Available online at www.sciencedirect.com
ScienceDirect
Expert Systems with Applications 35 (2008) 150–160
Expert Systems with Applications
www.elsevier.com/locate/eswa

The effects of information technology on knowledge management systems

Shu-Mei Tseng *

Department of Information Management, I-Shou University, Kaohsiung, Taiwan, ROC

Abstract

Due to the rapid development of knowledge and information technology (IT), business environments have become much more complicated. In order to cope with ensuing complications, enterprises ought to incessantly innovate; otherwise, it will be very difficult for them to survive in the marketplace. Hence, many enterprises have applied IT in order to cut production costs, introduce innovations in products and services, promote growth, develop alliances, lock in customers and suppliers, and create switching costs and raise barriers to entry. In other words, IT can help a firm aiming to gain a competitive advantage. In addition, many studies have argued that business value comes mainly from intangible assets, such as knowledge. Thus, knowledge workers will be able to replace clerical workers as the new mainstream of manpower resources, a field in which the development of IT is the major force for change in knowledge management system (KMS). Therefore, based on the definition of the five gaps in KMS, this study explores the role and effect of IT in the implementation of KMS on firms; moreover, relationships between KMS and IT are analyzed and demonstrated by means of the literature reviews, expert interviews and questionnaire analyses. Furthermore, this study discusses how to enhance the effectiveness and efficiency of implementing KMS through appropriate IT.

Keywords: Knowledge management; Information technology; Case studies

1. Introduction

In recent years, the rapid development of information technology (IT) has made it easier for employees, customers, suppliers, and partners to interact while carrying out each of their business functions; moreover, cross-function collaborations become feasible in product development, marketing, distribution, and customer service. That is, IT does not merely support efficient business operations, workgroup task and collaborations, and effective business decision-making; but they also change the way businesses compete (Ruiz-Mercader, Merono-Cerdan, & Sabater-Sanchez, 2006). Therefore, it is obvious that IT is a tool crucial for enterprises to achieve a competitive advantage and organizational innovation.

Due to the IT revolution and advancements of the Internet, the value of knowledge assets has been greatly enhanced. Many companies are building knowledge management system (KMS) in order to manage organizational learning and business know-how. The main purpose of such a policy is to help knowledge workers to create important business knowledge, to organize it, and to make it available whenever and wherever it is needed in the companies (O'Brien & Marakas, 2006). Facing a tremendous amount of data on a daily basis, enterprises only use IT to integrate each division of various tools, such as intranet, data warehouse, electronic whiteboard, artificial intelligence and expert systems so that the jumbled business data is well-organized and more integrated (Khandelwal & Gottschalk, 2003). Furthermore, the value of business can be increased by applying IT. For example, many hotel chains and travel companies record individual preferences, so that the client is automatically given their favorite rooms or seats in the future (Probst, Raub, & Romhardt, 2000).

* Tel.: +886 7 6577711x6574; fax: +886 7 6577056.
E-mail address: y97576@isu.edu.tw

0957-4174/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.eswa.2007.06.011

Another case in point is Citibank's special system which recognizes atypical spending patterns in the use of credit cards, thus being able to alert customers to the possible loss or misuse of their cards. If there were no such knowledge-oriented technological assistance, enterprises would not possess a strong concept of knowledge management (KM). The highest value of IT to KM is in allowing the expansion and universalization of the scope of knowledge and in increasing the speed of transferability. Additionally using IT, we are able to retrieve and store knowledge in individual or groups, which allows this knowledge to be shared with other divisions in the same organization or business partners in the world. Furthermore, IT contributes to the integration of knowledge or even to the stimulation of new knowledge (Davenport & Prusak, 1998).

Nowadays, a long-lasting competitive advantage is achievable only if companies develop into knowledge-creating companies (Carlucci & Schiuma, 2007; Vouros, 2003). However, many companies have faced various kinds of difficulties in implementing KMS. First, if knowledge is merely accumulated in workers' brains, there is no way of recording it systematically. Second, even though knowledge is recorded and recorded in documents, it is very complicated to search for, retrieve, or review it, a problem which erects barriers to the diffusion of knowledge. Thus, in past times, even though managers knew how important KM was, it was very difficult to implement it successfully (Bradley, Paul, & Seeman, 2006).

2. Knowledge management and information technology

IT concepts are pervasive in the current business environment, yet its definition also contains certain intangible aspects. This study mainly probes IT as a tool which is able to manage, store, and transmit structural knowledge. It can support us in our efforts to make the knowledge stored in the human brain or in documents available to all employees of an organization (Davenport & Prusak, 1998). In the process of KM, the absorption, creation, arrangement, storage, transfer and diffusion of knowledge are all dependent on assistance provided by IT. Khandelwal and Gottschalk (2003) pointed out that the application of IT to the support of KM apparently influences the results of knowledge collaboration within the organization. Spiegler (2003) stated that certain methods, such as data mining, can be helpful to an organization in extracting valuable information from a database, particularly when they are applied to field such as marketing, customer relationship management (CRM), and e-commerce. Furthermore, Sher and Lee (2004) suggested that both endogenous and exogenous knowledge are effectively manageable through the application of IT, as well as being able to increase the dynamic capabilities of the enterprise.

Hence, IT plays an important role in determining the success or failure of the implementation of KMS (Johannessen, Olaisen, & Olsen, 2001). However, the concepts of knowledge encoding and translation are not completely new to the world of organizations; on the contrary, training to encode development curriculums, organizational policies, routines, procedures, report and guidance manuals, etc. has been conducted for years. Only through advancements in IT will the progress of KM be given the impetus to accelerate (Alavi & Leidner, 2001). Thus, the growth of KM has been closely tied to information and communication technology (Chumer, Hull, & Prichard, 2000). Therefore, it is found that IT plays a major role in the implementation of KMS (Hislop, 2002). Nevertheless, few studies explore the role and effect of information technologies in the KMS. Hence, the purpose of this study is to investigate the role and effect of IT in implementing the KMS. Furthermore, this study also discusses how to enhance the effectiveness and efficiency of implementing KMS through appropriate IT.

