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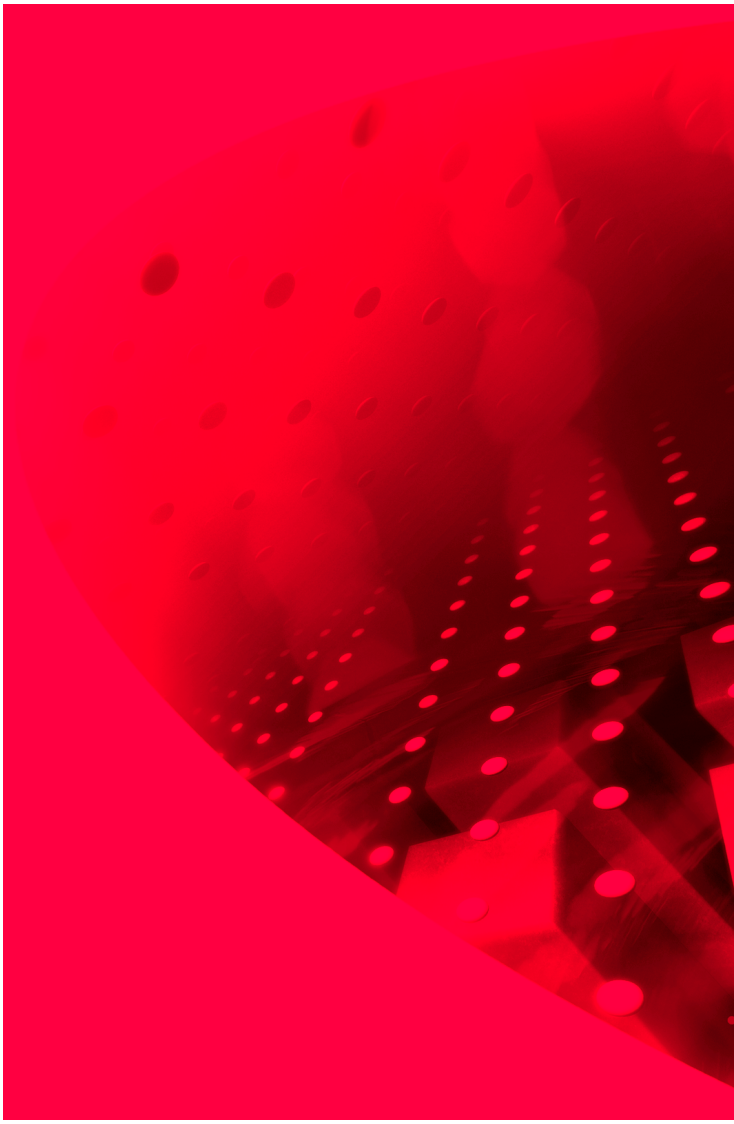

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Foreword

Eric Tsui

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Since the early 1990's, the importance of Knowledge Management to create competitive advantage for organizations has been recognized worldwide. Three recent reports published by Economic Intelligence Unit, Bain and company, and McKinsey all revealed that the adoption of KM in the update worldwide and in particular, medium size enterprises in Asia Pacific lead their counterparts in introducing and valuing the importance of KM to enhance a firm's competitiveness. Early efforts in KM concentrated on the introduction of IT systems to automate the collection and searching of explicit knowledge assets whereas in recent years much of the KM effort has been directed at providing an environment that entices the elicitation and sharing of tacit knowledge as well as the fostering of a co-learning environment among knowledge workers free of organizational and location constraints.

The 3rd Asia-Pacific Conference on Knowledge Management was held in Hong Kong from 11-13 December 2006, and had attracted more than 700 delegates, including practitioners, academics and civil servants, from more than 30 countries. Up to now, this event is still the largest of its kind in the region. With six keynote speakers and over 100 presentations, the conference brought together renowned speakers from all over the world and the presented topics covered almost the complete spectrum of knowledge management from management of intangible assets; knowledge discovery through data mining and taxonomy, capturing and sharing tacit knowledge, and collaborative technologies and systems. All in all, the event has provided a good opportunity for both practitioners and researchers to update their knowledge of the latest developments in this field.

This special issue contains nine selected papers from the Conference and covers a broad spectrum of insights and research findings in the area of knowledge culture, information management, knowledge sharing and applications in various industry sectors. I would like to express my sincere thanks to the contribution from the members of the Technical Committee, reviewers and the authors who have made this special issue possible.

Investigating KM antecedents: KM in the criminal justice system

M. Nordin, David J. Pauleen and G.E. Gorman



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This article is dedicated to the memory of M. Nordin who passed away shortly after its completion.

Abstract

Purpose – *The specific aim of this paper is to explore the multi-disciplinary academic antecedents of KM in order to better understand KM. By doing so, it is suggested that KM can be more effectively applied in real-world situations, such as professional occupations.*

Design/methodology/approach – *The approach is conceptual: five core antecedents of KM – philosophy, sociology, psychology, computing and information systems, and management – are explored and associated with the criminal investigation process.*

Findings – *KM antecedents can be applied to the professional discipline of criminal investigation to create a conceptual model of knowledge management for the criminal investigative process. The model offers guidance on ways in which KM can be understood in terms of the criminal investigative process.*

Research limitations/implications – *KM has been considered a somewhat nebulous subject, so there is value in exploring its multidisciplinary roots to gain a better understanding of it and how it can be more effectively applied in specific organizational or practitioner contexts.*

Practical implications – *By mapping the KM antecedents to the criminal investigation process a conceptual model has been developed, which it is believed could prove useful in helping police organizations, as well as academics studying the criminal justice system, to better understand the discipline of KM in the context of law enforcement-related work.*

Originality/value – *While KM antecedents have been identified, the paper is one of the first to explicitly show how they can be used to link KM to real world situations – in this case the criminal investigative process.*

Keywords *Criminal justice, Policing, Knowledge management, Administration of justice and law enforcement*

Paper type *Conceptual paper*

Introduction

On the surface the disciplines of knowledge management (KM) and criminal justice seem to be distinct; however, deep within the foundations of both disciplines are apparent and significant links. The aim of this paper is to explore these links. We do so by first investigating the multi-disciplinary academic antecedents of KM. We then map them onto one particular sub-system of the criminal justice system (CJS) – policing – specifically one of policing's key activities, the criminal investigation process (CIP). By antecedents we mean those disciplines that arguably inform and support much of what is considered to be KM. We suggest that because KM is often considered a somewhat nebulous subject, that there is value in exploring its multidisciplinary roots in order to gain a better understanding of it and possibly more effective ways to apply it in organizational and practitioner contexts.

