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A Study of the Factors Influencing Knowledge Management within Inter Organizational Projects

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Abstract

Modern management theories agree that the effective use of knowledge management (KM) is one of the key determinants in the performance of a business organization. KM permits a firm to accurately measure its adaptability and competencies and predict its survival in the market place. There are two types of KM: one that focuses upon measuring the performance of a single organization (known as "internal KM") and another that measures performance across organizational boundaries (known as "cross-organizational KM"). This research deals only with cross-organizational KM, a topic that has received scant attention in prior studies. The research focuses upon the factors that are measured to produce a statistical

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analysis of performance in cross-organizational collaborations. The study concludes that four clusters of factors have the greatest influence on the success of inter-organizational projects. These clusters relate to: knowledge reserve, corporate culture/institution, communication and cooperation, and the characteristics of the specific project.

Key words: Inter-organizational cooperation; Knowledge management, knowledge absorption

Introduction

In the knowledge-driven economy of today, the source of profitability has shifted from tangible assets to intangible assets. How effective and how efficient businesses are at knowledge production, knowledge acquisition and knowledge utilization determine whether they are competitive in the market place. Knowledge management has been an effective tool to help more and more enterprises and research institutions to build their core competencies. KM can help them to coordinate different resources so as to predict and solve problems more creatively.

The diversification and complexity of the technological environment in a global market place poses considerable difficulties for individual companies that seek to achieve technological innovation (Teece, 1998). Because knowledge decentralizes in different enterprises and even in different countries, knowledge integration and innovation most effectively occurs across organizational boundaries (Chen, He & Tong, 2004). More and more, for innovative projects to succeed different enterprises in the same industry and even in different industries must collaborate

So how do we manage knowledge in cross-organizational projects? A large body of literature already exists on knowledge management within an enterprise, but many fewer studies have examined knowledge management between organizations. So there is a need for greater research on (1) the factors that can be examined by cross-organizational knowledge management systems, and (2) the impact those factors can have upon the success of cross-organizational projects. In this paper, only KM involving such cooperative programs is examined.

Literature Review

While there is a dearth of studies on the use of KM in cross-organizational collaboration, there is plenty of research on inter-organizational cooperation. Oliver (1990) defined inter-organizational cooperation as continued interactive activity and linkage between organizations in a certain business environment. Williams (2005) proposed another definition of inter-organizational cooperation: one firm exchanging knowledge with another for the same or a complementary objective. Moreover, according to Williams, the vitality of this relationship will depend largely on the future benefit expected by each firm. The collaboration will be more easily accepted -- and the network will be more inclined to expand and deepen the cooperation -- if it provides more opportunities for each member to gain added value.

Studies show that inter-organizational cooperation can create new knowledge. Davenport & Miller (2000) proposed that inter-organizational cooperation can help firms in competition with one another to acquire new knowledge. Das & Teng (1998) believed that the degree to which a business will form cross-organizational linkages is dependent upon the amount of trust it places in its partners. And the benefits derived from inter-organizational cooperation need to be mutual.

The location of the cooperating businesses and the degree of their cooperation can determine how much they can improve their competitive positions through cross-organizational cooperation. Kumar & van Dissel (1996) concluded that with effective planning and management, inter-organizational projects will facilitate access to new knowledge, and through information and technology exchanges between their staffs, the collaborating firms will experience improvement in their knowledge management capability.

Inter-organizational cooperation can be implemented in various ways that will be dictated by what knowledge or resources each side needs. The form of cooperation will also be dictated by the objectives and past experiences of each side, which may change over time and as the business environment changes (Pisano, 1991; Parkhe, 1993; Simonin & Helleloid, 1993). Firms will take different inter-organizational forms under different conditions (Oliver,1990). Inter-organizational cooperation can take many forms: such as strategic alliances, joint ventures, partnerships, out-sourcing, supplier-customer agreements; distribution channels, cartel agreements, resource-sharing agreements and cooperative alliances among governments (Das & Teng, 1998;

Oliver, 1990; Uzzi, 1997). Each of these forms has its own characteristics; therefore, different forms of cooperation may be better suited, or not, depending upon different conditions. Sobrero & Roberts (2002) too observed that cooperation can take the form of strategic alliances, long-term contracts and joint R&D arrangements. Inter-organizational cooperation resulted in gains in productivity and break-through in innovation and sales revenue increases. Brown, Cobb & Lusch (2006) concluded that interactive activity based only upon a contractual relationship will be prone to conflict, whereas activities that arise out of a relationship of trust will lead to greater satisfaction and less conflict.

