THE IMPACT OF KNOWLEDGE CREATION AND UTILIZATION PROCESSES ON THE EFFECTIVENESS OF INNOVATION

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Abstract

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With the emergence of knowledge management (KM), a branch of knowledge studies began to extend this construct to the long list of possible antecedents of innovation. Research of innovation through KM approach is particularly timely. Despite the great amount of efforts undertaken in this approach, current literatures have three obvious limitations: many studies didn't account for innovation in their theoretical review; there is relatively small number of empirical evidence used; a considerable amount of studies lacked an underlying theoretical model of KM which caused their research disorganized and hard generalizable.

In addressing these research gaps, this study proposed a research model which is grounded in contingency fit by jointing two robust theories—Knowledge Creation and Utilization Model and a novel typology of innovation (internal-sourced/external-sourced innovation) to demonstrate the link between knowledge management processes and innovation effectiveness. As a special case of problem solving, innovation will result in higher effectiveness when the arrangement of knowledge management processes aligns with the certain innovation type. Two hypotheses were derived from the model for empirical testing. 58 usable observations were collection from banks. Results using SPSS provide partial support for the hypotheses.

As expected, the fit between Knowledge Utilization on external-sourced innovations has a significant effect on innovation effectiveness. Regrettably, the finding of effect of coalignment between Knowledge Creation and internal-sourced innovation on innovation effectiveness is non-significant. The results are in concert with prior KM and innovation studies. Discussions of implication and potentials for the future research are also presented.

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I own this achievement to my family—to my mother Fengyun and my father Jiayu, for being supportive in all my life.

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To my parents

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I. Introduction

From at least the late 1950s, innovation has been recognized as an enhancing sustaining competent power of high performance for most firms (Evan 1966; Nelson and Romer 1996; Darroch and McNaughton 2002). After the emphasis of the main source of competitive advantage for firms shifted from efficiency and quality to innovation (Bolwijn and Kumpe 1990), in either tarnished or glowing firms, practitioners need a shot of innovation more than ever (Harden 2003).

Although many disciplines like sociology, history, economics, and psychology (Gopalakrishnan and Damanpour 1997; Nieto 2004) have improved our understanding of innovation, notably they seldom focused on the organizational level and practical direction. They also expand the absence of knowledge exchange amongst the various academic communities and delayed research activities by rendering more difficulty in innovation study (Nieto 2003). Accordingly, the present research concerns only organizational innovation, which tries to answer a lasting and baffling question—"what can we do to improve the innovation effectiveness, or how can we realize innovation effectively?"

With the emergence of knowledge management (KM), a branch of studies began to add these constructs to the long list of possible antecedents of innovation (Coombs and Hull 1998; Gopalakrishnan and Bierly 2001; Conceicao and Heitor 2002; Darroch and McNaughton 2002; Hall and Andriani 2002; Newell, Huang et al. 2003).

Research of innovation through KM approach is particularly opportune. One the one hand, KM emphasizes both static "knowledge" and dynamic "knowing" (Polanyi 1966; Bellinger 2004). As a result, the study of innovation shifted to a more dynamic way in which practitioners can initiatively examine and promote their current innovation behavior with the help of effective KM practices. On the other hand, this kind of study is consistent with the central idea of a knowledge-based view of firms; that is, it considers *knowing* as the central elements to many organizational activities, including innovation (Grant 1996). Gurteen (Gurteen 1998) notes that "Knowledge Management needs to fundamentally focus on creativity and innovation," not only because the joint effect by knowledge management and innovation is important for theoretical and strategic reasons (Darroch and McNaughton 2002), but also because there is a natural causality relationship between innovation and knowledge—"innovation is the application of knowledge to produce new knowledge (Drucker 1993)". Consequently, it is justified to say that KM approach can authentically represent and record the innovation activities in firm level.

Extant innovation research based on KM approach can be categorized into two domains: viewing knowledge as an object (knowledge typology), or as processes. While studying innovation in KM approach, some academics believe that to focus on the various forms of knowledge seems to be a fruitful start to construct plausible accounts of development of specific innovations, but in fact it would be hard for researchers to access specific knowledge and generate research findings since knowledge is firm specific and is constrained by specific environments (Coombs and

Hull 1998). Another group of researchers propose that KM approaches are best studied as a set of practices or practices (Hislop, Newell et al. 2000). Coombs and Hull (Coombs and Hull 1998) list 3 advantages of treating KM as processes in innovation studies.

- The processes are easily and empirically observed as practical activities.

- Effective KM processes are similar among most of enterprises. Such ordinary features are 'transferable' from one firm to another.

- They are one of the most analyzed and concerned fields in reality that reflect the performance of firm, and they are readily promoted.

Besides, knowledge itself does not ensure profits. Some knowledge is even meaningless for organizations (Argyris and Schon 1978). People argued that how an organization uses its knowledge determines whether or not the knowledge is useful and is used appropriately in that organization. Moreover, analysis of innovation in KM processes approach is the only way that can employ existing KM theoretical models. In short, present research adopts the domain of viewing knowledge as processes

Despite the great amount of efforts undertaken in KM innovation study, current literatures have three obvious limitations.

- Many studies failed to account for innovation in their theoretical review. Since the purpose of these studies is to research the linkage between the two topics and innovation is commonly recognized as the one of the most complex organizational phenomenon (Smits 2002), the literature review and analysis of innovation are necessary. Downs and Mohr suggested (Downs and Mohr 1976) that researchers should postulate the existence of distinct types of innovation because the determinants that are important for one innovation may very possibly not important for others. Poor innovation literature review may be one of the reasons why results of KM innovation studies are typically unsatisfactory.

- There is relatively scarce empirical evidence used (Kimberly and Evanisko 1981; Blackler 1995; Hislop, Newell et al. 2000; Darroch and McNaughton 2002). Articles of conceptual propositions are more prevailing than empirical studies. Moreover, among an insufficient number of empirical studies, case studies constitute the large proportion. It is not to deny the central importance of case studies as a source of insight and testable hypotheses. Rather it is to encourage diverse quantitative empirical measures so as to offer managers and academics more directions on how innovation can be achieved.

- IS researchers would overwhelming agree that theory should form the basis for any serious empirical study; however, a considerable amount of studies lack an underlying theoretical model to help explain KM effect on innovation, (Taylor, Tillsley et al. 2000; Gopalakrishnan and Bierly 2001; Darroch and McNaughton

2002). Without support from a robust theoretical model, many analyses appear disorganized.

These occurrences of "wonderful" and "dull" studies lead KM approach of innovation study to a bottleneck. How can we utilize our conventional understanding of KM to improve and examine the effectiveness of innovation, or is there any concealed relationship between the innovation performance and knowledge management still remains as an ambiguous question.

Against this backdrop, the purpose of present thesis is to demonstrate the link between KM processes and innovation effectiveness. The theoretical basis used to address the innovation as a special case of problem solving. Vessey (Vessey 1991) has demonstrated that problem solving with a cognitive fit results in increased problem-solving effectiveness. Accordingly, more effective innovation will result when the processes of KM support the innovation types. Specifically, the central hypothesis of the model is that the effectiveness of innovation is influenced by the fit between KM processes and types of innovation. The research will apply an existing KM theoretical model, and the study hypotheses will be tested empirically.

The paper is organized as follows. First, we propose to select on innovation category as the target of our research, and then we introduce a most widely cited KM model. In the third chapter, the proposed research model is built by weaving innovation types with KM processes according the theory of cognitive fit. Detailed hypotheses will be

established there. This is followed by description of research methodology and data analysis. The last chapter will discuss the results obtained, research implication, limitations, and possible future studies.

II. Literature Review and Conceptual Foundations

2.1 Definitions of Innovation

Despite the long-term academic concerning, there is no one commonly accepted definition of innovation (Gopalakrishnan and Bierly 1997), The following table collects the innovation definitions that are within our reach.

Table 1 Collection of Innovation's Definition

Study	Definitions of Innovation
(Zaltman, Duncan et al. 1973; Damanpour and Evan 1984)	Organizational innovation is defined as the implementation of an internally generated or a borrowed idea—whether pertaining to a product, device, system, process, policy, program, or service—that was new to the organization at the time of adoption.
(Damanpour 1987)	Innovation is also defined in terms of its newness to the adoption organization, rather than the first use ever or its newness to a population of organizations.
(Drucker 1985)	Innovation is the means by which the entrepreneur either creates new wealth-producing resources or endows existing resources with enhanced potential for creating wealth.
(Darroch and McNaughton 2002)	The innovation scale is identified as three factors. The first factor accounts for innovations that are incremental in nature and so includes the addition of new products or services to existing product ranges and the revision and repositioning of existing products or services. The seconds factors is labeled "innovation that changes consumers" and accounts for new-to-the world innovations. The last factor includes both new-to-the-world and new-to-the-firm innovations that have the potential to destroy

	existing competencies, because those within the firm lack the technological and business experience for them.
(Darroch and McNaughton 2002)	The central notion of innovation is the distinction between refining and improving and existing design and introducing a new concept that departs in a significant way from past practice.
(Evan 1966)	Innovation is a process of implementation of a new idea, whether a product of invention or discovery.
(Smits 2002)	Innovation is a successful combination of hardware, software or both, viewed from a societal and / or economic point of view.
(Daft 1978; Damanpour and Evan 1984; Damanpour 1991)	Innovation is defined as adoption of an internally generated or purchased device, system, policy, program, process, product, or service that is new to the adopting organization. The adoption of innovations is conceived to encompass the generation, development, and implementation of new ideas or behaviors.
(Lemon and Sahota 2003)	Innovation is the result of a group's knowledge of new markets and or new technical possibilities leading to improved product development.
(Drucker 1993)	Innovation is the application of knowledge to produce new knowledge.
(Gundling 2000)	Innovation is New ideas + action or implementation which results in an improvement, gain, or profit.
(Johannessen, Olaisen et al. 2001)	Innovation has six different types of activity: new product, new services, new methods of production, opening new markets, new sources of supply, and new ways of organizing.
(Slappendel 1996)	Innovation is defined as any idea, practice, or material artifact perceived to be new by the relevant unit of adoption. Newness or novelty is recognized as the key distinguishing feature of innovation.
(Niosi, Saviotti et al. 1993)	Innovations are new and improved products and processes, new organizational forms, the application of existing technologies to new fields, the discovery of new resources, and the opening of new markets.
(Utterback 1971)	Innovation will be defined to refer to an invention which has reached market introduction in the case of a new product, or first use in a production process, in the case of a process innovation. The key idea here, first use, simply requires that an idea has been carried far enough to begin to have an economic impact
(Tushman and Nadler 1986)	Innovation is the creation of any product, service, or process which is new to a business unit.
(Perez-Bustamante 1999)	Innovation is a process of acquisition, processing, storage and recovery of information that can be studied from five perspectives: general knowledge creation, R&D learning; manufacturing learning, commercial learning and survival learning.

After integrating those definitions, it has been recognized that firm-level innovation (1) is ubiquitous and pervasive; it can penetrated into the every single organizational activities, either within or outside of the organizational boundary, (2) can happen in any form, for instance product, system, process, policy, new device, and so on, (3) is a multi-stage process which fundamentally consists of the generation and adoption, (4) should emphasize its newness or novelty, (5) aims to enhance the performance and maintain sustainable competitive advantages of the organization, including enhancing profit, enlarging market share, reducing cost, improve quality and anything that benefits to organization, (6) is essentially the application and generation of knowledge, and (7) has two methods of sourcing—internal and external. These features will be discussed later.

2.2 Typologies of Innovation, With Emphasis on K-Based Typology

Variform innovations determine the diversified typologies. Most of frequently used typologies tend to view innovation as a dichotomy, which are: product vs. process; technical vs. administrative; radical vs. incremental.

Technical innovations pertain to changes of the technology in products, services, devices, tools and product process technology, while administrative innovations are directly related to the policies, systems and management of an organization, for example, the recruitment of new employees, the structure of tasks or hierarchy of

authority and so on (Evan 1966; Aiken, Bacharach et al. 1980; Kimberly and Evanisko 1981; Damanpour 1987).

Product innovations are new products or services introduced to cater the external users—customers so as to handle the market fluctuation, increase market share, win customer loyalty, or stay ahead of competition. Process innovations are motivated by quality control and efficiencies improvement, which consist of new elements introduced into an organization's production or services operation, to be specifically, including input material, task specifications, work and information flow management and so on (Abernathy and Utterback 1978; Hull, Hage et al. 1985; Tushman and Nadler 1986; Gopalakrishnan, Bierly et al. 1999; Damanpour and Gopalakrishnan 2001).

Incremental innovations introduce relatively minor changes to the existing products. They exploit the potential improvement of the established design and reinforce the dominance of the established firm (Tushman and Nadler 1986; Henderson and Clark 1990). Radical innovations are fundamental changes or milestone revolutionaries that often open up a whole new market or change existing market structures in large region scale (Normann 1971; Dess and Beard 1984; Ettlie, Bridges et al. 1984; Dewar and Dutton 1986; Tushman and Nadler 1986).

Analysis of innovation definitions shows that innovation is a form of knowledge application and generation that can be achieved through internal invention or external

borrowing. Naturally, some researchers (Gopalakrishnan, Bierly et al. 1999; Gopalakrishnan and Bierly 2001) reexamined innovation typology with regards to knowledge-based differences and source methods. According to their novel typology, innovation can be classified into *internal-sourced innovation* and *external-sourced innovation*, namely the knowledge in internal-sourced innovations is more tacit, systemic and complex; while the knowledge in external-sourced innovation is more explicit, autonomous and simple (Gopalakrishnan and Bierly 2001) .

Gopalakrishnan and Bierly (Gopalakrishnan and Bierly 2001) identified that:

> "*...different types of innovations are sourced differently. Basically, the nature of knowledge associated with an innovation may affect the decision of whether to (a) internally source, which refers to the adoption of knowledge developed predominantly within the boundaries of the firm, or (b) externally source, which refers to the adoption of knowledge developed by other outside the boundaries of the organization.*"

Internal-sourced innovations provide firms with core competency and promotes its innovation atmosphere inside the organization which gain the vanguard organizations a foothold in standard items (Hull, Hage et al. 1985). The advantages of external-sourced innovation have been discussed by many studies. They include increased speed of R & D innovation and implementation; utilization of more specialized talent resources and a large pool of technological facilitate; development of information and ideas. In addition, they expand a wider range of studies, spread out risks across

organization boundraries, provide much more flexible and integrated services, keep tabs on the "best in world" for knowledge sources, save expenditures and so on (Powell, Koput et al. 1996; Quinn 1999; Quinn 2000; Ritter and Gemunden 2003). Hull (Hull, Hage et al. 1985) argued that external-sourced innovation should be adopted first so as to catch up with the newest technology and skills and to imitate product and improve process. Organizations can then use indigenously educated experts for making internal-sourced innovations. For a long time, external-sourced innovations have been used in a wide variety of projects in diverse industries (Quinn 2000).

By balancing comprehensiveness and parsimony, Gopalakrishnan (Gopalakrishnan and Bierly 2001) classify the innovation according to each type of source method associated with three knowledge dimensions: tacit—explicit, systemic—automatic, and complex—simple.

Without much lessons or experience stemmed from outside, internal-sourced innovations are the in-house products of the firm. To develop internal-sourced innovations, firms are required to perform much more informal communication and acquire experts and skilled workers equipped with tacit knowledge. Moreover, under the situation that certain technology and information are ambiguous, systematic knowledge is also necessary to help innovators achieve the smooth coordination. Both tacit and systematic knowledge consist an environment with shared meaning that permit innovators readily understand each other by taking a hint (Nonaka 1994). This

kind of environment can be found in internal-sourced innovations more than in external-sourced innovations since it's hard to be simulated and transferred across organizational boundaries. Finally, since both tacitness and systematization increase the complexity of knowledge, it is rational to conclude that internal-sourced innovations tend to incorporate the firm's knowledge that is more tacit, systemic, and complex. Developed by hard-to-copy assets, skills, and tacit knowledge, internal-sourced innovations are referred to as core competencies or distinctive capabilities that confer the competitive advantages on the firms.

On the contrary, external-sourced innovations are more likely use the explicit, autonomous and simple forms of knowledge, which reduces designing cycle and ambiguity in the innovation processes (Gopalakrishnan and Bierly 2001). It's clearly perceptible that both innovation buyers and sellers more prefer the specific performance targets that are fair, few in number, easy to understand, and readily usable by the people doing the work (Quinn 2000).

Table 2 is the classification of the innovation according to the three knowledge dimensions (Gopalakrishnan and Bierly 2001). This typology is selected as the representation of innovation in current research since it's tightly associated with the common attributes of knowledge.

Table 2 Typology of Knowledge-based Innovation

Table 2. Typology of Knowledge-based Innovation						
Innovation Type	Tacitness		Autonomy		Complexity	
	Tacit	Explicit	Systemic	Autonomous	Complex	Simply
Internal-Sourced	+		+		+	
External-Sourced		+		+		+

2.3 Innovation Process Model

Generation and adoption are two primary phases in innovation process (Damanpour 1991; Gopalakrishnan and Damanpour 1994; Gopalakrishnan and Damanpour 1997), each of which makes up of several steps. Respectively, generation consists of idea generation, project definition, problem solving, design and development and marketing or commercialization; while adoption consists of initiation and implementation. To be specific, initiation includes awareness of an innovation, formation of an attitude towards it, and evaluation of feasibility from an organizational standpoint, such as resource assessment. The implementation process finally put innovation into practical effect. Based on the action range, implementation can be divided into to (a) trial implementation, which means initial and limited utilization of the innovation to ascertain its suitability to organizational needs, and (b) sustained implementation, which means continuative use innovation to assimilation into the organization and to make it a routine feature of the organization.

Recognizing innovation processes is a distinguish part in innovation research. Since this study direction focuses on the vicissitudes according to time flux, it would better

use longitude study, which means not only extending the research time cycle, but also requesting a specially and carefully designed methodology. As a result, the innovation process is neglected in current research.

2.4 K-Creation and Utilization Processes

The Knowledge Creation and Utilization model, or namely SECI model (Nonaka 1991; Nonaka 1994; Nonaka and Takeuchi 1995; Nonaka and Konno 1998; Nonaka and Reinmoeller 2000) is one of the most well known theories in the context of organizational knowledge learning and creating. According to the model, knowledge activities can be divided into Knowledge Creation (K-Creation) and Knowledge Utilization (K-Utilization), each of which includes two basic patterns of knowledge conversation between two very different types of knowledge—tacit and explicit. The four patterns are: Socialization, Externalization, Combination and Internalization.

Socialization is the beginning pattern in the K-Creationand and Utilizaiton model. It's a movement of knowledge from Tacit to Tacit. Since tacit knowledge is highly personal (Nonaka 1991), socialization mostly happens in joint activities, including both informal and semi-formal learning, e.g., mentorship and apprenticeship, being together, or working closely in the same environment, where knowledge is increased with the help of observation, imitation and practices. No coding action happens in this phrase. The procedure of learning is imperceptibly influenced and improvement subconscious; only by being totally absorbed in the culture of common perspectives

and shared experiences can apprentices attain the knowledge they need (Nonaka 1994).

The second process is Externalization. Some apprentices have the ability to verbalized and articulate the tacit knowledge that they have developed. In doing so, tacit knowledge is converted into explicit. During this process, knowledge is first refined and preserved in the head of individuals, and then synthesized, organized, and codified into conceptual knowledge. The explicitness helps knowledge to be shared and communicated in a large range, for example, among groups or within organization.

Combination is the knowledge interaction between explicit to explicit. People link explicit knowledge together, standardize it, eliminate the false and retain the true, discard dross and keep essence, make it more systematic and complex, edit it into a manual, a workbook, a report, a software program and so on. Sometimes it is embodied into a product (Nonaka and Takeuchi 1995).