Very little research has been conducted based on the antecedents of KM, though many of the antecedents have been identified (Table I – see *Determining the KM Antecedents* (p. 7)). No instances of studies have been found that explicitly explore the relationship between KM antecedents and CJS activities such as the CIP, though there have been several previous

Table I Knowledge management antecedents selected from multiple disciplines

Source	*Multi-disciplinary antecedents of KM*
Prusak (2001)	Intellectual antecedents: economics, sociology, organizational learning, philosophy and psychology. Practices bringing significant content and energy to knowledge management are information management, the quality movement, and the human factors/human capital movement
Pemberton (1998)	Among those laying claims to KM are: librarianship, artificial intelligence, records management, archives management, information technology, psychology, philosophy, neurobiology, philosophy, organizational theory, information science, systems analysis, industrial training, human resources, and computer science
Armistead (1999)	Philosophy, economics, social science and the physical sciences are on the academic side of the scale, while the application of ICT tends towards the more pragmatic end
Standards Australia (2003)	A primary characteristic of knowledge management is its integration of a range of business and academic disciplines including: human resource management; communications; philosophy; business management; change management; information management; information technology; sociology; organizational learning; and strategic planning
Wiig (cited in Despres and Chauvel, 2000)	*Historical efforts* religion and philosophy (e.g. epistemology) psychology economics and social sciences business theory. *Twentieth century efforts to improve effectiveness* rationalization of work (Taylorism), total quality management, and management sciences psychology, cognitive sciences, artificial intelligence (AI), and the learning organization
Day (2001)	Documentation; linguistics; politics; social science
Despres and Chauvel (1999)	Management; economics; organization theory; strategy; human resource management; cognitive psychology; epistemology; social science; creativity; information science; information systems
Baskerville (1998)	Information economics; strategic information systems; organizational culture; organizational behaviour; artificial intelligence; quality management
Skyrme (1999)	Business transformation; innovation; information management; knowledge-based systems; intellectual assets; learning organization
Davenport and Cronin (2000)	Library and information science; process engineering; organizational theory

KM related CIP studies (see Greenwood *et al.*, 1977; Innes, 2003; Luen and Al-Hawamdeh, 2001; Morgan, 1990; Simms and Petersen, 1991; Swanson *et al.*, 2003). These studies were mostly related to the objectives of police work and the issues related to police organizations.

The paper poses two questions:

1. Which KM antecedents are relevant to the criminal investigative process?
2. What is the nature of the relationship between these KM antecedents and the criminal investigation process?

Essentially we develop a conceptual model that links all the constructs related to both the KM antecedents and the criminal investigation process. This conceptual model will be useful for any police practitioners, such as criminal investigators, who need to understand the link between KM and the CJS, particularly, the CIP.

The criminal justice system

According to Maxfield and Babbie (2005, p. 42), the CJS is a field founded on many other disciplines such as sociology, economics, geography, political science, psychology, anthropology, and biology. At its basic structure, the CJS encompasses the police, courts, and corrections. The police service represents the law enforcement component, the courts process represents the adjudication, and the correction process represents the (re)making of people to suit the system. These sub-systems are related to one another (Chamelin *et al.*, 1975) as shown in Figure 1.

In this paper we focus on the first sub-system of the CJS, which is related to policing. In particular we are only concerned with the function of the criminal investigation process, whose purpose is to control crime through the accumulation of information and generation of knowledge by an investigator to find who is involved in a crime and why it was committed (Innes, 2003).

KM concepts

A discussion of KM concepts must begin with an understanding of the core component of it, which is knowledge. A relevant definition of knowledge is provided by Davenport and Prusak (1998, p. 5):

> . . . a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers.

Many proponents of KM agree on two general kinds of knowledge: tacit and explicit. Tacit knowledge is a personal knowledge, which is difficult to articulate or record (Bouwen, 2001). Brockmann and Simmonds (1997) argue that this kind of knowledge includes the insights and skills embedded in individuals. The second category of knowledge is explicit knowledge. Stover (2004) explains that explicit knowledge is expressed knowledge that can be used to communicate with others. When this knowledge is documented, it is codified. Codified knowledge is usually in the forms of written reports, databases, and other media. As a working definition, we adopt the one proposed by Standards Australia (2003, p. 1):

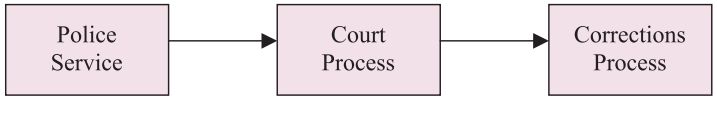
> . . . a multi-disciplinary approach to achieving organizational objectives by making the best use of knowledge. It involves the design, review and implementation of both social and technological processes to improve the application of knowledge, in the collective interest of stakeholders.

Any discussion of KM is of questionable significance if it is not put in a proper context. Such a context normally has to do with people and organizations and involves tacit and explicit forms of knowledge.

Personal and organizational knowledge

Personal knowledge and organizational knowledge are two different yet interdependent concepts (Bhatt, 2002). Ipe (2003) states that personal knowledge is created, shared, and disseminated among individuals in an organization. Personal knowledge can be enhanced, externalised, and stored as organizational knowledge. In the organizational setting, personal knowledge is created through various means such as interaction between individuals at various levels of the organization. Organizational knowledge cannot be created without individuals and personal knowledge must be shared among individuals and

Figure 1 The criminal justice system model



Source: Chamelin *et al.* (1975, p. 3)

> **"Any discussion of KM is of questionable significance if it is not put into a proper context."**

groups at various levels of the organization in order to enhance organizational effectiveness (Ipe, 2003). Knowledge sharing is important because it enables the relationship between the individual and the organization by moving personal knowledge to the organizational level. Knowledge that resides at the organizational level will enable the innovation of the organization's practices and subsequently this knowledge can help it to achieve goals and objectives (Ipe, 2003).

Organizational knowledge includes all the tacit and explicit knowledge that individuals possess about products, systems, and processes and the explicit knowledge that is codified in manuals, databases, and information systems (Bryant, 2003). It also includes routines, standard operating procedures, technological implements, and organizational artefacts (Patriotta, 2004).

Nemati (2002) asserts that organizational knowledge has become an important asset in the world economy. Organizational knowledge coupled with information technology, such as the Internet, can assist organizations in making better decisions. Nemati (2002) suggests that the interplay between tacit and explicit knowledge can create new knowledge for the development of new content or for replacing the existing content within the organization's knowledge base.

The KM antecedents

Despite many publications and discussions, there is no consensus on the meaning or application of KM. A wide range of approaches is available, both theoretical and practical, that can be used to explore and understand KM. By breaking the KM concept down to its fundamentally formative parts, we suggest it will be possible to make more concrete and useful associations between KM and the criminal investigation process. In this paper we refer to these KM parts as KM antecedents.

Determining the KM antecedents

Only a few researchers have looked at KM in terms of its parts (see Currie and Kerrin, 2004; Guptill, 2005). However, none has explicitly examined the links between KM antecedents and the criminal investigation process. To do so, we first determined the KM antecedents from the existing literature. This was done through an extensive search of the KM literature.

The list of KM antecedents as understood by various authors is shown in Table I. As can be seen there is no consensus on what constitutes the antecedents of KM. There are, arguably, a number of important antecedents. Using a technique known as sample selection using key words (Im *et al.*, 2001), we selected five core antecedents of KM: philosophy, sociology, psychology, computing and information systems, and management, which we believe can be used to better understand KM in relation to the CIP. Other KM antecedents may be relevant given other objectives. Our strategy is to deconstruct each antecedent and apply its relevant elements to the criminal investigation process.

The Links between KM antecedents and the CIP

A careful analysis of the KM antecedents and how they relate to many of the key processes and qualities inherent in the CIP was conducted[1]. Table II shows the five main antecedents that are critical to an understanding of knowledge management as well as those specific elements that are closely related to the applications of the criminal investigation. We will discuss each of the antecedents in this section. Concepts that represent an obvious linkage between KM and CIP are underscored in the following discussions.