3. Conceptual framework

Based on the concept of KM gaps proposed by Lin and Tseng, 2005b, this study proposes a holistic framework, depicted in Fig. 1, within which to explore the role and effect of IT in KMS. The KM gaps model is divided into five gaps (Gap 1 to Gap 5) and fully illustrates the management gaps that might occur during the implementation of KMS. These five gaps are defined as follows:

- Gap 1: The gap between the knowledge required to enhance the competitiveness of an enterprise as perceived by the upper management and the knowledge actually required to enhance its competitiveness.
- Gap 2: The gap between the knowledge required to enhance an enterprise's competitiveness as perceived by the upper management and the plan to implement KM.
- Gap 3: The gap between the plan to implement KM as proposed by the upper management and the progress of the implementation of the KM plan.
- Gap 4: The gap between the knowledge obtained after implementing the KMS and the knowledge required to enhance an enterprise's competitiveness.
- Gap 5: The gap between the knowledge required to enhance an enterprise's competitiveness as perceived, on the one hand, by the upper management and, on the other, other employees.

Furthermore, reasons for establishing reality of these gaps have been discussed, while several fundamental approaches have been proposed bridge these gaps, which could serve as useful references for enterprises in the process of implementing the KMS. As a result, it has been stated that IT is one of the most crucial factors influencing the magnitudes of these gaps. Thus, it is necessary for a firm to have well-developed technology that is accessible and that makes it easy to leverage KM (Desouza, 2003). Therefore, based on the definition of the five gaps in KMS, this study

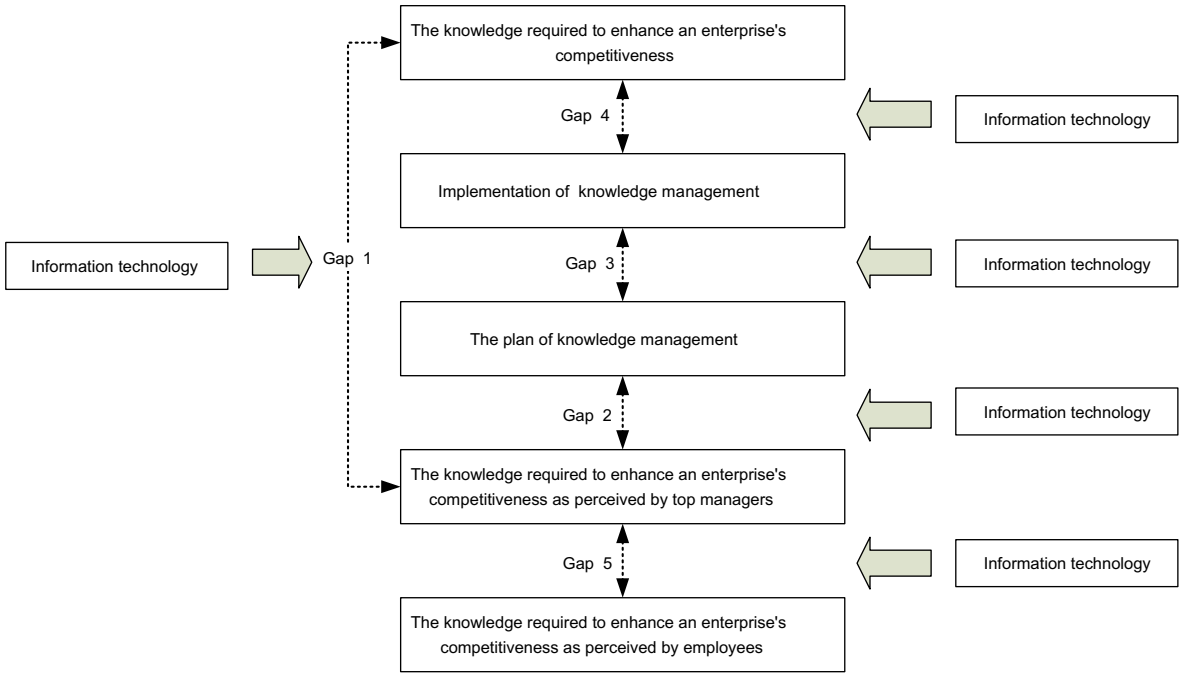

Fig. 1. Conceptual framework.

explores the roles and effects of IT in the implementation of KMS for firms. Through review of the literature, expert interviews and questionnaire analyses, the relationships between each gap and IT are demonstrated and analyzed. Furthermore, this research also discusses how to enhance the effectiveness and efficiency of the implementation of KMS through appropriate IT.

4. Methodology

Research methods can be generally divided into two types: quantitative research and qualitative research. The main objective of this research is to explore the roles and effects of IT in KMS with an emphasis on the "contextual" factors suited to further exploration in qualitative research (Berg, 2000; Hammersley, 1996). In other words, it is not known whether there exist any concrete relations between IT and KMS. If certain connections are discovered, it would be desirable to pursue their study in future research. In that case, the characteristics of the qualitative research method make it better suited to be applied here. Furthermore, in order to assess whether the conclusions of qualitative research are valid or not, the quantitative method is also applied in order to test these findings.

Therefore, there are two design phases involved, each of which possesses distinct methodology. The first phase involved voluminous review of the literature and in-depth interviews with senior managers from four companies, both of which were aimed at collecting data. Interviews are one of the most extensively used methods of data collection (Bryman & Burgess, 1999). The individual in-depth interviews conducted in this study are of a face-to-face, semi-structured nature, which is one of the most common approaches in qualitative research. This type of interview involves asking a number of pre-determined questions and special topics. Under such circumstances, respondents are able to determine the direction and content of the interview within a broader framework provided by the interviewer. After the interview at each company had been completed, the results were assembled, transcribed and e-mailed to the respondents for their review and approval in order to prevent any misinterpretations. This process is expected to provide this study with a richer and more holistic appreciation of the problems regarding KMS. Secondly, a questionnaire (developed on the basis of a review of the literature and the in-depth interviews) that functions as a quantifier of the constructions was mailed to other 500 companies. After a few days, the respondents were reminded to submit completed questionnaires via e-mails. This measurement technique was used as a preliminary assessment of the general understanding of KMS and as verification that the qualitative data from the interviews matched the quantitative responses to the questionnaires.

