (in comparison to the competition) – (NEFEMP11)
	Risk-taking within the company relative to the competition – (NEFEMP12)
Non-financial performance from the customer perspective (NEFCUST)	Increase/decrease in the number of customer complaints within the last period – (NEFCUST1)
	Speed of dealing with customer complaints (relative to the competition) – (NEFCUST2)
	Losing existing clients/attracting new ones – (NEFCUST3)
	Increase/decrease in the reputation of the company in the eyes of customers – (NEFCUST4)
Non-financial performance from the supplier perspective (NEFSUP)	Quality and longevity of relations with suppliers – (NEFSUP1)

Table 4: Operationalization of the Financial Performance (FP) Construct

Measurement Variables	Items
Return on assets (ROA)	Return on assets (ROA, %) in the company relative to the industry average – (FIN1)
Value added per employee (VAEMP)	Value added per employee in the company relative to the industry average – (FIN2)

The operationalization of the Financial and Non-Financial Performance constructs is presented in Tables 3 and 4. In general, both objective and subjective measures can be used to operationalize organizational performance construct(s). Llorens-Montes et al. (2005) report that managers were more open to offering their general views (subjective measures) than precise quantitative data (objective measures). What is more important is that previous research (Venkatraman and Ramanujam, 1987; Lyles and Salk, 1997; Llorens-Montes et al., 2005) shows high correlations between objective and subjective measures of organizational performance (where objective measures exist in the first place) and that both types of measurement are valid when establishing a firm's performance.

4.2 Data Collection and Sample

In our research a cross-cultural dimension was introduced. During September and October 2005 questionnaires were distributed to Slovenian and Croatian companies with more than 50 employees. The Slovenian and Croatian economies share a significant amount of common history; the languages belong to the same family, and so there are several similarities. Nevertheless, there is also significant dissimilarity. Above all, there is a difference in the national culture as well as the level of economic development for various reasons (which are beyond the scope of this research). With regard to dimensions of national culture (Hofstede, 2001), Slovenia and Croatia significantly differ in three out of four dimensions: individualism, masculinity, and uncertainty avoidance. In 2007, Slovenia had a GDP per capita of USD 28,010, while Croatian GDP per capital was USD 16,758 (Appendix A). In March 2004, Slovenia became the first transition country to graduate from borrower status to a donor partner at the World Bank, an indication that Slovenia has started to cross the threshold from a transition to a developed country. Slovenia also joined the Euro zone in January 2007, while Croatia has the status of EU candidate country. Having selected these two countries, we control for the level of economic development and national culture in the model of organizational learning and performance.

The main source of data about Croatian companies was the database of the Institute for Business Intelligence; the data was gathered in cooperation with the Faculty of Economics at the University of Zagreb. Since 3,700 companies with more than 50 employees exist in Croatia, we decided to send out the questionnaires to half of this population and hence to use a systematic sampling procedure. In Slovenia, the questionnaire was sent to all 1,237 companies of the same size across industries. Data on the companies was gathered from the Business Directory of Slovenia (IPIS). The questionnaire was addressed to the CEOs or chairpersons of the companies, who were instructed to fill out the questionnaire themselves or forward it to a competent person within their organization. In the case of Slovenia, 203 completed questionnaires were returned (making a 16.5% response rate) while in Croatia 202 completed questionnaires were returned (11.5% response rate). The Slovenian and Croatian samples were compared according to four factors: the proportion of samples in terms of the population, the criteria for selecting the companies (number of employees and company revenues), the distribution of companies according to the industry type, and the hierarchical position of the respondents.

The size of a company can be determined on several bases (the number of employees, revenues, market share, etc.). The selected companies were analyzed according to the number-of-employees criterion. About two-thirds of the selected Slovenian and Croatian companies had between 50 and 250 employees, around 16% between 250 and 499 employees, and around 12% of the selected companies exceeded 500 employees. According to the companies' revenues in 2004, there is a slight difference between the Slovenian and Croatian companies. Slovenian companies from the sample had higher annual revenues in 2004 than their Croatian counterparts, which is evident in Fig. 1.

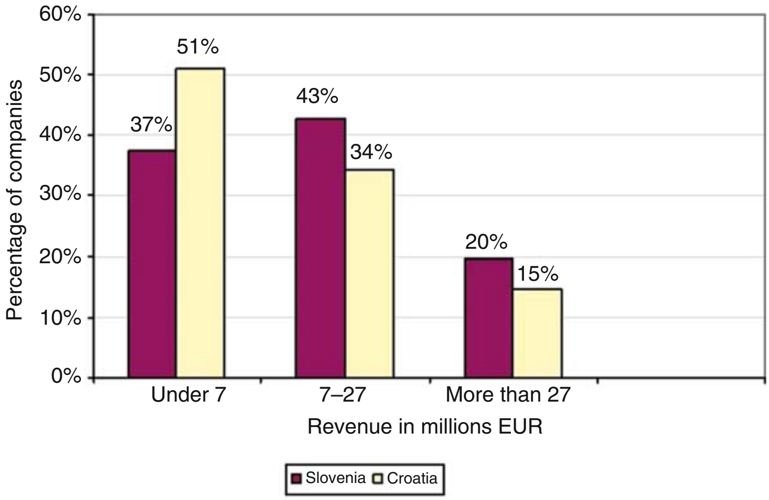

Fig. 1: Distribution of the Companies According to Their Revenues in 2004

Table 5: The Examined Companies According to the Industry Type

	Industry Type	Slovenia Frequency	Slovenia Share (%)	Croatia Frequency	Croatia Share (%)
A	Agriculture, hunting, and forestry	5	2.5	5	2.5
B	Fishing	0	0	0	0
C	Mining and quarrying	2	1.0	3	1.5
D	Manufacturing	95	46.8	64	31.7
E	Electricity, gas, and water supply	3	1.5	10	5.0
F	Construction	21	10.3	32	15.8
G	Wholesale and retail trade	21	10.3	27	13.4
H	Hotels and restaurants	7	3.4	13	6.4
I	Transport, storage, and communication	13	6.4	11	5.4
J	Financial intermediation	7	3.4	6	3.0
K	Real estate, renting, and business activities	2	1.0	0	0
O	Other community, social and personal service activities	20	9.9	26	12.4
	Data not available	7	3.4	5	2.5

Source: own survey

The Slovenian and Croatian samples differ mostly by the third criterion: the percentage of companies according to the industry type. Business entities were classified into different industry types according to the European Classification of Economic Activities NACE Rev 1. The percentage of companies is almost the same for some industry types, while differences are most noticeable in Manufacturing (D). The frequencies and shares of companies with regard to their industry type are shown in Table 5.

Table 6: Characteristics of the Examined Companies and Respondents

Characteristics of the…		Slovenia	Croatia
	Number of employees		
	50–249	72.4%	71.3%
	250–499	16.1%	16.3%
	500+	11.5%	11.8%
Companies	Data not available	–	0.5%
	Annual revenue in 2004 (mil. €)		
	Up to 7	37.4%	50.0%
	From 7 to 27	42.8%	33.7%
	27 and more	19.8%	14.4%
	Data not available	7.9%	2.0%
	Hierarchical position of the respondents		
	Top management	31.5%	22.4%
Respondents	Middle management	31.5%	55.7%
	Lower management and operational level	12.8%	13.0%
	Data not available	24.2%	8.9%

Source: own survey

In Croatia, the questionnaire was completed mostly by people from the middle-management level (directors of functional departments), although top management members were also significantly represented. In Slovenia, top and middle management were equally represented within the sample. For a better understanding of the sample, data showing selected characteristics of the companies and respondents are summarized in Table 6.

5 Results

5.1 Validity and Reliability

Having gathered the data, the next step in the process relates to the development of a valid and reliable measurement sub-model. According to Thorndike and Hagen (1969), there are three major criteria for evaluating a measurement tool: validity, reliability, and practicality. Validity refers to the extent to which a test measures what we actually wish to measure, reliability has to do with the accuracy and precision of the measurement procedure, while practicality is concerned with a wide range of factors regarding economy, convenience, and interpretability. In the following section the issues of the different forms of validity and reliability will be raised and discussed.

Many forms of validity are mentioned in the research literature (Cooper and Schindler, 2003; Hair et al., 1998; Tabachnick and Fidell, 2001). The two main forms of validity are external and internal validity. External validity of research findings refers to the data's ability to be generalized across persons, settings, and times. The focus in this section will be more on internal validity, which should reflect the extent to which differences found with a measuring tool reflect true differences among the participants being tested (Cooper and Schindler, 2003). Two major forms of validity exist: content validity and construct validity, which is composed of convergent and discriminant validity.

5.1.1 Content Validity

The content validity of a measuring instrument (the composite of measurement scales) is the extent to which it provides adequate coverage of the investigative questions guiding the study. According to Cooper and Schindler (2003), if the instrument contains a representative sample of the universe of the subject matter of interest, then the content validity is good. Usually, the level of content validity depends on the quality of work in the literature review stage of research and is subjective and, as such, left up to the reader to evaluate. Significant efforts have indeed been invested in obtaining content validity (among others). This was also done via pre-testing procedures by the inclusion of several academics knowledgeable in the field. Furthermore, semi-structured interviews with selected respondents (from various industries) were conducted in order to assess the content (and face) validity of the instruments. All of this was done in three different iterations (2003, 2004, and 2005).

5.1.2 Construct Validity

On the other hand, methods for evaluating construct validity are much more tangible. SEM and the LISREL 8.51 software package offer the following methods to assess construct validity: (1) an examination of the statistical significance of the factor loadings; (2) an examination of the size of the factor loadings; and (3) an examination of the direction of the factor loading estimate, while we combine this knowledge with factor analysis to determine convergent validity and Pearson pairwise correlations to determine discriminant analysis using the SPSS software package.

5.1.2.1 Convergent validity

Starting from the operationalizations of all four constructs under consideration (INFOPROC, BCC, FP and NFP) presented in Tables 1–4, first, factor analysis of a pooled sample was performed regarding each of the eight measurement variables in order to establish convergent validity. According to Hair et al. (1998), convergent validity is achieved when (a) item loadings exceed 0.45; (b) the eigenvalue criterion equals 1; (c) the percentage of variance extracted by a selected number of factors accounts for at least 60% of such; and (d) the screen plot starts to flatten out. In two cases of variables with multiple items – INFINT and Non-Financial Performance from the Customer Perspective (NEFCUST) – the factor analyses revealed one factor. However, in three cases the factor analysis revealed more than one factor: INFOACQ, BCC, and Non-Financial Performance from the Employee Perspective (NEFEMP). In Tables 7–9 the results of the factor analyses for the constructs Information Acquisition, BCC and NEFEMP are presented.

Table 7: Results of the Factor Analysis for Information Acquisition (INFOACQ)

		Factor Loadings	
Item	Description	Factor 1	Factor 2
INFOACQ12	External sources (reports, consultants, newsletters, etc.) are exteremely important for the operations of our organization	**0.68**	–0.07
INFOACQ11	Our organization has employees whose job is related to searching for external information	**0.57**	0.07
INFOACQ8	Joint tasks and mergers contribute a great deal of knowledge about the industry and economic environment, new methods, and services/products	**0.57**	0.03
INFOACQ10	Top managers making any important decision seek information or advice from sources outside the company (hiring experts, contacting top managers of other companies, etc.)	**0.56**	–0.49
INFOACQ13	In our organization we explicitly reward employees who are a source of quality information	**0.53**	0.15
INFOACQ4	Reports prepared by external experts are an extremely important source of information	**0.52**	–0.26
INFOACQ6	Competitors are an extremely important source for learning new methods and services	**0.51**	0.16
INFOACQ5	Clippings service	**0.47**	–0.09
INFOACQ1	Employees are an extremely important source of information	**0.43**	**0.39**
INFOACQ7	Expertise about the industry, products, and services is an extremely important criterion for hiring a new employee	**0.41**	**0.40**
INFOACQ2	Previous decisions important for current decisions	**0.33**	**0.57**
INFOACQ9	Top managers making any important decision seek information or advice from the board of directors or owners	**0.42**	–0.56
INFOACQ3	New business methods and services are always worth trying even if they may prove risky	**0.29**	–0.08

Note. $N=405$. Rotated factor matrix using an orthogonal VARIMAX rotation. Underlined and bold items included in the factor

The results indicate that Information Acquisition is not a unidimensional construct and that instead of summarizing all 13 items in the one measurement variable, two measurement variables should be introduced: (1) External Information Acquisition (IAEXT) and (2) Internal Information Acquisition (IAINT), which is similar to the approach of Perez-Lopez et al. (2005). IAEXT is the sum of eight items which all relate to different aspects of acquiring information outside the company, while IAINT includes three items related to the acquisition of internal information. The items INFOACQ9 and INFOACQ3 were excluded from further analysis. As expected, there are two factors involved in BCC. Hence, the corresponding items will be summarized in two measurement variables: (1) Behavioral Changes and (2) Cognitive Changes.