Table II Summary of the applications of KM Antecedents in the CIP

KM antecedents	*Elements of KM antecedents*	*Applications of the elements of KM antecedents*
Philosophy	Logic	Cognitive reasoning
	Ethics	Police code
	Epistemology	Right actions
		Right reasons
		Right judgments
		Right decisions
		Moral rules
		Good policing
		Personal knowledge
		Organizational knowledge
		Information (explicit knowledge)
		Tacit knowledge
		Intelligence
		Evidence
		Interview (information and knowledge generation)
		Interrogation (information and knowledge generation)
Sociology	Culture	Police culture
	Social	CID culture
	Organization	Occupational culture
		Organizational perspectives to act
		Community policing
		Society informants
Psychology	Cognitive	*Psychology research:*
		Attitudes
		Skills
		Management problems
		Psychology tests:
		Mental illness
		Behavioral styles
		Personality traits
		Unfit for job
		Psychological profiling
		Hypnosis
		Cognitive interview
Computing	Applications	Administrative systems
	Hardware	Data retrieval systems
	Networking	Analytical systems
	Communication	Process control systems (CAD or 911)
	Databases	DNA databank
		Crime and Intelligence analysis
		AFIS (Automatic Fingerprint Identification System)
		GIS (Geographical Information System)
Management	Personal	Management of the investigative knowledge
	Administration and managerial control	Management of the investigator's actions
	Investigation	Selection and posting of resources in the CID
		Case management (caseload allocation)
		Police administration
		Time management
		Case file management

Philosophy

The first antecedent of KM is philosophy. The term literally means love of wisdom and was coined by Pythagoras who said that philosophy is a desire of people for wisdom. Through philosophy, people are trying to bring the vagueness of consciousness of their thinking to the foreground. By so doing, their thinking will become clear and have a proper direction (Nicholson, 1939). There are many elements of philosophy, but the most relevant elements in terms of CIP are logic, ethics and epistemology.

Stroll and Popkin (1961) defined logic as a discipline that attempts to distinguish correct from incorrect reasoning. Innes (2003) relates investigation and logic:

> The investigative methodology binds together the various methods employed by detectives to generate knowledge about crime, providing them with a grounding and unifying logic (Innes, 2003, p. 174).

Thiroux (1985) describes ethics as the study of morality based on values. One of the things that seem to distinguish human beings from other inhabitants of this planet is our desire and ability to value things.

The criminal investigators as police personnel are bounded by the police code of ethics. According to Kleinig and Zhang (1992 cited in Davis, 1995), the International Association of Chiefs of Police (IACP) produced a document entitled ''Law Enforcement Code of Ethics'' in 1957, which was the first 'code of ethics' for police. They defined a code of ethics as ''a formal statement of a certain kind of practice'' (p. 84). Codes of ethics are based on practices of morality and the practices of law. Based on a similar code of ethics, the investigator is expected to make the right judgements and take the right actions for the right reasons during the investigation process (Neyroud, 2003, p. 589).

Pemberton (1998) states that epistemology derives from *episteme* (the Greek word for knowledge), so it means the study of knowledge. Epistemology is a branch of philosophy that asks often circular questions about how we can know that we really know anything. In the criminal investigation process, Dienstein (1995, p. 160) asserts that the investigators need to answer several questions: who, what, when, where, and how? Sometimes an investigator needs to answer the why question.

It is important for the investigators to answer the entire list of questions to ensure successful prosecution and conviction of the criminal. Knowledge is also critical for the investigators, as it can prevent them from prosecuting an innocent person (Dienstein, 1995). The investigation process comprises the stages of information and knowledge generation constructed by the investigator in order to understand the crime situation. The process is not a linear sequence of actions but a more complex process, which involves mental and physical aspects of the investigator (Innes, 2003).

Maguire (2002) states that the investigative practice has two basic objectives or tasks: the generation of (investigator) ''knowledge'', and the production of ''evidence''. As for the first objective, knowledge refers to the conclusions and understandings reached by the investigator regarding the crime. The production of knowledge normally involves the following tasks:

- determining that one or more criminal offences have been committed;
- producing a ''narrative'' of the circumstances surrounding the offences;
- determining the most promising ''line of inquiry'';
- identifying and/or eliminating one or more ''suspects'';
- exploring the backgrounds, motivations, lifestyles and activities of suspects or ''known offenders'' and their associates; and
- gathering intelligence about planned offences (Maguire, 2002, p. 370).

In relation to the second objective, Innes (2003) states that evidence is the information that has been selected and can be understood and represented in accordance with the logic of a legal framework. The investigative activity of the investigators is in the direction of collecting

"Despite many publications and discussions, there is no consensus on the meaning or application of KM."

information that can generate knowledge and evidence that allows them to identify and charge the criminal in a court of law. Maguire (2002) points out that the production of evidence entails the following basic tasks: producing evidence that specific offences were committed (or were planned), and producing evidence to link suspected persons with particular offences.

When suspects or witnesses are required to assist the investigation, the investigators use techniques to help them to gain knowledge about the crime being investigated. The techniques help to elicit the *tacit* knowledge from their minds. Among the techniques used are interviewing and interrogation (Dienstein, 1995). Swanson *et al.* (2003) note that interviewing is the intended gathering of information from people who have or may have knowledge needed in the investigation. Investigators obtain information perceived from the five senses (sight, sound, smell, taste, and touch) of the witness. Interrogation is also used to obtain information and match it with other information about a particular suspect to secure a confession (Swanson *et al.*, 2003). However, according to Dienstein (1995), there are legal requirements that must be followed by the investigators in obtaining information this way. Failure to adhere to the requirements will negate the use of the information gained during the interrogation as evidence in a court of law.

Sociology

The study of social influence on human behaviour can be traced back to the ancient Greeks but it was only 200 years ago that this discipline became known as a science (Coser *et al.*, 1983). Sociology is a systematic way to understand the world and social life. The main focus of sociology is human beings and their actions. Among major themes in sociology are culture, organization, and society. The three themes are interrelated when discussed from a knowledge management perspective.

The social aspect of the investigators is always intertwined with the culture of the CID and the organizational expectations of their work. Investigators are expected to perform by solving criminal cases within a certain time and they need to clear a number of case files within that time limit. When a case is of public interest, an investigator needs to gain clear knowledge about the case in a short period of time, which later needs to be prepared as an account for the superior officers regarding the case. Some investigators spend a long time on their cases due to the complexity of the investigation. Owing to these kinds of pressures, investigators are identified as having a strong occupational culture (Innes, 2003). Manning (1995, p. 472) defined an occupational culture as ''a reduced selective, and task based version of culture that is shaped by and shapes the socially relevant worlds of the occupation.'' This culture serves ''as a source of knowledge about 'doing' policing, establishing a set of background common-sense understanding of what policing means and how in a practical sense it is accomplished'' (Innes, 2003 p. 14).

The influence of culture on the investigators at the organizational level is described by Innes (2003, p. 15) as:

> The values and norms of detective culture are inflected by the position of this aspect of police work within the structures of the organization and its attendant stratified status hierarchies. These cultural attributes that do much to order and structure investigative practices are shaped by the range of interspersed policy, procedural, product and presentational discourses that effectively constitute the organization in a ''structural'' sense.

This shows that the organizational setting can influence the investigators' actions when responding to crimes and the way they may conduct themselves during the investigation process. Investigators as actors are conditioned by the social purposes and functions of the organization of which they are members (Innes, 2003). The organization provides a ''perspective'' on how members are to view the world, render it meaningfully and orderly, and make it suitable to act (Weick, 1995 cited in Innes, 2003).