The last process is Internalization, in which explicit knowledge is transferred to tacit, internalized into employees' own tacit knowledge basis. Internalization is also completed by practice, tutored by verbal reference. But different from socialization, knowledge in internalization has been captured and codified clearly, without any ambiguity; therefore, it is able to be shared and integrated throughout an

organization's operation smoothly. Systematic insights are gained in this process and the original knowledge system of organization is broadened, extended and reformed.

Socialization and externalization emphasize more about the knowledge creation; combination and internalization accent on knowledge utilization (Nonaka and Reinmoeller 2000). As the commonly recognized model in KM study, K-Creation and Utilization Processes cover the most knowledge movements and transformations in organization (Figure 1). Through these conversions, tacit and explicit knowledge expands in terms of quality and quantity.

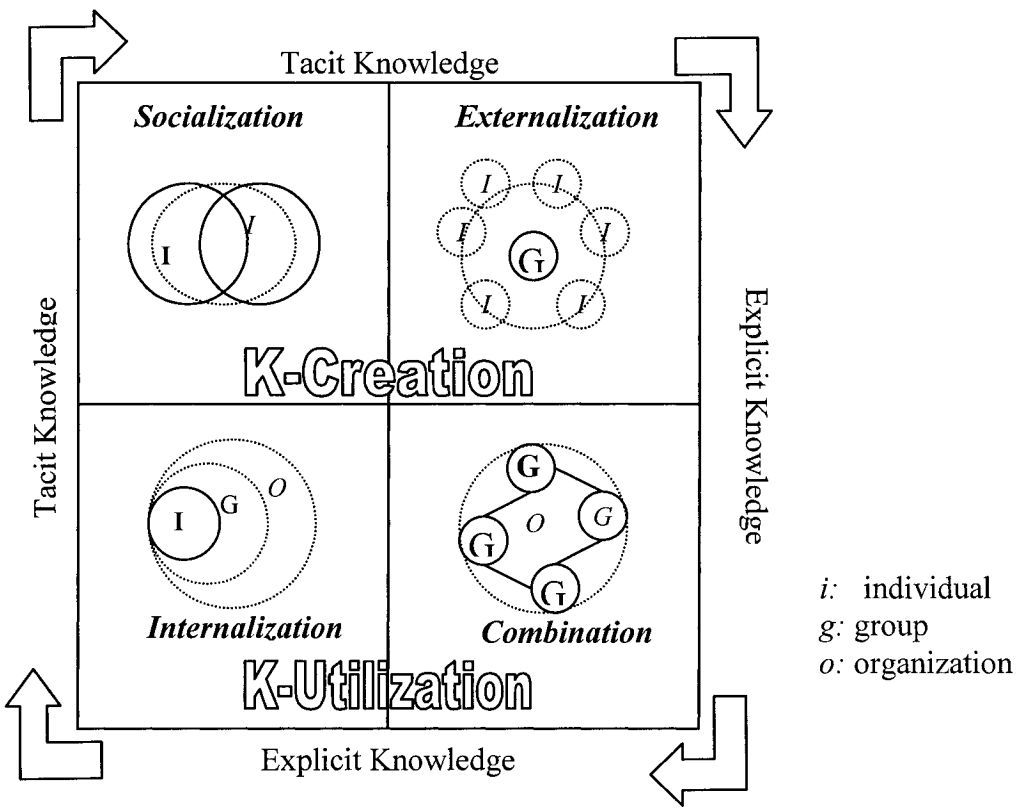

Figure 1 The SECI Model of Knowledge Creation and Utilization (Nonaka and Takeuchi 1995; Nonaka and Konno 1998; Nonaka and Reinmoeller 2000)

III. Research Model and Hypotheses

3.1 Conceptual Framework

3.1.1 Innovation as a Special Case of Problem Solving

Newness or novelty is one of the key distinguishing features to recognize innovation. The newness theme has been especially discussed in understanding the link between innovation and entrepreneurship (Johannessen, Olaisen et al. 2001), innovation and new business startup (Vesper 1988), innovation and key entrepreneurial process (Lumpkin and Dess 1996), innovation and market strategy (Manu and Sriram 1996); innovation as an associated organizational renewal (Stevenson and Jarillo 1990) and so on.

The researches cited above show the trend to study innovation, especially its newness feature, not only as a sustainer of competency, but also as a fundamental component of entrepreneurship to solve the real corporate problem. Practitioners and academicians need to push and transcend their current business or study across boundaries, to think new realms, to look at different markets, including many contexts that they might never meet before. These challenges provide them many specific problems, requiring them to distill the generic problems and design the generic solutions so as to finally achieve innovation. Beckenbach (Beckenbach and Daskalakis 2003) explicitly noted that innovation is a creative act of problem solving

which specify the endowment of the inventor in terms of cognitive resources. In the case of innovation, a profound knowledge of the domain, generally the explicit or declarative knowledge is necessary; moreover, there is a requirement for the procedural knowledge shifting toward knowing how to solve a given problem. Two conditions have to be considered in this process. One is the feasibility of applying the inventive idea/concept in technical, managerial and behavioral terms; the other is the demonstration of benefits to organization. Hence, it is natural saying that innovation is a special case of problem solving.

3.1.2 Theory of Cognitive Fit

According to Vessey (Vessey 1991), the basic paradigm of cognitive fit views problem solving as an outcome of the relationship between problem representation and the task of problem-solving. When problem-solving elements match; explicit speaking, when problem representation aligns the problem solving in the information format, the problem solving performance will be facilitated. During this process, a mental representation of the problem is formed which links the task to the consistent similar problem solving processes. Since no information transformation is needed, problem solving with cognitive fit leads to more effective problem solving performance. On the contrary, if there is a mismatch between problem representation and task, problem solvers have to formulate a mental representation either on problem representation or on task, either of which needs an extra transformation process to derive a solution for problem. Agarwal (Agarwal, Sinha et al. 1996) summarized that "Cognitive fit exists because the cognitive processes used to act on the problem

representation and the cognitive processes used to complete the task match; this synergy results in superior problem solving performance."

Extending to the paradigm of cognitive fit, Agarwal (Agarwal, Sinha et al. 1996) discovered that synergistic problem solving will take place when there is a match between any two different problem solving elements, including problem-solving task, problem representation, problem solving tools, which emphasize different types of information.

3.1.3 Concept of Fit

Venkatraman (Venkatraman 1989) developed a conceptual framework which classified six perspectives of fit. Not only the various fits have distinguished meanings, but also each fit has its specific analytical schemes. As a result, the decision of the concept of fit directly determines the selection of statistics tool which has to be correspondent with the hypotheses definition and the variable conceptualizations. To make a prudent and precise judgment, anchoring the concept of fit was left to be decided in the next chapter.

3.2 Hypothesis Development

Based on the perspective of cognitive fit and viewing innovation as a case of problem solving (Beckenbach and Daskalakis 2003), the type of innovation can reflect the problem solving task; KM processes represent the problem solving tool, and

effectiveness of innovation is reflected as problem solving performance. As illustrated by the theory of cognitive fit, the central hypothesis of research model can be summarized as:

> The superior problem-solving performance (*effectiveness of innovation*) will result when the problem-solving task (*type of innovation*) and the problem-solving tool (*KM processes*) emphasize the same type of information (*knowledge*).

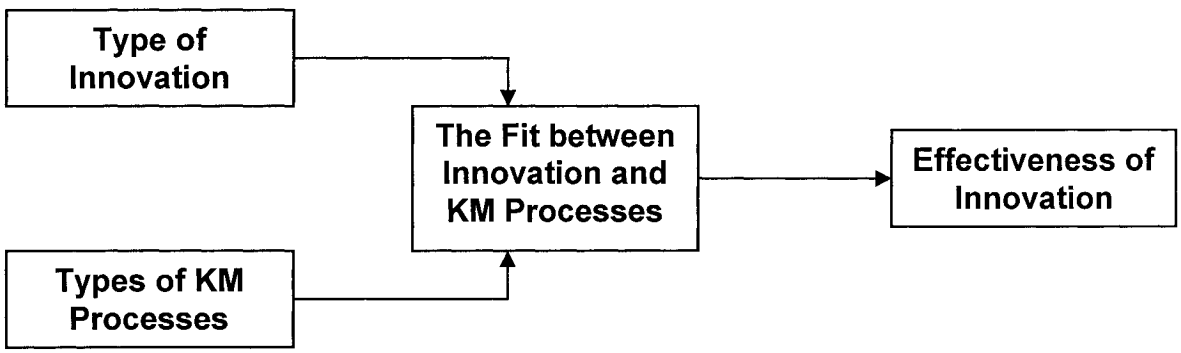

Figure 2 Research Model—A Cognitive Fit of Innovation Case

The typology of innovation is internal-/external sourced innovation. The types of KM processes are the two KM processes in the Knowledge Creation and Utilization Model (Nonaka and Takeuchi 1995; Nonaka and Reinmoeller 2000). The present study defines the KM process profile as a multidimensional construct where different innovations are characterized along these two processes.

According to the paradigm of cognitive fit, a diversification of innovation task requires a multidivisional KM processes, failure to achieve such match will lead to

innovation administration ineffective. Be specifically, KM processes—K-Creation and K-Utilization will facilitate certain well-differentiated innovations, either internal-sourced or external-sourced. More detailedly, K-Creation better supports internal-sourced innovations; while K-Utilization better supports external-sourced innovations. In conclusion, planning KM system should be aligned to the required ideal system, and such alignment enhances the innovation performance.

In consistent with the theory of the knowledge-based view of firm, Internal-sourced innovation exploits one of the best resources of ideas available to the recognized organizations—their staff. The staff is a group of indigenous experts whose technological know-how is crafted through experience, which grants them the desired tacit and systemic knowledge for innovation. Using tacit, systematic and complex knowledge in an innovation project not only adds more competent value to the internal-sourced innovation, but also deters the potential imitations from outside. It is argued that tacit rather than explicit knowledge typically offers more value to innovation (Grant 1996). Since tacit and systematic knowledge cannot easily be articulated in explicit forms, their communications require some apprenticeship or mentorship. Hence it indicates that socialization maybe more suitable for the development of internal-sourced innovations.

This argument can be demonstrated via the fact of effective innovations in Japan, where most engineers and highly educated graduates work along with other forefront production workers. A Japanese CEO explained that "because most good ideas come

from factory experiences, so all of our R&D employees work or have worked in manufacturing (Hull, Hage et al. 1985)." Through socialization, R&D workers make their efforts to identify, capture and master the necessary tacit, systemic and complex knowledge from their practical colleagues, and apply it to internal-sourced innovation.

Moreover, tacit knowledge underlies not only manual dexterity, but also scientific capability (Polanyi 1966). Imitation and experience is the only method for acquiring the skills to formulate scientific problems and develop strategies aimed at the organizational solution. That means internal-sourced innovation is more effective with the help of socialization.

Further, since organizations commit to the entire risk and investment of internal-sourced innovation, the R&D employees tend to develop more trust than those in the external-sourced innovation projects. The increased trust reduces the potential of opportunistic behavior but at the same time improves collective learning (Gulati 1995). The building process of such kinds of trust requires prolonged socialization and externalization to assure stakeholder sincerity (Braun 2002).

In the development of internal-sourced innovation, a large volume of knowledge is generated based on the internal consensus, including the contents of specific tasks and their relationship, department concerning comments, process-related information system, output information and so on (Jang, Hong et al. 2002). The entire knowledge

is so precious to every organization that it is advantageous to be recorded the knowledge for the future reuse or reference. According to some researchers (Nonaka and Takeuchi 1995; Jang, Hong et al. 2002), normally externalization is frequently used to articulate and codify tacit knowledge into explicit knowledge.

In view of socialization, tacit knowledge is widely spread with the minimum threat of valuable knowledge assets physically "walking out of the door" (Swan, Newell et al. 1999). Second, socialization and externalization are trigged by observation, imitation, practice, metaphor, or analogy, which are meanwhile referred as organizational learning. These learning activities facilitate the internal-sourced innovation, by not only motivating an innovation development environment, but also stimulating invention and inspiration. For all the innovative organizations, improving environment is indispensable because most innovations are mainly driven by the producers' unconsciousness; purposeful search for innovation opportunities are only found in a few number (Drucker 1985; Smits 2002). Inventions and inspiration are stimulated through these activities because they increase the knowing level of organization of each person and give people the chance to locate the weaknesses and errors of organizations. Drucker (Drucker 1985) argued that failures, errors, unexpected occurrences, process needs are all sources of innovation. Hence, socialization and externalization are those that create the learning and searching culture for the organization. Since both socialization and externalization belong to K-Creation, we hypothesize that:

Hypothesis 1: *The better the fit between internal-sourced innovation and K-Creation, the more effective the innovation will be.*

Many researchers suggest that organizations should share the "burden" of innovation between or among several organizations if they wish to seek a broader range of alternatives (Chesbrough and Teece 1996; Hargadon 1998; Quinn 1999; Quinn 2000; Ritter and Gemunden 2003). Because external-sourced innovation has more explicit and autonomous knowledge than the tacit and systemic, also because combination is the most efficient ways to learn explicit and autonomous knowledge, in cognitive view of fit, combination may be more appropriate for external-sourced innovation projects. Quinn (Quinn 2000) concluded that due to limited resources, no single company can innovate better than the combination of all potential components, and that this combination can be overwhelming. Knowledge combination merges the existing explicit knowledge in new ways that result in dramatic synergy. Hargadon explained that when organizations develop external-sourced innovation, they exploit the current position and then link a wide range of existing problems and solutions. By doing so, the organizations span the market and technology domains by converting knowledge from it originated to where it hasn't shown up. In this way, innovation solutions are created in form of new combinations of existing ideas (Hargadon 1998).

Complying with the demanding of development and spreading of new knowledge across industries, a new profession named *knowledge brokers* came out in the late 1990's (Hargadon 1998). It could be commented that most knowledge brokers are

neither equipped with the completed knowledge that resides within each industry, nor have the ability to produce breakthroughs in any one technology or domains of any one industry. But they are instinctively sensitive to newly emerged knowledge, and agile in mastering necessary explicit knowledge in each industry. By linking past knowledge and ideas from diverse industries, they achieve solutions for the current problem. Other firms not only can turn to knowledge brokers for help of external-sourced innovation, but can also draw lessons from their combination experience.

For firms which develop external-sourced innovation, over-demanding on socialization and externalization is discouraged. K-Creation processes are usually time-consuming so that they can slow down the speed of outsourcing to the point of losing its merits. Albeit the organizations with external-sourced innovations have the capability to absorb and apply the external core technology for its own use, socialization and externalization will make them lose the very things they endeavor to from external sources—greater knowledge depth, the most up-to-date systems, highest quality and lowest cost, maximum flexibility, and no front-end investment on its part. Quinn (Quinn 1999; Quinn 2000) believed that the organizations with external-sourced innovation focusing attention on managing "how" the result is produced instead of "what" is the desired result may prevent the very innovation they seek and be futile in actually.

Since external-sourced innovations dispirit socialization and externalization, there would be less need of mentorship or apprenticeship or job rotation during innovation

development, which means that the operation in external-sourced innovation is more stable than in internal-sourced innovation. Alavi and Leidner (Alavi and Leidner 2001) suggested that organizations with stable business environment should expect a relative emphasis on explicit knowledge flowing, including both flowing from individual to organization and flowing from organization to individuals. According to Alavi and Leidner, it's possible to deduce that shift the attention focus from K-Creation to K-Utilization so as to exploit already-existing knowledge should be more advantageous for stable environment like external-sourced innovations.

Discouraging socialization and externalization does not mean to deny the effect of tacit knowledge in external-sourced innovation. Organizations have to determine the potential areas for improvements and internalize the explicit knowledge to keep core competencies. Without personalized internalization, organizations only could locate and invest on where it seems an opportunity for unique value-added, how much the obtained external knowledge truly values for them will remains ambiguous, which eventually lead them miss the chance of assimilating and forging this external knowledge into their own core competency (Quinn 1999). Chesbrough and Teece (Chesbrough and Teece 1996) argued that although external-sourced innovations can make organizations more flexible; at the same time, they undermine the organizations' ability to do internal-sourced innovation. This point could be illustrated by a fascinating example of IBM (Chesbrough and Teece 1996) which attempted to steal a development idea from its rival corporate enterprises—Compaq and Intel. IBM loyally copied the complete strategy with little concern left on which

competitive advantages they should establish except pure duplication. The blunder made it lost 82% of its PC market in 10 years. The grieved lesson of IBM reveals the importance of internalization in innovation projects. By combining the existing ideas and knowledge to the new problem, external-sourced innovations offer increased opportunities to companies through faster innovation speed, mitigating the development risk, lowering the cost and so on. Besides, internalization can maintain the creative capability of in-house human resources due to the negative impact of external-sourced innovation (i.e. failing individual development) (Shan, Walker et al. 1994; Ritter and Gemunden 2003).

Standing at a different viewpoint, internalization bestows the learning ability while the organizations collaborate with the innovation providers. The collaboration is achieved through the formal contracts or agreements, which are the only legal protection for both sides, especially when the collaboration is in the immature stage. Innovation buyers have to simultaneously learn how to choose and initiate collaborations, know how to function within a context of multiple cooperative ventures, how to handle, inspect, and benefit timely from collaborative relationships. Even in the common collaboration community, the only information that innovations buyers can follow and refer to is the standardized rules and contracts or agreements (Shan, Walker et al. 1994). In order to achieve success in the external-sourced innovation and protect themselves maximally, organization must internalize these routine processes; develop experience during the processes of cooperation and create a reputation as external-sourced innovation consumers. Such experience is not only

necessary to manage a diverse portfolio of ties with innovation providers, but also to assist the organization to situate a good position during the interacting with other firms (Powell, Koput et al. 1996), which conversely has important direct and ancillary effects on innovation success (Shan, Walker et al. 1994; Ritter and Gemunden 2003). Studies also proved that this kind of experience is very useful for successful completion of forming core competency (Shan, Walker et al. 1994; Ritter and Gemunden 2003).

Since combination and internalization patterns together constitute the K-Utilization, the following hypothesis is stated based on the above analysis:

> Hypothesis 2: *The better the fit between external-sourced innovation and K-Utilization, the higher the effectiveness of innovation will be.*

In conclusion, the relationship between innovation typology and KM processes can be proposed as in the follow table:

Table 3 Aligning Innovation Type with K-Creation and Utilization Processes

Innovation Type	KM Processes
Internal-sourced Innovation	K-Creation (Socialization, Externalization)
External-sourced Innovation	K-Utilization (Combination, Internalization)

IV. Research Methodology

The subsequent section describes the major research activities with regards to the operationalization of the research model constructs. In addition, the web-survey methodology will be portrayed, including the layout of the measurement instrument, the sample population, the questionnaire pretest, and main data collection processes.

4.1 Operationalization of Variables

As the basis of research, the definition of innovation should be established proceeding to variable operationalizations because the questionnaire needs it to explain to respondents the present research subject and objective. Because of the absence of standard and worldwide-accepted definition, we defined the innovation based on previous research instruments and literature as presented in the literature review. Accordingly, the definition is:

> **Innovation means adoption and exploitation of new products, new services, new processes, or new organizational setups in your bank.**

All the academic elements and rhetoric description were avoided in order to keep the definition, to be followed by respondents, concise and more substantial rather than abstract.

Whenever possible, existing, established, well-validated measures from previously validated instruments were adopted and modified in measuring all of the constructs. The references of measures are listed in the following Table.