Similarly, NEFEMP revealed two factors. The first is a set of nine items, which all seem to be relatively objective and respondent-dependent, while the second factor seems to comprise three items (costs of work, absenteeism, and work productivity) which are all subjective meas-

Table 8: Results of the Factor Analysis for Behavioral and Cognitive Changes (BCC)

		Factor Loadings	
Item	Description	Factor 1	Factor 2
BCC2	Quality of products/services	0.23	**0.66**
BCC4	Technology of operations	0.26	**0.65**
BCC5	Speed of operations	0.29	**0.60**
BCC3	Number of products/services offered	0.01	**0.55**
BCC6	Introduction of new marketing approaches	0.30	**0.55**
BCC7	Average productivity of employees	0.36	**0.52**
BCC1	Adaptability to environmental pressures	0.16	**0.49**
BCC9	Overall atmosphere	**0.78**	0.26
BCC8	Satisfaction of employees	**0.77**	0.28
BCC12	Employees' level of understanding of the company's strategic orientation	**0.70**	0.22
BCC10	Personal communication between top managers and employees	**0.73**	0.23
BCC13	Employees' level of understanding of major problems in the company	**0.69**	0.16
BCC11	Efficiency of team meetings	**0.56**	0.29
BCC14	Efficiency of information systems within the company	0.47	0.44

Note. $N=405$. Rotated factor matrix using an orthogonal VARIMAX rotation. Underlined and bold items included in the factor

Table 9: Results of the Factor Analysis of Non-Financial Performance from the Employee Perspective (NEFEMP)

		Factor Loadings	
Item	Description	Factor 1	Factor 2
NEFEMP3	Trust in the leadership	**0.82**	0.20
NEFEMP6	Commitment of employees	**0.82**	0.16
NEFEMP10	Satisfaction with working conditions	**0.79**	0.22
NEFEMP4	Mutual trust of employees	**0.74**	0.31
NEFEMP5	Efficiency of the work organization of employees	**0.73**	0.36
NEFEMP7	Employees prepared to go the extra mile for the company	**0.66**	0.41
NEFEMP11	Learning ability and adaptability	**0.64**	0.40
NEFEMP1	Net fluctuation of employees	**0.60**	0.14
NEFEMP12	Risk taking of employees	**0.51**	0.43
NEFEMP8	Costs of work	0.07	**0.83**
NEFEMP9	Absenteeism	0.29	**0.68**
NEFEMP2	Work productivity of employees	0.35	**0.66**

Note. $N=405$. Rotated factor matrix using an orthogonal VARIMAX rotation. Underlined and bold items included in the factor ures of otherwise objective indicators. Hence, the first factor is named Subjective Non-Financial Performance from the Employee Perspective (NEFEMPS), while the second one is Objective Non-Financial Performance from the Employee Perspective (NEFEMPO).

5.1.2.2 Discriminant Validity

Besides convergent validity, the measures should also have discriminant validity (Dimovski, 1994). Discriminant validity is defined as the extent to which the measure is novel and not simply a reflection of some other construct or variable (Churchill, 1979). Discriminant validity is measured by pairwise correlations, as proposed by Venkatraman (1989). Discriminant validity is indicated by low correlations between the measures of interest and other measures that are supposed to measure different constructs (Heeler and Ray, 1972; Venkatraman and Grant, 1986). Discriminant validity is accomplished when the correlation of a variable with another variable does not exceed 0.55 and is significant at $p < .05$ (Schwab, 1980). Furthermore, the correlation should have the directions assumed by theory (Venkatraman, 1989). Table 4.10 presents a matrix of Pearson's pairwise correlations for the initial 11 measurement variables analyzed for the pooled sample data. The results from Table 10 indicate that discriminant validity is mostly achieved, with the exception of IAINT and VAEMP. IAINT exhibits low correlations with both of the measurement variables included in the construct Ol (with IAEXT 0.36 and with INFINT 0.32). VAEMP correlates strongly with ROA. However, it also correlates statistically significantly and strongly with NEFEMPS and NEFEMPO which might indicate problems with discriminant validity.

5.1.3 Initial and Final Measurement Model

In Table 11 the initial model with all 11 measurement variables which were attained after the examination of convergent validity is presented. The examination of factor loadings (together with the corresponding *t* values) in the initial model shows two measurement variables that do not achieve a cut-off value of 0.70: IAINT and Non-Financial Performance from the Supplier Perspective (NEFSUP). While all of the standardized loadings were statistically significant (at $p < 0.05$), by far the least valid indicator is IAINT ($\lambda = 0.48$), which will be omitted from further analysis.

In Fig. 2 a measurement model without IAINT is presented, all parameters in the model are significant at <0.05 and the vast majority of the loadings exceed the threshold value, while two of the loadings (IAEXT and NEFSUP) are relatively close to 0.70 and will be kept in the model.

5.1.4 Reliability Assessment

Assessing the reliability of the measurement sub-model involves two steps (1) the researcher needs to evaluate the reliability of individual measurement variables; and (2) construct (composite)

Table 10: Pairwise Correlations for the Pooled Sample

Variable	IAEXT	IAINT	INFINT	BC	CC	ROA	VAEMP	NEFSUP	NEFCUST	NEFEMPS	NEFEMP0
IAEXT	1										
IAINT	**0.36****	1									
INFINT	**0.52****	**0.32****	1								
BC	0.29**	0.26**	0.40**	1							
CC	0.36**	0.28**	0.39**	**0.59****	1						
ROA	0.08	0.09	0.17**	0.36**	0.23**	1					
VAEMP	0.11*	0.08	0.13*	0.30**	0.26**	**0.66****	1				
NEFSUP	0.14**	0.10	0.22**	0.28**	0.26**	0.27**	0.34**	1			
NEFCUST	0.21**	0.12*	0.26**	0.40**	0.32**	0.25**	0.34**	**0.55****	1		
NEFEMPS	0.25**	0.18**	0.32**	0.48**	0.48**	0.36**	0.47**	**0.55****	**0.67****	1	
NEFEMPO	0.14**	0.12*	0.15**	0.34**	0.31**	0.34**	0.47**	**0.47****	**0.48****	**0.63****	1

$N=405$. *Significant at $p<0.05$. **Significant at $p<0.01$. Correlations among measurement variable of the same constructs are bold

Table 11: Initial Measurement Model with 11 Variables

Latent Variable	Measurement Variable	No. of Items	Standardized Factor Loading (*t* Statistics)
INFOPROC	IAEXT	8	0.70
	IAINT	3	0.48 (6.72)
	INFINT	11	0.75 (8.68)
BCC	BC	7	0.78
	CC	7	0.76 (9.72)
FP	ROA	1	0.72
	VAEMP	1	0.92 (9.80)
NFP	NEFSUP	1	0.65
	NEFCUST	4	0.72 (11.95)
	NEFEMPS	9	0.85 (11.45)
	NEFEMPO	3	0.71 (11.77)

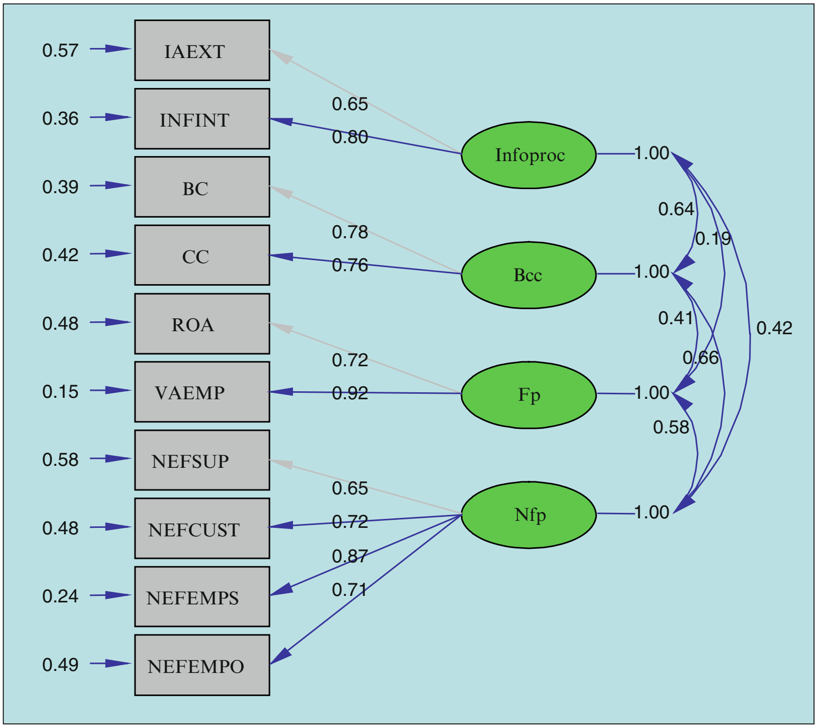

Fig. 2: Measurement Sub-model (IAINT Excluded)

reliability. Squared multiple correlation (R^2) is used for the individual indicator reliability assessment as well. The results are presented in Table 12.

Hair et al. (1998) suggested that squared multiple correlations (R^2) – indicator reliabilities – should exceed 0.50, which roughly corresponds to a standardized loading of 0.70. However, they also said that "this is not an absolute standard and values below 0.70 have been deemed acceptable if the research is exploratory in nature" (Hair et al., 1998, p. 612), which is to a certain extent also our case. As far as indicator reliabilities go, all of the measurement variables seem to be reliable indicators of their latent variables with the exception of IAEXT and NEFSUP. Acknowledging the partially exploratory nature of the study, ubiquitous difficulties with the operationalization of the organizational learning process and the fact that both measures have another much better indicator in the corresponding construct, we are willing to accept the set of 10 indicators as being relatively reliable measures of the constructs studied.

In addition, composite reliability indices and average variance extracted are calculated (manually) using the following formulas:

$$CRI = \frac{\left(\sum \lambda_i\right)^2}{\left(\sum \lambda_i\right)^2 + \sum \theta_i} \qquad 1$$

$$AVE = \frac{\left(\sum \lambda_i^2\right)}{\left(\sum \lambda_i^2\right) + \sum (1 - \lambda_i^2)} \qquad 2$$

where λ_i stands for standardized loadings of the measurement variable (indicator) i and θ_i corresponds to the measurement error for each indicator. Diamantopoulos and Siguaw (2000) suggest that the threshold for CRI should be set at 0.60. Constructs exceeding this value are considered to have a good composite reliability, which is the case with all latent variables in both cases, with the exception of Ol in the Slovenian sample. The cut-off value for AVE is 0.50 (Hair et al., 1998), where reliable constructs should exceed this value, while with Cronbach alphas researchers usually use a cut-off value of α=0.70 for studies in advanced phases (α1), and for exploratory studies alphas ranging from 0.50 to 0.60 (α2) are considered adequate (Nunnaly, 1978; Van de Ven and Ferry, 1979; Dimovski, 1994, p. 103). All of the constructs attain the recommended cut-off values using all three measures of construct reliability. The only exception is the construct Ol, which slightly fails the Cronbach alpha internal consistency test (α1) but fulfills the Cronbach alpha for exploratory studies (α2) and, what is more, satisfies the CRI and AVE criteria.

To summarize, in assessing the measurement sub-model regarding the pooled sample data, it was established that the measures and constructs used are valid and reliable enough to continue with further analysis.

5.2 Normal Distribution of Data

Presumably the most important assumption of SEM is the normality of the data (Coenders, 2006). Nevertheless, in practice it is very often the case that the data do not have a normal distribution and asymptotic covariances need to be employed as input data. For that reason, a special Chi-square

Table 12: Reliability Assessment

Latent Variable	Measurement Variable	Standardized Loadings (t Values)	Squared Multiple Correlation for Measurement Variables (R^2)	Cronbach α	Composite Reliability Index (CRI)	Average Variance Extracted (AVE)
INFOPROC	IAEXT	0.65	0.43	0.68	0.79	0.66
	INFINT	0.80 (6.89)	0.64			
BCC	BC	0.78	0.61	0.74	0.84	0.72
	CC	0.76 (9.16)	0.58			
FP	ROA	0.72	0.52	0.80	0.88	0.79
	VAEMP	0.92 (9.76)	0.85			
NFP	NEFSUP	0.65	0.42	0.70	0.89	0.68
	NEFCUST	0.72 (11.97)	0.52			
	NEFEMPS	0.87 (11.45)	0.76			
	NEFEMPO	0.71 (10.77)	0.51			

$N=405$

Table 13: Normality Testing – Univariate Skewness and Kurtosis

Measurement Variable	Skewness	*p* Value	Kurtosis	*p* Value	Skewness and Kurtosis Test, *p* Value
IAEXT	–0.49	0.00	0.64	0.03	0.00
INFINT	–51	0.00	0.68	0.02	0.00
BC	–0.96	0.00	3.28	0.00	0.00
CC	–0.70	0.00	1.48	0.00	0.00
ROA	0.65	0.00	5.4	0.00	0.00
VAEMP	–0.32	0.01	0.29	0.01	0.00
NEFSUP	–1.05	0.00	1.30	0.00	0.00
NEFCUST	–0.91	0.00	1.64	0.00	0.00
NEFEMPS	–0.74	0.00	0.87	0.01	0.00
NEFEMPO	–0.61	0.00	0.87	0.01	0.00

Table 14: Normality Testing – Multivariate Skewness and Kurtosis

Skewness	*p* Value	Kurtosis	*p* Value	Skewness and Kurtosis, Chi Square	*p* Value
19.80	0.00	176.93	0.00	951.68	0.00

test (Satora-Bentler χ^2) has been developed in order to acknowledge the non-normality of the data. As is clearly evident from Table 13, our data are not normal, while univariate skewness and kurtosis values in the vast majority of cases exceed the absolute threshold value of 0.50 and in all cases are statistically significant. As expected, Table 14 shows multivariate non-normality, which determines the need to use the Satorra-Bentler χ^2 fit index.