In a crime prevention programme, the investigators are also involved in community policing. Hatty (1991) states that community policing is a strategy used by police organizations to establish a close relationship with local community residents for the benefit of that

community in terms of security and safety. Zhao *et al.* (2002) argue that community policing has been shown to help reduce social disorder and crime incidents through information sharing between the police and the public. In terms of investigations, with community policing the investigator has wider access to the local criminal information about incidents in the community due to the rapport established with that community. Some of the victims and witnesses in the community have become good sources of information *(informants)* and knowledge for the investigator (Aguilar, 2002).

Psychology

Psychology is broadly defined as the science of behaviour and mental processes (Lefton, 1994). It uses scientific principles and well-defined methodology to present an organized body of knowledge and to make inferences. Psychologists study many aspects: observable human actions, mental processes include thinking and reasoning processes, emotions, and psychological reactions associated with biological reactions due to the emotional responses. Psychologists are expected to describe, explain, predict, and manage the basic components of behavior (Lefton, 1994).

Ainsworth and Pease (1987) believe that psychology is of some value to the serving police officer. They assert that psychology is relevant to particular tasks such as training and the handling of hostage or siege situations. Recent developments indicate that the police are increasingly interested in what psychology might offer (Brogden *et al.*, 1988).

There are three questions normally asked by psychologists regarding police work in general. First, what kind of attitudes do police officers have; second, what kinds of skills are required of police officers; and third, what are the management problems involved in harnessing such attitudes and skills in the production of ''good police practice'' (Brogden *et al.*, 1988 p. 11)? Brogden *et al.* (1988) point out that several studies of police personalities have answered these questions. The studies suggested that the typical police personality has characteristics such as: authoritarianism as a learned response to doing a particular kind of job in a particular organizational setting; suspicion as a consequence of the dangers of the job or specific training; and conventionalism resulting from their involvement in a disciplined paramilitary organization.

The policing skills in general are related to observation, interrogation, and situation. Observation skills require the ability of sense making, a good memory, and perceptual processes and expectancy. Interrogation skills along with incriminating evidence enable the investigator to persuade the accused to confess to the crime. Situational skills are the ability of the investigator to respond in a critical situation without escalating it.

In police training and recruitment, the use of psychology tests is well established as an entry point. Barrett *et al.* (2003) mention that psychology tests are commonly used in the selection of law enforcement officers before they can be accepted for recruitment training. McKenna *et al.* (2002) discuss the use of the Myers-Briggs Type Indicator (MBTI) for the prediction of behavioral styles that fit with certain job tasks. The MBTI test shows that police officers or detectives are inclined towards the combination of Extraversion, Sensing, Thinking and Perceiving (ESTP) (McKenna *et al.*, 2002).

Moreover, criminal investigation has adopted a psychological method of detecting criminals, which is known as psychological profiling. Usually, this method is used to aid investigators in the investigations of serial crimes (Ratcliffe, 2004). Teten (1995, p. 475) defined psychological criminal profiling as ''a method of identifying the perpetrator of a crime based on an analysis of the nature of the offence and the manner in which it was committed.'' This method uses various aspects of a criminal's personality deduced from known actions before, during, and after the criminal act. This information, combined with other pertinent details and physical evidence, is then compared with the characteristics of known personality types and mental abnormalities to develop a practical working description of the offender (Teten, 1995). Holmes and Holmes (1996) suggest that psychological profiling is an essential investigative tool when the investigator deals with cases without obvious criminal motives and which can therefore be considered abnormal.

> **"Knowledge management is sometimes regarded as an oxymoron by those who consider it somehow impossible to manage knowledge."**

Kebbell and Milne (1998) indicate that the identification of an offender normally relies on fingerprints, DNA samples, or informers. When a crime occurs, the investigator needs assistance from the public to provide information about the crime if they have seen it. The members of the public who come forward are eyewitnesses and the method that they normally provide to the investigator in identifying suspects is using descriptive information. However, if eyewitnesses are unable to remember details of a crime, perpetrators may go unpunished; on the other hand, if eyewitnesses recall information inaccurately, innocent people may be convicted of crimes.

In relation to such evidence, psychologists have devised methods of enhancing eyewitness recall such as hypnosis and cognitive interviews (Kebbell and Milne, 1998). According to Swanson *et al.* hypnosis is ''a means of aiding witnesses in recalling facts buried in the subconscious memory'', cognitive interviews are ''an interview approach in which a witness is asked to recall events and details in different ways as a means of fostering the witness's recollections'' (Swanson *et al.*, 2003, pp. 134, 141). Both methods are used as investigative tools that suggest descriptions of the events or offenders and provide new knowledge to the investigator for further investigative actions.

Computing and information technology

In the last two decades computers have also changed the way knowledge is processed, stored, distributed, and accessed (Ceric, 2003). Thus organizations using knowledge management initiatives are inevitably involved with setting up a computing and information infrastructure. There is also a perception that this kind of technology can assist the members of the organization in performing their knowledge management tasks more efficiently (CIKM, 2003).

Generally, law enforcement agencies implement systems that can be categorised among the following: administrative systems, data retrieval systems, analytical systems, and process control systems (Stevens, 1995). Administrative systems include personnel records handling, budgeting activities, payroll processing, and other administrative duties. In addition, data retrieval systems provide information on suspect, victim, or witness identification and administrative support activities. Analytical systems may provide general information, data summaries, and statistical analysis. Among functions provided by analytical systems are criminal investigation, crime analysis, research and planning, management analysis and evaluation, manpower allocation as well as budgetary analysis and audit. Process control systems are used to support and control police. In essence, the system provides a ''command and control'' approach for the management of daily police activities.

At the crime scene, the investigator is concerned with two important issues: the people involved in the crime and the physical evidence that is usually present at a crime scene. Using scientific investigation, the involvement of specific people can be identified through the physical evidence left by them. The physical evidence at the crime scene includes fingerprints, bloodstains, fibres, hairs, and soil (Sagara, 1995). With the advances in computer technology, computers have been used to collect, store, and analyse the physical items found at the scene of crimes. Fingerprints previously stored in fingerprint card files are now being scanned and stored in digital forms. Computers are now being used for fingerprint filing and searching purposes (Menzel, 1995). Bloodstains found at the crime

scene are now analysed using DNA analysis, which has become essential in criminal investigation with the advancement of DNA typing systems and sampling capability.

For the last two decades, the increases in computer power and digital storage and also a steady reduction in computer costs have encouraged the police to computerize their records for statistical and managerial purposes. At the same time, police realized that the same records could be used for crime and intelligence analysis such as crime mapping. Rossmo (2003) indicates that crimes do not happen at random: rather they follow certain patterns. After committing a number of crimes, the criminals leave behind a blueprint of their mental map. This mental map when entered into a computer program will produce a map showing the most probable areas that police should target. Ratcliffe (2004) mentions that law enforcement has shown interest in using geographical information systems (GIS) to map the incidence of crime occurrences, which is parallel to research activities in the identification of patterns and psychological aspects of criminals. The potential of this technology in assisting criminal research and investigation makes the police the first criminal justice agency to show considerable interest in crime mapping. Although this technology faces many obstacles at this early stage, recent developments have overcome the technical difficulties with the availability of computer mapping packages for the desktop market (Ratcliffe, 2004).