Table 4 Construct Operationalization

Constructs	Number of Items	Questions	Measure Reference
EFFECTIVENESS OF INNOVATION	1	1	(Gopalakrishnan and Bierly 2001)
Innovation typologies			
Complexity	2	2-3	(Pelz 1985; King 1992)
Autonomous	3	4-6	(Gopalakrishnan and Bierly 2001)
Tacit	1	7	(Gopalakrishnan and Bierly 2001)
Knowledge Management Processes			(Nonaka, Umemoto et al. 1998)
Knowledge Creation			
Socialization	3	8-10	(Sabherwal and Becerra-Fernandez 2003)
Externalization	5	11-15	(Huang and Wang 2002)
Knowledge Utilization			
Combination	2	16-17	(Huang and Wang 2002; Sabherwal and Becerra-Fernandez 2003)
Internalization	3	18-20	(Sabherwal and Becerra-Fernandez 2003)

4.1.1 Effectiveness of Innovation

The effectiveness of innovation was scarcely discussed in empirical research, due to its diversiform definitions and abstracted intrinsic quality. Table 5 is a collection of prior studies in which the innovation construct is similar or related to innovation effectiveness. Taylor et al. (Taylor, Tillsley et al. 2000) measured innovation performance by rating the overall technical and financial success of innovations in organization; Rodan (Rodan 2002) used the assessment of general manager's

performance; Gopalakrishnan and Bierly (Gopalakrishnan and Bierly 2001) measured this through evaluating the level of realization of organizations' original business goals and objectives. Albeit the diversiform of phrasing, all the existing researches (Taylor, Tillsley et al. 2000; Gopalakrishnan and Bierly 2001; Rodan 2002) achieved the certain degree of agreement on this construct that the measurement of innovation effectiveness should be related to the company's practical performance, which is usually compared with the goals of companies' innovation strategy proposal. Hence, the uni-dimensional assessment developed by Gopalakrishnan and Bierly's (Gopalakrishnan and Bierly 2001) scale is adopted—the innovation is effective if its performance meets the goals and objectives of the organization.

Table 5 Collection of Innovation Effectiveness's Construct

Publications	**Key items for dependent variables**
(Dougherty, Borrelli et al. 2000)	Non-innovative; Incrementally innovative; Fully innovative Survey, 119 people in 12 organizations
(Dewar and Dutton 1986)	Innovations were rated on a three-point scale indicating whether each innovation: (1) had no new knowledge contained in the machine or process; (3) represented a major technological advance. The judges were persons designated as most knowledgeable in their organization about the acquisition of new technology. Survey, 40 firms
(Rodan 2002)	The corresponds to your assessment of a manager's performance over the 12 months Survey, 258 manager is a European telecommunication service provider
(Gopalakrishnan and Bierly 2001)	The bank respondents were asked to evaluate the overall contribution of each of these innovations in meeting the goals and objectives of the bank. The effectiveness was evaluated on a 5-point Likert scale where I was equivalent to very low and 5 to very high. Survey 101 banks.
(Taylor, Tillsley et al. 2000)	The measure regards to innovation practice and performance. • To rate the overall innovative performance of your organization compared to other organizations operating in your sector (above average, average, below average, don't know, not applicable) • To rate the overall technical and financial success of innovations in your organization over the last two years? (Very successful, fairly

	successful, not very successful, very unsuccessful, don't know, not applicable)
(Landry and Amara 2001)	The following items are more likely the internal capability of firms regarding the development of innovation. We propose to use this question as an indicator of the creativity of innovative firms and to distinguish firms according to four categories of creativity. (1) Innovations developed mainly by the firm interviewed; (2) Innovations developed jointly by the firm and other firms or institutions; (3) Innovations developed mainly by other firms or institutions; (4) No innovation developed by the firm interviewed. Survey, 440 manufacturing factory

Reliability and Validity of Effectiveness of Innovation

To improve the content validity, Gopalakrishnan and Bierly (Gopalakrishnan and Bierly 2001) conducted first a pilot survey among 5 experts either commercial bankers or academics, then a pre-test among 10 banker individuals, finally a mail-survey collected from 101 bank respondents. The reliability was acceptable, with an inter-rater reliability of 0.69, which is significantly higher than the average inter-rater reliability of supervisory performance rating based on correlation of .52 provided in the meta-study by Viswesvaran (Viswesvaran, Schmidt et al. 1996).

Gopalakrishnan and Bierly (Gopalakrishnan and Bierly 2001) didn't discuss their validity test for this construct.

4.1.2 Innovation Typologies

Gopalakrishnan and Bierly (Gopalakrishnan and Bierly 2001) originally developed the idea of internal-sourced and external-sourced innovation; meanwhile, they

designed and tested a 7-items measurement of categorization for this typology. The study findings demonstrated their hypotheses, namely that the more explicit, more autonomous and simpler knowledge are associated with external-sourced innovation. Conversely, the more tacit, more systematic and more complex knowledge associated with internal-sourced innovations. Since no valid discussion was provided Gopalakrishnan's (Gopalakrishnan and Bierly 2001) study, the items were developed and tested in pilot test for content validity.

4.1.3 Knowledge Management Processes

The two knowledge management processes were assessed by combining of Sabherwal's (Sabherwal and Becerra-Fernandez 2003) and Huang's (Huang and Wang 2002) scales, which results as a multi-dimensional and multi-facet measurement. The detailed adopted information has been explained in the previous table. These two measurements were adopted because they both employed the Nonaka's (Nonaka and Takeuchi 1995) Knowledge Creation and Utilization model, and both studies have acceptable reliability and validity. Detailed information is discussed in the following paragraphs.

Reliability and Validity of Knowledge Management Processes in Sabherwal's (Sabherwal and Becerra-Fernandez 2003) scale

Based on a survey of 159 individuals and two rounds of personal interviews, the reliability of four KM patterns in Sabherwal's (Sabherwal and Becerra-Fernandez

2003) scale were above the recommended minimum standard 0.60 (Bagozzi and Yi 1988). The Cronbach alphas were 0.66, 0.79, 0.77 and 0.80 for Socialization, Externalization, Combination and Internalization respectively; three of four measures were above 0.70, which is the generally accepted cut off value. The resultant measurements were made of 17 items.

The validity test also yielded satisfactory results. Convergent validity was assessed using t-statistics for the path coefficients from the latten constructs to the corresponding items. Path coefficients for all the17 measures are statistically significant, with the lowest t-value of 5.65, which were all considerably higher than the standard of 2.00 (Anderson and Gerbing 1988). Discriminant validity was demonstrated by (1) the confidence interval for all pairwise correlation estimates were excluded (Anderson and Gerbing 1988); (2) the extracted variances for each of the constructs all exceeded their shared variance; (3) all the test of χ^2 difference were significant at level of $\rho <= 0.001$.

Reliability and Validity of Knowledge Management Processes in Huang's (Huang and Wang 2002) scale

Huang's (Huang and Wang 2002) measurements was first experienced the pilot test with the 171 valid responses from undergraduate student in Soochow, then it was tested by 52 R & D teams with the sample of 260 individuals. The Cronbach alphas for four items varied from 0.70 to 0.87, all exceed the cut off value 0.70. The discriminant validity was suggested by the four factors of principle component factor.

Each factor has an eigenvalue larger than 1.0 and together account for 56% of variance of data.

4.1.4 Fit Between Innovation Typology and KM Processes

Fit between innovation typology and KM processes is an internal-generated variable during statistics analysis. Since the hypotheses and operationalizations of other variables have been explicitly clarified in preceding sections, it is now the appropriate moment to decide the fit construct.

As a core concept in contingency model, fit itself has been identified into six perspectives (Venkatraman 1989)—fit as moderation, fit as mediation, fit as matching, fit as gestalts, fit as profile deviation, and fit as covariation. Fit as moderation is that impact of a predictor variable (X) on a criterion variable (Y) is dependent on the level of a third variable, termed as moderator (Z). The fit between predictor variable (X) and moderator (Z) primarily affect the direction between predictor variable (X) and the criterion variable (Y). In the case of fit as Mediation, there is a significant intervening variable (Z) between an antecedent variable (X) and consequence variable (Y). Fit as matching defined a match between two related variables (X, Z) influences a criterion variable (Y). The remaining three fit perspectives discuss the situation when more than two variables are involved in analysis. Fit as gestalts looks for the organizational reality of internal coherence among a set of theoretical related variables (X_1, ..., X_m), no criterion variable is needed here. In perspective of fit as profile deviation, the degree of adherence to an

externally specific profile of theoretically related variables (X_1,..., X_m) has a significant effect on criterion variable Y. Fit as covariation is a patter that fit as internal consistency among a set of underlying theoretically related variables (X_1, ..., X_m) to form a co-alignment which finally has significant effect on the criterion variable (Y).

According to Venkatraman (Venkatraman 1989), the first three fits belong to the "reductionistic" category which only studies the bivariate coalignment relationships between exactly two related variables in terms of one dimension. In contrast, the "holistic" category containing the latter three fits examines the alignment among more than two variables. Since current study contains more than two dependent variables: innovation typology, K-Creation and K-Utilization and each variables has more than one dimension, the fits in the "reductionistic" category are eliminated. Fit as gestalts was also removed from candidates because it is criterion-free, contrary to the fact that a criterion variable—effectiveness of innovation exists in the present study. As a result, the candidates were narrowed down to Profile Deviation and Covariation.

Fit as covariation seems to be the accurate choice. It is "formally represented by the variables standardized weight in forming the coalignment construct, and its effect on criterion variable—innovation effectiveness in current case, can be directly assessed by the path coefficient (Bergeron, Raymond et al. 2001)." The problem is that the numerical weights between constructs and coalignment require all the constructs to be

measured as ratio or interval scales; no logical variables are possibly included in. This requirement contradicts the fact that construct of innovation typology is measured as nominal variable. Suppose we change the innovation construct into scale variables by evaluating tacit, autonomous and complexity levels simultaneously with two KM processes so as to form the coalignment construct, the measurement will directly blot out the original intention in the hypotheses that classifies innovations into two categories and examine KM processes effect in each environment. The result will become the coalignment among the KM processes and three innovation characteristic dimensions.

Consequently, fit is defined here as the "Profile Deviation", which can be interpreted as follow: in given business environment, the ideal profile is the Knowledge Management resource deployment that benefits performance of the specific innovation. Adherence to such profile will improve the innovation effectiveness, whereas deviation to from this pattern allocation represents a misalignment between innovation task and KM processes which will result in lower expected performance.

Fit as profile deviation is "flexible in terms of varying the theoretical conceptualization (Venkatraman and Prescott 1990)." Testing this specific conceptualization involves several critical interplaying issues. Details are provided in the following sections.

4.2 The Sample

The data for the study were collected from banks in multiple countries. There are several reasons to choose banks as particular interesting sample. First, banking is always recognized as an extremely technology-intensive industry. Strict and effective requirements of information manipulation make the banking industry one of the biggest investors and customers in IT industry. According a new *TowerGroup* report titled as "Perspectives Across Financial Services Institutions for 2004; Investing in IT to Sustain Growth", an estimated $362 billion in IT investment will be made and managed by banks for banking, securities and insurance issues in 2005. With the booming of Knowledge Management, people started to view banking as a extremely knowledge-intensive industry (Anonymous 2004). The trend of growing international businesses forces individual and team bankers to work across expanding distance so as to manage daily increasing flood of information; as a result, the coordination of knowledge creation and utilization become more and more important. The World Bank even officially claimed to launch a knowledge management program in 1996.

Secondly, with the population of enterprise collaboration software, financial institutes are able to share enormous volume of data effectively and keep cost down. How to keep sharing knowledge with partners and clients, even with competitors sometimes, but still retain or promote innovation began to attract more and more attentions recently. Furthermore, banks are particularly interested in outsourcing and its effectiveness research.

The third reason is due to the consideration of feasibility for questionnaire designing. Downs and Mohr suggested (Downs and Mohr 1976) that innovation-decision design should be an extension of single-innovation project by respecting unitary innovations so as to reduce the empirical instability and theoretical confusion. With the analogous business operation, financial products and services, the banking industry has intensively high level of similarity around the whole world. This is the most essential reason for choosing banks as research sample. High resemblance in management and operation forced the banks adopt the same innovations; as a result it's very possible to distinguish individual innovations in this research, which enables us to draw meaningful and generalizable conclusion about each type, and meanwhile to enlarge the potential response.

Suggested by MIS studies (Tallon, Kraemer et al. 2000) and marketing studies (Narver and Salter 1990; Jaworski and Kohli 1993), the target respondents are rich-experienced bankers, for example bank CEOs, CIOs, general managers, bank technology engineers and so on. The seniority positions and the long experiences allow these individuals to have insightful opinions regarding the central construct of the questionnaire developed.

4.3 Design and Pre-testing

The survey was split into two phases. The first phase was used to generate a list of the important innovation projects that occurred in banking industry over the last five

years. The second phase questionnaire was generated based on the appropriate innovations selected from the responses of first phase survey. Both surveys were pilot-tested and pre-tested.

4.3.1 First Phase Questionnaire Design, Survey and Result

First Version Design and Pre-test

To get the newest and most popular bank innovations, we first designed a questionnaire to invite bankers to identify top 10 innovations in the last 5 years and give a brief explanation for each. The difficulty of impromptu considerations and diverse responses in pre-testing among 9 bankers led to the second version of the questionnaire. The detailed report for this questionnaire is included in Appendix 1 (About First Pre-test).

Second Version Design and Pre-test

To redesign the first phase questionnaire, a careful online review of the 3 biggest Canadian Commercial banks was carried out to collect the basic banking information—what kind of banking products or services they have; and among these products and services, which could be regarded as banking innovations. Besides website browsing, two bank journals were also reviewed. The research yielded a list of 20 innovations, which were included in the second version questionnaire.

A pilot test was conducted before the first phase pre-test. We consulted with a graduate professor who is familiar with the banking industry and one graduate student who has 5-year banking experience. Three innovations were dropped because they were either insignificant or no longer innovative; two new items were then added. The pre-test was conducted among 5 bankers by asking their opinions on item wording and questionnaire appearance, to make sure the questionnaire is clear and concise.

The term "commercial bank" was changed to "bank" because of expanding operational fields of many financial institutes. The phrase of "your organization" was replaced with "your bank" or "your bank or your branch". Two background questions asking "how many employees work in the IS department" and "what is the annual revenue of your bank" were eliminated. The investigated time range was also expanded from 5 years to 10 years in order to generate more ideas. In addition, some design changes were made to the layout and colors. An open-end question was also added to encourage banker respondents to put on the missed innovations that they believed as equally important as those in the questionnaire.

The final version questionnaire includes a cover letter, consent form, closed-ended questions about innovation adoption period, open-ended questions for adding the missed innovations, background information and a thank-you letter. Its layout is quite similar to the second phase questionnaire. To avoid redundant description, only the layout of the second phase questionnaire was depicted thoroughly, which is in the

following section. The final version of first phase questionnaire is included in Attachment (Appendix 2).

First Phase Survey and Result

The data were collected through web site survey and fax survey at the same time. Since the data collection process for first phase was as same as the second phase which is also the most crucial part in this research, the detailed introduction to the data collection processes is moved to the following sections.

According to the gathered data, there is a large time lag in bank innovation adoption among different countries. Finally, nine innovations were selected. They are:

Electronic Billing and Payment
Electronic Fund Transfer (EFT)
Electronic Data (EDI)
Mobile Banking
Telephone Banking
Online Invest
Check Imaging
Online Payroll system
Internet banking

The detailed report of first phase survey is in the attachment "The First Phase Data Collection" (Appendix 3).

4.3.2 Second Phase Questionnaire Design and Pre-test

The basic thinking about second phase questionnaire is to ask construct items developed in section 4.1 about each innovation. Following practices and rules for designing an ideal questionnaire were incorporated (Erdos 1983; Dillman, Sinclair et al. 1993; Czaja and Blair 1996):

- Limiting instruments from six to eight pages.
- Grouping questions into sections with similar qualities and relevance.
- Questions should be relevant, easy to answer and interesting.

Since each innovation has 20 question items, to restrict the instrument into eight pages or fewer, nine innovations were grouped into 5 categories because of their similar qualities and relevance. They are: **Electronic Billing and Payment**, **Electronic Funds Transfer/Electronic Data Interchange (EFT/EDI)**, **Internet Banking (Online Banking, Online Payroll System, Online Invest)**, **Check Imaging**, and **Mobile Banking**.

Questionnaire Layout

The questionnaires of first phase and second phase have similar layout, both consist of 5 parts. The final version of second phase question is included in Appendix.

a. Cover Letter

The cover letter introduces the study with a simple and clear explanation of research purpose, questionnaire objectives, estimated time to complete the questionnaire and

the reward granted upon the respondent's participation—a personalized copy of research findings.

b. Consent Form

It's obligatory to include consent form in human research subject survey according to the policy of university research center. The objective of the consent form is to make sure the respondents know about their willingness of participation, their rights, confidentiality of information, and meanwhile to get their permissions for utilization of information in the filled questionnaire under the protection of anonymity.

c. Research Construct

At the beginning of this part, certain instructions were given to the respondents. A first impression was demanded to answer each item; also the respondents may skip the whole innovation if it doesn't exist in their banks. 20 same questions were asked for each innovation. The respondent was asked to rate the items by using a 5-point Likert-type scale, ranging from "1—Strongly Disagree" to "5—Strongly Agree". An additional choice "Not Applicable" was also provided.

d. Background Information

This section specifically collected demographic information about respondents, including bank background and personal information. The questions in this section are the same as those in the first phase survey.

e. Thanks Letter

A thank-you letter was given to appreciate each respondent's support and precious time.

Pre-test of Questionnaire

One professor and two graduate students with bank experience were invited to evaluate the content validity of questionnaire.

The questionnaire was then pre-tested among four individual bankers through personal interview. The pre-testers were either customer service managers or customer service representatives. Time cost on filling was recoded while waiting their responses. The pre-tested group was asked for opinions of general questionnaire impression, instrument verbalism and some sensitive questions after finishing responding. The pre-test ensured that the survey instrument was clearly clarified, concise, easy to reply and no misleading elements. Modification was made according to these first-hand feedbacks.

All the pre-testers believed that the questionnaire was overlength. Eight pages of information needed to be read and a total of 112 questions had to be answered, which took each respondent at least 25 minutes to respond. For this reason, one innovation—Mobile Banking was eliminated and grouped into Internet Banking section, which reduced the question number to 92. No more reduction was possible because we must make sure to collect enough data so as to maintain the certain level

of reliability and validity. Four question items were rephrased to make them more concrete and easy to follow. Some refinements to the design were also made after the pre-test. Because of the tight arrangement of questions, gray background color was adopted in every other in order to distinguish the different items. Some minor changes in questionnaire appearance were also made.

After that, a careful web-site survey was designed in a commercial online survey website—www.surveymonkey.com . With the help of survey software, nearly all the questions were marked as requiring-a-response questions, except the last one which demands respondent's email address. Also, the option of one response per respondent was chosen. The repeat answer from the same IP address automatically covered the previous response, which means that only one response was allowed from each computer; however respondents might return to the survey to edit their existing answer, or to finish uncompleted survey. The web site sample is included in the attachment.

4.4 Data Collection

The data were collected through web site survey, and fax survey as well. The emails addresses and fax numbers were both collected through browsing online directory. In November 2004, 307 survey invitation letters were sent through emails to banks in US; another 1027 invitation letters were faxed to Canadian banks to invite bankers visit survey website. In addition, the survey link was sent to the friends in Mainland

China, Switzerland, and Hong Kong. Also twenty physical copies were mailed to a friend in France. A Banking and Finance Innovation Mailing-List found in *YahooGroup* on Internet named "*bank-innovation-proprietaire*" was also used to recruit respondents. One week later, follow up letters were sent to the same target respondents.