5.3 Global Fit

Having examined the measurement part of the model, we next need to address the global fit in order to assess whether the model as a whole fits the data gathered. This will be done using multiple fit indices for the model for the (1) pooled; (2) Slovenian; and (3) Croatian samples. In Table 15 global fit indices for the model testing of all three samples are provided.

Global fit indices were assessed on three levels of classification following the approach presented by Marsh and Bala (1988). Hence, (1) absolute, (2) relative, and (3) adjusted indices were used in order to evaluate the global model fit on a pooled sample and separately with the Slovenian and Croatian data. Absolute fit indices offer a response to the question of whether the residual (unexplained) variance in appreciable, relative fit indices explain how well the model does compared with other models with the same data, and adjusted indices explicate the ability of the model to combine fit and parsimony (Maruyama, 1998). Different authors are inclined to various indices, thus Diamantopoulos and Siguaw (2000) and Coenders (2004, 2006) recommend using multiple measures in order to evaluate the global model fit, Bryne (2001), Diamantopoulos

Table 15: Global Fit Indices for the Pooled, Slovenian, and Croatian Samples

Fit Index	Value Pooled Sample	Value Slovenian Sample	Value Croatian Sample	Reference Value	Level of Fit
Absolute: Is the residual (unexplained) variance appreciable?					
Chi-square (χ^2)/df	59.35/31 = 1.91	48.97/31 = 1.58	42.05/31 = 1.36	≤2	Good
Standardized root mean square residual (SRMR)	0.04	0.04	0.05	≤0.05	Good
Root mean square error of approximation (RMSEA)	0.05	0.05	0.04	≤0.05	Good
90% Confidence interval for RMSEA	0.03–0.07	0.02–0.08	0.00–0.07	Should include value 0.05	Excellent
Goodness of fit index (GFI)	0.97	0.95	0.95	≥0.95	Excellent
Relative: How well does the model do compared with the (range of) other possible models with the same data?					
Comparative fit index (CFI)	0.98	0.97	0.97	≥0.95	Excellent
Incremental fit index (IFI)	0.98	0.97	0.97	≥0.95	Excellent
Adjusted: How well does the model combine fit and parsimony?					
Non-normed fit (Tucker-Lewis) index (NNFI, TLI)	0.96	0.95	0.96	≥0.95	Excellent

and Siguaw (2000), Marsh and Balla (1988), and West et al. (1995) recommend using reference cut-off values of 0.05 for SRMR, 0.08 for RMSEA and 0.90 for all the other fit indices, while we used the even stricter criteria recommended by Coenders (2004, 2006). The model on all three levels of analysis using all three data sets provides a very good to excellent global fit. On the global level, the model seems to be an adequate representation of reality, which allows us to proceed with the assessment path coefficients and to test the hypotheses.

5.4 The Relationships Between Organizational Learning and Organizational Performance Constructs

In the following section, hypotheses (H1–H4) addressing the impacts and relationships among the latent variables INFOPROC, BCC, FP, and NFP will be addressed (1) for the pooled sample and separately for (2) the Slovenian and (3) Croatian samples. Furthermore, a multi-group analysis will be performed in order to compare the models from both countries and to test Hypothesis 5 (H5) regarding the invariance of the path coefficients between the two countries studied.

5.4.1 H1–H4: Relationships among Information Processing, Behavioral and Cognitive Changes, Non-Financial and Financial Performance

Figures 3–5 represent models of the impact of Information Processing through BCC on Financial as well as Non-Financial Performance, respectively for the pooled sample and for Slovenia and Croatia. In the following figures, standardized solutions of the path coefficients (with the corresponding *t* values in brackets), standardized loadings and error variances of the measurement variables, and structural multiple correlation coefficients are presented, which will allow us to test Hypotheses 1–4.

The results of the analysis of all three samples offer support for H1, H3, and H4, while we cannot say that the impact of BCC on Financial Performance (FP) is statistically significant (H2). The results are consistent in all three data sets (the pooled sample and for the Slovenian and Croatian firms).

Hypothesis 1 assumes a statistically significant impact of the Information Processing Construct (INFOPROC) on BCC, which was also the case in our analysis. INFOPROC demonstrated a statistically significant, positive, and strong to very strong impact[1] on BCC. The results are consistent with previous findings and theory, while especially authors from an action learning theoretical background believe that organizational learning has de facto not happened if not accompanied by BCC (Argyris and Schön, 1978; Fiol and Lyles, 1985; Dimovski, 1994). Only when INFOPROC is accompanied by BCC can we say that the organizational learning process has been completed. Based on the data from all three data sets and the model, it cannot be asserted that BCC have a statistically significant direct effect on Financial Performance (FP). No support for H2 was found.

[1]Diamantopoulos and Siguaw (2000) classify path coefficients below 0.30 as moderate, from 0.30 to 0.60 as strong, and from 0.60 above as very strong.

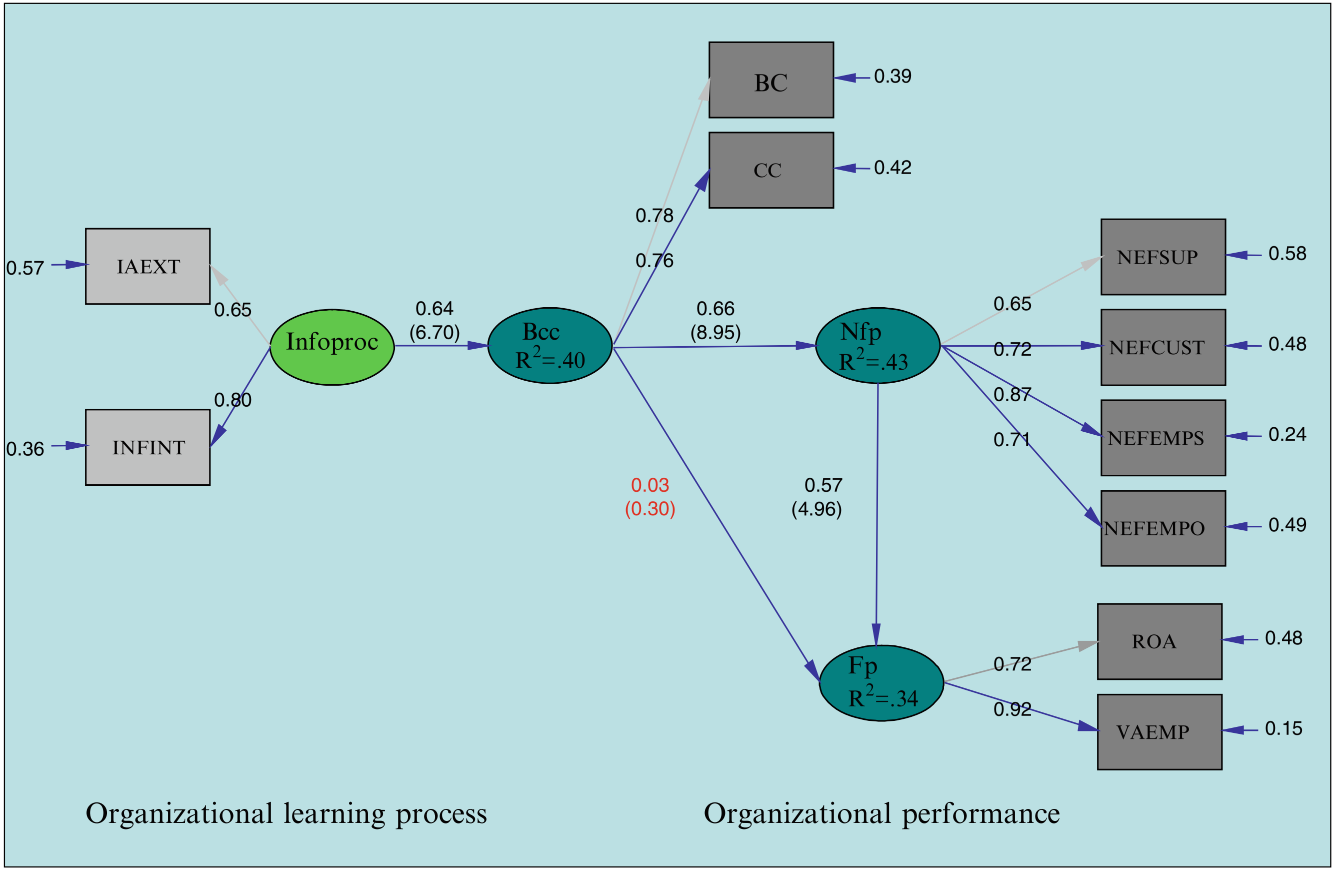

Fig. 3: Research Model (Standardized Solution) for the Pooled Sample. Values in *Brackets* Are *t* Values, Not Standard Errors!

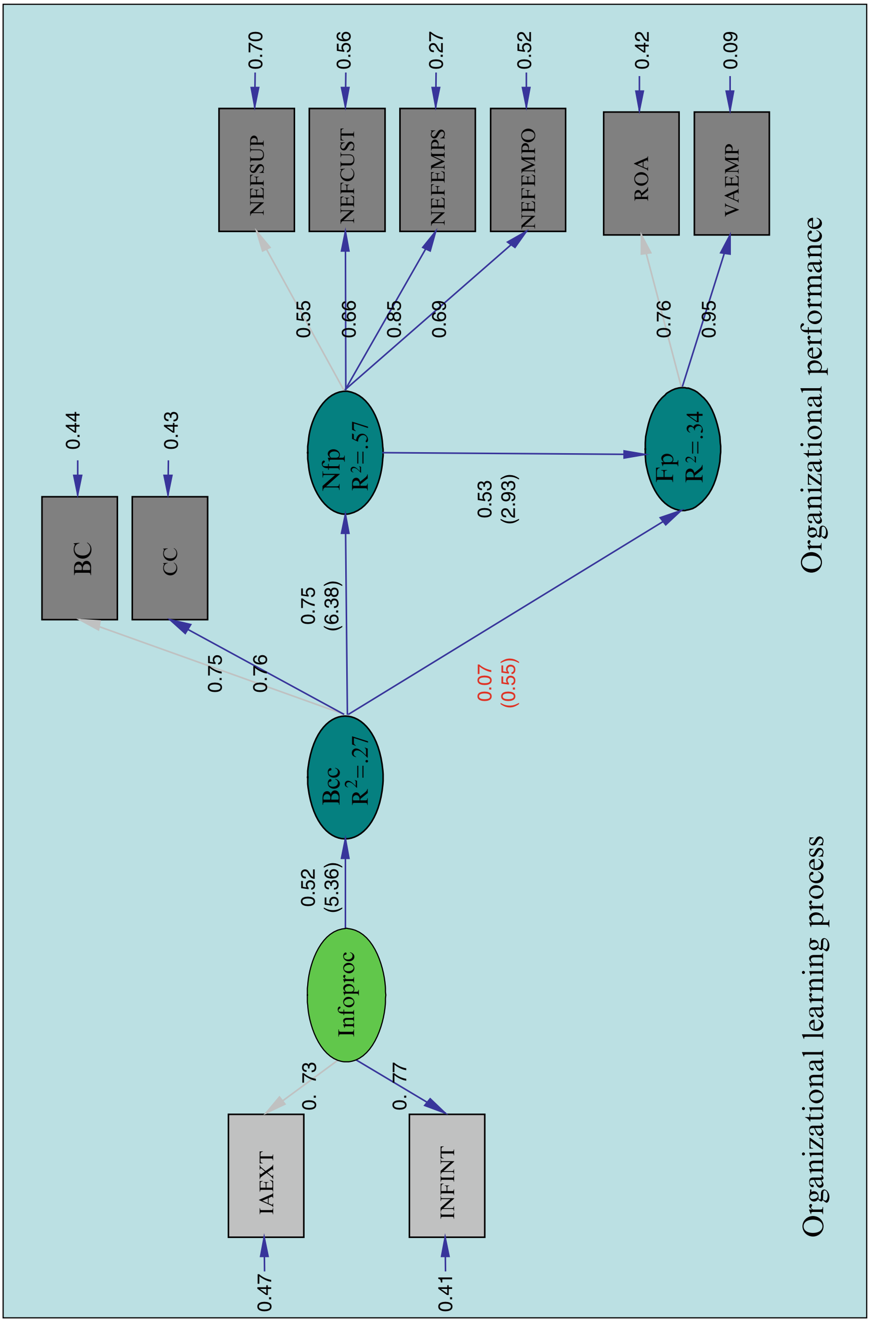

Fig. 4: Research Model (Standardized Solution) for the Slovenian Sample. Values in *Brackets* Are *t* Values, Not Standard Errors!