The use of KM antecedents, as distinct from generic KM, is particularly instructive in the case of computing technology. In much of the KM literature information and computing technology is considered to be one of the primary, if not the only, element of KM. This has led to less than ideal KM implementations in many organizations. By classifying computing and information technology as a KM antecedent, its proper, but still important, role in a more holistic application of KM can be better understood. In the CIP, technology plays a crucial role, but its application to the CIP cannot on its own be considered KM.

Management

Management is a multi-disciplinary area of study, which is best seen as a cluster of activities, roles, and tasks (Griseri, 2002). It has four operational functions: planning, organizing, influencing, and controlling (Mondy and Premeaux, 1995).

In the criminal investigation process, the investigator is involved in the management of knowledge, which is related to the investigation process and the management of actions, which is related to the line of inquiry of the investigation. At the tacit level, the investigator manages his or her own cognitive thought concerning the identification, interpretation, and ordering of knowledge with the objective of ascertaining how the crime occurred, who was involved, and how (Innes, 2003). At the explicit level, the investigator organizes the information collected in a coherent form, which is legally valid, and prepares a structured narrative description of the crime incident according to what has been investigated and considers the case for prosecution (Innes, 2003).

The management of actions is in accordance with the availability of explicit knowledge accumulated during the investigative work. Innes (2003, p. 133) describes the management of investigative actions as the interplay between information and the progress of actions:

> Many investigative actions are products of the information collected, and analysis of this interwoven, complex, mutually productive relationship and action is a difficult but necessary task, in terms of understanding the conceptual base of investigative work. Using the data collected, what becomes apparent is the way in which as an enquiry progresses the focus of the information sought shifts, as does the orientation of investigative actions designed to produce it.

Ward (1995) asserts that a key success element in the criminal investigation process is the use of case management systems. He defines case management as ''a planned, coordinated, and tested way of maximizing both efficiency and productivity in the reporting and investigation of crime'' (Ward, 1995, p. 58). A good case management system starts shortly after the police force become aware of a crime. However, according to Ward, despite previous studies, which tried to refine the case management system so that it can be both efficient and effective, many police departments still use ''hit or miss'' methods. Poor or

"The KM-Criminal Investigation Process model comprises three main constructs: the KM antecedents, the criminal investigation process, and an investigator."

nonexistent managerial direction has contributed to the poor results of crime investigations in most police departments (Ward, 1995).

Ward (1995) adds that when an investigator is assigned to a case, it is his or her responsibility to follow through with it. Good case management occurs when each investigator maintains a list of active cases, records their state of development and other relevant information. The investigator should also prepare an investigative program that will include a list of results required in order to investigate the case, the strategy to be followed, and a time sequence. The time sequence should include opportunities for management review and discussion (Ward, 1995).

Since administration is synonymous with management, it is worthwhile discussing it here (Megginson *et al.*, 1983). As an example, some aspects of police administration are related to the selection of investigators to join the CID. Cordner (1995) states that the administration side of the police is always concerned with the performance of the officers who execute government policies regarding crimes. Owing to this concern, the police administration must be selective in acquiring and posting resources to perform the criminal investigation. The personnel assigned to the CID must possess certain criteria that fit the nature of the job. Individuals assigned to criminal investigation must have the necessary basic skills, and appropriate personality for the work and the culture of the CID (Innes, 2003). Innes (2003, p. 9) describes the investigative skills as follows:

> [Investigative work is] founded upon a ''dialectical'' synthesis of ''craft'' skills blended with a ''scientific'' style of rationality. [It is] a mix of the rational and the intuitive, a synthesis of art and science. Good investigators were held to be possessed of a combination of fairly intuitive perceptual skills and ''technical'' knowledge related to crime and its investigation.

Along with the process of investigation, the investigator is required to manage a case file. A case file is a folder where the investigator collects and collates the documentation of the case under investigation. The investigator records all the actions taken during the investigation, explicitly described in codified form.

Knowledge management is sometimes regarded as an oxymoron by those who consider it somehow impossible to manage knowledge. This may be an extreme point of view, but by looking at management as an antecedent of KM it can be more directly and relevantly linked to the task at hand. In this case, we can link management concepts, which directly affect knowledge use, to the CIP.

The criminal investigation process

Martin Innes (2003, p. 176) views the criminal investigation process as follows:

> Crime investigations are composed of a number of discrete yet linked investigative actions, which are directed towards the production of knowledge about how and why the crime occurred.

Garvin (1998) states that processes are collections of tasks and activities that are combined together and transform inputs into outputs. These inputs and outputs consist of materials, information, and people. Davenport (1993, cited in Garvin, 1998) argues that the work process entails a specific ordering of work activities across time and space, a structure for action.

The criminal investigation process in this study is synthesized from the processes and events of criminal investigation of several sources (Innes, 2003; Swanson *et al.*, 2003). The process (Figure 2) shows how an investigator undertakes a series of sequential actions from the time a crime is reported to the police (or the police detected the crime themselves) until a case is constructed. The main events of the process are: crime reported or detected by police, preliminary investigation, follow-up investigation, suspect development, and case construction. Each process is briefly discussed (for a more detailed description see Nordin and Pauleen, 2005).

Crime reported or detected by police

Reporting a crime is normally the initial stage of a criminal investigation. Reports can be in verbal or written form regardless of the nature of the case, and also incidents can be reported via telephone. Reports may be lodged by the public or by the police themselves.

Preliminary investigation

This is the stage when an investigator receives the crime report. The investigator will read the report thoroughly to understand and make sense of the incident or situation. In a case where a patrol officer is the first responder to the case, this officer will attend the case and conduct a preliminary investigation.

Follow-up investigation

In the follow-up investigation, the investigator gains information subsequent to the preliminary investigation. This involves visiting the crime scene, and interviewing witnesses and suspects.

Suspect development and apprehension

The main objective of an investigation is to find the offender behind the incident and also the motives for the crime. With all the information and evidence accumulated at this stage, the investigator may be able to identify and locate a suspect.

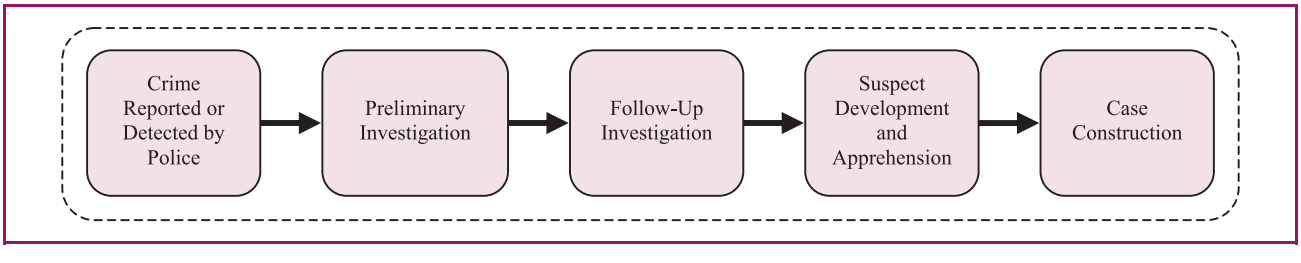
Case construction

In this stage the police need to ''legalize'' the information that they have collected and organized to form a coherent, legally valid, structured narrative account of what the investigator believes has taken place in the crime incident (Innes, 2003).