83 emails to US were returned, 39 fax numbers were wrong or out of service. A total of 69 responses were received through either online survey or fax or mail. 11 responses were not included in the following analysis because of too much missing information or unfinished questionnaire or improperly filled out, which finally left us 58 usable observations.

V. Data Analysis

This chapter presents the procedures and processes of data evaluation and analysis by using Microsoft Excel XP and Statistical Package for Social Sciences (SPSS) 11.0. The contents cover demographics of the collected data, reliability analysis and validity test prior to the creation of the construction of the research model, and finally the assessment of the measurement model by using the calculation of a Euclidean distance score.

5.1 Demographic Analysis

This section describes the general background information of respondents and their banks.

5.1.1 Bank Information

The questionnaire was specifically designed for the bankers. All of the respondents come from the banks that have more than two commercial bank subsidiaries, and the subsidiaries spread more than one state or province. The frequency of bank's nationality is listed in Table 6.

Table 6 Bank Nationalities

Bank Nationality	Frequency	Percent
Canada	9	16.4
Lebanon	3	5.4
Singapore	8	14.5
P. R. China	35	63.6
Total	55	100.0

Total 27 branches from 18 banks answered the survey. One of fifty-five respondents didn't specify his bank name.

5.1.2 Personal Information

Among the respondents, 64.8% hold the positions of high executive such as CEO, vice CEO, CIO, chief, or other general manager. The count and percentage of each job title held by the respondents are listed in Table 7.

Up to 70.9% respondents had completed bachelor degrees. 21.8% were master graduates. Detailed information was listed in Table 8.

The educational majors of respondents came from 3 fields: (1) 38% from Accounting / Finance; (2) 37.8 from Mathematics / Computer Science / Engineering / Information Technology; (3) 23.4% from Administration / Economics. Detailed information was listed in Table 9.

Table 7 Respondent Job Title

Job Title	Frequency	Percent
CEO	1	1.8
Vice CEO	1	1.8
CIO	1	1.8
Manager IT/IS	5	9
Chief Accountant	5	9
Manager other	20	36
Chief other	3	5.4
Engineer	5	9
Financial Analyst/Representative	5	9
Financial Security	1	1.8
System Administrator	1	1.8
System Analysis	1	1.8
Capacity Analysis	1	1.8
Others	5	9
Total	55	100.0

Table 8 Education Level

Education Level	Frequency	Percent
Bachelor	25	45.5
College	16	29.1
Master	9	16.4
MBA	2	3.6
Postgraduate	1	1.8
University	2	3.6
Total	55	100.0

Table 9 Education Background

Education Field	Frequency	Percent
Accounting	9	16.4
Applied Mathematics	2	3.6
Management/Administration	8	14.4
Computer Science	13	23.4
Economics	5	9
Engineer	2	3.6
Finance	12	21.6
Information Technology	4	7.2
Total	55	100.0

5.2 Measure Assessment

Once banks confirmed that an innovation had been adopted, they were asked to provide details for each innovation. Count out the background information, each returned questionnaire has four innovation projects, which means that it's possible to have a maximum of 232 adoptions supposing that every respondent's bank adopted all 4 innovations. The final number of available source data was 209, resulting in an average of 3.60 innovations per bank.

5.2.1 Data Distribution

The population should pass normality test without sampled violations before analysis to avoid incorrect or misleading results. As anomalous values in the data, outliers could have dramatic effects on data distribution, for example they could rejecting the hull hypothesis in normality test even sometimes the remainder of the data did in fact normally distribute. Suggested common tool for detecting presented outliers is the examination of normal distribution for each variable. Appendix 5 Histogram Charts for Individual Items show a bar chart of the responses along with a normal curve for each variable. No standard deviations from the mean of the distribution are observed.

Individual missing values and "not applicable" options were replaced with the mean value of items within the same construct in order to preserve as many observations for analysis as possible. In total 50 missing data were replaced, resulted in 1.1% missing responses per respondent

The nonnormal distributions are characterized by both skewness and kurtosis. Nonzero Skewness indicates a lack of symmetry. Negative Skewness indicates a distribution with an elongated tail to the left. Positive Skewness indicates a distribution with an elongated tail above the mean to the right. Normal distribution Skewness is zero. Kurtosis measures the extent of deviation between height of the curve and the normal curve. The Kurtosis of standard normal distribution is three. Appendix 6 Descriptive Statistics show that Skewness of all measure items is between –0.918 to 0.063; Kurtosis is between –0.925 to 1.890. Both indicate the approximated normal distributions of all present variables.

5.2.2 Measure Reliability and Validity

This section includes the discussion of the reliability assessment, measurement of validity, and then the results of assessment.

Assessing Reliability

Reliability is the stability of the instrument over various conditions. For those identically scored constructs, through Likert scales for example, Cronbach's α is the most typically used indicator answering "the extent to which the respondent can answer the same questions or close approximations the same way each time" (Straub 1989). In general, 0.60 is the recommended minimum standard of reliability coefficient for the confirmatory research (Nunnally 1978; Barki, Rivard et al. 2001; Baker, Parasuraman et al. 2002).

Before evaluating the reliabilities, confirmatory factor analysis was conducted to reduce the number of items and to detect structure in the relationships between variables. The extraction method is Principal Component using the option of varimax rotation and pair wise deletion.

The appropriateness of employing Factor analysis is determined by KMO and Bartlett's Test sphericity. KMO closing to 1 indicates the correlations are relatively compact so that the factor analysis can generate distinct and reliable factors. As a general rule, a KMO value greater than 0.5 is considered adequate for extraction (Kaiser 1974; Kline 1994). Besides, a highly significant Barteltt's Test of Sphericity also means that factor analysis is appropriate (Field 2000).

An orthogonal rotation identifies and estimates factors, which reveals a simple structure of factors and aids interpretation as well (Johnson and Wichern 1998). According to the rule of thumb, the loadings for common social practices less than 0.40 on the predicted factor were cut off because lower loadings indicate a lack of convergent validity.

a. Innovation Typology

The construct was adopted from Gopalafrishnan's (Gopalakrishnan and Bierly 2001) scale, and was modified based on the pre-test's feedback. Verified with Cronbach α, the reliability of the scales was 0.6483 (Appendix 7). The result of factor analysis

shows that KMO value is 0.673 and Bartltt's Test of Sphericity is highly significant (Appendix 8).

Rotated Component Matrix of innovation typology construct (Appendix 8) indicates that three items should be removed since they load to the factors other than the one they were supposed to load. The three factors are explicit number 2, autonomous number 1, and simply. Since simply is the single-item scale and is one of the three essential aspects in determining innovation typology, deleting it will cause the problem of inexplicableness. Field (Field 2000) said that factor analysis should exclude those variables that are identified as problematic, which suggests us to keep it rather than to remove. This point is also proved by new lower reliability value after removing the three factors, which was 0.5718. According to this situation, a new round of Factor Analysis was run by only including in items of complexity and autonomous. The new result indicates that all the items of complexity and autonomous are loaded to the right factors and should be retained (Appendix 9). Finally all seven items of Innovation typology were remained, and naturally the reliability of the scales was still .6483.

b. Knowledge Management Processes

For the convenience of later hypothesis tests, four knowledge management patterns were measured in terms of two KM processes—K-Creation and K-Utilization.

K-Creation

K-Creation consists of socialization and externalization, which measured by 3-item scale and 5-item scale respectively.

0.838 KMO value and highly significant Bartltt's Test of Sphericity also indicates that factor analysis is appropriate (Appendix 10). Rotated Component matrix suggests most of the items loaded as predicted on their relevant dimension, except that externalization number 1 should be removed because it loads on factor of socialization. Externalization number 4 loads on both factors. Since it is closer to assembly group for externalization, it is remained.

The reliability of remaining K-Creation scale was established by Cronbach α. The overall α value is 0.7756 (Appendix 11), indicating an adequate level of internal consistency.

K-Utilization

K-Utilization includes Internalization and Combination, which were tested by 2-item and 3-item scale respectively.

Through Factor Analysis for K-Utilization (in Appendix 12), it's easy to tell that using factor analysis is appropriate here (KMO=0.673, and Barlett's Test of Sphericity highly significant). Rotated Component Matrix (Appendix 12) shows a

very delicate loading classification, which suggested that Combination # 1 and Internalization # 1 and # 2 should be in one group, and Combination # 2 and Internalization # 3 are belong to another group. This means either Combination # 2, Internalization # 1 and # 2 should be removed, or Combination # 1 and Internalization # 3. Three-factor solution seems to be a better choice over 2-factor solution.

To avoid the arbitrary justification, reliability α values for both classifications are calculated and compared. For loading of Internalization #1 and Combination # 3, the α value is –0.0067 (Appendix 13). The other selection shows a much more optimal value—Cronbach α=0.5925 (Appendix 14), which almost reach the general cut-off value. As a result, group of Combination # 2 and Internalization # 1 and # 2 was selected.

Assessing Validity

Validity is an issue of accuracy measurement. It concerns that why the selected instrument items for a given construct are, considered as a whole, more reasonable than other operationalizations of the construct (Cronbach and Meehl 1955; Straub 2004). Content, convergent, discriminant and factorial validity all belong to be forms of validity. Content validity is decided by comprehensive literature review or other solid theoretical basis, such as expert panels or judges, or pretest (Straub 2004). It's established before data collection. Convergent validity refers to the extent to which items measuring the same trait indeed behaved as if they were measuring the same

construct. Discriminant validity investigates the observed differences between constructs. Factorial validity is the alternative term for factor analysis, which has been evaluated in the previous section. Factor validity can be viewed an alternative method of assessing both convergent and discriminant validity, although it can't avoid methods bias (Straub 2004).

The most classic and highly formal approach to test convergent and discriminant is multitrait-multimethod analysis (MTMM) (Campbell and Fiske 1959). First correlations were calculated among all items of certain construct. Second, the resulting matrix was examined using MTMM. Convergent validity is confirmed if the inter-item correlations are positive and significantly correlated. Discriminant validity was assessed by examining whether or not the correlations of the same trait are higher than other different traits.

Correlation matrix of items shows strong correlation among the items. In the correlation matrix of Innovation Typology construct, except one correlation, all the other fourteen inter-item correlations were positive, with 8 significances at $p<0.000$, 5 significances at $p<0.01$ (Appendix 15). In the correlation matrixes of K-Creation trait and K-Utilization traits (Appendix 16, 17), all the inter-item correlations of both matrixes were positively and significantly related, at $p<0.01$. These results indicate an adequate level of convergent validity.

Discriminant Validity was also evaluated by correlation matrix. Since it means to prove that a measure does not assess what it's not supposed to assess, it examines the correlations between any two different constructs. As in Appendix 18, all items of four main KM patterns correlated significantly higher with the processes they were presumed to measure than with any other processes. So do the group construct of K-Creation and K-Utilization (Appendix 19).

If the correlation between two constructs is significantly different form unity, then discriminant validity was verified. To achieve an acceptable level of discriminant validity, confidence interval around the correlation should exclude 1.0. In Appendix 20, the Pearson's correlation between knowledge creation and knowledge utilization is 0.435, which equals to 0.466 after converted into Fisher's z'. Thus, at data size (N) of 209, the 99% confidence interval for correlation coefficient ranges from $0.466 \pm 2.58 * \frac{1}{\sqrt{N-3}}$, which is $(0.286 \quad 0.646)$. Converting back to r, the confidence interval is: $0.278 \leq \rho \leq 0.569$, ρ excludes 1.0. Hence, the constructs are discriminantly valid.

5.3 Hypotheses Test

This section includes the brief introduction of classic analysis procedures for fit as profile deviation and the detailed processes of current study.

5.3.1 Classic Analysis Tool for Fit as Profile Deviation

The classic analysis Tool for fit as profile deviation can be grouped into two categories, the method originated by Drazin and Van de Ven (Drazin and Van de Ven 1985; Van de Ven and Drazin 1985); and the method optimized by Venkatraman (Venkatraman and Prescott 1990).

Analysis Tool Represented by Drazin and Van de Ven (Drazin and Van de Ven 1985; Van de Ven and Drazin 1985)

The premier procedures for fit as profile deviation were developed by study by Drazin and Van de Ven (Drazin and Van de Ven 1985; Van de Ven and Drazin 1985), which composes of three basic steps.

First the sample was divided into certain number of subgroups according to the task-representation variables. In our study, the subgroups will be internal- and external-sourced innovations.

Second, the cases with high scores in performing variables of each subgroup were identified as ideal profile and the mean scores of problem-solving variables in ideal

profile sample were calculated. The ideal profile serves as a benchmark for calibrating the problem-solving variables. For example the problem-solving variables could be the unit structure and unit process (Drazin and Van de Ven 1985), standardized unit design (Gresov 1989), vertical coordination and horizontal coordination (Nidumolu 1996), internal integration, user participation and formal planning (Barki, Rivard et al. 2001), and K-Creation and K-Utilization in current study. T-test or ANOVA was used to ensure the statistical differences among mean values.

Third, the Euclidean distance scores were calculated between the remaining units and ideal profiles for each group. Fit was then determined by the correlation between distance score and performance variable.

Analysis Tool Optimized by Venkatraman (Venkatraman and Prescott 1990)

Based on fundamental analysis manner of fit as profile deviation, Venkatraman (Venkatraman and Prescott 1990) consummated method by adding two distinguished features.

First, before calculating the mean values of the strategy variables for the ideal profile, which are problem-solving variables in his case, an OLS regression was processed to identify the weight of each strategy variable. Only the variables having strong relationships with performance variables were kept in the study sample and used for coalignment measurement. Those variables which were eliminated through OLS

regression consisted of a BASELINE sample. Hence the study sample and BASELINE sample have same dataset expect they split the original strategic variables. After determining the coalignment for the study sample, the exactly identical steps of testing fit were repeated by using BASELINE sample. Theoretically, the deviation from ideal profile of BASELINE sample shouldn't have significant effect on performance and the correlation between performance and BASELINE should be zero. Finally, the two sets of correlations were compared with t-test. The correlations of study sample would be significantly stronger than the correlation of BASELINE sample because the strategic variables in study sample were more theoretically related and important to performance variable. In brief, the result from study sample provides necessary condition to the conclusion, while result from BASELINE sample strengthens the conclusion by adding sufficient condition.

Second, Venkatraman (Venkatraman and Prescott 1990) repeated the entire testing steps by using a replication sample from different time period. The cross-sectional test enhanced the stability and robustness of the findings.

Albeit Venkatraman's (Venkatraman and Prescott 1990) method was more convincing and reliable, its prolix steps and stringent requirement of sample size deterred many researchers to adopt it. Likewise current research used the simply profile deviation analysis tool represented by Drazin and Van de Ven (Drazin and Van de Ven 1985; Van de Ven and Drazin 1985).

5.3.2 Testing Hypotheses

As described in previous chapter, present paper defined fit as a theoretical deviation from the "ideal profile" or the "best practices". In other words, the shorter the distance between a project's profile and the calibration sample is, the higher the effectiveness of innovation will be. A Euclidean distance score is employed to get the deviations from an ideal system, which indeed is the degree of fit. In the final step, the correlation between fit and performance is calculated. Negative and significant correlation indicates establishment of contingency relationship, since the smaller the deviation to the ideal practices is, the higher effectiveness of the performance will be and vice verse. The study analyzed the two innovation pattern systems and accounted for both K-Creation and K-Utilization as a set.

To test hypotheses, the analysis technique employed by Drazin (Drazin and Van de Ven 1985), Gresov (Gresov 1989), and Barki (Barki, Rivard et al. 2001) was imitated. Certain modifications were made at the first step because in present research, one antecedent variable innovation type needed to be classified to form a nuclei of clusters finally, not just stratification.

First the sample was divided into two groups according to the construct of innovation typology—the internal-sourced innovation and external-sourced innovation. A nonhierarchical cluster technique is required since the clusters grouped here are items, rather than variables. With the contexts that retained from factor analysis, all the cases were expected to be assigned into two clusters. K-Means method is one of the

more popular nonhierarchical procedures. It assumes that the number of clusters is specified in advance, and it uses the algorithms classifying each item to the cluster having the nearest centroid (mean). The cluster membership was saved during classification. In this analysis, "cluster 1" represents external-sourced innovation, because five-point signifies the high extent of explicitness, autonomy and simplicity (Appendix 21), which are the three distinguished quality of external-sourced innovation. There were 88 cases of external-sourced innovation. Naturally the remaining 121 cases were internal-sourced innovations, belonging to cluster 2.

Table 10 Innovation Classifications

Number of Cases in each Cluster

Cluster	1	88.000
	2	121.000
Valid		209.000
Missing		.000

Second, another classification was processed based on innovation performance measure. The observations with highest performing score on this item were identified as high effective and labeled as Cluster 1; all the remaining observations were combined into low effective category Cluster 2.

The two performance dimensions combining with two types of innovations resulted in four sub-groups (See Table 11). Appendix 22 describes the frequencies and percentages of the each group.

Table 11 Innovation/Effective Sub-Groups (2 sources * 2 effectiveness)

Group Number	Innovation Type		Level of Performance		Number of cases
	Cluster #	Group Quality	Cluster #	Group Quality	
1	1	External-sourced	1	Low effective	60
2	1	External-sourced	2	High effective	28
3	2	Internal-sourced	1	Low effective	74
4	2	Internal-sourced	2	High effective	47

Third, high-performance sub-groups were selected to be the calibrations of ideal profile. Ideal profile is a system of KM structure that satisfies the corresponding innovation diversification task requirements, which finally leads to a high effective performance. Since there is an absence of standard score for KM system, we used empirical data to generate calibration score. Two ideal groups were external-sourced innovation/high effectiveness and internal-sourced innovation/high effectiveness. Empirically derived ideal knowledge management profile for a given innovation type was calculated by taking the mean values of the both K-Creation and K-Utilization for the corresponding high effective innovations. For each group, an independent-samples t-Test was used to calculate the mean values and to help determine whether or not the two calibration ideal profile groups had the same K-Creation and K-Utilization populations.

Figure 3 shows the results of third step with the scores of K-Creation and K-Utilization in the high effective projects under the condition of external-sourced and internal-sourced innovation, which are group 2 and group 4 respectively. In the table "Independent Samples Test" (Appendix 23), since the "Sig." value of "Levene's Test for Equality of Variances" is greater than .05, we used the "Equal variances assumed"

row. The t-statistics for variables kc (K-Creation) and ku (K-Utilization) were all significant (kc: t = 6.173, df = 73, ρ < 0.000; ku: t = 2.864, df = 73, ρ < 0.01) (Appendix 23), which means for both K-Creation and K-Utilization, group 2 and group 4 have the statistically significant different practices.