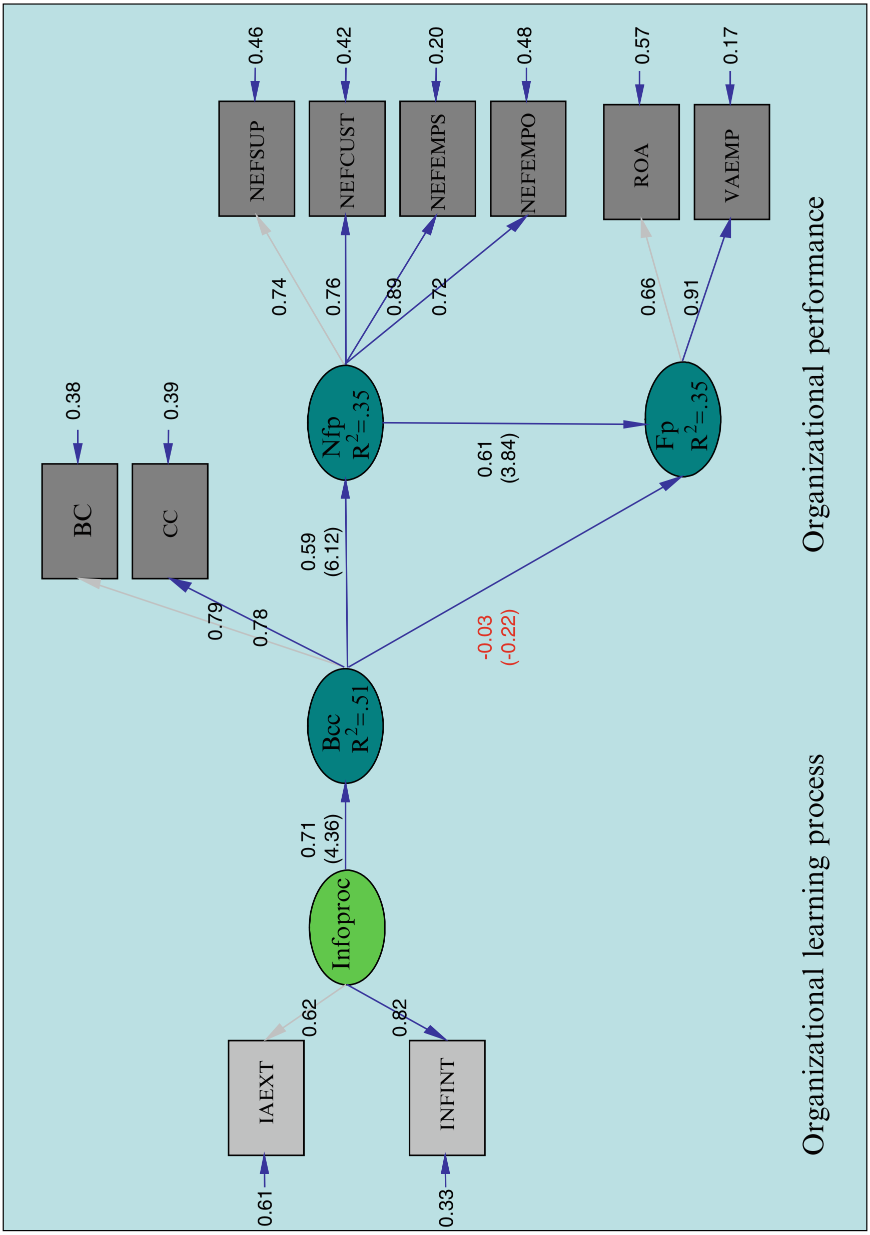

Fig. 5: Research Model (Standardized Solution) for the Croatian Sample. Values in *Brackets* Are *t* Values, Not Standard Errors!

What is more important is that the link between BCC and NFP is statistically significant, positive, and very strong (H3), which means that action-oriented learning directly improves performance related to employees, customers, and suppliers (and not only owners). In addition, NFP demonstrated a statistically significant, positive, and strong impact on FP (H4). Hence, we might argue that we have three types of effects in the model that are indirect, rather than direct: (1) the impact of BCC on FP (through NFP); (2) the impact of INFOPROC on NFP (through BCC); and (3) the impact of INFOPROC on FP (through BCC and NFP).

Table 16 shows the size of completely standardized values of indirect effects among the constructs in the model for the pooled, Slovenian, and Croatian data. The results indicate that even though Information processing (understood in terms of IAEXT and INFINT) demonstrated no direct impact on either Financial or Non-Financial Performance, it has a strong impact on NFP (through BCC) and a moderate impact on Financial Performance (through BCC and NFP). Similarly, BCC proved to have an indirect (rather than a direct) effect on FP through NFP. Furthermore, the measurement variable which best explains the construct NFP is NEFEMPS, with standardized values of loadings $\lambda_{SLOCRO}=0.87$, $\lambda_{SLO}=0.85$, and $\lambda_{CRO}=0.87$. The implication of this finding might suggest a deeper understanding of employee learning relationships within the few selected companies and a case which calls for the application of the social network analysis approach to organizational learning. The model based on the pooled data managed to explain 40.4% of the variance in BCC, 43.3% in NFP, and 34.2% in FP. The Slovenian model had a somewhat lower explanatory power for BCC ($R^2=.27$), higher for NFP ($R^2=0.57$), and approximately the same for FP ($R^2=0.34$). The Croatian data were explained by the model similarly well (BCC: $R^2=0.51$, NFP: $R^2=0.35$, FP: $R^2=0.35$).

5.4.2 H5: Cross-Cultural Model of the Impact of Organizational Learning on Organizational Performance

In order to develop a model of the impact of organizational learning on organizational performance which can be meaningfully used in different cultures, recent research findings dealing with the concept of cross-cultural comparability should be taken into account (Singh, 1995; Steenkamp and Baumgartner, 1998; Konečnik, 2005; Koufteros and Marcoulides, 2006). The question is whether the research instrument and models developed in one country can be eloquently transferred to and applied in other countries. Steenkamp and Baumgartner (1998, p. 78) argued that "cross-national differences in relationships between scale scores could indicate real differences in structural relations between constructs or scaling artifacts, differences in scale reliability, or even nonequivalence of the constructs involved". Horn (1991, p. 119) also called for utilization of a multi-group approach to SEM, saying "without evidence of measurement invariance, the conclusions of a study must

Table 16: Completely Standardized Indirect Effects for the Pooled, Slovenian, and Croatian Samples

Path	Pooled Data	Slovenian Sample	Croatian Sample
BCC → NFP → FP	0.38	0.40	0.36
INFOPROC → BCC → NFP	0.42	0.39	0.42
INFOPROC →BCC → NFP → FP	0.25	0.25	0.24

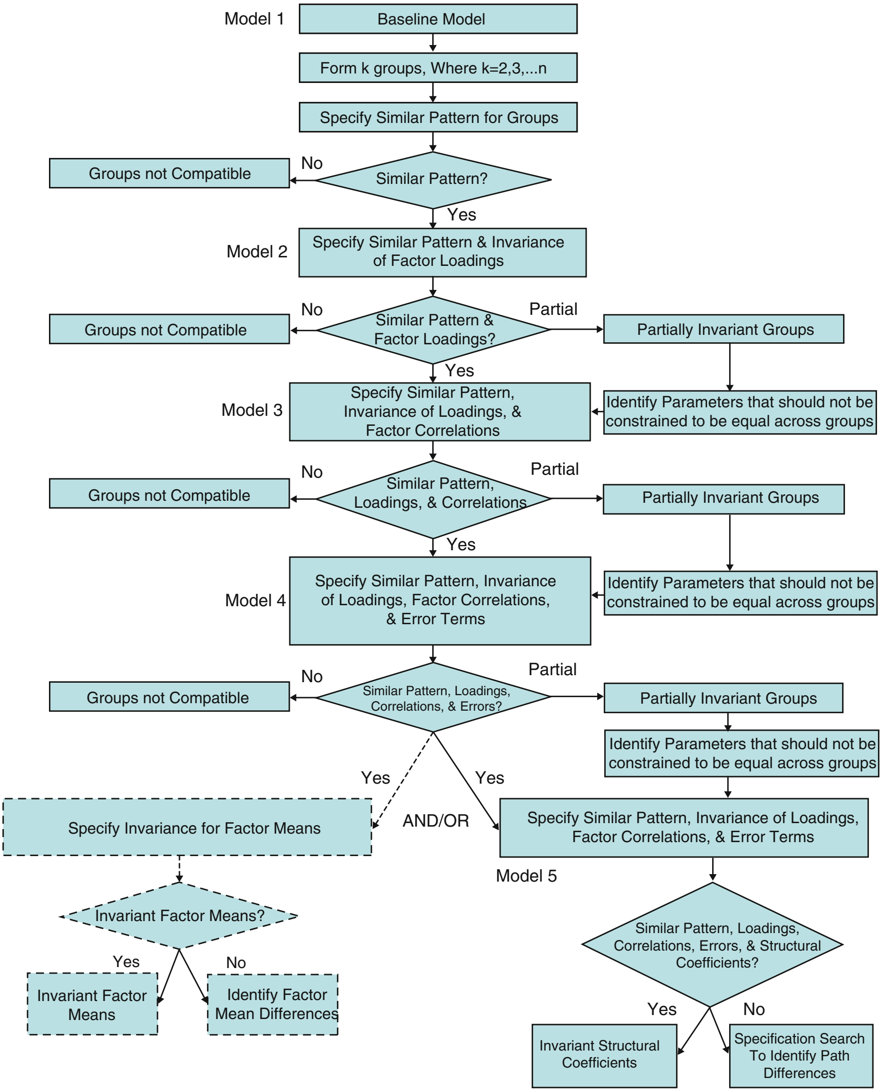

Fig. 6: A Multi-group Analysis Approach. Sources: Steenkamp and Baumgartner (1998) and Koufteros and Marcoulides (2006)

be weak." Steenkamp and Baumgartner (1998) offered a systematic overview of the levels of invariance (1) configural; (2) metric; (3) scalar; (4) factor covariance; (5) factor variance; and (6) error variance invariance. In the following subsections each of these is briefly described and assessed, for which the procedure suggested by Koufteros and Marcoulides (2006) combined with the findings of Steenkamp and Baumgartner (1998) and depicted in Fig. 6 are used.

Another prerequisite for attaining measurement invariance is sample comparability. Where sample comparability is not achieved, possible problems in measurement invariance could be a consequence of the differences in the sample characteristics (Steenkamp and Baumgartner, 1998, p. 84). Sample comparability has been addressed in the section on data collection and is believed to have been achieved.

5.4.2.1 Configural Invariance

Configural invariance deals with the pattern of salient (zero) and nonsalient (zero or nonzero) loadings which defines the structure of the measurement instrument (Steenkamp and Baumgartner, 1998). The principle of simple structure (Horn et al., 1983) implies that the items comprising the measurement instrument should exhibit the same configuration of salient and nonsalient factor loadings across different countries (Horn and McArdle, 1992). In plain words, configural invariance is defined as the fact that individuals of different groups conceptualize the construct in the same way (Konečnik, 2005). Configural invariance demands a researcher to conduct separate analyses of the proposed samples in order to evaluate whether (1) the specified model with zero loadings on non-targeted factors fits the data well in all countries; (2) all salient factor loadings are significantly and substantially different from zero; and (3) the correlations between the factors are significantly below unity (i.e., that there is discriminant validity between the possible sub(factors) comprising the construct(s) under investigation). As is evident in Table 17, both samples exhibit an excellent level of fit.

Table 18 shows the correlations between constructs, which are all statistically significant, while Table 19 confirms the construct reliability for all four constructs in all three data sets. Due

Table 17: Global Fit Statistics – Configural Invariance Testing

Sample/Index	X^2	df	SRMR	RMSEA	GFI	CFI	IFI	NNFI (TLI)
Pooled sample	59.35	31	0.04	0.05	0.97	0.98	0.98	0.96
Slovenia	48.97	31	0.04	0.05	0.95	0.97	0.97	0.95
Croatia	42.05	31	0.05	0.04	0.95	0.97	0.97	0.96

Table 18: Correlations[a] between the Constructs OL, BCC, NFP and FP

	Pooled Data				Slovenian Data				Croatian Data			
	OL	BCC	NFP	FP	OL	BCC	NFP	FP	OL	BCC	NFP	FP
OL	1.00				1.00				1.00			
BCC	0.66	1.00			0.75	1.00			0.59	1.00		
NFP	0.40	0.58	1.00		0.47	0.58	1.00		0.33	0.60	1.00	
FP	0.64	0.41	0.25	1.00	0.52	0.39	0.25	1.00	0.71	0.42	0.24	1.00

[a]All correlations statistically significant at 0.05 or better

Table 19: Reliability (Internal Consistency) Measures for the Constructs OL, BCC, NFP, and FP

	Pooled Data		Slovenia		Croatia	
	CRI	AVE	CRI	AVE	CRI	AVE
OL	0.73	0.66	0.82	0.69	0.79	0.65
BCC	0.84	0.72	0.82	0.70	0.85	0.74
NFP	0.88	0.79	0.65	0.49	0.82	0.69
FP	0.89	0.68	0.93	0.78	0.92	0.76

CRI Composite reliability index and *AVE* average variance extracted

to the acceptance of the model in both samples and the statistically significant correlations between constructs, full configural invariance has been established, which allows us to proceed with the test of metric invariance.