An analytical approach combined with a thematic analysis was used to analyze the qualitative data. Essential themes were pre-determined based on a review of the literature and identification of the following eleven core categories: insights into an enterprise's problems, the recognition of IT, the setting of the goal of KM, the establishment of knowledge repository system, the continuous updating of dynamic knowledge, the implementation of KMS, the monitoring and controlling of the KMS, the application of IT, the knowledge measurement system, communication and collaboration, and the knowledge community. By using a thematic analysis, the interview data was parsed

into information – rich quotations that were ultimately placed into thematic categories (Anderson & Felsenfeld, 2003). To reduce the possibility of misinterpretations, various procedures were employed, including the redundancy of data gathering and procedural challenges to explanations. In qualitative casework, these procedures are collectively called triangulation (Stake, 1998). Triangulation is often used in order to confirm the validity of qualitative research. It also involves the comparison of data relating to the same phenomenon derived from different phases of the fieldwork, from different sources, and/or at different points in the temporal cycle (Khera, Stroobant, Primhak, Gupta, & Davies, 2001). In qualitative research, one of the methods applied to validate findings is the participant check. During this check, the draft questionnaire was tested by interviewing people at four companies, which led to minor modifications in the wording of some survey items. Then, several companies who are engaged in KM were invited to participate in this study.

5. Case studies

The case study represents one of the most commonly research designs in qualitative research. The case analysis is a good starting point in the inductive process of theory building (Yin, 1988, 1994). In addition, it is an apt method for inductive or teleological studies since it permits the researcher to observe and gather information about new or undiscovered natural phenomena that has never been studied before.

The purpose of our case study is to explore the relation between IT and KMS. As this research is rooted in organizational rather than technical interests, the case study approach is, therefore, appropriate. It is usually possible to develop the core categories of the constructs observations derived from case studies (Yin, 1988, 1994).

5.1. Case selection

This case study examines the role and effect of IT in the KMS within an enterprise. Thus, four companies have been selected for research purposes. The first company deals in equipment modules and components mainly used in the semiconductor and TFT–LCD industries; the second company is involved in developing and manufacturing in the TFT–LCD industry; the third company does business in the consumer goods, food manufacturing, and convenience stores; the last company is involved in the semiconductor and integrated circuit (IC) packaging industry. In the following, we provide background information on and a profile of the competitive environment of these four companies.

1. Foxsemicon Integrated Technology Incorporation
   Foxsemicon was established in 2001 and has become the worldwide leading professional equipment manufacturer and service provider in the semiconductor and flat panel display industries. The company has laid the foundation for R&D in high-performance materials, and engages in the designing, manufacturing and marketing of highly integrated system products through the application of core technologies in precision processing, complex assembly, and automation. Major applications of their products are in equipment modules and components mainly used in the semiconductor and TFT-LCD industries. And, the company incorporates simultaneous technical research, prompt response to customer's needs, high-end technology, versatile customized products, and a competitive advantage in a global operation. (http://www.foxsemicon.com.tw).
2. InnoLux Display Corporation
   InnoLux was established in 2003 and mainly focuses on the development and manufacturing of the new generation of graphic display products. Their products fall into two major categories: display modules for digital consumer products and communications products. In order to meet the high demands of youths from all over the world who lead digital lifestyles, visual communications will soon play a significant role in people's lifestyles. InnoLux, by integrating the advantages of its tremendous technological resources and its global clientele, implements graphic display techniques in order to realize the infinite potential of a digital lifestyle (http://www.innolux.com.tw).
3. Uni-President Corporation
   Uni-President was established in 1967; since then, its business scope has been diversified from its original activities in flour manufacturing, animal feed, and beverages to include convenient store chains, distribution, construction, etc. The company believes in and practices the principles of best quality, highest credibility, best service, and reasonable price. They believe that human resources are their biggest asset, which has have led them to undertake a series of human resource management innovations and developments. They encourage employees to participate in more executive management courses, and to share their experiences with different people from different business fields (http://www.uni-president.com/).
4. Advanced Semiconductor Engineering Inc. (ASE Inc.)
   ASE Inc. was founded in 1984. It is one of the world's leading providers of semiconductor manufacturer and service provider and takes pride in offering a comprehensive range of advanced integrated circuit (IC) packaging. The company possesses expertise in product and process technology for the manufacturing of chip scale packages, high-frequency packages, and multi-chip modules, as well as for flip chip and wafer bumping manufacturing. It offers customers turnkey services for integrated tests, packaging, system assembly and product delivery. The company's vision is to become the world's best and largest IC packaging plant with a mission to satisfy the needs of its valued customers while improving overall employee satisfaction. The company can accomplish this by remaining as flexible as possible

while working closely with its customers and partners (http://www.asetwn.com.tw/).

In order to examine the comprehensive set of effects of IT on KMS, we chose to interview both traditional and high-technology industries. Uni-President is the leading company in the food industry in Taiwan and clearly a good example of the "traditional industry" model. Foxsemicon and InnoLux were initially invested in by the Hon Hai Group for the purpose of breaking into the semiconductor and TFT–LCD equipment manufacturing markets. ASE Inc. is the leader in the Taiwan IC packaging industry and a representative model of the high-technology industry. These four companies have established dedicated departments to implement KM, and they are recognized as having successfully adopted KM and quality philosophies. Therefore, it is more than fitting that they be set up as case studies into the effects of IT on the implementation of KMS.

5.2. Case findings

5.2.1. Gap 1

Interviewees explain that information technologies play a significant role in management and operations, while such influences may differ in different fields of works. For example, professionally trained workers not only increase production, but are also more flexible in their working methods. Due to the increasing volume and frequency of information, managers who make good use of IT are better able to deal with decision-making. Hence, information technologies are potentially useful in helping managers to gain a deeper understanding of the problems that exists in their enterprises and to locate the competitive environments. Furthermore, interviewees also emphasize that an over-optimistic attitude should not be maintained towards resource technologies which function merely as supports.

After synthesizing the results of the interviews, the primary causes for Gap 1 are described as follow:

- Managers who improperly apply the IT to assist core problem findings.
- IT, which is only used in a supporting role, is not omnipotent.