Knowledge Management

Knowledge is a commodity that can be shared among several different persons at the same time. The knowledge you possess will not be diminished even as it is shared with others. Indeed, sometimes it may increase by reason of its dissemination. Drucker (1993) proposed that knowledge is information that changes a person or thing; knowledge can serve not only as an instrument to promote action, but also guides an individual or organization to adopt more efficient methods. According to Johannessen, Olsen & Olaisen (1999), knowledge is structured experience that provides a framework for the generation and evaluation of new information. In these definitions, knowledge is no longer regarded as disorderly or disjointed, but is instead woven into a dynamic system that enables people and organizations to interact with one another.

Most researchers on knowledge management divide knowledge into two classes, depending on the ease of its transfer: tacit knowledge and explicit knowledge, both which can be created and acquired in specific ways (Nonaka, 1994; Dutta & Weiss, 1997; Brown & Duguid, 1998; Rubenstein-Montano et al., 2001). Tacit knowledge resides in employees' consciousness and is exhibited on a daily basis in their experience, know-how, inspiration and intelligence. It is unspoken, highly individualized and difficult to formalize or express in language. Conversely, explicit knowledge is knowledge stored in information systems, which has been reduced to a structured or semi-structured format such as a report, brochure, manual, etc. If we were to liken explicit knowledge to the portion of the iceberg that is above the water, then tacit knowledge is the much larger portion that is below the surface.

Some aspects of knowledge management are concrete, such as staffing, processes and physical systems. Other aspects are abstract and resist easy quantification or qualification, such as the creation, transfer and use of tacit knowledge. Hence, processes and definitions used in knowledge management may not have universal applicability. Bartezzagai, Corso & Verganti (1997) described knowledge management as an emerging hot topic, entailing a series of activities, such as knowledge creation, knowledge distribution, knowledge application, learning, etc., that occur simultaneously at the organizational level and project level. Tranfield et al. (2003) defined knowledge management as a process to improve an organization's competitive position, not only by enhancing knowledge retention, but also by

promoting knowledge sharing and knowledge application.

The Process of Knowledge Management

Hedlund and Nonaka (1993) concluded that the effectiveness of knowledge management correlates highly to the implementation of two important knowledge transfer processes: relection and dialogue. Relection is the conversion of tacit knowledge into explicit knowledge; dialogue is a transfer among different levels of knowledge. Nonaka & Takeuchi (1995) divided knowledge management activities into the following four categories: socialization, externalization, combination and internalization. Socialization is knowledge transfer occurring primarily through common experiences. Externalization is the process of changing tacit knowledge into explicit knowledge through metaphor. Combination is the process of moving from explicit knowledge to systematic explicit knowledge. Internalization refers to the acquisition of tacit knowledge (like know-how and public intelligence) through imitation and "learning by using."

We can better understand knowledge management by studying its process. It is generally accepted that the process of knowledge management includes at least the following three aspects: knowledge access, knowledge distribution and knowledge application (Tippins, 2003). Marquardt (1996) breaks the process into four aspects: knowledge creation, knowledge acquisition, knowledge application and knowledge storage. McAdam (2000) believes that knowledge management systems should include four activities: knowledge construction, knowledge integration internalization, knowledge distribution and knowledge application. Others have devised other names

for these components. For example, Liebowitz & Beckman (1998) divide knowledge

management into knowledge affirmation, knowledge acquisition, knowledge selection,

knowledge storage, knowledge sharing, knowledge application, knowledge

internalization, knowledge usage, and knowledge updating and knowledge market-

orientation. We have summarized some of these components in Table 1.

Table 1. Components of the Knowledge Management Process

Barton, 1995	Knowledge sharing, solving problems creatively, importation and absorption of external knowledge, experiment, implementation and integration of new methods.
Andersen & APQC, 1996	Knowledge sharing, creation, delimitation, collection, revision, organization, application.
Wiig, 1993	Knowledge creation, explicit, usage, transfer.
Choo, 1996;Speck & Spijkervet, 1997	Knowledge identification, creation, decision, development, transmission, integration, possession and usage.
Nonaka, 1996; Alavi, 1997	Socialization, internalization, integration, externalization. Knowledge acquisition, retrieval, filtration, connection, transmission, application.
Szulanski, 1996	Knowledge excitation, implementation, transmission, integration.

Synthesizing the literature, there appears to be common acceptance that

knowledge absorption, knowledge application and knowledge sharing are three

activities that knowledge management systems should monitor. It is these three

activities that we examine in this study.

In the context of cross-organizational cooperation, *knowledge absorption*

means member organizations acquiring knowledge from their partners. *Knowledge*

application refers to problem-solving by the members with newly-acquired

knowledge. And *knowledge sharing* means sharing knowledge that has been

generated by the cross-organizational collaboration.