5.4.2.2 Full Metric Invariance

Metric invariance provides a stronger test of invariance (than configural invariance) by introducing the concept of equal metrics or scale intervals across countries (Rock et al., 1978). If an item satisfies the requirement of metric invariance, difference scores for the item can be meaningfully compared across countries (Steenkamp and Baumgartner, 1998; Coenders et al., 2003). Metric invariance demands loadings to be the same across groups, in our case countries. A procedure for testing metric invariance (and other subsequent forms of invariance) is based upon a hierarchical sequence of nested models which compare the fit of competing models in a systematic manner. A traditional way to do this is the χ^2 difference test (Jöreskog and Sörbrom, 1993). However, Steenkamp and Baumgartner (1998) noted that "one should not rely exclusively on the χ^2 difference test as it suffers from the same well-known problems as the χ^2 test for evaluating overall model fit" (see, e.g., Anderson and Gerbing, 1988; Marsh and Grayson, 1990). They recommended using the following four alternative fit indices: RMSEA, CAIC, NNFI (TLI), and CFI. Smaller values of RMSEA and CAIC and larger values of CFI and TLI indicate better models. Table 20 shows the above mentioned global fit statistics for the (1) baseline model (a model with data pooled from the Slovenian and Croatian samples) and (2) a model where all free loadings were constrained so as to be equal across Slovenia and Croatia. Loadings for the first measurement variable (IAEXT, BC, NEFSUP, and ROA) for each of the four constructs (INFOPROC, BCC, NFP, and FP) were fixed.

Various authors (Jöreskog and Sörbrom, 1993; Steenkamp and Baumgartner, 1998; Yoo and Donthu, 2002; Marcoulides and Heck, 1993) suggest using the nested models approach in order to test for model invariances across groups. While early authors (Jöreskog and Sörbrom, 1993) use only the $\Delta\chi^2$ test, modern research on multi-group SEM (Steenkamp and Baumgartner, 1998; Yoo and Donthu, 2002; Marcoulides and Heck, 1993) calls for the utilization of other global fit indices as well. Specifically, Steenkamp and Baumgartner (1998) suggested using RMSEA,

Table 20: Global Fit Statistics – Full Metric Invariance Testing

Sample/Index	χ^2	df	RMSEA	CAIC	NNFI (TLI)	CFI	Nested Models	$\Delta\chi^2$	Δdf	Sign. Level[a]
1. Baseline model (pooled sample)	109.65	62	0.06	442.71	0.96	0.97				
2. Full metric invariance (all loadings equal)	116.23	68	0.06	406.85	0.96	0.97	2-1	6.58	6	>0.10

[a]Significance level is calculated by comparing $\Delta\chi2$ to critical $\chi2$ with corresponding degrees of freedom at an appropriate level of significance

CAIC, CFI, and TLI (NNFI), while they account for both goodness of fit and model parsimony. Smaller values of RMSEA and CAIC and larger values of CFI and TLI indicate better models. When comparing Model 2 with Model 1 (Table 20), the difference in the chi squared was found not to be statistically significant at $p>0.10$, TLI, CFI, and RMSEA have not deteriorated, while CAIC even decreased. This means that full metric invariance between the Slovenian and Croatian samples was achieved. Having achieved configural invariance along with full metric invariance allows us to proceed by testing for differences in individual path coefficients among the four constructs between the Slovenian and Croatian samples.

5.4.2.3 Structural Coefficients Invariance

Table 21 presents the nested model approach to testing the invariance of single path (structural) coefficients between Slovenia and Croatia. The procedure employed compares models where individual path coefficients are allowed to differ (one by one) between the countries to Model 2. Again, the $\Delta\chi^2$ test is used in order to test the hypothesis of path coefficient invariance between Slovenia and Croatia.

By relaxing each individual structural coefficient one by one, the hypothesis regarding the invariance of particular path coefficients can be tested. The results show that there are no statistically significant differences between Slovenia and Croatia where structural coefficients relating BCC to FP, NFP to FP, and BCC to NFP are concerned. Namely, comparing Models 2b, 2c, and 2d (where the constraint of the equality of certain structural coefficients was relaxed) to Model 2 (full metric invariance) showed no statistically significant difference.

On the contrary, the hypothesis regarding the equality of structural coefficients relating INFOPROC to BCC for Slovenia and Croatia needs to be rejected at $p<0.01$. Companies in Croatia report a significantly higher impact of INFOPROC on BCC ($\beta_{CRO} = 0.71$) than Slovenian companies ($\beta_{SLO} = 0.52$), however it is strong and positive in both cases. Hence, we have established configural, metric and structural coefficients invariances for Slovenia and Croatia. This means that the constructs Information Processing, BCC, NFP, and Financial Performance were perceived and measured in a similar way across the two selected countries. In addition, organizational learning demonstrated a very similar pattern of impacts on financial and non-financial performance.

Table 21: Nested Models for Comparing Path Coefficients in the Slovenian and Croatian Samples

Sample/Index	χ^2	df	RMSEA	CAIC	NNFI (TLI)	CFI	Nested Models	$\Delta\chi^2$	Δdf	Sign. Level[a]
2. Full metric invariance (all loadings equal)	116.23	68	0.06	406.85	0.96	0.97				
2a. INFOPROC → BCC invariant	123.81	69	0.06	406.20	0.95	0.96	2a-2	7.58	1	<0.01
2b. BCC → FP invariant	116.73	69	0.06	399.94	0.96	0.97	2b-2	0.50	1	>0.10
2c. NFP → FP invariant	116.72	69	0.06	400.81	0.96	0.97	2c-2	0.49	1	>0.10
2d. BCC → NFP	117.59	69	0.06	400.35	0.96	0.97	2d-2	1.36	1	>0.10

[a]Significance level is calculated by comparing $\Delta\chi^2$ to critical χ^2 with corresponding degrees of freedom at an appropriate level of significance

The introduction of the cross-cultural dimension did not distort the research findings found in previous one-country research designs. This is an encouraging fact regarding the reconfirmation of the beneficial direct impact of organizational learning on NFP and the indirect positive influence on financial performance.

6 Discussion

We developed several specific hypotheses to address the organizational learning-organizational performance link. In Table 22 all five hypotheses are presented together with their support for the Slovenian, Croatian, and pooled samples. The results are consistent across both individual country samples and in the pooled sample as well.

The results in relation to H1 suggest that information processing has a strong (in the case of Slovenia) or even very strong (in Croatia and in the pooled sample) impact on BCC within companies. Hence, better management of information acquisition methods and techniques, providing opportunities for INFINT, collecting information from internal and external sources, etc. – all these lead to changes in the way companies operate; in the way they perceive and understand their situation (cognitive changes) as well as changes in the way they behave. These results indicate that those companies which manage to acquire and interpret information faster, better, and to a greater extent also adapt faster to the challenges of the business environment. Having information and understanding this information leads to BCC in order to adapt to and even to create changes in the business environment, which rounds off the organizational learning process.

Another evident and consistent finding is the absence of the direct impact of the organizational learning process on financial performance (H2). Instead, the impact of organizational learning is indirect but still (very) strong. Higher-level organizational learning improves non-financial results from the perspectives of employees, customers, and suppliers (H3) and in turn,

Table 22: Summary Overview of the Results

		#	Hypothesis	Support Found in…
		SLO	CRO	Pooled Sample
H1	Better information processing (INFOPROC) induces the need for more behavioral and cognitive changes (BCC)	++	+++	+++
H2	Faster adaptation to challenges in terms of behavioral and cognitive changes (BCC) leads to improved financial performance (FP)	0	0	0
H3	Faster behavioral and cognitive changes (BCC) in sync with the needs of the external and internal business environments lead to improved non-financial performance (NFP) from the perspectives of employees, customers, and suppliers	+++	++	+++
H4	Improved non-financial performance (NFP) leads to increased performance in financial terms (FP)	++	+++	++
H5	Country origin will not moderate the relationships posited in H1-H4, thereby suggesting that the relationships of Slovenian firms will be invariant from Croatian companies	/	/	✓

+++ Very strong and positive, ++ strong and positive, + moderate and positive, 0 not statistically significant, – disconfirmed, / not tested, √ true

non-financial indicators of performance have a (very) strong and positive impact on financial indicators of performance (H4).

These results are consistent with some very recent research in the context of Spanish companies (Prieto and Revilla, 2006), which adds to the reliability of the research findings. This corroborates and justifies the expansion of the shareholder to the stakeholder perspective in organizational performance evaluations and also management. Good financial performance is a consequence, as well as a symptom of an adequate treatment of the organizational learning process and devoting enough attention to non-financial indicators of performance, such as customer satisfaction and retention rate, employee satisfaction and productivity, and involvement of suppliers in firms' research and development processes.

While the above findings are not surprising, testing H5 brings an additional dimension to an understanding of the organizational learning–organizational performance link. Using a multi-group SEM technique and data from Slovenia and Croatia, it implicitly controls for the contextual variables of level of economic development and national culture. As expected, H5 was confirmed and thus provides evidence that organizational learning is an equally important concept for companies in both recently developed (Slovenia, according to World Bank criteria) and transitional economies (Croatia). Combined with knowledge from the USA, Spain, and other developed countries, the generalization can be made that organizational learning does contribute significantly to the competitive advantage of a company regardless of the level of economic development and the national cultural traits.

Organizational learning is an important factor in attaining and sustaining a competitive advantage. Companies around the globe that learn better, faster, and to a greater extent also perform better than their competitors in spite of the level of economic development and the traits of their national cultures.

7 Conclusion and Implications

Within the broader conceptual framework, this study focused on the relationship between the organizational learning process and organizational performance. In the last two decades an extensive body of empirical research on this issue has been published. However, so far, to our knowledge this study is the only one to address organizational learning empirically on a set of two different countries simultaneously using a multi-group SEM technique. It expands the generalizability of the research findings by including a relatively new EU member state that just crossed the threshold to the status of developed country as well as a country in transition. As such, it controls for external macro- and mezzo-economic factors that are often neglected in the research on organizational learning and performance. In addition, Slovenia and Croatia differ also in terms of the dimensions of the national cultures. As its main contribution, this study showed that organizational learning is equally important for organizational performance regardless of the level of economic development and the dimensions of the national culture.

Despite its certain strengths, this study also has some limitations that point toward several research opportunities. First, Slovenia and Croatia are two neighboring countries that shared some part of their histories in common countries. Nevertheless, they are different enough to control for two important contextual factors: economic development and national culture. Future research will need to expand the generalizability of the research findings in order to include other countries and to also control for factors where Slovenia and Croatia do not differ significantly. Numerous contextual variables from the external business environment need to be accounted for (technological, socio-cultural, legislative-political, the international environment).

In addition, while we have here used cross-sectional data, there might be some time lag between organizational learning initiatives and performance (especially financial). The challenges faced by future research include collecting longitudinal data and developing dynamic models to test organizational learning and performance. While this study only involved organizational performance as the only consequence of organizational learning, there are most certainly others. For instance, organizational learning is a facilitator of innovation within organizations (Liao et al., 2008). Furthermore, there is another side of the coin regarding the positive impact of organizational learning on performance. Namely, what are the antecedents to organizational learning? How can we induce organizational learning? Škerlavaj (2007) developed a conceptual model of antecedents, consequences, and the context of organizational learning that will need to be tested empirically in the future – also in cross-cultural settings.

The research findings extend beyond the academic field of organizational learning and bear some important implications for the practice of management as well as for policy makers. For academics, this study is the first to test the organizational learning and performance link in two countries simultaneously and to introduce two contextual variables in the empirical research:

level of economic development and national culture. It is just the way organizational learning happens that differs, as Dimovski et al. (2008) suggest – while European companies rely more on previous experience, Asians build upon external information sources. Researchers interested in the phenomena under investigation can benefit from this study by understanding the importance of contextual variables and as a platform for further investigations. We argue that the methodological framework is also adequate for such endeavors. For managers, this research is a reaffirmation of the well known concept that investment in knowledge does pay off – first, in terms of non-financial indicators, and consequently also in financial terms. Mastering the process of information acquisition, interpretation, and acting upon that knowledge in terms of BCC leads to better performance – regardless of the level of economic development or national culture.

For policy makers, the most important implication of these findings is that joining the knowledge-based economy is not a buzzword but rather an urgency. This study is empirical evidence for the claim that modern countries will need to put investment in knowledge at the very top of their list of priorities should they wish to succeed in the global battle for talent. This means creating opportunities and an appropriate environment (regarding, e.g., taxation, the educational system, etc.) in order to develop and attract a capable workforce and companies that will be willing to invest in organizational learning initiatives.