The investigator

The CIP is usually conducted by an investigator, who is a police officer, allowed to exercise all or any of the special powers in relation to police investigation given by the law (*Criminal Procedure Code*, 2003). According to Innes (2003), a good investigator is required to have both intuitive skills and technical knowledge. Intuitive skills indicate that an investigator is capable of functioning at several levels: physical, emotional, mental, and spiritual (Vaughan, 1979, cited in Yoong, 1999). The underlying knowledge that forms personal competence in carrying out the investigation can include both tacit and explicit knowledge. The tacit knowledge explains how things happen while the explicit has the potential to explain why

Figure 2 The major criminal investigation stages



things happen. Tacit and explicit knowledge are components of mental models (Koskinen, 2003).

Kim (1993) explains that the investigator views the crime situation through mental models. These provide the context in which to view and interpret new material, and they determine how stored knowledge is relevant to a given situation. According to Kim (1993), they represent more than a collection of ideas, memories, and experiences: they also help the investigator to make sense of the world.

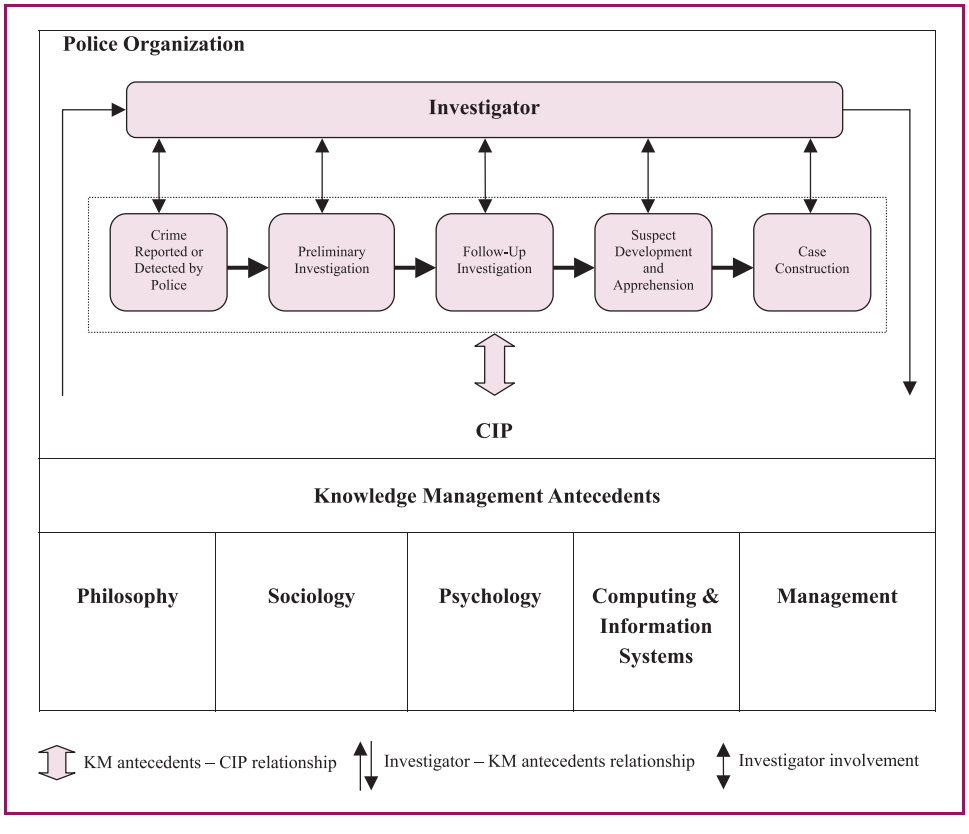
Similarly, an investigator must have the personal integrity to face physical, emotional, and material temptations. At a technical level, the investigator must have a sound knowledge of the techniques and procedures required in a criminal investigation. Socially, the investigator must have a good knowledge of and understanding of people, their mental processes, their culture, their customs, and their environment (Dienstein, 1995).

In sum, many elements of an investigator's work can be directly linked to the KM antecedents discussed earlier. The usefulness of the KM antecedents in understanding and enhancing the investigator's role in the CIP are mapped in Figure 3.

KM antecedents and the CIP: a conceptual model

Figure 3 presents a conceptual model of knowledge management and the criminal investigation process (KM-CIP). The KM-CIP model comprises three main constructs: the KM antecedents, the criminal investigation process, and an investigator. The model shows the involvement of the investigator in each event of the criminal investigation process in the context of the police organization. The legend of this model shows two-way arrows that represent the relationships between the constructs.

Figure 3 A conceptual model of knowledge management for the criminal investigation process



The usefulness of the model lies in its power to break down the usually difficult-to-understand concept of KM into its more manageable and applicable antecedents.

Conclusion

In this paper we have tried to show why it is important to understand the roots of KM and how such an understanding can help make KM more relevant to particular applications in organizational or practitioner contexts. Specifically, we have discussed five core antecedents of KM and shown the linkage between these antecedents and the application of the elements of the antecedents within the criminal investigation process. The proposition that KM is a multi-disciplinary subject was established through the association of the antecedents that we have put forward in this paper. The conceptual model of KM-CIP shows how the KM antecedents can be mapped and linked to the CIP. In this relationship, the personal knowledge of the investigator is used in every stage of the CIP, whether to make decisions or to advance the investigation according to the leads of the inquiry. The antecedents of KM have certain roles in supporting the CIP as well as the investigator. The model can point to ways in which a police organization can use KM to augment police procedures.

In this conceptual article we did not attempt to rate the relative importance of the antecedent disciplines, and we acknowledge that some CIP applications as stated may be located in multiple antecedents (i.e. tacit knowledge). We also acknowledge there may be overlap between antecedents (i.e. sociology and psychology). Rather, our goal has been to illustrate how KM antecedents can be used to link KM in a meaningful way with CIP. We believe that the antecedents and the conceptual model in this paper can be useful for police organizations, both from the perspective of academics and practitioners in the criminal justice system to better understand the discipline of KM particularly in the context of law enforcement related work.

Future research is encouraged to extend this conceptual model so that it can be adapted to other situations related to criminal investigation, the criminal justice system, and criminology. We also urge researchers and practitioners to consider the use of relevant KM antecedents when applying KM to specific professional and organizational contexts, processes and, practices.

Note

1. The first author was a member of the Royal Malaysian Police and was trained in CIP.

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Knowledge and information sharing in a closed information environment

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Abstract

Purpose – *The objectives of this research are to ascertain the current status of, and barriers to, knowledge and information sharing; to elicit suggestions for improvement; and to determine whether the situation is different from that experienced by organizations operating in an average business environment.*

Design/methodology/approach – *The approach adopted was a survey conducted within the New Zealand Defence Force, for the purpose of obtaining a deeper understanding.*

Findings – *It was found that much similarity existed between the two types of organizations except that the organization operating in a closed information environment presented as an extreme example of an average organization. In particular, the requirement to maintain high security yet encourage the free flow of knowledge and information presents a considerable challenge.*

Originality/value – *The paper presents some insights into an area about which very little is known and which is, by its nature, difficult to research. It shows how closed information environment organizations could provide insights and examples for those operating in the average business environment. When consequences are more critical, practice will become more finely honed.*

Keywords *Knowledge sharing, Information exchange, Knowledge management, Information transfer*

Paper type *Research paper*

Introduction

Many organizations have realised the benefits of knowledge management and, in particular, those of sharing information and knowledge within the organisation. However, the highly competitive environment in which many organizations operate gives rise to a paradox between allowing information and knowledge to flow freely within the organization, and the need to keep certain information very secure. In ''closed-information'' environment organizations such as national defence forces, the challenge of balancing the free flow of information and knowledge with tight security becomes exaggerated.