Knowledge Absorption

Knowledge absorption is a concept that subsumes topics such as knowledge recognition, knowledge source identification, knowledge acquisition and knowledge storage. Usually, firms acquire new technology from the outside based on experience. That is, they continuously monitor changes in the external environment so as to obtain knowledge to achieve improved performance in their projects. Some researchers have concluded that knowledge recognition and knowledge creation are two important elements of knowledge acquisition, which itself is the beginning of knowledge management. Only through the formal process of knowledge acquisition can new knowledge be understood, accepted and used by organizations (Nonaka & Takeuchi, 1995; McAdam, 2000). Cohen & Levinthal (1990) have determined that the efficiency with which an organization will absorb new knowledge from the outside, and the quality of such knowledge, will be enhanced as the organization improves its communication with outside sources. They also concluded that the capability of an organization to identify and evaluate new information rested with those employees who are interfacing with external sources, including those appointed to act as liaisons for cross-organizational projects, so-called information "gatekeepers," and knowledge "sensors." Nonaka & Takeuchi (1995) pointed out that knowledge acquisition was a social interaction that occurred primarily at the employee level.

Researchers have studied knowledge acquisition as it takes place across different levels: that is, from individual to individual, or from organization to organization. Crossan, Lane & White (1990) studied this at the individual level and concluded that only through individual learning by employees can an organization

recognize and accumulate new knowledge. Helleloid & Simonin (1994) studied this process from the organizational level, and concluded that organizations can advance by exploiting external resources. The ways an organization can obtain new knowledge include internal development, aided internal development, inter-organizational cooperation, purchasing of new technology, and mergers and acquisitions, among others. Leonard-Barton (1995) studied the sources of new knowledge and determined that when an organization wants to obtain knowledge from an external source, it would do well to consider universities, national laboratories, consultants, and marketing enterprises.

In cross-organizational projects, firms can obtain knowledge not only from these external sources, but also from within the organization. So, in this research, we will consider processes that utilize either external or internal sources of knowledge -- although this study will focus on the former.

Knowledge Application

When used in this research, the term *knowledge application* means the process of utilizing existing knowledge, including knowledge recently gained, to find new solutions to problems. Knowledge application is an important process by which an organization can improve its competitive position by exploiting its accumulated knowledge (Yang, 2005). Before knowledge application will benefit the organization as a whole, senior management must implement on a firm-wide basis the applications that are developed by individual employees.

Knowledge management is dynamic, not static, and requires that learning be a

continuous process in order for the organization to achieve its objectives. A business entity will lose knowledge, even while it is acquiring and creating new knowledge. Therefore, a system must be developed to retain and retrieve existing knowledge as it is needed to apply in appropriate processes. This means organizations must establish a central knowledge base, and assimilate sporadic knowledge and knowledge possessed by individual employees into this base. Lynn et al. (2000) studied knowledge from the perspective of organizational memory, and demonstrated that knowledge documentation and database management systems were crucial to the successful development of new products.

Knowledge Sharing

When faced with complex problems that cannot be solved within their own knowledge base, organizations will look outside the firm to seek support. Holtshouse (1998) analyzed the flow of knowledge in this context as being like a supply and demand chain. For the knowledge supplier there is a selective "push," while there is a corresponding selective "pull" from the knowledge demander. This "push" and "pull" process underlies the concept of knowledge sharing.

This research addresses knowledge sharing in cross-organizational projects between partners, to promote cooperation and to achieve the objectives of the project. Nonaka & Takeuchi (1995) developed a "knowledge creation model" in which employees spread newly-learned knowledge within their departments at the individual level, and organizations add such knowledge to their firm's knowledge base to be shared at the organizational level. Organizations share knowledge using two primary

mechanisms: knowledge externalization and knowledge socialization. This can be seen when an organization documents some learning by making inputs into its information systems. Organizations can also share knowledge through mentoring programs and seminars.

Johannessen, Olsen & Olaisen (1999) studied sharing mechanisms for different types of knowledge. They were satisfied that people have fairly well mastered how to share explicit knowledge; however, they suggested that if people can better learn to share tacit knowledge, the process of knowledge transfer and innovation will significantly speed up. The results of their research are summarized in Table 2.

Table 2. Sharing Mechanisms for Different Types of Knowledge

Types of Knowledge	Method of Access	Sharing Mechanism	Media
Systematic knowledge	Research model	Computer imitation, Scenario planning	System tools
Tacit knowledge	Practice	Brain-storming	Experimentation, mentoring system
Explicit knowledge	Listening, reading	Communication	Publications and presentations
Hidden knowledge	Socialization	Focused groups	Intelligence model
Relationship knowledge	Interaction	Partnership, team work	Social setting

Factors Influencing the Knowledge Management Process

The literature on cross-organizational cooperation reveals many factors that may influence the KM process. These include:

● culture (Leonard-Barton, 1995; Arthur Andersen and APQC, 1996; Szulanski, 1996; van der Spekand Spijkervet, 1997);

- leadership (Arthur Andersen and APQC, 1996);

- technology (Arthur Andersen and APQC, 1996; van der Spek and Spijkervet, 1997);

- organizational adjustments (Szulanski, 1996; van der Spek and Spijkervet, 1997);

- evaluation of knowledge management activities and/or knowledge resources (Wiig, 1993; Anderson and APQC, 1996; van der Spek and Spijkervet, 1997);

- employee motivation (Szulanski, 1996; van der Spek and Spijkervet, 1997); and

- external factors (van der Spek and Spijkervet, 1997).