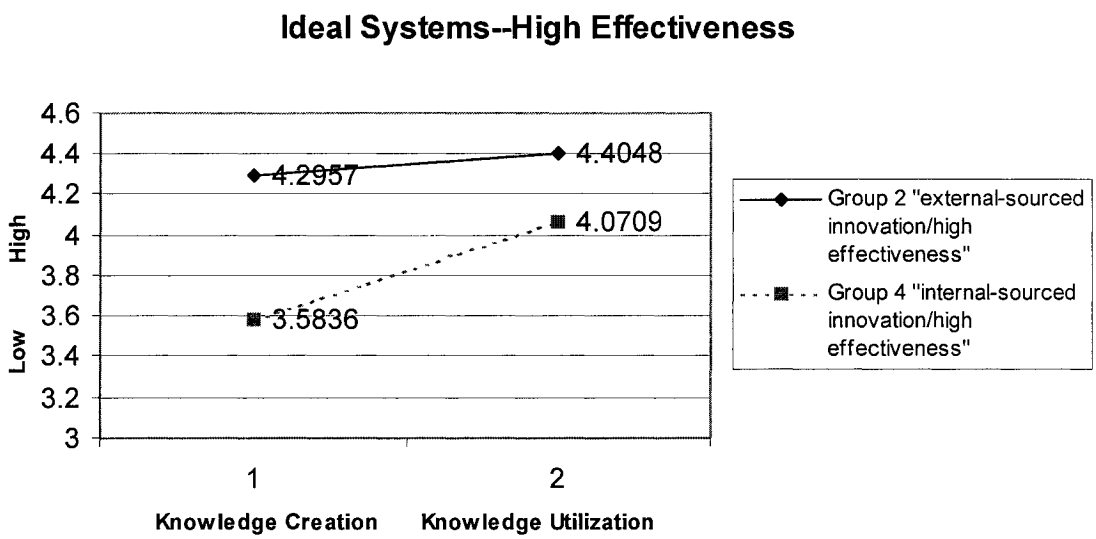

Figure 3 Ideal Systems of High Effectiveness for Internal-/External-sourced Innovations

The comparison between two groups also showed that derived values matched one of the predicted ordinal relationships—the hypothesis 2, namely that the external-sourced innovations have higher mean value of K-Utilization (mean=4.4048) compared with internal-sourced innovations (mean=4.0709). Hypothesis 1 wasn't supposed by the mean value of K-Creations. Contrary to the original hypothesis that internal-sourced innovations were supposed to have higher level of knowledge creation actives than external sourced innovation to reach the high effectiveness, the mean value of K-Creation for internal-sourced innovations was 3.5836, while for

external sourced innovations was 4.3957. Further analysis and information were still required for both hypotheses.

Forth, the deviations to the ideal system were computed by taking the Euclidean distance matrix. By using deviation score, an absolute difference between the standardized scores of two processes was calculated which indicates a lack of fit (Venkatraman 1989). The calculation was between two knowledge management dimensions of a given project to the two coordination scores of the corresponding ideal project, based on their innovation classification. Similar to prior researches, the high effective projects were excluded from the deviation computation; in other words, only data from group 1 and group 3 were used in this analysis. The Euclidean distance was computed as follows:

$$DIST_j = SQRT(SUM(X_{is} - X_{js})^2)$$

Where $DIST_j$ is the deviation from the ideal system for performance measure of the jth given project. X_{is} is the score of the idea system on the sth dimension and X_{js} is the score of the jth project on the sth dimension. For example, within group 1"external-sourced innovation/low effectiveness", the project j's distance score was calculated as:

$$DIST_j = SQRT[(4.2957 - KC_j)^2 + (4.4048 - KU_j)^2]$$

Similarly, the distance for the jth project within group 3 "internal-sourced innovation/low effectiveness" was:

$$DIST_j = SQRT[(3.5836 - KC_j)^2 + (4.0709 - KU_j)^2]$$

Fifth, the distance score matrix was correlated with their actual performance score—innovation effectiveness. As explained in the beginning of this section, to support the hypotheses, the correlation value should be significantly negative, which means the greater the distance from the ideal type, the lower the effectiveness of the innovation.

Table 12 Correlations of Distances (Excluding High Effective Innovations)

Distance	All Dimensions		Knowledge Creation		Knowledge Utilization	
	Correlation	Sig.	Correlation	Sig.	Correlation	Sig.
All Innovations	-0.004	.964	-0.017	.844	-0.029	.737
Innovation typology						
External Sourced	-0.208	.111	-0.205	.116	-0.217*	.096
Internal Sourced	0.151	.199	0.165	.160	0.090	.445
$\rho < .10$						

The results of the analysis are shown in the Table 12 (Detailed information See Appendix 24). Ignoring the innovation types, the correlations for both KM dimensions, dimension of K-Creation and K-Utilization were all negative, but none of them was significant ($\rho = 0.10$ level). It suggests a lack of support for general idea of coalignment in the innovation KM situation. Detailed conditions, such as the innovation classification in current case, should be taken into account for further analysis.

Under conditions of external-sourced innovation, the correlations with all two KM dimensions or either dimension were negative. Among these correlations, one deviation of K-Utilization was significantly (correlation=-0.217, ρ=0.10 level) correlated with ideal system, which partially supported the Hypothesis 2. Specifically

there is a negative significant correlation between the external-sourced projects and ideal profile in K-Utilization system.

For the internal-sourced innovations, all the correlations were positive and non-significant, indicating a lack of support for Hypothesis 1.

VI Discussion

This section includes elaboration of the findings, conclusion, both academic and practical implications, limitations, and the future studies.

6.1 Findings

Findings discuss the results of the hypotheses tests.

6.1.1 Fit between Internal-Sourced Innovation Type and K-Creation Process

The results indicate that alignment between internal-sourced innovation and ideal K-Creation process did not significantly boost the innovation performance. Additional analyses were conducted to study what kind of KM processes would have positive influence on the effectiveness of internal-sourced innovation. Similar deviations were calculated when both KM processes' scores exceed values of the ideal profile. The

correlation was positive but non-significant (0.279, p=0.592), again confirming that no obvious relationship was observed between internal-sourced innovations and KM processes.

The analysis (Figure 3 Ideal System—High Effectiveness) from previous section reveal that for internal-sourced innovations, the ideal system score of K-Creation was not only lower than the corresponding dimension of external sourced innovation, but also lower than K-Utilization in the same innovation classification. In other words, K-Creation is less utilized within internal-sourced innovation than K-Utilization. Lack of support for a contingency relationship hypothesis between internal-sourced innovatiosn and K-Creation in this study corroborates Sabherwal's (Sabherwal and Becerra-Fernandez 2003) recent finding that both K-Creation processes—socialization and externalization, do not play important roles in KM at organization level. Sabherwal (Sabherwal and Becerra-Fernandez 2003) explained that it's not because people don't pay enough attention on the importance of socialization and externalization, but because of the restrictive ranges that these K-Creation processes could be used in, especially socialization. People need novel alternative methods to improve the speed, scale and quality of mentoring between new employees and assigned mentors. Second, a plausible explanation could be given to this unsupported hypothesis. Although internal-soured innovation uses more tacit, systemic and complex knowledge, it doesn't mean all the knowledge should be original and be created instantly. It still could use existing knowledge without much new stuff, but in a genetic or peculiar way of usage. Through this direction, combination helps

internal-sourced innovation better employ the current resources by careful and complete exploitation of existing knowledge, and internalization digests the knowledge into tacit; and meanwhile, makes utilization of knowledge more effective.

Glisby (Glisby and Holden 2003) analyzed that the less significance of socialization and externalization in organization could be due to Nonaka's ignorance of cultural embeddedness—an important influential factor in model utilization. As one of the most developed countries, Japan has its unique commercial and organizational culture which both stimulate the prevalence of K-Creation processes and K-Utilization processes in its organizations, especially K-Creation processes. For example, the traditional seniority priority that links promotion and payment to seniority improves senior employees and experts' willingness of sharing tacit knowledge with others or being newcomers' mentors. But to the organizations without Japanese culture, since there is no open system to guarantee the welfare of senior employees or experts, mentorship and apprenticeship could be too luxury to afford. First, mentoring novices to be journeymen or experts takes considerable resources, long time and continuity. Senior employees or experts would be reluctant to share their own business time with others. Moreover, during this tedious progress, once the apprentices change new employer, it's hard to estimate the loss. Second, using experts to train the novices means experts have to spare time from the intensive organizational practices for the new comers to mentor them. Third, mentorship needs strong sympathy between experts and protégés. Experts need know how to be a good mentor, protégés have to equip the sufficient basic knowledge and strong mental quality to accept the prestige

of mentor and encounter frustrates (Swap, Leonard et al. 2001). These misgivings all possibly reduce the prevalence of socialization and externalization in innovation development.

6.1.2 Fit between External-Sourced Innovation Type and K-Utilization Process

The support for that the fit between external-sourced innovation and K-Utilization process will improve the effectiveness of innovation partially answers our research question that the compatibility between knowledge manipulating activities and the type of knowledge associated with innovation could affect the success of the innovation process. According to the result, failure of achieving alignment between external-sourced innovation and K-Utilization would reduce the effectiveness of innovation.

Backing to the survey questionnaire, the question remained in the data analysis disclosed the three ways that companies using K-Utilization to enhance their chance of successfulness of innovation. The three activities are (1) well utilize company's information repositories, such as the documented best practices, lessons learned from previous work experiences, and so on; (2) on-the-job-training; (3) learning-by-doing. The fact revealed in this study is that the companies with successful contingency relationship between external-sourced innovation and K-Utilization processes are more likely to achieve success in innovation projects. The finding of K-Utilization benefits is consistent with some of previous studies about innovation. For example, organizations need to ensure a productive exploitation of existing knowledge to

maintain a competitive edge or to manage innovation (Levinthal and March 1993; Drejer 2002); creation of knowledge through codified business practices was positively related to the product innovation (Landry and Amara 2001). Based on this study, it seems that to make external-sourced innovation more effective, improving K-Utilization processes are one of the organizational management strategies that companies can leverage to benefit from.

K-Utilization process contains two themes—Combination and Internalization. Intranet, coupled with other documentary software such as IBM Knowledge X and Microsoft Office are considered as the most pervasive tools for combination. In the study by Persaud (Persaud, Kumar et al. 2001), 90% R&D respondents confirmed that they could not reach wide-ranging knowledge sharing without internal information repositories. Through their companies' intranets, these respondents "learned of ongoing and new projects in which they can participate, disseminate the results of their research activities, and profile their labs (Persaud, Kumar et al. 2001)." The timely information from intranet raised their visibility of external word and gave them more chance to copy and study from peer colleagues. In conclusion, to external-sourced innovations, combination cumulates and shares already-existing resources, exerts the values of explicit knowledge, rearranges and systematizes it from several different strands and turns it into systematic way instead of staying autonomous. Through this way, combination helps organizations dig the hidden or potential crucial information, and assists them in making novel synthesis of knowledge. These actions make the organizations get acquaintance to the existing

knowledge; therefore, they could be much sensitive to information about changes in either marketplace or technology area, and hence they have chance to improve their reaction speed and quality.

Likewise, internalization helps organizations utilize the existing codified knowledge. Preliminary throughout traditional learning and didactics, internalization helps digest the codified knowledge and turn them into tacit, and thus support organizations to learn from competitors' strong points so as to offset their own weaknesses. The main tools of internalization—learning-by-doing and learning-by-observing are especially recommended by Swap (Swap, Leonard et al. 2001) because learning-by-doing is a crucial way to develop expertise and enhance ability to recognize patterns while learning-by-observing happens when employees immerse in an organizational culture they value and then they learn through observing expert's behavior. Swam (Swap, Leonard et al. 2001) emphasized that these conscious actives make learning becoming part of organizational culture.

In brief, because combination helps employees diffuse and carefully study already-exist knowledge and lead them to learn how to utilize existing knowledge resources to find answers themselves, plus internalization spurs the employees initiative learning behavior and foster organizational learning culture, K-Utilization processes stimulate employees fighting will in innovation development, improve their abilities of observation, fast learning, independence, self-improvement and surviving in the

unstable competitive environment. All these factors positively control the external-sourced innovations developing in a promising way.

Same as internal-sourced innovation, among the external-sourced innovation, K-Creation showed a smaller ideal-system value than K-Utilization, and no significant relationship exists between K-Creation and innovation, which again corresponds to the previous studies that both K-Creation processes, socialization and externalization were less used in organizational level management (Becerra-Fernandez and Sabherwal 2001; Sabherwal and Becerra-Fernandez 2003).

6.1.3 Summary of Findings

The consistence with Hypothesis 2 and less consistence with Hypothesis 1 don't indicate that it's possible to disregard K-Creation processes. Albeit its lower intensity, K-Creation processes were still evident in innovation management. In present study, up-than-neutral level scores of K-Creation and K-Utilization for ideal profiles of both internal-sourced and external-sourced innovation in data analysis implies that all processes in Nonaka's K-Creation and Utilization models are important to the organizational innovation management. Organization is an entity that is capable of learning on a collective basis (Hutchins 1991). In standpoint of viewing organizations as culture entities, the four knowledge movement patterns are equally necessary in organizational learning (Dyck, Starke et al. 2005). Dyck (Dyck 2002) suggested that with reduced resources spending on socialization, long-term organizational learning and effectiveness would be hampered. That means only joint

power of K-Creation and K-Utilization can create the organizational culture for high effective innovations, overrating K-Utilization processes would deteriorate the health environment for internal competition. Specifically, it could possibly lead to malignancy competition, such as internal scheme and plot, and undermine the willing and communities of sharing tacit knowledge or mentoring new comers. In this situation, the gulf between employees will be enlarged, which leads companies to lose their organizational culture. Finally the organizations will lose their long-term competitive advantages in innovation as well as in industry.

The finding of present and prior studies also reinforced the correct choice of applying contingency model in proposing the hypotheses. In current research, the contingency model is labeled as "matching" or "fit" which could be theoretically interpreted as that there is a value of structure for each kind of innovation that will maximize effectiveness. Applying the summary in present finding, the well-established K-Creation processes plus well-established K-Utilization processes with comparatively more emphasis on K-Utilization is a right structure for enhancing the effectiveness of external-sourced innovations.

6.2 Conclusion

The objective of the present study was to test the general hypothesis that innovation effectiveness is influenced by Fit as profile deviation, defined as the compatibility between knowledge manipulation activities and the corresponding knowledge associated innovation. To address the question, we drew up Nonaka's (Nonaka and

Takeuchi 1995) K-Creation and Utilization model which includes four knowledge movement patterns—socialization, externalization, combination and internalization. The four patternss were identified as two major knowledge manipulation processes—K-Creation and K-Utilization. New typology of innovation proposed by (Gopalakrishnan and Bierly 2001) was adopted to classify innovation tasks into internal-sourced innovations and external-sourced innovations. Also an empirical measure was designed and executed to evaluate the respective contingence extent. Based on contingency framework and cognitive fit, a research model was proposed as the fits between problem-solving task and problem representation will improve the innovation successfulness, be specific, the fit between internal-sourced innovation and K-Creation (H1), and fit between external-sourced innovation and K-Utilization (H2). The findings suggest the external-sourced innovation projects need to achieve the fit as so to improve the innovation effectiveness.

6.3 Contributions of Study

Contributions of present study include academic implications and managerial implications.

6.3.1 Academic Implication

Given the novelty of knowledge management and the paucity of empirical researches focused on innovation, this research contributes to existing knowledge in several ways.

The current research adds theoretical and practical understanding of KM values in innovation adaptation. The findings reveal that there is a fit relationship existing between external-sourced innovation and K-Utilization. Corresponding with other prior KM studies on innovation, this result replicated the implication of importance role of K-Manipulation activities as one of the problem-solving representation in the innovation development. To certain extent, the established fit relationship found in this study filled the gap identified in the previous reviewed research.

One of the significance of this study is that it used a new innovation typology, i.e., internal-sourced innovation and external-sourced innovation, and employed the evaluation method implied by Gopalakrishnan (Gopalakrishnan and Bierly 2001). The new classification and measurement haven't been widely used in the in the MIS field. The result confirmed the practical relevance of such choice. The survey

indicates that chance of external-sourced or internal-sourced innovation was half-split.

The study also measured the K-Manipulation activates through empirical test. The questionnaire was developed by combining and modifying three important KM studies which in the same way employed K-Creation and Utilization model representing basic KM activities; hence it's an extension of previous research.

6.3.2 Managerial Implication

This study offers practitioners an overview of how companies could improve the innovation effectiveness through KM. Specific analysis and discussion focuses on the influence of compatibility between innovation type and K-Manipulation.

Organizations are suggested to evaluate their internal knowledge resource and possible features of in-coming innovation so as to decide the innovation type. Corresponding K-Manipulation actions should be emphasized during the innovation development. During the innovation development, it's useful to observe and analyze their organizational KM practices in order to find out potential areas for improvement. One lesson learned from this study is that compatibility of K-Utilization processes with external-sourced innovation can stimulate innovation's success. Differentiated from K-Creation, K-Utilization processes more stress on explicit knowledge. Throughout combination and internalization, K-Utilization exerts the values of codified knowledge and expands the restrains of traditional unitary

knowledge combination by turning knowledge from autonomous into systematic. To achieve effective K-Utilization, an effective knowledge infrastructure needs to be developed in order to maintain the healthy balance between problem orientation and problem-solving skill, and meanwhile, on-the-job training and learning-by-doing also need to be stressed.

Drucker (Drucker 1985) concluded that Knowledge–based innovations is distinguished from all others because of the time they take, their capriciousness, and the predictability, as well as posed challenges to the entrepreneurs. It depends on market-oriented more than other history-making innovations. Knowledge creation goes forward one by one. New knowledge is always built on preceding knowledge, and usually overlaps with prior knowledge. Thus, a comprehensive understanding of existing knowledge can effectively improve innovation's success. Besides, it's obvious that absorbing codified knowledge is faster and more efficiency than learning tacit knowledge. These facts make K-Utilization become more special than K-Creation in innovation projects.

There is no relationship observed between both innovation and K-Creation, it suggests that for the organizations with restrictive budget or tight schedule, it's plausible for them to strengthen the key activities that improve certain innovation performance, and transfer available resources to core competency.

6.4 Limitations

This section outlines some limitations that are needed to be overcome in future studies.

Although there were 209 pieces of data in the hypothesis analysis, the data were subdivided into four groups, and the actual number of respondents was only 55. The ideal sample should be enlarged to achieve more robust conclusion.

Second, there was paucity of empirical research about innovation and fewer about the effectiveness of innovation. Summarizing the limited prior available studies, a single-item performance scale was adopted to evaluate innovation effectiveness, which could have many downfalls. Withal, the study uses respondents' perception as proxy measures for realized effectiveness measurement of innovation. The legitimacy of perceptual measures is open to debate because of possibility of different evaluation criterions the respondents have. Although no standard innovation measure was established, a more objective assessment can be used to provide support to the conclusion.

Third, the measure of innovation typology was inferred from study by Gopalakrishnan (Gopalakrishnan and Bierly 2001), no other study repeated or imitated the similar constructs. The absence of multiple samples to confirm the measurement model might reduce the reliability and validity of the study, and could make the hypothesis test results tentative.

Similarly, measure of K-Creation and Utilization model was modified from several prior studies. Although these studies have strong reliability and validity which made constructs in current test strong in construct validity, many variables in data analysis showed relatively low reliability coefficient, or some reliability coefficient was even a tad insufficient adequate.

Very possible, there are many other variables which could also have significant influence on the innovation performance; however in survey-based fieldwork, it's hard and impossible to control many other factors. For example, Sorensen (Sorensen and Stuart 2000) showed that organizational age has significant positive effect on the organizational innovations. Such limitations are inherent in the multiple analysis of this study.

6.5 Future Research Directions

Although the results of present study provide interesting insights for KM impacts on innovation, a number of important issues do emerge and these can serve as a framework for future research in this area.

First, as described in limitation section, the reliability coefficients for K-Creation and Utilization constructs were low; efforts are needed to gain refinement for the measure of these variables.

Second, as a distinguish part in innovation research, study on innovation phases is worth further effort to recognize the influence of different KM processes in different development phases.

Third, four banking programs were identified as innovations based on the fact that they were the most popular and newest one in recent 10 years, and they have generalities around the worldwide banks. According to the literature review, besides the source typology, innovation could also be classified as product vs. process, or technical vs. administrative. Some prior researches have demonstrated the importance of distinguishing different types. The four innovations in present study all belongs to technical or product innovation. The existence of empirically distinguishable categories of innovations and their associated models call for additional studies by using different typology or diverse innovations, for example, the innovation of organizational internal-process, or new services other than pure technology product.