Because of the necessarily secretive nature of many military operations very little has been researched on the knowledge management practices within such organizations. Although Erwin and Tiron (2002) reported that the US Army had been one of the most fervent adopters of knowledge management, very little, if any, material is available on the knowledge management practices in other national military organizations. Reports that do emanate from the US about their activities, focus more on the information sharing software packages that they might have acquired for human resources management or for acquisitions management. Similarly the UK Ministry of Defence (IBM Global Business Services, 2006) and the Canadian Defence Force (Defence Research and Development Canada, 2008) report on information sharing and collaborative software packages that they might have acquired. The focus of these reports thus seems to be on the means rather than the content, or the policies surrounding their use. In fact, the US Department of Defense banned YouTube

and MySpace for fear that their use would divulge secure information to the wrong recipients (McCarthy, 2007).

A study was thus undertaken in the New Zealand Defence Force (NZDF), which aimed to gain some insight into the knowledge and information sharing component of knowledge management. Its objectives were:

1. To ascertain the status of knowledge and information sharing in the NZDF, with particular focus on:
   - current practices and policies;
   - information communication technologies in place; and
   - current level of knowledge/information sharing, and organizational culture.
2. To identify the factors which are perceived to be barriers to knowledge and information sharing in the NZDF.
3. To elicit suggestions as to how to improve the knowledge and information sharing within the NZDF.
4. To ascertain whether the barriers and suggestions for improvement are different from those of an organization operating in an average business environment.

Background

For a number of years now companies have focused on their knowledge resources as a primary means of gaining a strategic advantage. This focus has taken the form of an increased emphasis on knowledge management (Hansen and Avital, 2005). The benefits of a well-functioning knowledge management system have been widely documented. Some of the more commonly noted benefits are: improved loyalty; speedier decision making; quicker ''gearing-up'' of staff; greater staff retention (Machy and Johnson, 2000); development of more innovative ideas; greater flexibility in dealing with change and responding to crisis; increased capability to control the coordination of complex activities; and superior strategic decision making (Davidson and Voss, 2002).

Although the benefits described refer specifically to those experienced by organizations operating in an average business environment, they could be the types of benefits sought by an organization operating in a closed information environment. However, the benefits that have been identified as specifically applying to the latter types of organizations are a reduction in time spent piecing together fragmented information (Frank, 2003) which results in increased efficiency and effectiveness in solving complex problems; justification of research and development; and appropriate design of field operations and training programmes (Erwin and Tiron, 2002).

Despite the well-documented benefits, a number of barriers to knowledge management, and in particular knowledge sharing, exist. One of the most important barriers, as identified by Pan and Scarbrough (1999), is the absence of trust. Carr *et al.* (2003) and Hexmoor *et al.* (2006)all saw the need for security as often triggering this absence. Bartol and Srivastava (2002) and Hexmoor *et al.* (2006) attributed a lack of sharing to the perception that knowledge is power, while Ladd and Ward (2002) and Hansen and Avital (2005) saw too strong a focus on competition within an organization as being the cause.

Further barriers include insecurity or ignorance about the value of one's own knowledge (Riege, 2005) – ''unconscious competence'', as Goman (2002) referred to it; zero tolerance of mistakes; and a low readiness to accept new ideas (Goman, 2002).

In addition, bureaucracy (Ladd and Ward, 2002); a high level of organisational stratification (Riege, 2005); employee and employer goal divergence; functional silos (Skyrme, 2002; Stevens, 2000); lack of top management support (Figallo and Rhine, 2002), and lack of commitment and strategy, regardless of the amount of resources being spent (Stoddart, 2001) have been noted as obstacles to knowledge management.

> **"The highly competitive environment in which many organizations operate gives rise to a paradox between allowing information and knowledge to flow freely within the organization, and the need to keep certain information very secure."**

In particular, inappropriate reward and recognition programmes often act as impediments to producing the desired results (Bartol and Srivastava, 2002; Davidson and Voss, 2002; Lunney, 2002; Gross, 2001; Stevens, 2000). Rewards can be either public or private but recognition is usually public.

Further barriers include lack of training (Figallo and Rhine, 2002) in both technical and interpersonal skills (Davidson and Voss, 2002); lack of tools and/or inadequate information systems, poor information quality (Skyrme, 2002; Stoddart, 2001) and overpopulation of the knowledge management systems with non-essential information (Davenport, 1997); lack of time and resources (Lunney, 2002; Stoddart, 2001); and a general lack of balance between the investment in human and technological resources (Davenport, 1997).

With particular relevance to a closed information environment, although Erwin and Tiron (2002) indicated that lack of trust was one of the factors hindering the sharing process they stressed the need for extreme caution as inappropriate information might endanger a current mission. French and Michael (2003) and Riege (2005) noted that power struggle or control of the use of the knowledge or information was another problem, while Lichtblau (2003) reported that sharing was almost impossible amongst different agencies due to the different types of software and databases used. Kellogg (2003) also noted that in a closed information environment, such as the US Defence Department, hierarchical organizational structures have been seen to act as barriers to knowledge sharing.

Methodology

A quantitative approach was adopted and a survey was chosen as the method of enquiry. Because of the highly secure nature of a national defence force, the investigation needed to be conducted anonymously and the identity of the respondents needed to be kept confidential. This restricted the range of methodology options. However, for the purposes of the research, a survey was the ideal enquiry means.

The development of the survey instrument, a questionnaire, was guided by the research questions and was based on the literature reviewed. The questionnaire assessed perceptions and consisted of five open-ended questions and 32 closed-ended questions. The latter were grouped into three main sections: current practices and policies, information communication technology; and current level of knowledge sharing and organizational culture.

A total of 97 surveys were distributed to potential participants in selected departments. These had been chosen based on the fact that they handled high levels of secure information as well as possessing the technological expertise needed to support a secure transfer of information. These were selected in consultation with relevant officials in the NZDF. A specially appointed senior NZDF staff member both distributed the questionnaires according to a pre-designed stratified sampling pattern, and then collected them. A total of 70 responses (72.2 per cent response rate) were received. This was within a two-week period after the despatch.

Findings

The data from the returned questionnaires were captured and the analysis ensued. The findings are reported in the following sections.

Current practices and policies

In order to ascertain the current situation in terms of knowledge and information sharing, respondents were asked for their perceptions of a number of aspects. Their responses are reflected in Table I. The response options in bold reflect the answers of the majority of respondents. The numbers represent the exact number of those majorities. The total number of respondents (70) should be born in mind when interpreting the table, although in some instances only 69 or 68 responded. (Tables II and III follow the same approach.)