Holsapple & Joshi (2000) arranged these factors into three categories: managerial influences, resource influences, and environmental influences. Managerial influences are those that emanate from the IT managers within the participating organizations. There were four main factors that influence KM in this category: exhibiting leadership in the management of knowledge, coordinating the management of knowledge, controlling the management of knowledge, and measuring the management of knowledge. Resource influences come from an organization's financial structure, human resources pool and knowledge systems -- that is, the three main resources of a firm that might affect KM. Environmental influences are those influences that intrude from outside the organization to impact KM. Some of these are: competition, markets, technology, time and the GEPSE (governmental, economic, political, social, and educational) climate.

Eppler & Sukowski (2000) undertook research into knowledge management

within business teams, and identified three factors as being of particular importance. The first factor was team autonomy, which made decision-making transparent and encouraged teams members to more readily participate. The second factor was the implementation of a performance-measurement and incentive system that created incentives favoring knowledge transfer within the team while disfavoring unhealthy internal competition. The last factor was continuity, meaning a team that has a stable composition and was endowed with adequate, on-going resources.

Koskinen et al. (2003) suggested in their research that the sharing of tacit knowledge was more likely to occur in projects where the members of the team interact face-to-face with each other. Common language, mutuality of trust and geographical proximity are factors that affect the exchange of tacit knowledge utilization in cross-organizational projects. And Jen-te Yang (2004) demonstrated that organizational knowledge sharing was impacted by two attitudinal factors: the attitudes of individual employees toward learning and toward sharing. This study suggested that front-line managers should help rank-and-file employees to both learn and share knowledge, and should encourage employees to habituate such behavioral patterns.

Predictably, it is in cross-organizational projects that socio-political factors play the greatest role in determining whether an organization will share knowledge with a partner. In particular, two such factors -- trust and the partner's level of power -- had the greatest impact on decisions to enter into knowledge-sharing relationships (Weiling Ke, Kwok Kee Wei, 2007).

Conceptual Models and Hypothesis

Building upon our review of the literature, we compiled several small-scale case studies and concluded, from both the literature review and case studies, that there are four primary categories of factors that influence KM performance in inter-organizational cooperation.

The first category of factors relates to the *knowledge reserve* possessed by the enterprises participating in a project. The second category relates to the *corporate culture* of the firms participating in the project. The third relates to the *communication and cooperation* that takes place among and within the firms participating in the project. And the fourth category relates to the *characteristics of the project*. Each of these categories of factors is the object of a set of related hypotheses.

Hypothesis No. 1 (Knowledge Reserve)

The individual assigned to the project by an organization (referred to as the project member) is the principal possessor of knowledge, and knowledge transfer is conducted through the project member (Xiang & Zou, 2003). The knowledge level possessed by each project member to a certain extent reflects the strength of the enterprise. Generally speaking, the higher the knowledge level, the easier it is for the project member to understand the project, and to absorb knowledge.

Knowledge reserve is a term referring to a firm's general knowledge level. Only with a sufficient knowledge reserve can a firm internalize new knowledge and assure that knowledge flows fluidly throughout the firm.

The members of a project team will each have different levels of knowledge. Some team members will be more familiar with individual technologies, while some will be more familiar with the overall project. This means that the resolution of problems that arise in a project will depend on the input of different employees. Hence, the diffusion of knowledge throughout the staff will affect knowledge application to some extent. The project members will need to call upon knowledge residing in different places within the firm to overcome problems facing the project. Because new knowledge is not the only resource used in the problem-solving process, a firm's problem-solving ability will be affected by the knowledge reserve of the firm. Therefore, the knowledge application process will run more smoothly to the extent that the firm's knowledge reserve is available to the project members.

Hypothesis 1a : The knowledge reserve of the project member will significantly affect knowledge absorption.

Hypothesis 1b : The knowledge reserve of the project member will significantly affect knowledge application.

Hypothesis 1c : The knowledge reserve of the project member will significantly affect knowledge sharing.

Hypothesis No. 2 (Corporate Culture/Institution)

The second category of factors that influence KM performance is the corporate culture of the firm participating in the project.