Although banking is considered as one of the most potent knowledge-based innovation area, it's not a guarantee that the result of present study can be generalized to all industries. Various industries or difference across industries could be considered in future research.

Repeating prior citations, Glisby's (Glisby and Holden 2003) critique indicated that Nonaka's model should be used in flexible way instead of be copied mechanically in disregard of specific conditions, so new methods of spreading tacit knowledge should

be discovered to exert the advantages of K-Creation (Sabherwal and Becerra-Fernandez 2003), for example, using peer assists or assigning employees with more proximate experiences as mentors to transfer tacit knowledge. (Swap, Leonard et al. 2001; Talisayon 2001), using externalization (tacit-to-explicit) to surface the error and using Internalization (explicit-to-tacit) to learn a new or correct skill (Dyck, Starke et al. 2005). Continuing development new KM tools for each process and exploit their influences on innovation deserve deeper and further studies.

In our study, no obvious relationship was discovered between K-Creation and innovation. It doesn't mean that K-Creation plays a subordinate role in innovation development. In fact, it implied that K-Creation processes might have more intricate relationship with innovation. Future study should attempt to put more effort on the effects of K-Creation processes on the innovation for developing a richer understanding. Landry (Landry and Amara 2001) implicated that the relation between innovation and KM might be more complex than suggested by studies taking innovations as their dependent variable.

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Appendix

Appendix 1 First Phase Questionnaire Pre-test Report

First Phase Pre-test Report

To conduct the pre-test, I visited about 20 branches of 7 the commercial banks in Montreal, including TD CanadaTrust, CIBC, Royal Bank, Montreal Bank, National Bank, Nova Scotia Bank, and Bank Laurentian. Half branches refused me. Those who accepted my interview were very friendly and helpful.

Problems

1. Innovation Definition

It's necessary to modify the definition by emphasis that innovation is a change. Innovation means adoption of new service or new products provided to customers, or new internal process facing to employee. It could be any new change to the bank that aims to improve the customer satisfaction, competition competency or efficiency of organization.

2. Name 10 Innovations

Most interviewees can only think about 5 innovations maximum during the interviewing, probably because of their qualifications or working years, some of them only worked for one year. It also might due to their reflection ability in short period. Branch managers should be the best respondents of the questionnaire; regrettably, most of them refused my interview because of their high volume work. The result shows that young financial representatives are the friendliest group who would accept my request.

3. Personal Information

All questions about Personal Information are acceptable by all the respondents. They don't mind to fill in their age, length of work, education and other sensitive items. It's

better to list the option of the highest education level, specifying University level, College, or High School.

4. Bank Information

First, all the words "bank" should be replaced by "branch". It's natural that all the respondents only familiar with the present branch instead of the whole organization. Although we only list 3 questions about bank, most people can only answer the first one—the number of employees in the branch. Nearly nobody is aware of the annual revenue of the bank, neither the information about IS workers. According the survey, many banks outsourced the IS power instead of develop the homegrown IS department. For example, both TD bank and Scotia bank signed the contract with IBM Company to get the Information Systems support. Besides, all the IT or IS departments are in the higher level of bank organization, in other word they are in the headquarters, not in the branches.

Recommendation

1. Bank Selection

According to the pre-test result, most banks adopted similar innovations in banking product or services. This point is also testified by the comparison of official websites of those banks. But for each large product category, there are wide range of detailed options, which vary from one bank to another, bundled with different restrictions and conditions. So, to select the right bank and to improve the reliability and validity of the study, we can

a. Focus on one certain bank by specifying the detailed products. It's has been assured that all the branches of TD bank provide the identical services all over the country. Or,

b. Select several banks by only addressing the big product categories.

The research method (Gopalakrishnan and Bierly 2001) that we simulate conducted the survey among the diverse range of banks. One reason is because the banking system of US is different from Canada. The researchers have to include all the banks in order to accumulate the enough data because in US, few bank organizations are able to compete in the size with those of domestic banks in Canada. Another reason is the minuscule difference between innovations won't generate big bias or affect research reliability. The researchers believed that grouping together innovations by specific types enables them to draw meaningful conclusion about each type (Gopalakrishnan and Bierly 2001). Similarly, the tiny distinction product group among the different banks won't bias our conclusion; more ever, to enlarge the range of banks will improve the volume of data. Montreal Bank can be counted out of survey because there is an internal formal condition which restricts the employees to accept the external surveys.

2. Product or Service Selection

All of the research respondents are in the position of Financial Representative or Branch Manager, that means they only familiar with certain kinds of product or services. Naturally, it's more reasonable to restrict our questionnaire into several products by excluding non-frequent used services such as International Services.

3. Formation of Questionnaire

It's difficult for most interviewees to name 10 top innovations without any preparation or clues. And most of all, even if they fill up all ten spaces, not all the answers are correct and reliable. According to this point, it'd better be us who initiate the innovation selection ranges. Since most banks experienced similar innovations, the first part of questionnaire can be re-structured into the form of option. We list the several innovation options, and let bankers circle out the newest and most prevalent ones. The list of innovation can be draw from the websites of banks.

Innovation Effectiveness Survey—Phase I

Section 1/2 Bank Innovation

Innovation means adoption and exploitation of new products, new services, new processes, or new organizational setups in your bank.

I. Please indicate for how many years the following innovations have been introduced in your bank. The working definition of each innovation is included between parentheses.

Name of Innovation	1-2 years	3-4 years	5-6 years	7-8 years	9-10 years	> 10 years	Not Available
1. **Electronic Billing and Payment** (Receiving bills and other statements electronically, for example: *webdox*)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 Years ☐	N/A ☐
2. **Electronic Fund Transfer (EFT)** (An electronic debit or credit transaction from any designed account to other accounts initiated through electronic means, i.e., phone, computer network)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐
3. **Electronic Data Interchange (EDI)** (A computerized system that allows linked computers to conduct business transactions (i.e., invoicing, ordering) over a telecommunications network)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐
4. **Online Shopping** (A site hosted by your bank where list a wide selection of links for goods and services)	1-2 years ☐	3-4 Years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐
5. **Mobile Banking** (Using Internet-enabled mobile services such as phones, PDAs or Palms to deal the bank issues)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐
6. **Payroll Services** (A variety of payroll and Human Resources Management product for business customers by phone, PC input or through the Internet)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐
7. **Online Tax Filing & Payment System** (Pay and file business taxes online)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐
8. **International Trade Finance** (Variety specialized international trade service for both importer and exporter, removing the inherent obstacles in international trade, for example letter of credit and document collections)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐
9. **Smart Card (Prepaid Card)** (A plastic card, with an embedded computer chip, that can perform financial functions (e.g., credit card, debit card, or prepaid card) as well as other non-financial functions (e.g., a repository for medical information, for insurance records))	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐

10. **ABM and Branch Locator** (Find the nearest bank branch, ABM, Investment counsel or other services through Internet)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐
11. **Electronic Reporting** (Use technology to its fullest to access information, initiate business transactions, make payments, etc in terms of various option either via fax, PC, or Internet)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐
12. **Account Reconciliation** (Monitoring the issued cheques with positive pay to reduce the risk of cheque fraud)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐
13. **Private Banking** (A providing of banking services to very wealthy individuals and families to help them achieve their long-term financial objectives and needs)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐
14. **Online Invest (Online Brokerage, Electronic Brokerage System)** (Invest through Internet, PC or wireless devices)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐
15. **Electronic Money (Electronic Cash; e-Money; e-Cash; Digital Cash)** (A payment instrument in which monetary value is stored in electronic form)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐
16. **Electronic Purse (Electronic Wallet)** (A prepaid card that stores prepaid monetary value on an embedded computer chip)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐
17. **Check Imaging Processing** (Utilize the digital images of various documents to achive and interact with account processing)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐
18. **Telephone Banking** (A 7-24 service that allows customers to access account to carry out general transactions by touch-tone telephone)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐
19. ***Interac* Email Money Transfer** (Sending money directly from your bank account to anyone with an email address)	1-2 years ☐	3-4 years ☐	5-6 years ☐	7-8 years ☐	9-10 years ☐	>10 years ☐	N/A ☐

II. If there are other important innovations in your bank that are not included in the above list, please add and briefly explain them in the follow boxes.

Additional Innovation 1	
Additional Innovation 2	
Additional Innovation 3	
Additional Innovation 4	
Additional Innovation 5	

Section 2/2 Background Information

This information will be used for demographic analysis only. Your responses will be remained confidential strictly.

Bank Information			
In which country or region are you mainly working?	*Please Choose one:* Canada ☐ France ☐ Hong Kong ☐ P.R. China ☐ Switzerland ☐ U.S.A. ☐ *Other (Please specify):* _____		
How many employees work for your bank or your branch?	_____		
Personal Information			
What is your current job title?	_____		
How many years have you been working for your current bank or branch?	_____ years		
How many years have you occupied this position?	_____ years		
What is the title of the person in your bank or branch that you directly report to?			
What is your highest accomplished education level?	_____		
Which field your highest accomplished education level is?	_____		
Gender	M☐	F ☐	
Age	<20 ☐	21-30 ☐	31-40 ☐
	41-50 ☐	51-60 ☐	>60 ☐

To receive a personalized report please enter you email address.

Email: _____

Thank You

Thank you for taking the time to complete my questionnaires. Please be assured that the information you have provided will be kept strictly confidential.

The data is currently being analyzed and a personalized report will be sent to you around the end of this year.

If you have any comments or questions, please feel free to contact me.

Thank you again for your time and consideration.

Truly

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Appendix 3 First Phase Survey Data Collection Report & Reference

The First Phase Survey Data Collection

The first-phase data are taken from Canada, USA, P.R.China, and France, filed by commercial banks. All the holding companies meet two basic criteria for the banking research (Klein and Saidenberg 2000). First, they all have more than two commercial bank subsidiaries; and secondly, the subsidiaries spread more than more states or provinces.

Data Collection

The main purpose of this phase is to find some financial innovations that have become fully diffused, very prevalent, and still comparatively new around the world area, so we can utilize these items to develop new phase questionnaire for our final research purposes.

The questionnaire is designed through literature searching of the web-information of three top Canadian banks. This search generated 19 financial innovations, all of which are concerning around the banking product and services. New internal banking processes and new special policy preferential regulations were excluded in questionnaire because of their excruciating details and labyrinthine complexities. Besides, the variety of company process or government policy hinders us to find general criteria for later study. In the end, the 19 items were included into our questionnaire.

This period of data collection actually experienced two different versions of questionnaire. At first we adopted 5-year length as an innovation period. We believed that 5-year is longer enough to locate our objects; more important thing is, the research method that we duplicate from utilized the 2-year period, from 1982 to 1983. In-proceeding results showed that 5-year is relatively short for choosing popular financial innovations, because the paces of innovation adoption strategies are diverse among different banks, and among different countries. More than that, the bank industry services are considerately stable in recent 2-3 years; brand-new technologies are still under development stage. According to this situation, we enlarged the research duration from 5-year to 10-year. This change was too late to inform certain banks because either they have spread the questionnaire to employees or they have sent the answers back. Luckily, the modification doesn't affect our conclusion too much.

Table 12 is the survey result.

Data Analysis

Web-based survey, mailing survey, fax, and emails were chosen to collect the data required. 40 respondents sent their answers back. 18 responses were not included in the analysis because of the inferior response quality. Specifically, they have too many items omissions, many mistakes, or being paradox to the reality. Hence there were 21 valuable respondents remained, which came from 11 bank, 17 branches, and 3 countries. Among them, 7 responses came from Canada, 10 from China, 3 from France and 1 from USA.

According to the data, the diffusions of innovation in China are obviously tardier than in other countries. Most of Chinese banks adopted these innovations less than 4 year. So we can count these banks out in consideration of which innovation item would be used in next step. Because whatever we choose from these 19 items, they are all believed as new-introduced technologies in Chinese banks comparing with the same industry in other countries.

On the other hand, banks in USA are in lead position in innovation advocating and utilization. Most of financial innovations listed here have been spread out for over 5 years in US. As a result, banks in Canada and France play the chief decision role in item selection.

Conclusion

According to the table, **Electronic Billing and Payment**, **Electronic Fund Transfer(EFT)**, **Electronic Data (EDI)**, **Mobile Banking**, **Telephone Banking**, **Online Invest**, **Check Image**, **Online Payroll system**, and **Internet banking** are prevalent in both Canada and France, and they have experience less than 5 years in most banks. Simply saying, we can calls above services as financial innovation. All of selected items are electronic banking initiatives. The conclusion echoes the common believe that technology is tackling what is possibly the most universal challenge in every organization.

Testimony for above discovery is also available in banking journals or researches.

a. Electronic Billing and Payment (Havlik, 2001; Wilson 2002; Conference Summary 2002)

b. Online services, for example Online Payroll, Online Invest (Havlik, 2001; Wilson 2002; Newell 2002; Krebsbach 2003)
c. Internet Banking (Wilson 2002; Conference Summary 2002)
d. Check Image (Wilson 2002; Anonymous A 2004)
e. Mobile Banking (Anonymous B 2003)

Although financial innovation has been a critical and persistent part of the economic landscape over the past few decades, some research of literature review show that there are very scarcities of these empirical studies of financial innovation (Conference Summary 2002). That means our studies would be very meaningful, for both bank administration and innovation management.

There is still one problem remaining—we cannot include all of these 9 items in next phase questionnaire. They would make our second-round questionnaire too longer to be acceptable by general respondents. We of cause have to keep enough questions due to validity reason, but if the questionnaire was long, respondent will answer it without carefulness or instinctively refuse to answer it, which on the other hand, against the validity consideration. It would be better that we keep the question items under 50-60, less than 5 pages, including background information.

Table 13 Result of First Phase Survey

Financial Innovation	1-2 years	3-4 years	5-6 years	7-8 years	9-10 years	>10 years	Not Available
1. Electronic Billing and Payment	7 (1CA, 6CN)	10 (3CA, 4CN, 3 FR)	3 (3CA)				
2. Electronic Fund Transfer (EFT)	8 (1CA, 7CN)	4 (2CA, 2CN)	2 (1CA, 1CN)		5 (2CA, 3FR)	1 (1CA)	
3. Electronic Data Interchange (EDI)*	4 (4CA)	7 (4CN, 3FR)	4 (3CA, 1CN)			2 (1CA, 1 CN)	2 (2CA)
4. Online Shopping	5 (5CN)	4 (4CN)	7 (3CA, 1CN, 3FR)	1 (1CA)			3(3CA)
5. Mobile Banking	6 (6CN)	4 (1CA, 3CN)	5 (5CA)		3 (3FR)		2 (1CA, 1CN)
6. Payroll Services	5(5CN)	1(1CN)	7 (1CA, 3CN, 3FR)	1(CA)	1 (1CA)	3 (3CA)	2(1CA, 1CN)
7. Online Tax Filing	9(9CN)	2(2CA)	1(1CN)	2 (2CA)		1(1CA)	5(2CA, 3FR)
8. International Trade Finance	9(1CA, 5CN, 3FR)		4(1CA, 3CN)		1(1CN)	4(3CA, 1 CN)	2(2CA)
9. Smart Card	5(5CN)	2(2CN)		2(2CN)		3(2CA, 1CN)	8(5CA, 3FR)
10. ABM and Branch Locator	10(7CN, 3FR)		1(1CA)	1(1CA)		5(4CA, 1CN)	3(1CA, 2CN)
11. Electronic Reporting	6(6CN)	4(1CA, 3CN)	2(1CA, 1CN)	1(CA)	2(2CA)	4(1CA, 3FR)	1(1CA)
12. Account Reconciliation	3(3CN)	6(3CA, 3CN)	2(2CN)		1(1CA)	6(2CA, 1CN, 3FR)	2(1CA, 1CN)
13. Private Banking	6(6CN)	3(3CN)	1(1CN)	1(1CA)	2(2CA)	6(2CA, 1CN, 3FR)	1(1CA)
14. Online Invest	4(4CN)	5(5CN)	2(2CA)	3(2CA, 1CN)	2(2CA)	4(1CA, 3FR)	
15. Electronic Money	9(6CN, 3FR)	3(3CN)	1(CA)		1(CN)		6(6CA)
16. Electronic Purse	4(4CN)	4(4CN)	2(1CA, 1CN)			1(1CN)	9(6CA, 3 FR)
17. Check Imaging	3CN 3FR	5(1CA, 4CN)	2(2CA)		1CA	1CA	5(2CA, 3CN)
18. Telephone Banking	5(5CN)	3(3CN)	2(2CN)	3(3CA)	2(2CA)		5(2CA, 3FR)
19. Interac Email Money Transfer	3(1CA, 2CN)	1(1CN)	6(3CA, 3CN)				10(3CA, 3CN,3FR)

Reference

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8. Wilson, C., "In Search of New Core Banking Alternatives", Bank Systems & Technology; Oct 2002; 39, 10; p.24

- Please just indicate your first impression. There are no good or bad answers.
- If the innovation doesn't exist in your bank, just skip the whole part of that section.
- Indicate your views by rating the statements using the scale provided as following. If the question doesn't apply to your organization, check "*Not Applicable—n/a*".

Strongly Disagree	*Disagree*	*Somewhat Agree*	*Agree*	*Strongly Agree*	*Not Applicable*
1	**2**	**3**	**4**	**5**	**n/a**

1. Electronic Billing and Payment (Receiving and paying bills and other statements electronically, for example vie email address.)

*About this innovation, **please indicate your view using the scale provided.***	*Strongly Disagree*	*Disagree*	*Somewhat Agree*	*Agree*	*Strongly Agree*	*Not Applicable*
1. This innovation meets the goals and objectives of the bank.	1	2	3	4	5	n/a
2. Manuals and documents accurately explain the implementation and operation of this innovation.	1	2	3	4	5	n/a
3. Educating and personnel training make this innovation a quick and easy job.	1	2	3	4	5	n/a
4. This innovation is independent of other products and services in bank.	1	2	3	4	5	n/a
5. Users of innovation need to be in contact with other departments within the bank to implement it effectively.	1	2	3	4	5	n/a
6. Knowledge about other systems within the bank is necessary to implement this innovation effectively.	1	2	3	4	5	n/a
7. This innovation is intellectually simple or easy to implement.	1	2	3	4	5	n/a
8. Apprenticeship and mentorship are used to share knowledge about this innovation.	1	2	3	4	5	n/a
9. Informal meetings are very useful in sharing knowledge about this innovation.	1	2	3	4	5	n/a
10. Employee rotation across different business areas is an effective way to learn more about this innovation.	1	2	3	4	5	n/a
11. In team discussion, each participant shares his/her work experiences of this innovation with others.	1	2	3	4	5	n/a
12. I often use examples to explain obscure aspects of this innovation.	1	2	3	4	5	n/a
13. Employees consider transcribing some of the unorganized thoughts about this innovation is helpful.	1	2	3	4	5	n/a
14. Employees tend to use analogy to illustrate obscure aspects of this innovation.	1	2	3	4	5	n/a
15. When others cannot express themselves clearly, colleagues usually help them clarifying their points.	1	2	3	4	5	n/a
16. With regard to solving the problems associated with the implementation	1	2	3	4	5	n/a

this innovation, I usually tend to use my experience and the experience of my colleagues.