Appendix A: Country profiles

2008 Est.	Slovenia	Croatia
General indicators		
Population	2,023,358 (143rd)	4,453,500 (114th)
Official language	Slovenian	Croatian
Area (total)	20,273 km^2	56,542 km^2
Density	99.6/km^2	81/km^2
Economic development		
GDP (PPP)	\$48.343 billion (83rd)	\$74.419 billion
GDP (per capita)	\$28,010 (28th)	\$16,758 (51st)
Human development index (2003)	0.917 (29th)	0.85 (47th)
ILO unemployment rate	6.3%	9.1%
Accession to the EU	May 1, 2004	Candidate
Currency	Euro	Croatian Kuna
National culture dimensions (Hofstede)		
Power distance	71	72
Individualism	27	33
Masculinity	19	40
Uncertainty avoidance	88	80

Source: Hofstede (2001); Wikipedia (http://wikipedia.org/wiki/Slovenia and http://wikipedia.org/wiki/Croatia, Accessed on 14.3.2008)

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Sustainability, Learning, Adaptation, and Knowledge Processing

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Abstract. Sustainability is a system's concept and regards the dynamic balance between a dynamic artificial system and its dynamic environment. For an organization to survive as a social system it needs to be adaptive and effective while interacting and coevolving with its environment. In order to be sustainable an organization needs two things: (1) knowledge about its impacts on the world and (2) the capacity to learn and renew or innovate in response. This article explores the notion of social (or organizational) sustainability in relationship with knowledge, knowledge processing, learning and adaptation. The sustainability performance of organizational activities is considered to be a function of its impact on vitals capitals in the world. Social (or organizational) sustainability is defined as a disposition or capability of an organization to realize this balance and has two fundaments: an adaptivity-based theory and a capital-based theory. The first is the organization's ability to adapt to environmental challenges, while maintaining its own basic pattern of identity. The second is the ability to interact with the environment in such a way that it does not degrade levels of vital capitals beyond levels required by humans (and their future generations) for their well-being. These are also the internal and external dimensions of sustainability, linking knowledge ecology with natural and social ecology. Organizational sustainability performance is in part a function of knowledge management and of the knowledge processes within an organization. In this article we present a Four Dynamics Framework with two new concepts, illustrating the role of sustainability targeted knowledge management (KM). Concerning knowledge content, KM needs to focus on high quality Knowledge of Sustainability (KoS), whereas by enhancing a continuous and sustainable knowledge creation & innovation *process* in the organization it realizes what we call sustainability of knowledge (SoK). Both outcome and process need good metrics, and measurement and reporting tools.

Keywords: Sustainability, Learning, Organizational Learning, Adaptation

1 Introduction

This article is about learning, adaptation and sustainability in organizations. We will argue that sustainability, a topic that more and more moves towards the core of organizational activities, depends on learning and adaptation. Learning and adaptation are well known, although often not quite well understood, aspects of organizations. To learn and to adapt is something we humans do all the time in our life, but what it means for organizations - as a collection of individuals working within buildings and with other artifacts - is not so clear. Associations with change, innovation, improvement and, increasingly important nowadays, with sustainability of organizations are often

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made, but *who/what* learns and adapts and *how* these processes take place are not easy to determine or to measure.

For long, sustainability has been an ecological theme, having to do with reducing pollution and protecting the environment, that is to say with things of which some say it takes place at the edges and borders of organizations. This one-sided view on sustainability has rapidly changed in the organizational world the last ten years. Sustainability has become an issue in the centre of every organization. More and more sustainability's ecological and environmental connotations are overshadowed by other completions of sustainability, more related to social systems, such as adaptation, (organizational) learning, corporate responsibility or corporate knowledge creation.

Although discussions about sustainability, learning and knowledge have become more prominent in management and organization studies (Dalkir, 2005; McElroy, 2003), we believe that often the concepts are not made operational and measurable. A term like "organizational learning" is a metaphor and "measuring" properties of entities as metaphors is very difficult. In studying sustainability, we will present a conceptual framework based on the latest insights from knowledge management. Within the framework we take for granted the assumption that organizational learning and knowledge require the presence of the most important constituting elements of organizations: human individuals, individually as well as collectively, more and more in connection with advanced and sophisticated information systems. We already want to make clear that we will not discuss the distinction in the individual and organizational level of aggregation in this article. We assume that human individuals are the most important actors in any organization and for that reason we conceive an organization as a multiactor system (MAS).

In this article, we focus on sustainability and its basis in adaptation and learning. We want to explore and explain two things. First, that looking at (social) sustainability requires an adjusted, more operational view on organizations taking into account various kinds of actors and their knowledge. Therefore, we have to look at various perspectives on knowledge management. Second, and perhaps more important, we want to demonstrate that the notion of sustainability can indeed be applied to social and organizational structures.

In Sect. 2, we will start with the explanation of the framework, which is intended to conceptualize and thereby tackle the issue of sustainability in organizations in general. We will argue that a discussion of sustainability is not possible without taking into account knowledge and its dynamics. In Sect. 3, we distill out of the framework two research perspectives on sustainability: an adaptivity-based and a capitals-based view. In Sect. 4, we will discuss both views in detail also including the issues of learning and change. In Sect. 5, we give conclusions and reflections on future research.

2 A Framework for Dynamics, Sustainability, Knowledge, and Innovation

2.1 Knowledge and Sustainability

What do we think of when we hear words like "sustainable," "sustainability," and "sustainable development"? Sustainability comes from the Greek word "sustenare," which means "to hold up" or "to keep on." The essential idea of sustainability is that of maintaining or enhancing some valuable feature (of life) into the future. Sustainable development is development that "meets the need of the present without compromising the ability of future generations to meet their own needs" [WCED (1987), also referred to as the Brundtland definition]. In this conceptualization, the key value is the capacity to satisfy (human) needs. However, what kind of capacity are we talking about? Brundtland's often used conceptualization is not a definition of sustainability, it is a "definition" of a kind of development (sustainable development) in which the word "sustainable" is used as an adjective without actually defining the term. In literature we find two dominant ideas about what sustainability is (Hooker and Brinsmead, 2005): (1) sustainability as maintaining and enhancing adaptation and resilience (natural and human), and (2) sustainability as maintaining and enhancing capital (natural and human). The values to be sustained are regenerative options and adequate services and the corresponding ideals they serve are regenerative potential and quality of life. The theoretical value in terms of which decisions are formulated are adaptive capacity and carrying capacity. We will discuss the positions in detail in Sects. 3 and 4.

At present time, sustainability theory, policy and practice present an apparently confusing, diverse range of claims and proposals. There is no consensus and we doubt there will be one. In trying to map the chaos in the period 1960–2000 alone, we made an inventory of more than 35 conceptual definitions and 580 operational definitions or indicators (Faber et al., 2005). At first, it seems difficult to categorize the definitions. However, a clear understanding of relevant issues is enabled by taking a "system's perspective" on sustainability. We argue (Faber et al., 2005; Jorna, 2006) that sustainability is an attribute of a system, indicating the relationship between this system and its environment. More precisely, sustainability only attributes to artificial systems [conceptualized after "*the Sciences of the Artificial*" by Simon (1969/1998)]. Conceptually, sustainable differs from endurable. The latter means long lasting, the former means being in a dynamic balance. Systems that are sustainable are of human origin (conceptualized and constructed by humans) and function according to human desires. In other words, the way such systems interact with their environment is determined by humans, first in the way these systems are put together, and second in the way humans operate them. Sustainability refers to the balance between the artificial system and its environment. This means that a system should be able to keep itself in existence indefinitely in its environment (survival). Both, system and environment are "internally" dynamic, and are continuously searching for homeostasis, in terms of a dynamic balance. In this way, practice and development of organizations and businesses focus on the "health" of the social system. However, what are the features of a healthy social system? Who judges its health; by which criteria? In the following, we will provide the beginnings of an answer.

Earlier, we conceptualized an artificial system as human made and human operated. This means that the sustainability of an artificial system is mostly determined by how people behave. Their behavior subsequently follows from the knowledge they have (in their minds), knowledge in terms of *content* and knowledge in terms of *processes*, that is to say of how this knowledge is processed.

The distinction between knowledge in terms of content and processes forms the basis for two concepts in our framework: Knowledge of Sustainability (KoS) and sustainability of knowledge (SoK). KoS indicates (1) knowledge content about causes that underlie environmental, organizational, social and individual problems, and (2) the knowledge by which such problems can be resolved. The improvement of an organization's behavior, i.e., improving the sustainability of an organization, builds on the problem solving capabilities in which the firm applies KoS, and on the learning processes and its content based upon which the organizations learns KoS. SoK, on the other hand, focuses on the processes that govern the production, creation and integration of knowledge or KoS.

Adaptivity and learning are essential for any form of sustainability. Assuming that artificial systems exist in continuously changing environments, the human(s) who control these systems need to adapt their behavior to these changes and hence often need to acquire new knowledge. The newly generated knowledge should eventually result in knowledge use, i.e., humans need to incorporate new knowledge into their existing behavior. As indicated, SoK denotes the aspect that humans need adequate processes to acquire new knowledge and integrate this new knowledge in their behavior. SoK is about how individuals and groups learn, how people adequately interact, how knowledge is transferred and how it is developed. This also requires that they have Knowledge of Sustainability (KoS). This is knowledge that is used to operate the needs of an artificial system to be updated and adjusted continuously. Individuals, who control the artificial system, including themselves, have to cope with the changes of the system to maintain a balance between the system and its environment. Furthermore, it will remain uncertain whether all knowledge concerning sustainability is available, applicable, designed and organized in the right way. In other words, SoK needs to be targeted at the development of new KoS, and hence to the improvement of sustainability.

2.2 A Framework of Four Kinds of Dynamics

The two sides of the coin: Knowledge of Sustainability (KoS) and SoK are based on various kinds of feedback loops, dynamics and learning. For example, as we perceive discrepancies between desired and actual states, we take actions that will (hopefully) cause the real world to move toward the desired state. New information about the state of the world causes us to revise our perceptions and the decisions we make in the future. We know that not only we, but also the world changes continuously. In Fig. 1, where we present our framework for sustainability and sustainable innovation, this is indicated by D(ynamcis)1. It primarily concerns the external world that changes and develops. The other three D's refer to the internal organization, because we can look inside an organization (system) and concerning its internal dynamics make a distinction in routine learning (D2) and creative learning (D3) (Firestone, 2006). The role of knowledge management is to influence both Knowledge of Sustainability (content) and SoK (processes) which can be done by policies and programs (D4). We describe the dynamics D1–D4 in detail.

Dynamics 1. Real world dynamics: Underlying the first dynamics is understanding the nature of wholes and parts and how parts and wholes are interrelated. By encouraging deeper levels of learning, we create an awareness of the larger whole, leading to actions that can help to shape the organization's evolution and our future (Senge et al., 2005). Where the world is dynamic, evolving, and interconnected, we, human actors, tend to make decisions impacting vital natural and human capitals using mental models that are static, narrow and reductionist. Among the elements of dynamic complexity people find most problematic, are feedback structures, time delays and stocks and flows (Thompson and Cavaleri, 2009). To learn from evidence in a complex world, we also need systems thinking, system dynamics and (integral or whole system) modeling,

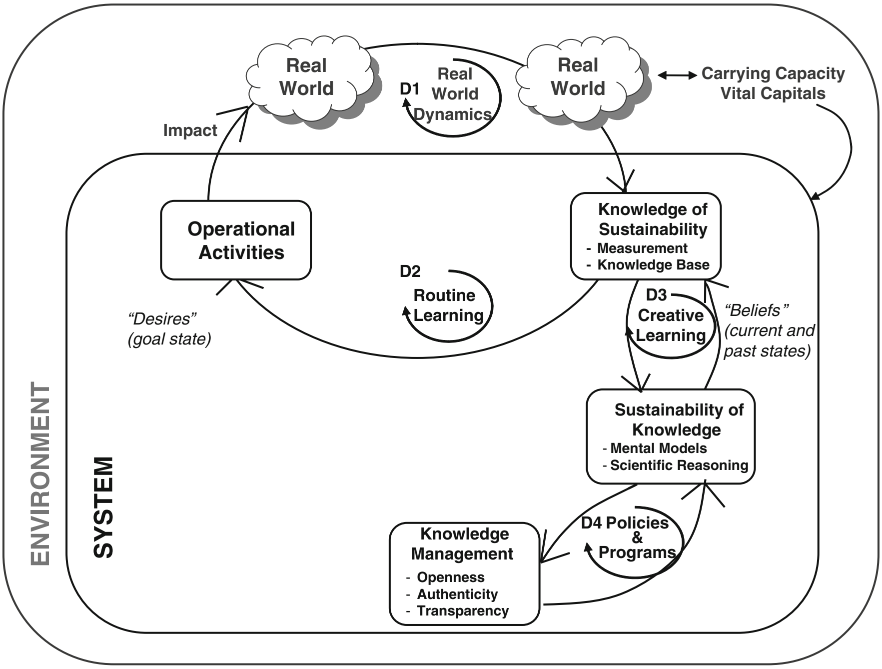

Fig. 1: The Four Dynamcs Framework for Sustainable Innovation

including the help of information systems and knowledge management tools. Understanding these principles improves the quality of Knowledge of Sustainability.