The term corporate culture refers to the values, norms and behavior shared by

the members of the organization (Davenport & Prusak, 1998). Whether a firm will encourage innovation, tolerate failure, encourage individual employees to develop their personal networks, and allow individuals to use their talents and knowledge are all aspects of corporate culture. All of these things impact knowledge transfer. Generally, cross-organizational projects require innovation and novel problem solving. Knowledge application is also greatly impacted by the firm's corporate culture, to the extent that the culture either encourages or discourages individuals to tap into the firm's knowledge reserve to solve problems and to innovate. Project members from different industries often approach problems in different ways, according to the culture that prevails in that industry. Tang & Huang (2004) proposed that if a firm's corporate culture encouraged its employees to share knowledge, the process of knowledge creation would be accelerated. If the corporate culture encourages knowledge sharing, the firm will more likely improve its competitive position in its industry.

Hypothesis 2a : The corporate culture/institution of project participants will significantly impact knowledge absorption.

Hypothesis 2b : The corporate culture/institution of project participants will significantly impact affect knowledge application.

Hypothesis 2c : The corporate culture/institution of project participants will significantly impact knowledge sharing.

Hypothesis No. 3 (Communication and Cooperation)

The third category of factors influencing KM performance relates to the level of communication and cooperation (i) among project members from the participating firms, and (ii) between the project member and his or her own firm.

When firms with different resources cooperate, their communication is a source of knowledge (Cegarra-Navarro, 2005).   He & Wang (2006) examined knowledge transfer between parents and subsidiaries, and proposed that as the number of ways to communicate increase, the more effective the knowledge transfer will be. Such communication channels include standing committees, appointed liaisons, task teams and individual lines of communication.   For the same reason, as project members find more ways to communicate with one another in cross-organizational projects, their knowledge sharing should improve.

Nonaka (1991) advocated that only by engaging in continuous new-knowledge creation, by disseminating knowledge freely throughout the organization and by developing new technologies and new products will a firm succeed.   A firm can integrate external knowledge with its own existing knowledge through its interactions with other organizations.   Communication creates the environment that permits the knowledge flow (Yli-Renko, Autio & Sapienza, 2001).   Knowledge will be shared when project members communicate with each other to solve problems.

Hypothesis 3a：The level of communication and cooperation (i) among project members from the participating firms, and (ii) between the project member and his or her own firm will significantly impact knowledge absorption.

Hypothesis 3b：The level of communication and cooperation (i) among project

members from the participating firms, and (ii) between the project member and his

or her own firm will significantly impact knowledge application.

Hypothesis 3c : The level of communication and cooperation (i) among project

members from the participating firms, and (ii) between the project member and his

or her own firm will significantly impact knowledge sharing.

Hypothesis No. 4 (Project Characteristics)

The fourth category of factors relates to the characteristics of the project. A feature of every project that impacts knowledge management is the degree to which the knowledge used in the project is explicit or tacit. OECD, in its 1996 annual report, categorized all knowledge as belonging to one of four types: know-how, know-who, know-what and know-why. Different types of knowledge will transfer more or less easily than others. Know-what and know-why are types of explicit knowledge that transfer relatively easily. Know-how and know-who are often tacit knowledge, and are more difficult to transfer.

He & Wang (2006) proposed that knowledge transfer was path-dependent. In other words, the transfer of knowledge must take place from a certain knowledge base. If there is too large a gap in knowledge reserve between the parent company and its subsidiary, knowledge transfer between the firms will be impeded. For project members, this means that the greater the knowledge gap between industries participating in the project, the more difficult knowledge absorption will be.

In addition, the size and duration of each project will also impact the degree to

which knowledge sharing takes place. For large, complicated projects of long duration, project members will become familiar with each other and will grow to trust one another, thus making knowledge transfer smoother and faster.

Hypothesis 4a : The features of the project will significantly impact knowledge absorption.

Hypothesis 4b : The features of the project will significantly impact knowledge application.

Hypothesis 4c : The features of the project will significantly impact knowledge sharing

So this study seeks to determine the impact these four categories (knowledge reserve, corporate culture, communication/cooperation and project characteristics) has upon three critical KM activities (knowledge absorption, knowledge application and knowledge sharing). Four or five factors within each category were identified by our research as being potentially significant for KM evaluation. Those factors -- labeled Q1 to Q17, according to the questionnaire numbers assigned to each -- are set forth in Table 3.

Table 3. Factors Within Categories Used to Evaluate KM Performance

Knowledge reserve (four factors)	Knowledge/technology diversification (Q1)
	Educational background of project members (Q2)
	Knowledge base (Q3)
	Accessibility of knowledge base (Q4)
Culture/institution (four factors)	Open culture (Q5)
	Management hierarchy (Q6)
	Tolerance for failure/mistakes (Q7)
	Trust of external information (Q8)
Communication (five factors)	Number of communication channels (Q9)
	Frequent communication between middle/senior managers (Q10)
	Routine meetings with partners (Q11)

	Frequent participation by senior management at meetings (Q12)
	Senior managers from different companies docking (Q13)
Project characteristics (four factors)	Degree to which knowledge is explicit (Q14)
	Experience-dependency (Q15)
	Industrial difference (Q16)
	Depth of industrial knowledge (Q17)

Research Methodology

Questionnaire and Interviews

Based on the studies discussed above and the actual conditions we observed at Chinese firms, we designed a questionnaire, and revised it through workshop discussion and small-scale pre-investigation. In all, we posed 25 questions that addressed the various factors within the four categories of factors that underlie the hypotheses.