As a result, we propose the following has generalizations regarding the major factors on influence Gap 1:

(1) Insights into an enterprise's problems: The primary benefit of IT was an enhanced ability to identify and target valuable knowledge. IT can assist in processing diversified knowledge resources and in performing on the basis of both implicit and explicit knowledge. Furthermore, it also helps upper management to gain a deeper insight into the core problems in their enterprises, and it facilitates in their decision-making (Campbell, 2003; Sher & Lee, 2004).

(2) The recognition of IT: In a rapidly changing marketplace, information technologies might also have sparked off unnecessary distractions. For instance, companies who do not provide integral workflow management and lead-in KM tools waste their knowledge resources. Furthermore, IT supports the abilities that the higher value of knowledge-creating has more limited. Thus, the company must recognize that IT is only one means to foster knowledge. Furthermore, proper recognition of IT improves the effectiveness of KM (Gravill, Compeau, & Marcolin, 2006; Martin, Hatzakis, Lycett, & Macredie, 2004; Spira, 2005).

5.2.2. Gap 2

Interviewees stated their companies seldom to help their employees make connections between their jobs and business goals. If the company wishes to extract the knowledge that is available from employees, management will have to identify that as a goal, and support appropriate behaviors. They also explained that during the implementation of their KMS, the frequency of use of the knowledge repository system is very high. Moreover, the knowledge repository system penetrates the whole KM process, thus playing the following three roles: first, as a resource for knowledge conversion during the capture of new knowledge; second, for providing staff with systematized knowledge during the process of knowledge diffusion; third, as a knowledge repository at the stage of knowledge storage. Although current IT has limited capabilities in terms of the externalization of an enterprise's competitiveness, as perceived by its upper management, this process can still be assisted by the implementation of a knowledge repository system. Furthermore, the need of incessant knowledge and system updates continuously stimulates the cognition and innovation of the organization.

According to the results summarized from the interviews, the primary causes for Gap 2 can be described as follow:

- The managers should set goals for knowledge management planning.
- Knowledge repository systems can be developed in order to assist managers in establishing knowledge management planning.
- Knowledge updates are crucial.

Hence, we generalize the main influential factors on Gap 2 as follows:

(1) Setting goals for KM: The ultimate goal of KM is to create value through the use of knowledge (Wu & Lee, 2007). Thus, it is important to confirm that the goals of KM are application, classification, modification, sharing, etc. (Kim, Yu, & Lee, 2003; Ndlela & Toit, 2001). When management clearly establishes goals, employees are more able to optimize their

efforts in the process of achieving their targets because they can better assess the value of certain information and knowledge.

(2) Establishment of knowledge repository systems: knowledge repository techniques contribute to the effectiveness of knowledge retrieval and distribution. The creation of a knowledge repository involves the integration of knowledge across multiple information sources (Oppong, Yen, & Merhout, 2005). That is, knowledge repository systems can help an enterprise externalize knowledge management planning, intensify organizational learning, and improve planning and decision-making. The whole process of establishing such systems includes building the knowledge platform, storing information, transforming tools, and managing content (Chen, Chen, Wang, Chu, & Tsai, 2005; Keeley, 2004).

(3) Continuous updating of dynamic knowledge: Knowledge comes not only from internal employees, but also including from external environments. Moreover, it is important to incessant update and share knowledge in order to conquer the problem of knowledge inertia (Wu & Lee, 2007). Continuous updating of dynamic knowledge can facilitate the processes of socialization, externalization, combination and internalization (SECI) of knowledge (Nonaka, Toyama, & Konno, 2000). Furthermore, it can encourage knowledge sharing and transmission, ignite creativity, and enhance effectiveness (Choi & Lee, 2003).

5.2.3. Gap 3

Interviewees clearly point out that KMS can improve organizational learning since it can be used as a tool to transform tacit knowledge into explicit knowledge (externalization) as well as to convert explicit knowledge into tacit knowledge (internalization). In the meantime, they also stated that there is a difference between planning and implementing KM since implied are the employees' willingness to share their knowledge and the evaluation of the effectiveness of KM plans. The underlying assumption is that it would be easier for employees to perceive the advantages of KM such as improving working abilities and self-learning by actually establishing a KMS. On the other hand, it would also be easier for managers to instantly control the progress of the planning via a KMS.

According to the results summarized from the interviews, the primary causes for Gap 3 can be described as follows:

- In order to enhance the effectiveness of KM plans, it is necessary to implement a KMS.
- KMS can enhance knowledge sharing, inquiring, and controlling, as well as other functions.

Hence, we generalize the main influential factors on Gap 3 as follows:

(1) Implementation of KMS: KMS are viewed as novel methods to the stimulation of creativity and innovation in post-industrial organization (Butler, 2003; Kanter, 1999). Such systems allow employees to inquire about information directly, and encourage them to share their knowledge with others, thus enhancing business competitiveness and creating an environment with knowledge authorization (Schroeder, 1999).

(2) The monitoring and controlling of the KMS: KMS is a key instrument for the creation, codification, storage, communication, analysis, diffusion and systematization of information and knowledge (Ruiz-Mercader et al., 2006). Thus, managers can monitor and control the implementation of KM planning in order to enhance the management performance (Soter O'Neil & Patrick, 2004).

5.2.4. Gap 4

Interviewees strongly indicate that un-human-friendly KM tools are not appealing to their users. If these tools were for the blind and functioned as lead-ins to KMS, they would not create business value, which, in turn, would increase the knowledge that was missed. That is, IT acts as a supporting tool to provide a friendly environment to standardize and store the knowledge, as well as to do the communication for the knowledge between employees or different parties. In addition, interviewees also stated that a complete measurement system needs to be developed in order to evaluate whether the company will enable the enterprise to enhance their competitiveness after the implementation of KMS. Simultaneously, they share the opinion that the results of KM do not always meet business expectations. Thus, comprehensive planning and designing are required in order to establish user-friendly KM tools and measurement systems.

According to the results summarized from the interviews, the primary causes for Gap 4 can be described as follows:

- IT always requires planning and user-friendly applications.
- Knowledge measurement systems can be utilized to evaluate the effectiveness of KMS.