17. Bank's information repositories, such as the documented best practices and lessons learned from previous work experiences provide a great help in solving the problems associated with the implementation this innovation.	1	2	3	4	5	n/a
18. On-the-job-training is essential in understanding the different aspects of this innovation.	1	2	3	4	5	n/a
19. Learning by doing is important to the successful adoption of this innovation.	1	2	3	4	5	n/a
20. Observing the others during work is helpful in understanding how this innovation works.	1	2	3	4	5	n/a

2. Electronic Funds Transfer/ Electronic Data Interchange (EFT/EDI)

About this innovation, ***please indicate your view using the scale provided.***	*Strongly Disagree*	*Disagree*	*Somewhat Agree*	*Agree*	*Strongly Agree*	*Not Applicable*
1. This innovation meets the goals and objectives of the bank.	1	2	3	4	5	n/a
2. Manuals and documents accurately explain the implementation and operation of this innovation.	1	2	3	4	5	n/a
3. Educating and personnel training make this innovation a quick and easy job.	1	2	3	4	5	n/a
4. This innovation is independent of other products and services in bank.	1	2	3	4	5	n/a
5. Users of innovation need to be in contact with other departments within the bank to implement it effectively.	1	2	3	4	5	n/a
6. Knowledge about other systems within the bank is necessary to implement this innovation effectively.	1	2	3	4	5	n/a
7. This innovation is intellectually simply or easy to implement.	1	2	3	4	5	n/a
8. Apprenticeship and mentorship are used to share knowledge about this innovation.	1	2	3	4	5	n/a
9. Informal meetings are very useful in sharing knowledge about this innovation.	1	2	3	4	5	n/a
10. Employee rotation across different business areas is an effective way to learn more about this innovation.	1	2	3	4	5	n/a
11. In team discussion, each participant shares his/her work experiences of this innovation with each other.	1	2	3	4	5	n/a
12. I often use examples to explain obscure aspects of this innovation.	1	2	3	4	5	n/a
13. Employees consider transcribing some of the unorganized thoughts about this innovation is helpful.	1	2	3	4	5	n/a
14. Employees tend to use analogy to illustrate obscure aspects of this innovation.	1	2	3	4	5	n/a

15. When others cannot express themselves clearly, colleagues usually help them clarifying their points.	1	2	3	4	5	n/a
16. With regard to solving the problems associated with the implementation this innovation, I usually tend to use my experience and the experience of my colleagues.	1	2	3	4	5	n/a
17. Bank's information repositories, such as the documented best practices and lessons learned from previous work experiences provide a great help in solving the problems associated with the implementation this innovation..	1	2	3	4	5	n/a
18. On-the-job-training is essential in understanding the different aspects of this innovation.	1	2	3	4	5	n/a
19. Learning by doing is important to the successful adoption of this innovation.	1	2	3	4	5	n/a
20. Observing the others during work is helpful in understanding how this innovation works.	1	2	3	4	5	n/a

3. Internet Banking (Online Banking, Online Payroll System, Online Invest, Mobile Banking etc.)

About this innovation, ***please indicate your view using the scale provided.***	*Strongly Disagree*	*Disagree*	*Somewhat Agree*	*Agree*	*Strongly Agree*	*Not Applicable*
1. This innovation meets the goals and objectives of the bank.	1	2	3	4	5	n/a
2. Manuals and documents accurately explain the implementation and operation of this innovation.	1	2	3	4	5	n/a
3. Educating and personnel training make this innovation a quick and easy job.	1	2	3	4	5	n/a
4. This innovation is independent of other products and services in bank.	1	2	3	4	5	n/a
5. Users of innovation need to be in contact with other departments within the bank to implement it effectively.	1	2	3	4	5	n/a
6. Knowledge about other systems within the bank is necessary to implement this innovation effectively.	1	2	3	4	5	n/a
7. This innovation is intellectually simply or easy to implement.	1	2	3	4	5	n/a
8. Apprenticeship and mentorship are used to share knowledge about this innovation.	1	2	3	4	5	n/a
9. Informal meetings are very useful in sharing knowledge about this innovation.	1	2	3	4	5	n/a
10. Employee rotation across different business areas is an effective way to learn more about this innovation.	1	2	3	4	5	n/a
11. In team discussion, each participant shares his/her work experiences of this innovation with each other.	1	2	3	4	5	n/a
12. I often use examples to explain obscure aspects of this innovation.	1	2	3	4	5	n/a
13. Employees consider transcribing some of the unorganized thoughts about	1	2	3	4	5	n/a

this innovation is helpful.

14. Employees tend to use analogy to illustrate obscure aspects of this innovation.	1	2	3	4	5	n/a
15. When others cannot express themselves clearly, colleagues usually help them clarifying their points.	1	2	3	4	5	n/a
16. With regard to solving the problems associated with the implementation this innovation, I usually tend to use my experience and the experience of my colleagues.	1	2	3	4	5	n/a
17. Bank's information repositories, such as the documented best practices and lessons learned from previous work experiences provide a great help in solving the problems associated with the implementation this innovation.	1	2	3	4	5	n/a
18. On-the-job-training is essential in understanding the different aspects of this innovation.	1	2	3	4	5	n/a
19. Learning by doing is important to the successful adoption of this innovation.	1	2	3	4	5	n/a
20. Observing the others during work is helpful in understanding how this innovation works.	1	2	3	4	5	n/a

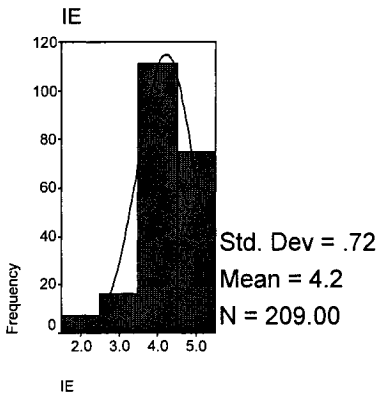
4. Check Imaging (Utilize the digital images of various documents to archive and interact with account processing.)

*About this innovation, **please indicate your view using the scale provided.***	*Strongly Disagree*	*Disagree*	*Somewhat Agree*	*Agree*	*Strongly Agree*	*Not Applicable*
1. This innovation meets the goals and objectives of the bank.	1	2	3	4	5	n/a
2. Manuals and documents accurately explain the implementation and operation of this innovation.	1	2	3	4	5	n/a
3. Educating and personnel training make this innovation a quick and easy job.	1	2	3	4	5	n/a
4. This innovation is independent of other products and services in bank.	1	2	3	4	5	n/a
5. Users of innovation need to be in contact with other departments within the bank to implement it effectively.	1	2	3	4	5	n/a
6. Knowledge about other systems within the bank is necessary to implement this innovation effectively.	1	2	3	4	5	n/a
7. This innovation is intellectually simply or easy to implement.	1	2	3	4	5	n/a
8. Apprenticeship and mentorship are used to share knowledge about this innovation.	1	2	3	4	5	n/a
9. Informal meetings are very useful in sharing knowledge about this innovation.	1	2	3	4	5	n/a
10. Employee rotation across different business areas is an effective way to learn more about this innovation.	1	2	3	4	5	n/a
11. In team discussion, each participant shares his/her work experiences of this innovation with each other.	1	2	3	4	5	n/a

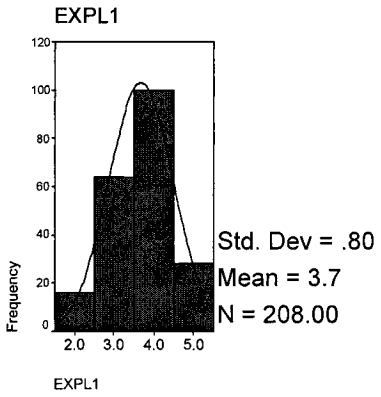
12.	I often use examples to explain obscure aspects of this innovation.	1	2	3	4	5	n/a
13.	Employees consider transcribing some of the unorganized thoughts about this innovation is helpful.	1	2	3	4	5	n/a
14.	Employees tend to use analogy to illustrate obscure aspects of this innovation.	1	2	3	4	5	n/a
15.	When others cannot express themselves clearly, colleagues usually help them clarifying their points.	1	2	3	4	5	n/a
16.	With regard to solving the problems associated with the implementation this innovation, I usually tend to use my experience and the experience of my colleagues.	1	2	3	4	5	n/a
17.	Bank's information repositories, such as the documented best practices and lessons learned from previous work experiences provide a great help in solving the problems associated with the implementation this innovation.	1	2	3	4	5	n/a
18.	On-the-job-training is essential in understanding the different aspects of this innovation.	1	2	3	4	5	n/a
19.	Learning by doing is important to the successful adoption of this innovation.	1	2	3	4	5	n/a
20.	Observing the others during work is helpful in understanding how this innovation works.	1	2	3	4	5	n/a

Appendix 5 Histogram Charts for Individual Item

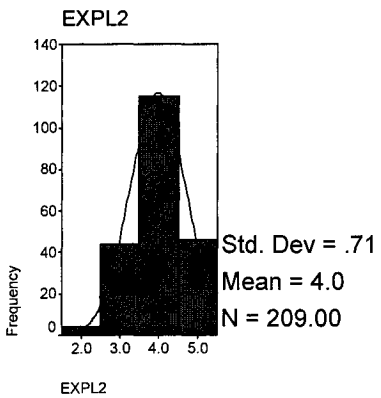
Histogram



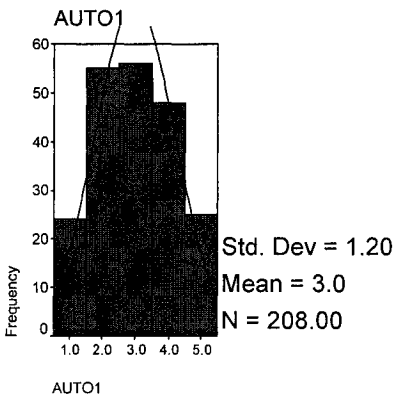
This innovation meets the goals and objectives of the bank.



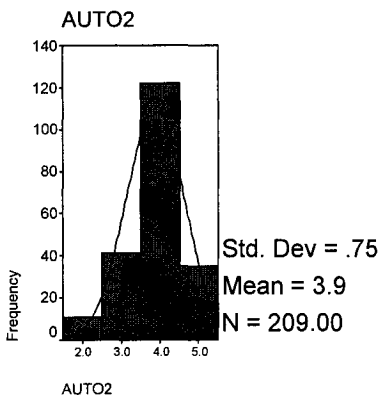
Manuals and documents accurately explain the implementation and operation of this innovation



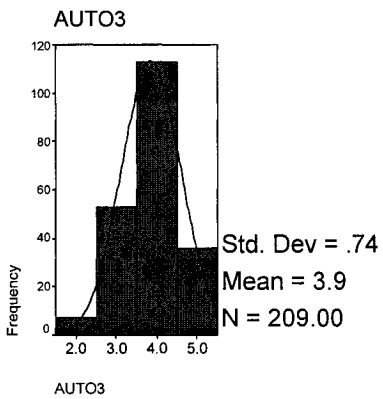
Educating and personnel training make this innovation a quick and easy job.



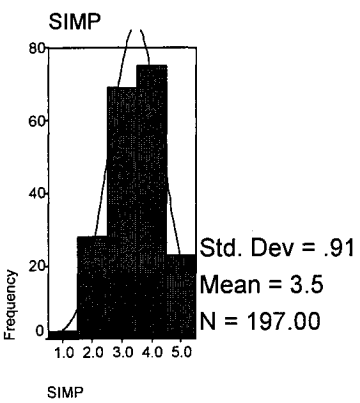
This innovation is independent of other products and services in bank



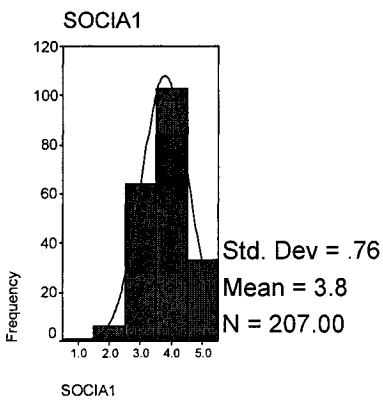
Users of innovation need to be in contact with other departments within the bank to implement it effectively.



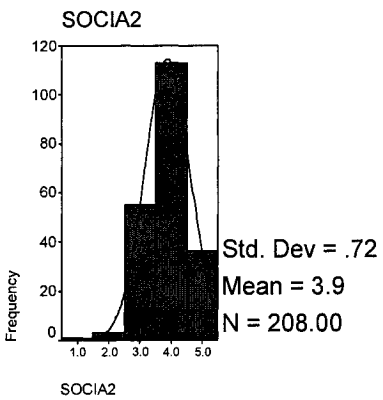
Knowledge about other systems within the bank is necessary to implement this innovation effectively.



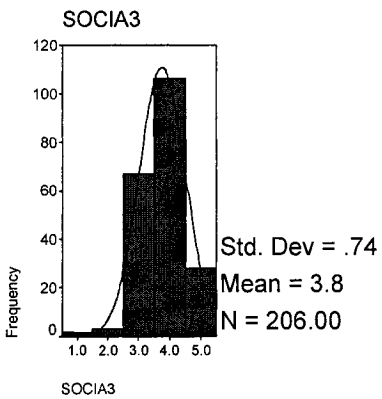
This innovation is intellectually simple or easy to implement.



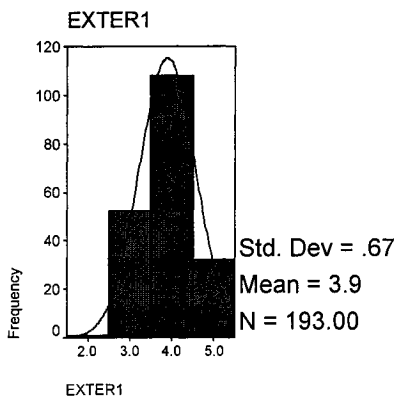
Apprenticeship and mentorship are used to share knowledge about this innovation.



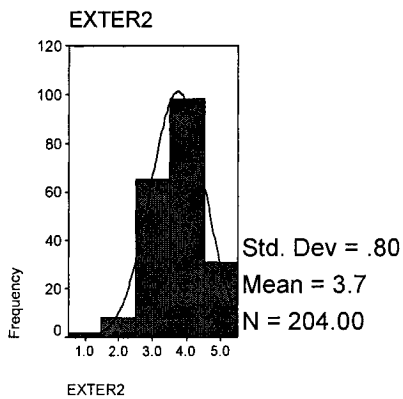
Informal meetings are very useful in sharing knowledge about this innovation.



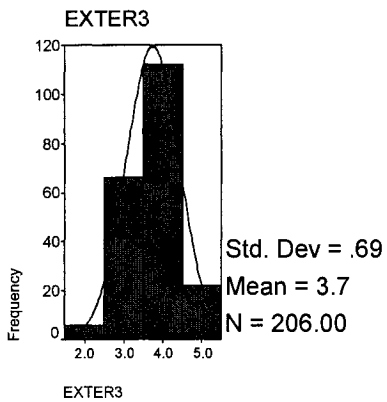
Employee rotation across different business areas is an effective way to learn more about this innovation.



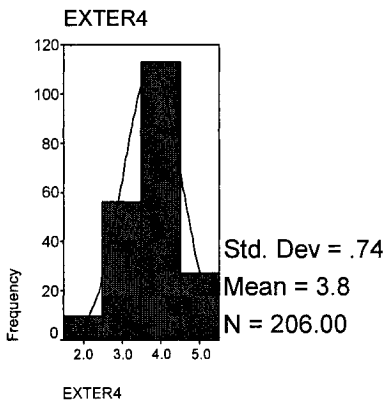
In team discussion, each participant shares his/her work experiences of this innovation with others.



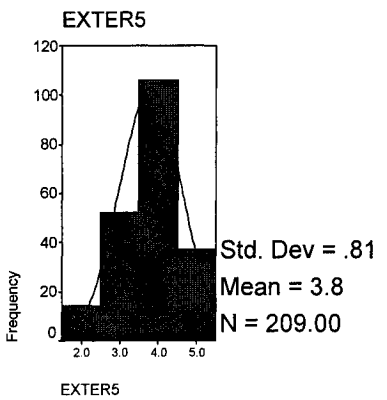
I often use examples to explain obscure aspects of this innovation.



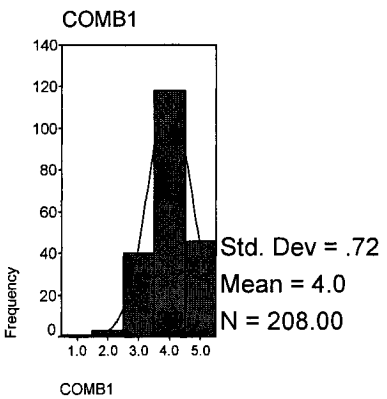
Employees consider transcribing some of the unorganized thoughts about this innovation is helpful.



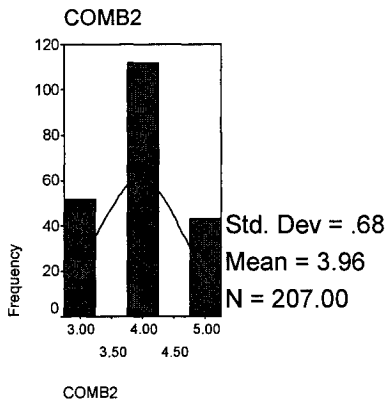
Employees tend to use analogy to illustrate obscure aspects of this innovation.



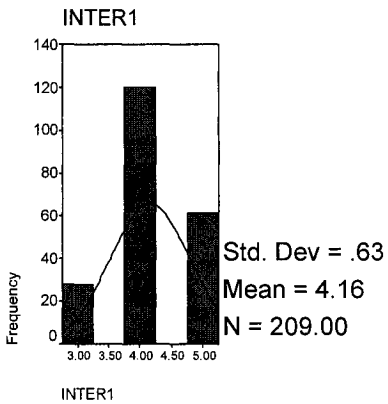
When others cannot express themselves clearly, colleagues usually help them clarifying their points.



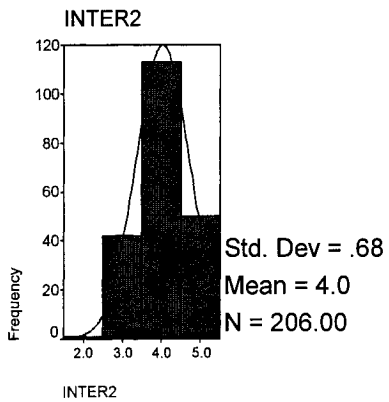
With regard to solving the problems associated with the implementation this innovation, I usually tend to use my experience and the experience of my colleagues.



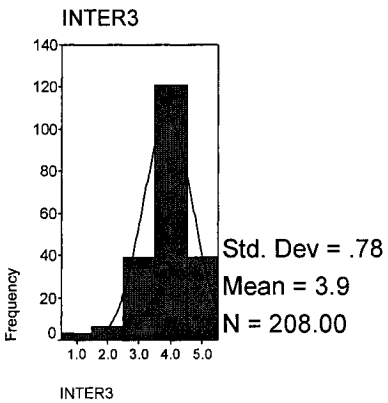
Bank's information repositories, such as the documented best practices and lessons learned from previous work experiences provide a great help in solving the problems associated with the implementation this innovation.



On-the-job-training is essential in understanding the different aspects of this innovation.



Learning by doing is important to the successful adoption of this innovation.



Observing the others during work is helpful in understanding how this innovation works.