The research sample consisted of middle managers who had taken part in at least five cross-organizational projects. It is felt that these individuals would have a depth of understanding and an objective evaluation of the KM process in this setting. Some questionnaires were mailed to respondents, some where sent electronically and the rest were administered on site (Sekaran, 2000). Questionnaires distributed by mail or electronically can cover a wide geographical area (Sekaran, 2000). By using field research and case studies, we determined which questions were subject to misinterpretation, and immediately modified and improved the questionnaire to avoid misunderstandings. We conducted reliability testing and validity testing after the questionnaires was recovered, and streamlined the questionnaire into 17 questions in the four areas of interest. We delivered 165 questionnaires in the course of our research, reclaimed 139 copies with 106 copies in force.

Reliability testing and validity testing were needed because respondents tended to answer the questionnaire based upon their subjective judgments, leading to bias. Fowler postulated that respondents might not give correct answers in a survey for four reasons: (1) they do not know how to answer the question; (2) they could not recall the information needed to answer the question; (3) they knew how to answer the question,

but they did not want to answer it; and (4) they did not understand the question.

We could not completely eliminate these four problems, but we took certain steps to minimize their impact. To avoid the first problem, we directed the research sample only to middle and senior managers who were familiar with knowledge management in inter-organizational projects. To counteract the second problem, we constructed a questionnaire that did not require the respondents to draw upon unavailable information. To lessen the third problem, we advised the respondents that we would feed the investigation results back to them, keep their information secret and not use the research for commercial gain. To address the fourth problem, we gave first-hand instructions to those respondents who were interviewed in person, and for those questionnaires delivered through mail or electronically, we explained to respondents that they could ask for help from intermediaries we trained specially for this project.

Results

We used SPSS 11.5 for the statistical analyses. We performed a descriptive statistical analysis before an empirical analysis. Thereafter, reliability testing, validity testing, factor analyses, relationship analyses and regression analyses were performed to ascertain the empirical relationship between the four categories of factors and performance across the three KM activities. To facilitate expression, we re-labeled "knowledge reserve" as F1, "corporate culture/institution" as F2, "communication/cooperation" as F3, and "project characteristics" as F4.

Table 4.1. Descriptive Statistics

	Sample size	Mean	Max	Min	SD
Q1	106	3.88	5	2	0.69
Q2	106	3.62	5	2	0.80
Q3	106	3.49	5	2	0.76
Q4	106	3.52	5	2	0.68
Q5	106	3.26	5	2	0.69
Q6	106	3.33	5	2	0.76
Q7	106	3.34	5	2	0.64
Q8	106	3.34	5	2	0.65
Q9	106	3.80	5	2	0.75
Q10	106	3.46	5	2	0.80
Q11	106	3.48	5	2	0.64
Q12	106	3.64	5	2	0.64
Q13	106	3.53	5	2	0.80
Q14	106	3.29	5	2	0.63
Q15	106	3.37	5	2	0.67
Q16	106	3.42	5	2	0.70
Q17	106	3.82	5	2	0.75

Table 4.2. Principal Components Analysis (a)

Variable	Factors			
	F1	F2	F3	F4
Q3	.815	.177	.004	.238
Q2	.724	.285	.063	.229
Q4	.567	-.076	.436	.195
Q1	.542	.127	.243	-.097
Q11	.241	.787	.120	-.123
Q10	.259	.647	.484	.089
Q12	-.016	.592	.064	.340
Q13	.555	.555	.072	-.061
Q9	.318	.513	.128	.246
Q6	.109	-.017	.834	-.103
Q7	.247	.287	.651	.415
Q8	.055	.244	.494	.207
Q5	.307	-.020	.452	.312
Q17	.160	-.020	-.018	.694
Q16	.040	.367	.106	.662
Q14	.133	-.030	.533	.553
Q15	-.032	.260	.482	.482

Table 4.3. Principal Component Analysis (b)

Variable	KM Activity		
	1	2	3
Q4	.782	.085	.043
Q5	.766	.255	.214
Q6	.699	.041	.261
Q1	.140	.791	.030
Q2	.316	.781	.004
Q3	-.071	.692	.305
Q8	.208	.095	.790
Q7	.053	.014	.749