Hence, we generalize the main influential factors on Gap 4 as follows:

(1) Application of IT: IT can play an important role in successful KM initiatives (Edwards, Shaw, & Collier, 2005). There is a necessity for the well-planned development of technologies, such as easy-to-use knowledge maps, workflow software, decision support systems, and so on, which are capable of supporting each procedure involved in KM controlling and implementing, and of boosting business competitiveness (Nilakanta, Miller, & Zhu, 2006).

(2) Knowledge measurement systems: The realization of value by an enterprise is related to its past performances, as reflected on the stock market (Sabherwal & Sabherwal, 2005). Besides, it is difficult to evaluate the creation of value based merely on general financial statements. Rather, such an evaluation is based on the capability of the enterprise which will face challenges in the future. In order to evaluate the follow up on KM, the evaluation the relationship between value realization and value creation can be performed by applying certain tools, such as a balanced score card and a strategy map (Boedker, Guthrie, & Cuganesan, 2005; Du, Ai, & Ren, 2007; Fincham & Roslender, 2003).

5.2.5. Gap 5

Interviewees point out that managers and employees play different roles. Hence, each group has different requirements regarding knowledge. In the meantime, due to lack of trust, the knowledge workers do not tell the executives what they really think and keep their concerns to themselves. The critical role for IT lies in its ability to support communication, collaboration, and coordination. Besides, traditional hierarchical organizational structures may impede knowledge sharing and innovative activities, therefore causing a knowledge gap in terms of KM between managers and employees. In other words, the implementation of cross-hierarchical interconnectivity requires a holistic approach, making changes in many elements of corporate management systems.

According to the results summarized from the interviews, the primary causes for Gap 5 can be described as follows:

- There is neither collaborative teamwork nor cooperative network systems to allow vertical communication in the organization.
- If a knowledge community were created in the active pursuit and sharing of knowledge, this would encourage the vertical and horizontal knowledge transmission of knowledge in the corporation.

Hence, we generalize the main influential factors on Gap 5 as follows:

(1) Communication and collaboration: IT, such as groupware, group decision support systems, workflow software, video conferencing, and intranet, can facilitate internal information exchanges, group discussions and communication in organizations. In addition, conventional hand-written and oral communications can easily be replaced by information technologies in order to facilitate communication and reduce errors (Hornik, Chen, Klein, & Jiang, 2003; Nilakanta et al., 2006).
(2) Knowledge community: IT, such as virtual communities, e-mail, electronic bulletin boards, long-distance learning technology and extranet, can facilitate cross-functional communication, external information searches and knowledge transmission among internal divisions of the same company. Developments in IT, especially the universalization of the internet and global telecommunications, have resulted in easily established support mechanisms for KMS (Fliaster, 2004; Liao, 2003).

6. Questionnaire Analysis

The results of the analyses of these four case studies are summarized in Table 1. These results were then used as a reference to design and develop a questionnaire aimed at quantifying the roles and effects of IT on KMS.

Samples were restricted to a list of the largest Taiwanese corporations which was compiled by the China Credit Information Service (2005), and from which 500 corporations were selected. The content and validity of the draft questionnaire was evaluated by performing interviews in four companies; afterwards, minor modifications of the wording of some items in the questionnaire were carried out. The questionnaire was then mailed to senior managers or directors of knowledge management units because they tend to play key roles in organizational activities (James, Stoner, Freeman, Daniel, & Gilbert, 1995). Research constructs were operationalized by means of related studies and a pilot test. Through the application of a five-point Likert-type scale, multi-item scales were used for measure the research variables.

We sent a questionnaire to each of the chosen 500 companies, among which 81 responded. There were 73 complete questionnaires considered usable for analysis. The effective response rate was 14.6%. During the period, there are many companies were telephoned to illustrate they have not pursued KM yet, so they were unable to fill out and answer this questionnaire. A direct or straightforward conclusion of such a low response rate is that the implementation of KMS may not be popular in Taiwan right now; nevertheless, the firms that we approached are interested in such issues. Table 2 shows the demographics of the sample.

Table 3 outlines the results of the reliability and validity tests performed on the survey items. Internal consistency measures (Cronbach's alpha) were obtained in order to assess the reliability of the measurement instruments. The item-to-total correlation, which was calculated between each individual item and the sum of the remaining items, was used to determine the convergent validity. In each case, when the item-to-total correlation score was lower than 0.4, the case was eliminated from further analysis. The reliability is more than acceptable (i.e., the minimum Alpha is 0.70). The content validity of the instruments was established by adopting the constructs that have already been validated by other researchers. According to the analyses mentioned above, it is found that our conceptual framework and the survey items on each gap, which were derived

Table 1
Theoretical constructs and relevant problems associated with KMS

Theoretical constructs		Relevant problems	Remark
Gap 1	Insights into an enterprise's problems	Can IT help you to gain insight into the enterprise's core problems?	Campbell (2003), Sher and Lee (2004)
	The recognition of IT	Does the company provide proper recognition knowledge for IT? Do you think that IT supports the abilities that the higher value of knowledge-creating has more limited?	Spira (2005), Gravill et al. (2006)
Gap 2	Setting goals for KM	Can you assure the goal of KM for your firm?	Ndlela and Toit (2001), Kim et al. (2003), Wu and Lee (2007)
	Establishment of knowledge repository systems	Do you think that knowledge repository systems can support your firm in defining its KM plan?	Keeley (2004), Chen et al. (2005), Oppong et al. (2005)
	Continuous updating of dynamic knowledge	Do you think that knowledge is derived not only from internal employees, but also from external environments? Do you think that continuously updating dynamic knowledge can facilitate knowledge sharing and ignite creativities?	Choi and Lee (2003), Nonaka et al. (2000), Wu and Lee (2007)
Gap 3	Implementation of KMS	Do you think that your firm's KMS allows employees to inquire about information directly? Do you think that your firm's KMS can encourage you to share your knowledge with others?	Schroeder (1999), Kanter (1999), Butler (2003).
	The monitoring and controlling of the KMS	Do you think that your firm's KMS can help to monitor and control the implementation of KM planning?	Soter O'Neil and Patrick (2004), Ruiz-Mercader et al. (2006).
Gap 4	Application of IT	Do you think that your firm has well-planned IT to support the implementation of KM ?	Edwards et al. (2005), Nilakanta et al. (2006)
	Knowledge measurement system	Do you think that your firm possesses an objective knowledge measurement system to evaluate the effectiveness of KM?	Fincham and Roslender (2003), Boedker et al. (2005), Du et al. (2007).
Gap 5	Communication and collaboration	Do you think that your firm's information system can support communication and collaboration within your department? Do you think that your firm's information system can help to decrease the probability of repetitive errors in the enterprise?	Hornik et al. (2003), Khandelwal and Gottschalk (2003), Nilakanta et al. (2006)
	Knowledge community	Do you think that your firm's information system can support communication and collaboration within your communities?	Alavi and Leidner (2001), Fliaster (2004)