Appendix 6 Descriptive Statistics

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std.	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
IE	209	3	2	5	4.22	5.01E-02	.72	.526	-.888	.168	1.116	.335
EXPL1	208	3	2	5	3.67	5.57E-02	.80	.646	.240	.169	.347	.336
EXPL2	209	3	2	5	3.97	4.93E-02	.71	.509	-.279	.168	-.156	.335
AUTO1	208	4	1	5	2.98	8.33E-02	1.20	1.444	.063	.169	-.925	.336
AUTO2	209	3	2	5	3.87	5.17E-02	.75	.569	.543	.168	.362	.335
AUTO3	209	3	2	5	3.85	5.03E-02	.74	.54[illegible]	-.273	.168	-.115	.335
SIMF	197	4	1	5	3.45	6.49E-02	.91	.831	-.162	.173	-.466	.345
SOCIA1	207	4	1	5	3.78	5.30E-02	.76	.581	.264	.169	.161	.337
SOCIA2	206	4	1	5	3.87	5.01E-02	.72	.523	-.333	.169	.490	.336
SOCIA3	206	4	1	5	3.75	5.15E-02	.74	.548	-.369	.169	.847	.337
EXTER1	193	3	2	5	3.89	4.80E-02	.67	.445	.027	.175	-.500	.348
EXTER2	204	4	1	5	3.73	5.62E-02	.80	.643	-.387	.170	.406	.339
EXTER3	206	3	2	5	3.73	4.79E-02	.69	.472	-.136	.169	-.109	.337
EXTER4	206	3	2	5	3.76	5.13E-02	.74	.543	.329	.169	.005	.337
EXTER5	209	3	2	5	3.79	5.60E-02	.81	.655	-.377	.168	-.224	.335
COMB1	208	4	1	5	3.99	4.93E-02	.72	.517	-.530	.169	.915	.336
COMB2	207	2	3	5	3.96	4.71E-02	.68	.459	.053	.169	-.805	.337
INTER1	209	2	3	5	4.16	4.39E-02	.63	.403	-.143	.168	-.571	.335
INTER2	206	3	2	5	4.03	4.76E-02	.68	.467	-.129	.169	-.550	.337
INTER3	208	4	1	5	3.90	5.43E-02	.78	.613	.918	.169	1.890	.336
Valid N (listwise)	167											

Appendix 7 Reliability Test for Innovation Typology

Reliability

```
Reliability Coefficients      6 items

Alpha =    .6312           Standardized item alpha =    .6483
```

Appendix 8 Factor Analysis Test for Innovation Typology

Factor Analysis

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.647
Bartlett's Test of Sphericity	Approx. Chi-Square	165.024
	df	15
	Sig.	.000

Total Variance Explained

	Initial Eigenvalues			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.196	36.606	36.606	1.553	25.877	25.877
2	1.100	18.337	54.942	1.496	24.930	50.807
3	.918	15.299	70.242	1.166	19.434	70.242
4	.818	13.631	83.873			
5	.507	8.450	92.323			
6	.461	7.677	100.000			

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component		
	1	2	3
EXPL1	.728		.525
EXPL2			.901
AUTO1	.504		
AUTO2		.860	
AUTO3		.767	
SIMP	.796		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.

Appendix 9 Factor Analysis for Innovation Typology

Improvement

Factor Analysis

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.648
Bartlett's Test of Sphericity	Approx. Chi-Square	113.978
	df	10
	Sig.	.000

Total Variance Explained

	Initial Eigenvalues			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.962	39.249	39.249	1.617	32.337	32.337
2	.952	19.036	58.285	1.297	25.948	58.285
3	.889	17.789	76.074			
4	.716	14.330	90.403			
5	.480	9.597	100.000			

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component	
	1	2
EXPL1		.670
EXPL2		.860
AUTO1	.659	
AUTO2	.709	
AUTO3	.795	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Appendix 10 Factor Analysis For K-Creation

Factor Analysis

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.838
Bartlett's Test of Sphericity	Approx. Chi-Square	358.500
	df	28
	Sig.	.000

Total Variance Explained

	Initial Eigenvalues			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.372	42.154	42.154	2.339	29.238	29.238
2	.921	11.510	53.665	1.954	24.426	53.665
3	.867	10.836	64.500			
4	.729	9.108	73.609			
5	.664	8.305	81.914			
6	.561	7.008	88.921			
7	.460	5.753	94.674			
8	.426	5.326	100.000			

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component	
	1	2
SOCIA1	.700	
SOCIA2	.688	
SOCIA3	.718	
EXTER1	.726	
EXTER2		.735
EXTER3		.652
EXTER4	.429	.455
EXTER5		.770

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Appendix 11 Reliability for K-Creation

Reliability

```
Reliability Coefficients      7 items

Alpha =    .7754            Standardized item alpha =    .7765
```

Appendix 12 Factor Analysis for K-Utilization

Factor Analysis

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.673
Bartlett's Test of Sphericity	Approx. Chi-Square	129.060
	df	10
	Sig.	.000

Total Variance Explained

	Initial Eigenvalues			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.017	40.335	40.335	1.892	37.848	37.848
2	1.117	22.347	62.683	1.242	24.835	62.683
3	.717	14.335	77.017			
4	.636	12.728	89.745			
5	.513	10.255	100.000			

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component	
	1	2
COMB1	.734	
COMB2		.660
INTER1	.799	
INTER2	.740	
INTER3		.887

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Appendix 13 Reliability Test for K-Utilization 1

(With Combination # 1 and Internalization # 3 as Retained Factors)

Reliability

```
 ****** Method 2 (covariance matrix) will be used for this
analysis ******



  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P
H A)


                    Correlation Matrix

                COMB1       INTER3

COMB1           1.0000
INTER3          -.0033      1.0000


        N of Cases =       207.0


Reliability Coefficients     2 items

Alpha =  -.0067           Standardized item alpha =  -.0067
```

Appendix 14 Reliability for K-Utilization 2

(With Combination # 2 and Internalization # 1 and Internalization # 2 as Retained Factors)

Reliability

```
 ****** Method 2 (covariance matrix) will be used for this
analysis ******



  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P
H A)


                   Correlation Matrix

               COMB2       INTER1      INTER2

COMB2          1.0000
INTER1          .3084      1.0000
INTER2          .2128       .4582      1.0000


        N of Cases =       206.0


Reliability Coefficients     3 items

Alpha =    .5895           Standardized item alpha =    .5925
```

Appendix 15 Correlations among Items of Measure of Innovation Typology

Correlations

Correlations

		EXPL1	EXPL2	AUTO1	AUTO2	AUTO3	SIMP
EXPL1	Pearson Correlation	1.000	.252**	.196**	.174*	.252**	.343**
	Sig. (2-tailed)	.	.000	.005	.012	.000	.000
EXPL2	Pearson Correlation	.252**	1.000	.084	.245**	.175*	-.067
	Sig. (2-tailed)	.000	.	.229	.000	.011	.352
AUTO1	Pearson Correlation	.196**	.084	1.000	.190**	.263**	.234**
	Sig. (2-tailed)	.005	.229	.	.006	.000	.001
AUTO2	Pearson Correlation	.174*	.245**	.190**	1.000	.497**	.209**
	Sig. (2-tailed)	.012	.000	.006	.	.000	.003
AUTO3	Pearson Correlation	.252**	.175*	.263**	.497**	1.000	.376**
	Sig. (2-tailed)	.000	.011	.000	.000	.	.000
SIMP	Pearson Correlation	.343**	-.067	.234**	.209**	.376**	1.000
	Sig. (2-tailed)	.000	.352	.001	.003	.000	.

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

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

Appendix 16 Correlations among Items of the Measure of K-Creation

Correlations

Correlations

		SOCIA1	SOCIA2	SOCIA3	EXTER2	EXTER3	EXTER4	EXTER5
SOCIA1	Pearson Correlation	1.000	.361**	.428**	.315**	.340**	.492**	.277**
	Sig. (2-tailed)	.	.000	.000	.000	.000	.000	.000
SOCIA2	Pearson Correlation	.361**	1.000	.298**	.332**	.254**	.275**	.209**
	Sig. (2-tailed)	.000	.	.000	.000	.000	.000	.002
SOCIA3	Pearson Correlation	.428**	.298**	1.000	.312**	.327**	.252**	.227**
	Sig. (2-tailed)	.000	.000	.	.000	.000	.000	.001
EXTER2	Pearson Correlation	.315**	.332**	.312**	1.000	.404**	.359**	.402**
	Sig. (2-tailed)	.000	.000	.000	.	.000	.000	.000
EXTER3	Pearson Correlation	.340**	.254**	.327**	.404**	1.000	.363**	.307**
	Sig. (2-tailed)	.000	.000	.000	.000	.	.000	.000
EXTER4	Pearson Correlation	.492**	.275**	.252**	.359**	.363**	1.000	.217**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.	.002
EXTER5	Pearson Correlation	.277**	.209**	.227**	.402**	.307**	.217**	1.000
	Sig. (2-tailed)	.000	.002	.001	.000	.000	.002	.

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

Appendix 17 Correlations among Items of the Measure of K-Utilization

Correlations

Correlations

		COMB2	INTER1	INTER2
COMB2	Pearson Correlation	1.000	.308**	.213**
	Sig. (2-tailed)	.	.000	.002
INTER1	Pearson Correlation	.308**	1.000	.458**
	Sig. (2-tailed)	.000	.	.000
INTER2	Pearson Correlation	.213**	.458**	1.000
	Sig. (2-tailed)	.002	.000	.

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

Appendix 18 Correlations of KM Processes Items Scales and Item-Cross-Scale

Correlations

Correlations

		SOCIA	EXTER	COMB	INTER
SOCIA1	Pearson Correlation	.794**	.492**	.246**	.210**
	Sig. (2-tailed)	.000	.000	.000	.002
SOCIA2	Pearson Correlation	.724**	.363**	.267**	.346**
	Sig. (2-tailed)	.000	.000	.000	.000
SOCIA3	Pearson Correlation	.759**	.379**	.332**	.185**
	Sig. (2-tailed)	.000	.000	.000	.008
EXTER2	Pearson Correlation	.418**	.777**	.384**	.209**
	Sig. (2-tailed)	.000	.000	.000	.003
EXTER3	Pearson Correlation	.404**	.709**	.376**	.105
	Sig. (2-tailed)	.000	.000	.000	.133
EXTER4	Pearson Correlation	.438**	.670**	.257**	.121
	Sig. (2-tailed)	.000	.000	.000	.084
EXTER5	Pearson Correlation	.304**	.699**	.259**	.154*
	Sig. (2-tailed)	.000	.000	.000	.026
COMB2	Pearson Correlation	.369**	.436**	1.000**	.303**
	Sig. (2-tailed)	.000	.000	.000	.000
INTER1	Pearson Correlation	.320**	.277**	.308**	.843**
	Sig. (2-tailed)	.000	.000	.000	.000
INTER2	Pearson Correlation	.228**	.092	.213**	.864**
	Sig. (2-tailed)	.001	.187	.002	.000

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

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

social: Socialization
exter: Externalization
comb: Combination
inter: Internalization

Appendix 19 Correlations of K-Creation and K-Utilization Items

Scales and Item-Cross-Scale

Correlations

Correlations

		KC	KU
SOCIA1	Pearson Correlation	.709**	.272**
	Sig. (2-tailed)	.000	.000
SOCIA2	Pearson Correlation	.593**	.384**
	Sig. (2-tailed)	.000	.000
SOCIA3	Pearson Correlation	.619**	.292**
	Sig. (2-tailed)	.000	.000
EXTER2	Pearson Correlation	.703**	.332**
	Sig. (2-tailed)	.000	.000
EXTER3	Pearson Correlation	.650**	.250**
	Sig. (2-tailed)	.000	.000
EXTER4	Pearson Correlation	.647**	.207**
	Sig. (2-tailed)	.000	.003
EXTER5	Pearson Correlation	.600**	.235**
	Sig. (2-tailed)	.000	.001
COMB2	Pearson Correlation	.461**	.688**
	Sig. (2-tailed)	.000	.000
INTER1	Pearson Correlation	.337**	.783**
	Sig. (2-tailed)	.000	.000
INTER2	Pearson Correlation	.173*	.755**
	Sig. (2-tailed)	.013	.000

**. Correlation is significant at the 0.01 level

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

kc: K-Creation
ku: K-Utilization

Appendix 20 Correlations among K-Creation and K-Utilization

Correlations

Correlations

		KC	KU
KC	Pearson Correlation	1.000	.435**
	Sig. (2-tailed)	.	.000
KU	Pearson Correlation	.435**	1.000
	Sig. (2-tailed)	.000	.

**. Correlation is significant at the 0.01 level

Appendix 21 Classification of Innovation

Quick Cluster

Initial Cluster Centers

	Cluster	
	1	2
EXPL1	5	2
EXPL2	5	2
AUTO1	5	2
AUTO2	5	2
AUTO3	5	2
SIMP	5	2

ANOVA

	Cluster		Error			
	Mean Square	df	Mean Square	df	F	Sig.
EXPL1	12.790	1	.587	206	21.779	.000
EXPL2	2.608	1	.499	207	5.230	.023
AUTO1	178.666	1	.584	206	306.162	.000
AUTO2	13.055	1	.499	207	26.187	.000
AUTO3	20.165	1	.446	207	45.256	.000
SIMP	25.574	1	.704	195	36.342	.000

The F tests should be used only for descriptive purposes because the clusters have been chosen to maximize the differences among cases in different clusters. The observed significance levels are not corrected for this and thus cannot be interpreted as tests of the hypothesis that the cluster means are equal.

Number of Cases in each Cluster

Cluster	1	88.000
	2	121.000
Valid		209.000
Missing		.000

Appendix 22 Frequencies of Innovation/Effectiveness Subgroup

Frequencies

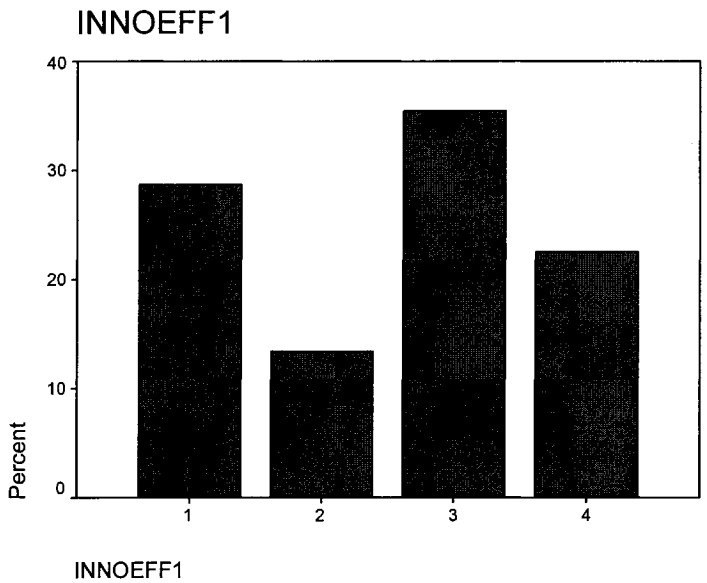
Statistics

INNOEFF1

N	Valid	209
	Missing	0

INNOEFF1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	60	28.7	28.7	28.7
	2	28	13.4	13.4	42.1
	3	74	35.4	35.4	77.5
	4	47	22.5	22.5	100.0
	Total	209	100.0	100.0	



Appendix 23 T-Test Between Two Ideal System Subgroups

T-Test

Group Statistics

	INNOEFF1	N	Mean	Std. Deviation	Std. Error Mean
KC	2	28	4.2957	.4923	9.304E-02
	4	47	3.5836	.4779	6.970E-02
KU	2	28	4.4048	.5080	9.601E-02
	4	47	4.0709	.4762	6.946E-02

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
							95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Lower	Upper
KC	Equal variances assumed	.034	.855	6.173	73	.000	.4822	.9421
	Equal variances not assumed			6.126	55.546	.000	.4792	.9451
KU	Equal variances assumed	.084	.773	2.864	73	.005	.1016	.5661
	Equal variances not assumed			2.817	53.981	.007	9.627E-02	.5714

Appendix 24 Correlations Between Effective and Distances

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
IE	4.22	.72	209
DIST2	.567114	.348665	134

Correlations

		IE	DIST2
IE	Pearson Correlation	1.000	-.004
	Sig. (2-tailed)	.	.964
	N	209	134
DIST2	Pearson Correlation	-.004	1.000
	Sig. (2-tailed)	.964	.
	N	134	134

Correlation between Innovation Effectiveness and the distances of internal-/external-sourced innovations in both K-Creation and K-Utilization dimensions

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
IE	4.22	.72	209
DI21	.635275	.363363	60

Correlations

		IE	DI21
IE	Pearson Correlation	1.000	-.208
	Sig. (2-tailed)	.	.111
	N	209	60
DI21	Pearson Correlation	-.208	1.000
	Sig. (2-tailed)	.111	.
	N	60	60

Correlation between Innovation Effectiveness and the distances of external-sourced innovations in both K-Creation and K-Utilization dimensions

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
IE	4.22	.72	209
DI23	.511848	.328419	74

Correlations

		IE	DI23
IE	Pearson Correlation	1.000	.151
	Sig. (2-tailed)	.	.199
	N	209	74
DI23	Pearson Correlation	.151	1.000
	Sig. (2-tailed)	.199	.
	N	74	74

Correlation between Innovation Effectiveness and the distances of internal-sourced innovations in both K-Creation and K-Utilization dimensions

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
IE	4.22	.72	209
DISTKC2	.339741	.295477	134

Correlations

		IE	DISTKC2
IE	Pearson Correlation	1.000	-.017
	Sig. (2-tailed)	.	.844
	N	209	134
DISTKC2	Pearson Correlation	-.017	1.000
	Sig. (2-tailed)	.844	.
	N	134	134

Correlation between Innovation Effectiveness and the distances of internal-/external-sourced innovations in K-Creation dimension

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
IE	4.22	.72	209
DISTKC21	.426575	.338973	60

Correlations

		IE	DISTKC21
IE	Pearson Correlation	1.000	-.205
	Sig. (2-tailed)	.	.116
	N	209	60
DISTKC21	Pearson Correlation	-.205	1.000
	Sig. (2-tailed)	.116	.
	N	60	60

Correlation between Innovation Effectiveness and the distances of external-sourced innovations in K-Creation dimension

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
IE	4.22	.72	209
DISTKC23	.269334	.234471	74

Correlations

		IE	DISTKC23
IE	Pearson Correlation	1.000	.165
	Sig. (2-tailed)	.	.160
	N	209	74
DISTKC23	Pearson Correlation	.165	1.000
	Sig. (2-tailed)	.160	.
	N	74	74

Correlation between Innovation Effectiveness and the distances of internal-sourced innovations in K-Creation dimension

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
IE	4.22	.72	209
DISTKU2	.378255	.312815	134

Correlations

		IE	DISTKU2
IE	Pearson Correlation	1.000	-.029
	Sig. (2-tailed)	.	.737
	N	209	134
DISTKU2	Pearson Correlation	-.029	1.000
	Sig. (2-tailed)	.737	.
	N	134	134

Correlation between Innovation Effectiveness and the distances of internal-/external-sourced innovations in K-Utilization dimension

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
IE	4.22	.72	209
DISTKU21	.389707	.296730	60

Correlations

		IE	DISTKU21
IE	Pearson Correlation	1.000	-.217
	Sig. (2-tailed)	.	.096
	N	209	60
DISTKU21	Pearson Correlation	-.217	1.000
	Sig. (2-tailed)	.096	.
	N	60	60

Correlation between Innovation Effectiveness and the distances of external-sourced innovations in K-Utilization dimension

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
IE	4.22	.72	209
DISTKU23	.368969	.326990	74

Correlations

		IE	DISTKU23
IE	Pearson Correlation	1.000	.090
	Sig. (2-tailed)	.	.445
	N	209	74
DISTKU23	Pearson Correlation	.090	1.000
	Sig. (2-tailed)	.445	.
	N	74	74

Correlation between Innovation Effectiveness and the distances of internal-sourced innovations in K-Utilization dimension