Q9		.274	.229	.582

1= knowledge absorption
2= knowledge application
3= knowledge sharing

4.4 Relationship between Questions and Knowledge Absorption, Knowledge Application and Knowledge Sharing

	Knowledge Absorption	Knowledge Application	Knowledge Sharing
Q1	0.243(**)	0.259(**)	0.249(**)
Q2	0.209(**)	0.380(**)	0.286(**)
Q3	0.235(**)	0.290(**)	0.317(**)
Q4	0.175	0.299(**)	0.284(**)
Q5	0.308(**)	0.301(**)	0.241(*)
Q6	0.108	0.334(**)	0.402(**)
Q7	0.195(*)	0.364(**)	0.291(**)
Q8	0.167(*)	0.188(*)	0.378(**)
Q9	0.396(**)	0.268(**)	0.203(*)
Q10	0.357(**)	0.203(*)	0.410(**)
Q11	0.255(**)	0.237(**)	0.358(**)
Q12	0.358(**)	0.113	0.127
Q13	0.272(**)	0.218(**)	0.353(**)
Q14	0.317(**)	0.304(**)	0.243(**)
Q15	0.397(**)	0.272(**)	0.152
Q16	0.447(**)	0.208(**)	0.218 (*)
Q17	0.384(**)	0.204(*)	0.068

Statistical Analysis

Knowledge Absorption

We performed a regression analysis for knowledge absorption across each of the four groups of factors, and the results are reported in Table 5.

Table 5. Regression Analysis of Knowledge Absorption

Model	Adjusted R^2	F	P	D-W
1	.140	24.314	.000	
2	.225	21.103	.000	
3	.299	19.024	.000	
4	.356	18.670	.000	1.878

Model	Standardized coefficient B	T Value	P Value	VIP
Constant		1.000	0.000	
F4	0.426	7.254	.000	
F3	0.327	5.091	.000	1.000
F1	0.196	4.02	.000	1.000
F2	0.149	3.73	.000	1.000

We conclude from Table 5 that these four groups of factors are all explanatory variables (t>0.05), and the regression equation can be presented as follows:

Knowledge absorption =F4×0.426+F3×0.327+F1×0.196+F2×0.149

These results indicate that knowledge absorption is correlated with all four of the variables: F4 (project characteristics), followed by F3 (corporate culture), F1 (knowledge reserve) and F2 (communication).

Knowledge Application

We performed a regression analysis for knowledge application across the four groups of indicators, and the results are shown in Table 6.

Table 6. Regression Analysis for Knowledge Application

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Model	Adjusted R^2	F	P	D-W
1	.103	14.101	.000	
2	.182	13.550	.000	
3	.236	12.998	.000	
4	.274	11.745	.000	1.912

Model	Standardized coefficient B	T Value	P Value	VIP
Constant		1.000	0.000	
F1	0.32	4.689	.000	
F2	0.286	3.826	.000	1.000
F3	0.223	3.530	.000	1.000
F4	0.211	3.356	.000	1.000

We conclude from Table 6 that these four factors are all explanatory variables (t>0.05), and the regression equation can be presented as follows:

Knowledge application **= F1×0.32+F2×0.286+F4×0.223+F3×0.211**

These results indicate that knowledge application is correlated with all four variables: F1 (knowledge reserve), followed by F2 (communication), F3 (corporate culture) and F4 (project characteristics).

Knowledge Sharing

We performed a regression analysis for knowledge sharing across each of the four groups of factors, and the results are reported in Table 7.

Table 7. Regression Analysis for Knowledge Sharing

Model	Adjusted R^2	F	P	D-W
1	.135	22.563	.000	
2	.209	19.863	.000	
3	.270	17.240	.000	1.975

Model	Standardized coefficient B	T Value	P Value	VIP
Constant		1.000	0.000	
F2	0.328	3.877	.000	1.000
F1	0.290	3.556	.000	1.000
F3	0.236	3.309	.000	1.000

We conclude from Table 7 that these four factors are all explanatory variables (t>0.05), and the regression equation can be presented as follows:

Knowledge sharing ＝F2×0.328 ＋F1×0.29 ＋F3×0.236

These results indicate that knowledge sharing is correlated with three of the four variables: F2 (communication), followed by F1 (knowledge reserve) and F3 (corporate culture).

Discussion

Knowledge has become one of the most important resources in what has become known as the era of information. Managing knowledge effectively not only can help an enterprise to acquire greater resources, but also to improve its core competitiveness. Moreover, given the complexities of today's information technologies, firms do well to pay greater attention to developing innovation by integrating knowledge across cross-organizational boundaries. In today's environment, it has become increasingly difficult for firms to gain market share relying solely upon their own resources. Firms need to promote knowledge flows by cooperating with one another, whether through strategic alliances or through cooperative product development. We propose the following actions

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based on our research.

(1) Establish an adequate knowledge base to promote smoother knowledge flows within the firm.

Having an adequate knowledge base is important if a firm wants to gain a foothold in the marketplace; therefore, its level of institutional knowledge can be a valuable asset. In order to develop an adequate knowledge reserve, firms can do three things.