Dynamics 2. Routine learning: Routine learning occurs when we are trying to close a (small) gap between what we want and what we have or between the way we think the world is and the way we think it should be. Information feedback about the real world is needed, and problems need to be detected. In routine learning, we make adjusted Knowledge of Sustainability (that is, we learn) by applying and integrating old Knowledge of Sustainability, in the form of rules or mental models we already developed.

Dynamics 3: Creative Learning: In general, routine learning does not concern severe problematic situations. It takes place within existing and accepted boundaries. However, sometimes we encounter more profound anomalies and irregularities, and as such, this gives way to creative learning and deep change, especially when "routines" become problematic. The transformation between the two types of learning processes happens when, during a routine learning process, we recognize that our routine learning has resulted in knowledge that conflicts with our expectations. It does not work to just close the behavioral gap and, consequently, we "learn" that a second gap exists: the gap between what we really know and what we need to know to close the first gap. The conflict between our expectations and reality and the realization that the second knowledge gap exists and prevents us from fulfilling our practical, operational (sustainability) objectives, defines a problem that we must recognize, clearly formulate, and solve (Firestone, 2006). The process of clearly formulating and solving this problem and looking for new Knowledge (of Sustainability) to close the knowledge gap is what we indicate as SoK. Creative learning is strongly adaptive compared to routine learning, which is limited. Routine learning uses previous knowledge (rules and mental models) to learn about specific conditions surrounding operational process activity. Creative learning, however, focuses on learning new general rules and models for transforming the ways in which we perform operational management and operational process activity.

Dynamics 4. Policies and programs: Knowledge management and its consequential behavior is aimed at enhancing sustainable knowledge processing which equals our concept SoK. Its goal is to enhance knowledge production & integration, organizational learning and/or innovation. The focus is on knowledge *making*, not just knowledge *sharing*. It also creates and enhances social and technological infrastructures, and its interventions are social and technological in form. The outcomes are strategies, policies and programs to enhance sustainable knowledge processing, learning and innovation. KM indicators and feedback measurements should be placed, here.

The four kinds of dynamics are external as well as internal, they are direct as well as indirect, they are mutually linked and they require entities (actors) that can learn, change and adapt and can use and create knowledge. Basically, human actors always learn, but the results and artifacts (including software agents) of their actions lead to adjusted and improved behavior and knowledge. Therefore, knowledge content is necessary as well as the processes to create and integrate knowledge. Here, we can see various kinds of barriers, applying to actors as well as to knowledge and learning. We see as barriers for KoS: selective perception, missing feedback, delays, biases, distortions, error and ambiguity and the inability to infer dynamics from mental models. For SoK we see as barriers: misperceptions of feedback, wishful thinking, judgmental biases, defensive routines, inconsistencies, gaming the system and high costs of error suppression (Sterman, 2006). Sterman also noticed that for learning to occur, each link in the routine and creative learning processes must work effectively, and we must be able to cycle around the loops faster than changes in the real world rendering existing Knowledge of Sustainability obsolete.

3 Knowledge Management: Making Adaptation and Sustainability Operational

The knowledge discussion shows the relevance of knowledge management for sustainability issues. Knowledge management is a relatively young discipline in both research and practice (Dalkir, 2005). From the start, the main objective of KM has been to get the right information to the right people at the right time in the right quality, in the right shape, against the lowest costs (Schreiber et al., Schreiber et al., 2002; McElroy, 2003). According to McElroy (2003), KM was highly technocratic in the beginning. Information technological applications dominated KM practice from the start (Ruggles, 1998). This is understandable, for KM has been perceived as nothing more then the distribution, delivery and transformation of information. McElroy calls this kind of KM, first generation KM. Today, especially in relation to sustainability, this approach within KM does not suffice anymore. KM, in its present second generation, has become much more than just delivering and transforming information and using information technology. It is now also about knowledge creation and production. For the remainder of this article, especially in relation to sustainability, we will focus on second generation KM and knowledge creation.

The conceptual framework in Fig. 1 is at a high level of aggregation and we already indicated that in order to determine and make operational various aspects of knowledge and sustainability, we have to step down to lower levels of aggregation, including human actors, mental models, learning and change (Jorna, 2007; Jorna et al., 2009). If human actors learn and organizations change, what kinds of adaptation, progress or development can we distinguish and what are the implications of these distinctions? We already made a start with sustainability, but we have to give more details of adaptation (or adaptivity), because sustainability presupposes adaptation.

In organizational literature, adaptation is explained in many ways. Terms that are used in this regard are innovation and organizational learning and single and double loop learning (Argyris and Schon, 1978). March (1991) explains adaptation (and learning) of organizations in terms of exploration and exploitation. Exploitation indicates that an organization utilizes its current configuration to generate as much benefits as possible. In this regard, exploitation fits neatly into first generation KM; knowledge that enables the organization to generate benefits that already exist and only need to be used in the appropriate organizational processes by the appropriate people or actors. March calls this the "exploitation of old certainties" (March, 1991, p. 71), comparable with what we call routine learning. On the other hand, March's exploration points to second generation KM. Exploration means that an organization actively searches for new ways to configure itself, in order to improve its fit with the environment. From this perspective, knowledge is not expected to exist, but needs to be developed; "the exploration of new possibilities" (March, 1991, p. 71), comparable with what we called creative learning. The concept of innovation is explained along similar lines.

Innovation is strongly connected to creativity (e.g. Pahl and Beitz, 1996). Jorna (2006) identifies the two phases of conceptualization and commercialization within innovation. The former refers to the generation of new, creative ideas, similar to March's exploration. The latter denotes the transformation of these new ideas into real products or services, which links to March's exploitation. Whatever term is used to refer to organizational change, the production of new knowledge is essential.

Again, we build on the insights of McElroy (2003) regarding KM, especially the management of knowledge production processes. He argues that learning and development of new knowledge are natural processes of human actors. Humans will constantly recognize problems while performing tasks within organizations, and search for solutions. In this search, they will gather information, share insights with others, formulate new knowledge claims, and put these claims to the test. Because knowledge production (or creation) is a natural process, KM should provide the environment in which the processes of knowledge claim formulation and testing can take place.

McElroy (2003) formulates four prerequisites that need to be met to ensure that knowledge production functions within an organizational context. First, individual human actors should be able to dictate their own learning agenda concerning what they want to learn. The organization provides a context that allows individuals to organize their learning ambitions alone, or in collaboration with others. The second prerequisite concerns the allocation of knowledge production processes. The idea is that knowledge production should take place throughout the entire organization, and not be concentrated in specialized units, such as R&D departments. In this way, an organization is able to utilize the knowledge producing capacities of all individuals. The third prerequisite is that knowledge production processes are performed by individuals with various backgrounds and this variety in knowledge content should be valued. The fourth prerequisite is the ability of individuals to communicate freely throughout the organization. Innovation and knowledge creation can only function in open communities. The idea is that when all these prerequisites are met, knowledge production can occur [for more details, see McElroy (2003, pp. 106–108)].

In all discussions on second generation KM and in McElroy's prerequisites for knowledge production, the focus is on change, on learning, on creation and on adaptation and all are used for sustainability. Change and learning are preconditions for knowledge creation, which is necessary for sustainability. In the next section, we start with change and learning after which we will discuss two operational interpretations of sustainability.

4 Change, Sustainability, Adaptation, and Social Capital in Organizations

4.1 Change and Learning

Knowledge creation and production automatically involve learning. Learning adds to human behavior the extra dimension of expansion, renewal, but also adaptation. Although every human being has the capability to learn and hence to adapt his/her behavior to changing circumstances, individuals and organizations differ in their capabilities and possibilities to adapt. Learning takes many shapes. In educational settings, for example, a distinction is made in supervised and unsupervised learning (Luger and Stubblefield, 1998). This distinction is based on the type of feedback an individual (intelligent actor) receives. Supervised learning refers to situations in which a teacher teaches an intelligent actor. In the unsupervised case, an individual learns him/her self from interactions with the environment, without a teacher who explains or structures the meaning of the actor's perceptions.

From an individual perspective, learning can be seen as a change (mostly interpreted as an improvement) in an individual's behavior or in the thought processes of the individual. In this respect, we distinguish three kinds of change. First, the individual may display an *acceleration* of behavior and thinking. If this takes place, learning not only refers to the acquisition of a new skill/routine, but also to the ability to rapidly apply this newly acquired skill/routine. In the second place we have *quantitative expansion* and in the third place *qualitative expansion.* Quantitative expansion means acquiring more of the same knowledge, for example in the case of KoS more indicators that are relevant for the performance of organizations. Qualitative expansion means acquiring complementary or "completely" new knowledge, for example in the case of KoS one learns dynamic system's theory for the feedback and feed forward loops that are related to organizational performance.

What learning is at the individual level is, is innovation at the organizational level. From the individual level, we see learning as a process that underlies innovation. Innovation concerns change and adaptation at the organizational level. At this aggregate level, innovation processes involve multiple individuals who realize a change in, for example, the organization, the production process, a new product line, etc. (following West and Far (1990). Hence, in order for individuals to learn and adapt, and thus for innovation to occur, the organizational context of the individual also plays a very important role. With regards to this context, Newell and Simon (1972) use the term constraint. In their line of reasoning, an individual is constrained by the organizational context. The argument is that organizational constraints force the individual to accomplish his/her task "at a specified level of intelligence or adaptability" (Newell and Simon, 1972, p. 83). While the organizational context is helpful in making an individual focus on accomplishing his/her task, it also influences his/her freedom of movement to learn and adapt. A context for learning should on the one hand allow the individual to learn, and on the other hand motivate and stimulate him/her to do so. We see this as in line with McElroy's four requirements for knowledge production.

4.2 Adaptability and Sustainability

As indicated in the introduction, organizational learning and innovation are connected with corporate social responsibility and sustainability. We repeat our earlier perhaps too implicit remark that organizations are complex adaptive multiagent systems consisting of various kinds of actors (Jorna et al., 2009). We already indicated that we use a unified "systems perspective" on sustainability and will present two alternative conceptions of sustainability. Sustainability is concerned with preserving or enhancing (sustaining) something of basic value ("the good"; Daly and Cobb, 1994) over time, and annex that the purpose of having a concept of sustainability is to inform a policy framework (for high sustainability performance) to this end.

Here humans come into play as entities within and outside the social system. We see "an organization" as a shorthand formulation for a MAS. Such a system has to satisfy the needs of those concerned and involved in an adequate way. Hereby, humans fulfill two roles: there is an internal instrumental role as a worker (executor, laborer) contributing to the realization of system functions, and there is the role of the external stakeholder (judging and making sense). In management theory, the "health" of a social system - in this case an organization or a firm - is mainly determined by the constituting notions: "effectiveness" and "adaptation." An organization has to fulfill the right functions the right way. To realize the desired functions correctly, a social system has to be effective. Realizing the right functions requires a constant change of system policy (goals, resources and priorities), and therefore a social system needs to be adaptive. Effectiveness is the degree of goal attainment and is a quotient in which the actual result is divided by the desired result (goal state) (McElroy, 2008).

In a more broad sense, system-effectiveness deals with two questions at the same time: (1) to what degree is the social system (organization, department) effective in using its means (instrumental role), and (2) to what degree is the social system as a means itself effective to fulfill the needs of those concerned (stakeholder role). Determining the effectiveness is not limited to economic results only, but has to deal with environmental and social bottom line results as well (including accountability, accounting issues and indicators, auditing, reporting and benchmarking). Adaptability (or the potential to change) of a system means its ability to adapt its essential characteristics, by reacting to internal and environmental changes. This notion is also called "self renewal" and "innovative or adaptive capacity." It implies that organizations are able to handle the whole decision cycle, from problem detection to implementation.

However, why are social systems not effective and adaptive enough? This is mainly because they often lack receptiveness and responsiveness, that is to say they have insufficient intentions, knowledge and possibilities to act. What we earlier called Knowledge of Sustainability. However, a "healthy" organization also needs certain specific properties, as is indicated in the theory of complex adaptive systems (CAS; Holland, 1975). Besides its "normal" structures and functions, such a system should also consist of elements like "openness, self-organization, self-adaptation, homeostasis, etc." In line with the main topic of this article, it should be sustainable.

The balance between artificial system and environment presented before connects the adaptivity and capitals perspectives on sustainability (Hooker and Brinsmead, 2005). With regard to adaptivity, the connection is made by looking at the balance-restoring capacity of the artificial system. With regard to the capital perspective, the connection is made through the capitals or resources that are used by the artificial system. For instance, if an artificial system utilizes capital X beyond the regenerative capacity of this resource, an unbalance exists from the capitals perspective. If, in addition, the artificial system is unable to reconfigure its functions to restore the balance between its use of X and the regenerative capacity of X, one can argue that the (artificial) system is unsustainable from this perspective.