Table 2
Demographic characteristics of the responding firms ($n = 73$)

	Percentage of firms
Industries	
Manufacturing companies	67.4
Non-manufacturing companies	11.6
Government enterprises	13.9
Banking & financing institutions	7.1
Annual sales (NTD)	
Less than 500 million	2.3
500 million to below 3 billion	30.2
3 billion to below 15 billion	30.3
15 billion to below 50 billion	14.0
50 billion to below 100 billion	9.3
100 billion and above	13.9
Number of employees	
<500	16.4
501–1500	39.5
1501–2500	2.3
2501–3500	4.6
3501–4500	7.0
4501–5500	2.3
>5501	27.9

from interviews and a review of the literature, are all effective.

Table 3
Reliability and validity test results for measures

Measure single factors	Items	Reliability (Cronbach's alpha)	Convergent validity (correlation of item with total score-item)
IT effect			
Gap1	3	0.825	0.708; 0.563; 0.803
Gap2	4	0.814	0.654; 0.725; 0.632; 0.523
Gap3	3	0.823	0.770; 0.707; 0.581
Gap4	2	0.737	0.583; 0.583
Gap5	3	0.824	0.709; 0.664; 0.660

Based on the survey findings from these questionnaires, the mean values of the theoretical constructs for each KM gap, which measure the influence factor of each item, are summarized in Table 4. The interview and survey responses provided a strong basis for developing our research model, which is validated to some extent by the results of the survey.

As seen from Table 4, we found:

1. Almost all of the KM gaps scored higher than 3.872 on a scale of 1–5, indicating that the measurement instrument is good enough to quantify the exploratory study.
2. Among the influence factors of Gaps 1–5, the recognition of IT, setting goals for KM, establishment of

Table 4
The means of gaps in information technology

Construct	Influence factors	Items	Item mean	Gap mean
Gap 1	1. Insights into an enterprise's problems	3	4.644	4.133
	2. The recognition of IT		4.014	
			3.740	
Gap 2	1. Setting goals for KM	4	3.644	3.908
	2. Establishment of knowledge repository system		3.630	
	3. Continuous updating of dynamic knowledge		4.151	
			4.206	
Gap 3	1. Implementation of KMS	3	3.562	3.872
	2. The monitoring and controlling of KMS		3.726	
			4.329	
Gap 4	1. Application of IT	2	4.343	4.466
	2. Knowledge measurement system		4.589	
Gap 5	1. Communication and collaboration	3	4.219	4.249
	2. Knowledge community		4.082	
			4.466	

knowledge repository systems and implementation of KMS have lower concurrence scores, but are still above 3.562, meaning that the influence factors identified in this study are valid.

3. The companies have lower concurrence scores on Gap 2 and Gap 3. These gaps concern disparities between KM plan devised by the management and the employees' execution of these plans. This phenomenon seems simple, but it implies the internalization and externalization of corporate knowledge in KMS. In other words, top managers are unable to perceive the knowledge that the enterprise needs to convey concretely into the implementation plan for the KMS (Lin & Tseng, 2005a); moreover, employees may not fully understand what KMS is or are afraid that their personal value might be negatively affected after sharing their knowledge. As a result, employees' unwillingness to share their own knowledge or their inability to understand exactly KMS. Therefore, top managers should help the employees to understand their KM plan and employees must absorb the KM plan so that it becomes tacit knowledge, thus allowing them to correctly implement this plan. This is the hardest part of KM (Nomura, 2002), and therefore it is difficult for IT to support all the factors that influence these two gaps.

7. Conclusion

Companies have long recognized the value of harnessing the data and information that reside and are created within the organization; thus, information management has been practiced for a long time primarily through the implementation and use of IT (Ford & Chan, 2003). Every organization has its own way of dealing with data, information and knowledge, and creates its own structures, jobs and systems for that purpose (Nonaka et al., 2000). Therefore, there is no standard method for introducing KM into a company. The best way to achieve this is to start with existing structures and methods, and then apply them effectively to reach the company's knowledge goals (Hall & Andriani, 2002). This study is based on the KM gap model (Lin & Tseng, 2005b) and explores the roles and effects of IT on KMS. After conducting a review of the literature, expert interviews and questionnaire analyses, a clear picture emerged. To elucidate this picture, the factors critical to the improvement of the quality of KMS by means of IT are presented in Fig. 2.