- First, import highly-competent professionals from the outside who will bring new knowledge to the firm.

- Second, build up a knowledge base from within the firm. In this regard, a firm should standardize its knowledge by documenting its project results and incorporating those results into its knowledge base. This will not only lead to the accumulation of greater knowledge by experience, but also to the acceleration of the flow of knowledge when engaged in similar projects in the future.

- And third, find ways to transfer knowledge inside the firm.

Dixon proposed five new ways to transfer knowledge in her book *Common Knowledge.* These are: serial transfers, near transfers, far transfers, strategic transfers and expert transfers. Firms can select from among these different transfer techniques, depending on the expected recipients of the knowledge, the nature of the work and the type of knowledge being transferred. *Serial transfers* are those transferring the knowledge a team has learned from doing its task in one setting to the next project that team undertakes in a different setting. The knowledge from each repeated action is gained in a serial fashion. Firms can transfer not only explicit knowledge but also tacit

knowledge using this transfer system. *Near transfers* occur when a team that has learned something routine shares that discovery within the organization with other teams that are doing very similar routine work. *Far transfers* occur when a team performing a non-routine assignment has acquired tacit knowledge that it makes available to other teams that are doing similar non-routine work. *Strategic transfers* occur when the firm's collective knowledge (both tacit and explicit) is shared so as to accomplish a strategic task that occurs infrequently but is of critical importance to the organization. And *expert transfers* occur when teams facing an unusual technical problem beyond the scope of their own knowledge seek the expertise of others within the organization to help them address it.

(2) Build a sharing- and learning-oriented corporate culture

Inter-organizational cooperation is spurred by common interests. The speed and efficiency of knowledge sharing will improve greatly if a firm's culture encourages it to take place and this is also compatible with its partner's culture. A culture that is conducive to knowledge-sharing will feature incentives for innovation and cooperation. To build a sharing- and learning-oriented corporate culture, a company should:

● Adjust current corporate thinking so as to cultivate knowledge sharing values. A firm must alter or remove values that pose obstacles to sharing, such as the glorification of individual achievements.

● Construct an organizational system that is helpful to knowledge sharing and mutual learning. In handling personnel, employees should be given greater autonomy. A firm should build rewards and penalties into the system to encourage learning, innovation and knowledge sharing. In conducting performance evaluations, firms should

identify mistakes as a learning opportunity.

- Reorganize the firm's framework to promote easier knowledge sharing and learning. A firm should consider streamlining itself into a "flat" organization to facilitate direct contact between the staff and management. Additionally, the organizational structure should be re-designed to overcome the obstacle posed by departmentalization, thereby facilitating cross-sectional learning and knowledge sharing.

- Create an atmosphere of mutual trust among employees, thus facilitating knowledge (especially tacit knowledge) sharing.

Nelson & Cooprider (1996) examined knowledge sharing between the information department and other departments of a firm, and determined that trust was an important factor influencing such knowledge sharing. As staffs communicate more regularly with each other, they will become friendlier, promoting greater sharing of problem-solving solutions. If the knowledge transmitter and recipient do not trust one another, there will not be successful knowledge sharing. It is important, therefore, to create an atmosphere from top to bottom where sharing becomes a spontaneous behavior. This includes knowledge sharing across departments.

(3) Establish mechanisms to promote effective communication between project partners to foster trust among companies.

As communication becomes more effective, the cost of knowledge transfer will decrease and the flow of knowledge will accelerate. Enterprises should build knowledge-sharing networks that respect the importance of communication. A platform for technical exchanges of information is not enough; firms should communicate with each other on the managerial level, such as by holding regular meetings of supervisory personnel.

Project members should coordinate with each other, trust each other and communicate with each other in a spirit of friendship and cooperation. If cooperation is to be fostered between firms in different industries, members should communicate more frequently using non-technical language that can be readily understood by everyone. After a period of coexistence, members should become more familiar with and trusting of one another, due in so small part by the important role that effective communication plays.

Limitations and Future Research

We researched the factors influencing KM in cross-organizational projects and justified our conclusions with statistical analysis drawn from hundreds of such projects. At the same time, we evaluated KM performance in the areas of knowledge absorption, knowledge application and knowledge sharing. But there are limitations in this research. First, the sampling in our research was conducted across different industries and geographical areas; therefore, there may be industry differences which were not captured in this study. In addition, we did not assign different weights to different types of enterprises. Second, our research did not evaluate KM as a whole, but rather divided the KM process into several phases, and evaluated these phases separately. Third, the four dimensions proposed in our research do not cover all of the potential factors influencing KM.

Therefore, we propose further research in the following differing respects: (1) narrowing the range of investigation to a certain geographical area or a certain industry, (2) revising our KM measurement by industry factor into consideration, and (3) examining one factor's impact on KM more deeply in future research.

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