Resulting from the above, we now have the concepts: adaptation and effectiveness (with regard to management) and adaptability and the capital-approach (with regard to sustainability). We will first discuss an adaptive-based theory of sustainability combining both adaptability dimensions (Sect. 4.3). Then we will describe a capitals-based theory of sustainability combining effectiveness with a capital approach (Sect. 4.4). Within both sections, we are referring to knowledge management and to knowledge processing. Knowledge management is about using and gathering knowledge content and about the adequate processing of knowledge. That is, it is about KoS and SoK, whereas knowledge processing primarily is about SoK.

4.3 An Adaptability-Based Theory of Sustainability

Sustainability, seen as adaptability, is closely linked to the theory of complexity science (Holland, 1975, 1995) and to the work of Maturana and Varela (1973/1980) on the self-maintenance of identity in complex systems. This work relates to the maintenance of the internal pattern of the organization of such systems, in the context of their interaction with the environment. In order to maintain its characteristic pattern, the organization reconstructs itself while co-evolving with the environment, so there is stability and change at the same time. Organizations will have to keep their identity intact as they adapt (Cavaleri and Seivert, 2005). This provides an alternative formulation of the Brundtland sustainability requirement: "sustaining adaptive resilience that will meet present adaptive needs (including human need-derived demands) without compromising the capacity to meet future adaptive needs."

Organizational adaptive behavior involves learning and acting, which is grounded in change and renewal to meet environmental (and internal) changes. That is, it depends on and uses adaptation. Adaptation, in turn, depends on problem solving, learning, and knowledge processing, including both knowledge production and knowledge integration. However, the quality of knowledge processing, in turn, is influenced by knowledge management, the set of activities which purpose is to enhance knowledge processing (see Fig. 1 for details). But, that is not all. Sustainability and high quality knowledge processing involve sustainable innovation, which means a continuous and successful walk through the knowledge life cycle (problem solving and learning). Sustainable innovation (1) produces solutions that solve current knowledge problems without side effects and (2) maintains or enhances the capacity of the system to adapt as it solves problems.

Sustainable innovation is a pattern of social learning and problem solving. It is a necessary pre-condition for how organizations and firms function; the ways they organize, the ways the members learn and behave, the products and services they make, the energy and resources they use, and the wastes they produce. To be sustainable, patterns of learning and innovation in human social systems must:

1. Actually enhance their members' ability to adapt; that is, the outcomes of such patterns (human innovations) must demonstrably enhance, and not diminish, the bottom-line sustainability of what human actors do when tested against the sustainability measurement and reporting approaches that we advocate;
2. Be internally authentic, meaning that they (the patterns) must be consistent with the ways in which people in organizations and firms tend to self-organize around problem solving when left to their own devices;
3. Be open, in the sense that they first are transparent to and inclusive of stakeholders of all kinds regardless of their rank or standing in the system, and second are "fallibilist" in their orientation towards knowledge, meaning that they reject the notion that someone, being a leader or follower, always knows things with certainty.

Benchmarked against the criteria above, most contemporary patterns of innovation in human social systems and organizations are dysfunctional and not sustainable. They prevent human actors from learning effectively, from recognizing and solving their problems, and from operating in sustainable ways.

Referring back to our earlier discussion about generations of knowledge management, the question may arise whether first generation KM - the information technological view on knowledge storage and use - enhances an organization's capacity to adapt. The answer is largely: no. This interpretation of KM is not supporting sustainability. KM should be about producing new knowledge and managing openness to do so, and it is still a long way to open enterprises and open innovation, involving all stakeholders. An example of a measurement and reporting tool and metrics to be used by organizations for their adaptive performance is the Adaptive Scorecard, developed by Firestone (2006), which is a revised version of the Balanced Score Card. This adaptive score card is one measuring tool within the adaptivity based view on social sustainability. Other tools still have to be developed.

4.4 A Capitals-Based Theory of Sustainability

In business literature, the capital-based view of effectiveness is becoming a dominant notion of organizational or social sustainability (Porritt, 2005). Corporate sustainability encompasses strategies and practices that aim to meet the needs of stakeholders today while seeking to protect, support and enhance the human and natural resources that will be needed in the future. Business and industry have a crucial role to play in helping countries and societies to become more sustainable and competitive. As a result, many organizations and industries are responding by reducing their social and environmental impacts and risks through improved environmental management practices and efficient use of human and natural resources. Organizations and industries around the world are beginning to recognize the value of demonstrating transparency and accountability beyond the traditional domain of financial performance. This trend is a consequence of increased public expectations of organizations and industries to take responsibility for their non-financial impacts, including impacts on the environment and the community.

Again, an emerging question with regard to corporate sustainability and sustainability reporting is: What is its theoretical basis? What does it mean to say that companies, or its operations, are socially sustainable? From Daly and Cobb (1994), Meadows et al. (1992), Vemuri and Costanza (2006), to Porritt (2005), and many others, the sustainability of a human population, or organization, is a function of its impact on (the stock of) one or more types of vital capital. This is the capitals-based theory of sustainability. Capital is here considered as a stock of anything that yields a flow of beneficial goods or services into the future as required by humans and/or non-humans for their well-being. In sustainability theory and practice, vital capitals generally consist of natural or ecological capital and anthro capital (i.e., human, social, and constructed capital). The use of this notion of capital goes far beyond the classical financial interpretation of capital (McElroy, 2008; McElroy et al., 2007). The sustainability of a population, or an organization, then, is simply a measure of the proportionate impact of its operations on the carrying capacities of these capitals on which people rely for their well-being. Carrying capacity is the extent to which flows of beneficial goods and services from a stock of capital can satisfy a population's basic needs.

A good example of a measurement and reporting tool and metrics to be used by organizations for their effectiveness dimension is the ecological footprint (Wackernagel and Rees, 1996) and more recently for social sustainability the social footprint developed by McElroy (McElroy, 2008; McElroy et al., 2007). McElroy proposes to codify a social sustainability concept in the form of a quotient or an equation that makes it possible for sustainability managers to operationalize the idea in organizational settings: $S = A/N$. The sustainability performance (S) of an organization is a measure of its actual social and/or environmental impacts (A) on the carrying capacities of vital capitals, relative to what its normative impacts (N) on the same carrying capacities of capitals ought to be. In other words, sustainability performance is the quotient of actual impacts on vital capitals over normative impacts on vital capitals. In this way, it is possible to measure the bottom-line ecological and social sustainability performance of organizations [see McElroy (2008) for details].

The sustainability of an organization is primarily defined as maintaining and enhancing the carrying capacity of natural and anthro-capital. Effectiveness is hereby seen as a sustainability quotient in which the numerator is the actual net quantitative impact of an organization's activities on capital, and the denominator is the net quantitative impact on capital that an organization is entitled or expected to have (McElroy, 2008; McElroy et al., 2007). A living system's behavior or actions are sustainable if their impact on the capitals on which it relies for well-being do not unduly degrade or diminish the related stocks of capital. This formulation expresses an obvious capital reading of the Brundtland's sustainability requirement: "manage social and environmental capitals so as to invest capital in the development of new productive capacity while consuming capital to meet the present needed (basic) services in such a way that the capital similarly required by future generations is available to them."

Does first generation KM enhance an organization's capacity to be effective in this respect? Here again, the answer is also largely no. First generation KM has always been widely practiced as being about "leveraging" existing intellectual capital. It is an exploitive strategy (extracting and harvesting knowledge assets), to take advantage of that which already exists. Very few investments are made in creating new valuable knowledge, so we often use low-quality, sometimes outdated knowledge. Second generation KM, which is about knowledge production and creation, assumes the value of ecological and social sustainability performance, although most businesses don't really see this as a value; the ROI of this is less compelling to them. Their daily practices are still mainly about economic growth and short-term financial profit. What we need here is a targeted KM approach leading to bottom line sustainability driven innovation for high quality sustainable performance.

What does sustainable knowledge management and knowledge processing look like from this capital-based view? We give the beginning of an answer. KM and knowledge processing are like any other sphere of human activity in the sense that they can have impacts that either cause or close gaps in capital required to meet human needs. In that regard, KM and knowledge processing is just a particular type of activity in an organization that can have impact on the carrying capacity of capitals required by humans and non-humans for their well-being. Thus, we can subject KM and knowledge processing to the same kinds of sustainability measurements or impact analysis that we might use for any other pattern of human activity. Sustainable KM, then, would be a KM program or activity that does not degrade levels of natural or anthro-capital beyond levels required by humans for their well-being. This also increases the supply of anthro-capital, where needed, for human benefit (McElroy, 2008). To the extent that intellectual (human) and social capital (two forms of anthro-capital) are comprised of knowledge, it is easy to see how KM's impact could result in beneficial forms of positive externalities in cases where supplies of anthro-capital are below sufficient levels. It can do this by helping to design, implement, and maintain knowledge processing systems that help their members to adapt (enhancing social-innovation- capital) (McElroy et al., 2007).

5 Conclusions and Future Directions

We explored organizational sustainability as a disposition or capability with two aspects. The first is the organization's ability to adapt to environmental challenges, while maintaining its own basic pattern of identity. The second is the ability to interact with the environment in such a way that it does not degrade levels of natural and anthro-capital beyond levels required by humans (and their future generations) for their well-being. These are also the internal and external dimensions of organizational or social sustainability (Firestone, 2006), linking knowledge ecology (Pór and Spivak, 2000) with natural and social ecology. Consequently, in our view sustainability (and change) management is broad. It encompasses both, the fields of KM and Corporate Social Responsibility. They should preferably not be confined to a specific function or department for they are everybody's business and an integral part of the tasks of the firm. In order to be sustainable an organization needs (among others) two things: (1) knowledge of its impacts on the world (receptiveness), and (2) the capacity to learn and innovate in response (responsiveness). Therefore, the quality of sustainable performance is, in part, a function of the quality of knowledge processing. KM is precisely the management function that exists to control the quality of organizational knowledge processing, for that is its domain.

We started this article with a framework formulated in terms of sustainability, learning and adaptation. In this framework, four kinds of dynamics were distinguished: dynamics in the environment, and within the organization, routine learning, creative learning and governing policies and programs. In order to make this framework operational we looked at the constituting elements: knowledge and change of actors and adaptation. We all know that organizations change and adapt. We argue that this can only be meaningfully understood if one or more of the human actors in the organization as a MAS change. This does of course not exclude other changes in structures, regulations and other (man-made) artifacts.

On the one hand, learning and change take place autonomously, on the other hand, it is designed and organized. We argue that in the later case, knowledge of the dynamics of the various change processes at different levels of aggregation and within and between various kinds of actors is necessary. Having knowledge of the change processes within an organization and of the processes of the environment of the organization is the first step in applying the concept of sustainability. We call this step knowledge of sustainability (KoS). Sustainability is the dynamic balance between a system and its environment, such that the system can continue. We argue that this balance holds for ecological as well for social dimensions of systems.

The second step in applying the concept of sustainability is using this knowledge in the dynamic balance as such and consequently designing internal organizational processes such that this knowledge and the continuation of the organization is guaranteed. We call the second step: SoK.

Knowledge management is necessary in any discussion concerning sustainability. It should organize the need for change and innovation on the one hand, but on the other hand also the knowledge content that is necessary in understanding and using dynamics and learning. It also implies that knowledge creation itself should be sustainable.

Guided by this framework, we discussed ways to make sustainability operational and measurable: the adaptivity based and the capitals based view. Concerning the sustainable outcomes of adaption and learning at the organizational level, we applied the notion of sustainability quotients (McElroy, 2008). In this quotient, actual and desired capitals, whether they are natural, human, social or constructed, are compared and depending on the areas of impact may result in judgments whether practices are sustainable or non-sustainable. This implies a careful quantification of change, growth, adaptation and learning

We also showed that KM contributes to the discussion on sustainability. First generation KM contributes very little, but it still provides knowledge content to actors about what and how to do things (better). Second generation KM contributes much more, because it operationalizes knowledge creation and innovation, which leads to better processes in using the knowledge. This in turn may lead to better information systems supporting, accompanying and advising us in first and second generation KM.

We need high quality organizational policies and high quality sustainable performance. We follow Little (2007) in their view that the corporate sustainability value formula is the following: innovation + integrity = sustainable performance. As we showed, the business value of innovation is well recognized. Less recognized is the value created by integrity. Although often linked to corporate governance and corporate ethics, integrity can also have a more epistemological interpretation, meaning "living the positioning" by keeping the stock of natural and anthro-capital intact. Integrity breeds trust, trust creates a good reputation, and a good reputation builds value.

From the notion that information systems support organizational processes, and thus knowledge processes, the big challenge for the future is to design information systems from the idea that they are adaptable. The concept of sustainable information systems (SIS) is a step in that direction (Maruster et al., 2008). This type of information systems are constructed from the perspective of adaptation to the organizational context in which they are applied. On the one hand, this implies the usage of advanced techniques that allow for adaptation from within the system, such as genetic and evolutionary algorithms. On the other hand, this means that information systems are constructed as loosely coupled systems, which are easily changeable. In any case, artifacts as advanced information systems are here to stay and they will be more and more integrated with human information processing systems. The big challenge for the future is to make them semantically and pragmatically more adaptable to us, so they can help us in sustaining a human future (Harper et al, 2008).

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