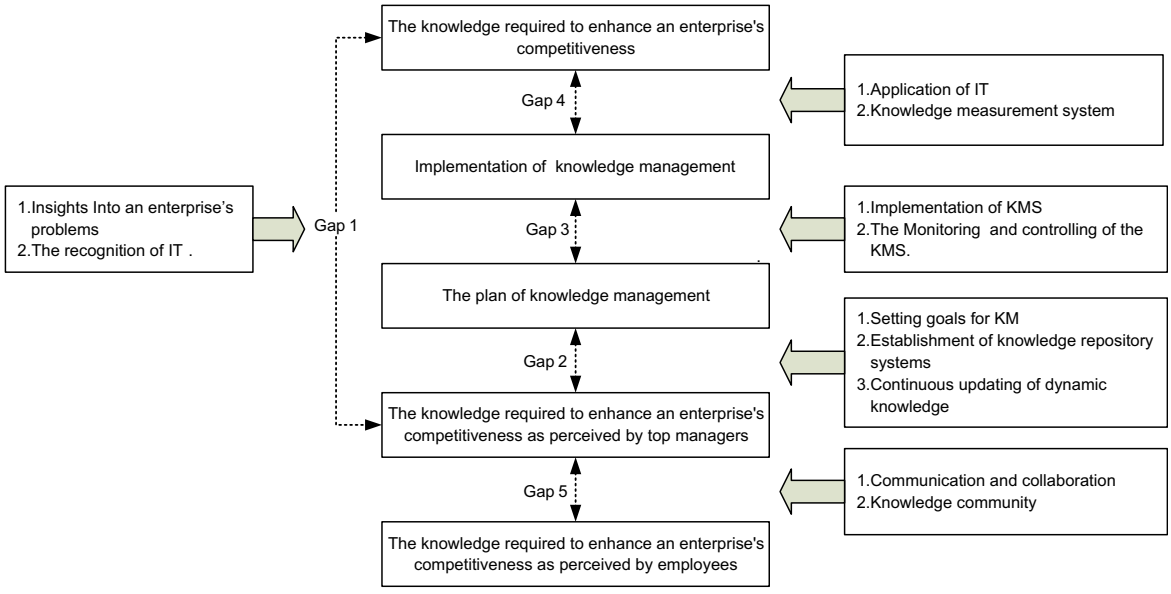

Fig. 2. The critical factors of KMS.

Due to knowledge is a more nebulous resource than data and information, tacit knowledge cannot be converted into explicit knowledge (Sabherwal & Sabherwal, 2005). As a result, people cannot articulate what they know (McDermott, 1999). The implication is that knowledge can never be effectively shared through IT that involves a static repository – such as an intranet – because as static information, such knowledge can never convey the richness of the context in which it was applied (Currie & Kerrin, 2004; Hayes & Walsham, 2000; Mackinlay, 2002). Therefore, it is difficult for IT to support all the factors that influence on KMS (Ford & Chan, 2003). Hence, although IT is the foundation for managing knowledge assets and enables people from different departments to cooperate in its implementation, it is merely a tool to assist in the implementation of a KMS. The key to implementing KM is the people themselves (Edwards et al., 2005; Lin & Tseng, 2005a).

Acknowledgement

The research was supported by NSC 94-2416-H- 432 - 002- (Taiwan National Science Council).

References

Alavi, M., & Leidner, D. E. (2001). Review: Knowledge management and knowledge management systems: Conceptual foundation and research issues. *MIS Quarterly, 25*(1), 107–136.

Anderson, T. K., & Felsenfeld, S. (2003). A thematic analysis of late recovery from stuttering. *American Journal of Speech – Language Pathology, 12*(2), 243–253.

Berg, B. L. (2000). *Qualitative Research Methods for the Social Science*. Boston: Allyn and Bacon.

Boedker, C., Guthrie, J., & Cuganesan, S. (2005). An integrated framework for visualising intellectual capital. *Journal of Intellectual Capital, 6*(4), 510–527.

Bradley, J. H., Paul, R., & Seeman, E. (2006). Analyzing the structure of expert knowledge. *Information and Management, 43*(1), 77–91.

Bryman, A., & Burgess, R. G. (1999). *Qualitative Research*. Thousand Oaks, CA: Sage Publication.

Butler, T. (2003). From data to knowledge and back again: understanding the limitations of KMS. *Knowledge and Process Management, 10*(3), 144–155.

Campbell, A. J. (2003). Creating customer knowledge competence: Managing customer relationship management programs strategically. *Industrial Marketing Management, 32*(5), 375–383.

Carlucci, D., & Schiuma, G. (2007). Knowledge assets value creation map: Assessing knowledge assets value drivers using AHP. *Expert Systems with Applications, 32*(3), 814–821.

Chen, Y. J., Chen, Y. M., Wang, C. B., Chu, H. C., & Tsai, T. N. (2005). Developing a multi-layer reference design retrieval technology for knowledge management in engineering design. *Expert Systems with Applications, 29*(4), 839–866.

Choi, B., & Lee, H. (2003). An empirical investigation of KM styles and their effect on corporate performance. *Information and Management, 40*(5), 403–417.

Chumer, M., Hull, R., & Prichard, C. (2000). Introduction: Situating discussions about "Knowledge". In C. Prichard, R. Hull, M. Chumer, & H. Willmott (Eds.), *Managing knowledge: Critical investigations of work and learning*. Basingstoke: MacMillan.

Currie, G., & Kerrin, M. (2004). The limits of a technological fix to knowledge management: epistemological, political and cultural issues in the case of intranet implementation. *Management Learning, 35*(1), 9–29.

Davenport, T. H., & Prusak, L. (1998). *Working Knowledge: How Organizations Manage What They Know*. Boston: Harvard Business School Press.

Desouza, K. C. (2003). Strategic contributions of game rooms to knowledge management: some prelimenary insights. *Information and Management, 41*(1), 63–74.

Du, R., Ai, S., & Ren, Y. (2007). Relationship between knowledge sharing and performance:A survey in Xi'an, China. *Expert Systems with Applications, 32*(1), 38–46.

Edwards, J. S., Shaw, D., & Collier, P. M. (2005). Knowledge management systems: Finding a way with technology. *Journal of Knowledge Management, 1*(9), 113–125.

Fincham, R., & Roslender, R. (2003). *The Management of Intellectual Capital and its Implications for Business Reporting*. Edinburgh: Research Committee of the Institute of Chartered Accountants of Scotland.

Fliaster, A. (2004). Cross-hierarchical interconnectivity: Forms, mechanisms and transformation of leadership culture. *Knowledge Management Research and Practice, 2*(1), 48–57.

Ford, D. P., & Chan, Y. E. (2003). Knowledge sharing in a multi-cultural setting: A case study. *Knowledge Management Research and Practice, 1*, 11–27.

Gravill, J. I., Compeau, D. R., & Marcolin, B. L. (2006). Experience effects on the accuracy of self-assessed user competence. *Information and Management, 43*(3), 378–394.

Hall, R., & Andriani, P. (2002). Managing Knowledge for Innovation. *Long Range Planning, 35*(1), 29–48.

Hammersley, M. (1996). The relationship between qualitative and quantitative research: paradigm loyalty versus methodological eclecticism. In J. T. E. Richardson (Ed.), *Handbook of Research Methods for Psychology and the Social Sciences*. Leicester: BPS Books.

Hayes, N., & Walsham, G. (2000). Safe enclaves, political enclaves and knowledge working. In C. Prichard, R. Hull, M. Chumer, & H. Willmott (Eds.), *Managing knowledge: Critical investigations of work and learning*. Basingstoke: MacMillan.

Hislop, D. (2002). Mission impossible? Communicating and sharing knowledge via information technology. *Journal of Information Technology, 17*(4), 165–177.

Hornik, S., Chen, H. G., Klein, G., & Jiang, J. J. (2003). Communication skills of IS providers: An expectation gap analysis from three stakeholder perspectives. *IEEE Transactions on Professional Communication, 46*(1), 17–34.

http://www.asetwn.com.tw/.

http://www.foxsemicon.com.tw/.

http://www.innolux.com.tw/.

http://www.uni-president.com/.

James, A. F., Stoner, R., Freeman, E., Daniel, R., & Gilbert, J. R. (1995). *Management* (Sixth ed.). Prentice Hall.

Johannessen, J. A., Olaisen, J., & Olsen, B. (2001). Mismanagement of tacit knowledge: The importance of tacit knowledge, the danger of information technology, and what to do about it. *International Journal of Information Management, 21*(1), 3–20.

Kanter, J. (1999). Knowledge management, practically speaking. *Information Systems Management, 16*(4), 7–15.

Keeley, E. J. (2004). *Institutional research as the catalyst for the extent and effectiveness of knowledge-management practices in improving planning and decision-making in higher education organizations*. North Central University (p. 135).

Khandelwal, V. K., & Gottschalk, P. (2003). Information technology support for interorganizational knowledge transfer: An empirical study of law firms in Norway and Australia. *Information Resources Management Journal, 16*(1), 14–23.

Khera, N., Stroobant, T., Primhak, R. A., Gupta, R., & Davies, H. (2001). Training the ideal hospital doctor: The specialist registrars' perspective. *Medical Education, 35*, 957–966.

Kim, Y. G., Yu, S. H., & Lee, J. H. (2003). Knowledge strategy planning: Methodology and case. *Expert Systems with Applications, 24*(3), 295–307.

Liao, S. H. (2003). Knowledge management technologies and applications – literature review from 1995 to 2002. *Expert Systems with Applications, 25*(2), 155–164.

Lin, C. H., & Tseng, S. M. (2005a). The Implementation Gaps for the Knowledge Management System. *Industrial Management and Data System, 105*(2), 208–222.

Lin, C. H., & Tseng, S. M. (2005b). Bridging the Implementation gaps in the knowledge management system for enhancing corporate performance. *Expert Systems with Applications, 29*(1), 163–173.

Mackinlay, A. (2002). The limits of knowledge management. *New Technology, Work and Employment, 17*(2), 76–88.

Martin, V. A., Hatzakis, T., Lycett, M., & Macredie, R. (2004). Building the business/IT relationship through knowledge management. *Journal of Information Technology Cases and Applications, 6*(2), 27–47.

McDermott, R. (1999). Why IT inspired but cannot deliver knowledge management. *California Management Review, 41*(4), 103–117.

Ndlela, L. T., & Toit, A. S. A. (2001). Establishing a Knowledge Management Programme for Competitive Advantage in an Enterprise. *International Journal of Information Management, 21*(2), 151–165.

Nilakanta, S., Miller, L. L., & Zhu, D. (2006). Organizational Memory Management: Technological and Research Issues. *Journal of Database Management, 17*(1), 85–94.

Nomura, T. (2002). Design of 'Ba' for successful Knowledge Management-how enterprises should design the places of interaction to gain competitive advantage. *Journal of Network and Computer Applications, 25*(4), 263–278.

Nonaka, I., Toyama, R., & Konno, N. (2000). SECI, Ba and Leadership: A unified model of dynamic knowledge creation. *Long Range Planning, 33*(1), 5–34.

O'Brien, J. A., & Marakas, G. M. (2006). *Management Information Systems* (7nd ed.). McGraw-Hill, International.

Oppong, S. A., Yen, D. C., & Merhout, J. W. (2005). A new strategy for harnessing knowledge management in e-commerce. *Technology in Society, 27*(3), 413–435.

Probst, G. S., Raub, S., & Romhardt, R. K. (2000). *Managing Knowledge Building Blocks for Success*. John Wiley and Sons Ltd.

Ruiz-Mercader, J., Merono-Cerdan, A. L., & Sabater-Sanchez, R. (2006). Information technology and learning: Their relationship and impact on organisational performance in small businesses. *International Journal of Information Management, 26*(1), 16–29.

Sabherwal, R., & Sabherwal, S. (2005). Knowledge management using information technology: Determinants of short-term impact on firm value. *Decision Sciences, 36*(4), 531–567.

Schroeder, J. (1999). Enterprise portals: Business information goes self-service. *Enterprise Systems Journal, 14*(9), 28–32.

Sher, P. J., & Lee, V. C. (2004). Information technology as a facilitator for enhancing dynamic capabilities through knowledge management. *Information and Management, 41*(8), 933–945.

Soter O'Neil & Patrick, W. (2004). Managing intellectual capital: Knowledge management and professional development in public relations firms. The University of North Carolina at Chapel Hill, 183 p.

Spiegler, I. (2003). Technology and knowledge: bridging a ''generating'' gap. *Information and Management, 40*(6), 533–539.

Spira, J. B. (2005). The high cost of interruptions. *KM World, 14*(8), 1–2.

Stake, R. (1998). Case studies. In K. D. Norman & S. L. Yvonna (Eds.), *Strategies of Qualitative Inquiry* (pp. 86–109). Thousand Oaks, CA: Sage Publications.

Vouros, G. A. (2003). Technological issues towards knowledge-powered organizations. *Journal of Knowledge Management, 7*(2), 114–127.

Wu, W. W., & Lee, Y. T. (2007). Selecting knowledge management strategies by using the analytic network process. *Expert Systems with Applications, 32*(3), 841–847.

Yin, R. K. (1988). *Case study research: Design and methods*. Newbury Park: Sage Publications.

Yin, R. K. (1994). *Case Study Research – Design and Methods* (Second ed.). Thousand Oaks; London: Sage Publication.