The most frequent method of communication identified by the respondents was e-mail, and information systems were considered the most important sources of information. There could be a number of reasons for technological means of communication and sources of information being preferred, such as time and location differences, convenience, as well as

Table I Current practices and policies of knowledge and information sharing

Most frequent ways of communication	E-mail / Face-to-face / Telephone
Important sources of information	Person-to-person / Person-to-system /Person–to-dept
Able to get information needed	Always 4 / 34 / 19 / 13 / 0 Never
Colleagues respond to information needs	Always 10 / 25 / 8 / 3 / 0 Never
Respondent responds to others' information needs	Always 30 / 34 / 1 / 0 / 0 Never
Designates places exist for informal communication	Yes 27 / No 26 / 10 Not certain
Designated times exist for informal communication	Yes 16 / No 45 / 9 Not certain
Management publicly supports knowledge and information sharing	S Agree 8 / 18 / 24 / 17 / 2 S Disagree
Staff are encouraged to contribute to corporate knowledge	S Agree 7 / 23 / 20 / 16 / 3 S Disagree
Formal policies encourage knowledge and information sharing	Yes 20 / No 9 / 40 Not certain
Formal security guidelines on knowledge and information sharing exist	Yes 62 / No 3 / 4 Not certain
Formal rewards exist for knowledge and information sharing	Yes 11 / No 35 / 15 Not certain
Knowledge and information sharing performance measures exist	Yes 7 / No 44 / 19 Not certain

Note: S = Strongly

Table II Use of Information communication technology in knowledge and information sharing

Systems facilitate knowledge and information sharing	S Agree 26 / 24 / 7 / 10 / 2 S Disagree
Available information is relevant	S Agree 22 / 24 / 18 / 3 / 3 S Disagree
Information is up to date	S Agree 8 / 24 / 29 / 6 / 2 S Disagree
Training is provided in use of systems	S Agree 4 / 14 / 17 / 25 / 10 S Disagree
Contributing knowledge and information via organizational IS is easy	S Agree 5 / 20 / 23 / 16 / 5 S Disagree
Finding useful knowledge and information in the organizational IS is easy	S Agree 7 / 17 / 19 / 21 / 9 S Disagree

Note: S = Strongly

Table III Current levels of knowledge sharing and organizational culture

Culture of trust in organization	Very much 23 / 23 / 12 / 6 / 5 Not at all
Sharing is a core value	Yes 41 / No 15 / 13 Not certain
Tolerance of mistakes	S Agree 3 / 23 / 26 / 11 / 6 S Disagree
Knowledge and information experts are approachable	Very 13 / 25 / 19 / 1 / 1 Not at all
Knowledge and information flow well between departments	S Agree 1 / 12 / 19 / 27 / 11 S Disagree
Information hoarding exists	Always 4 / 24 / 24 / 16 / 2 Never
Competition among employees	S Agree 7 / 13 / 22 / 16 / 11 S Disagree
Secrecy is often the reason for not sharing	S Agree 13 / 19 / 23 / 8 / 5 S Disagree
Organization rewards contribution to corporate K	S Agree 0 / 1 / 16 / 28 / 23 S Disagree
Assessment encourages group/individual action	Group 1 / Individual 13 / Both 7 / Not certain 46
Access to right information has improved	S Agree 16 / 26 / 20 / 4 / 2 S Disagree

Note: S = Strongly

trust in the system to deliver reliable information. However, while such tools have been proven effective and efficient, Burk and Richardson (2001) have found that non-visual tools can cause and escalate misunderstandings and conflicts.

The majority of respondents felt that they could always get the information they needed. It thus seemed that the need for security and the free flow of information might have been well balanced, as had been advised by Barth (2001). Linked to this point, it also seemed apparent that most of the respondents' colleagues knew what information they needed and passed it on to them, and that most of the respondents in turn knew what information their colleagues needed and passed it on.

Although a slight majority indicated that designated places existed for informal communication and sharing of ideas, a large group were of the opinion that there were no such places. Nonaka and Konno (1998), had stressed the importance of creating an appropriate space or places for people to interact, share ideas and problems.

Furthermore, the vast majority indicated that there were no designated times for informal communication and sharing of ideas, This is in contrast to the emphasis that Nonaka and Takeuchi (1995) and Dorfman (2001) had placed on the importance of allowing employees time to engage in the processes of socialisation, internalisation, externalisation and combination.

Most respondents were non-committal about their management's public promotion and support of knowledge and information sharing. It seems that the management were not very overt and proactive in this regard.

However, most respondents felt that staff were encouraged to contribute to corporate knowledge. This would follow the advice of Davenport (1997) and Spencer (1997) with regard to sharing explicit information. This encouragement could have come from non-management staff or by various non-personal communication channels. Nevertheless, the caveats of Davidson and Voss (2002) and Goman (2002) to ensure that the relevant systems are easy to use and employees are adequately trained to use them are also important in this regard. It doesn't help if staff are encouraged to contribute but are not equipped to do so.

Although a sizeable number of the respondents indicated that there were formal organizational policies in place, which encouraged knowledge and information sharing – which is in line with the advice of Dorfman (2001) – the majority of respondents were uncertain of the existence of such policies.

With regard to the existence and dissemination of formal security guidelines concerning the types of knowledge and information that may be shared, almost all respondents indicated that this was the case. This could be expected from a highly secure environment such as a national defence force where sharing inappropriate information could have fatal results.

> **"Because of the necessarily secretive nature of many military operations, very little has been researched on the knowledge management practices within such organizations."**

As noted by Stevens (2000), though rewards are not essential, they often act as a catalyst to improve sharing. However, most respondents were of the opinion that there were no such rewards in place in the NZDF. Such a reward system implies a knowledge and information sharing performance measurement system on which to base the rewards. On this point, too, most respondents indicated that there was no such measurement.

Information communication technology

The responses to the questions on the information communication technology used in the knowledge and information sharing are captured in Table II.

Most respondents were of the opinion that the NZDF had information communication systems that facilitated knowledge and information sharing, and that the information available within those systems was relevant to their work. This is in line with the advice offered by Davidson and Voss (2002) regarding the importance of information relevance, and with that of Davenport (1997) regarding the importance of ensuring that the systems are not populated with non-work related and non-value-adding information. Despite the perceived relevance, however, respondents were generally uncertain as to whether the information was up-to-date.

According to Grouard *et al.* (1999), lack of training is often cited as one of the barriers to knowledge management, including knowledge and information sharing. On this count, the majority of respondents reported that no formal training was provided with regard to the use of the information communication systems. As a result, the majority did not experience particular ease in finding useful information in the systems. In fact, they found it easier to contribute to the systems. The advice of Davidson and Voss (2002) that systems should be easy to contribute to, and retrieve from, should be noted in this regard.

Current level of knowledge sharing and organizational culture

In describing the current levels of sharing as well as the status of the organizational culture in terms of these practices, Table III highlights the main responses.

The core values promoted by the NZDF are loyalty, integrity, professionalism and commitment (www.nzdf.mil.nz/corporate/mission.html#values). From the description of each of these it is clear that trust in other members of the NZDF underpinned these core values.

Pan and Scarbrough (1999) emphasized the essential nature of a trusting culture in knowledge sharing, and the majority of respondents did feel that a trusting culture existed in the NZDF. Most respondents also felt that sharing was a core value. However, the majority tended to be less certain about the extent to which the organization was tolerant of mistakes. Although Goman (2002) and Lunney (2002) advised on the wisdom of creating a mistake-tolerant culture, this advice needs to be balanced with the consequences of mistakes in the context of a national defence force.

Despite the knowledge and information experts within the organization being perceived by most of the respondents as being approachable – as had been advised by Gordon (2000) – they did not seem to feel that knowledge and information flowed well between departments. This could be attributable to a silo-type structure in the NZDF, which might have enabled a good flow within but not between departments.

It could also be attributable to the information hoarding tendency amongst NZDF employees which the majority of respondents saw to be more the case than not. According to Davidson and Voss (2002), the hoarding of useful information or knowledge is harmful to the organisation.

Another reason for information not flowing freely could have been the feeling of competition amongst employees Skyrme (2002). However, most respondents were uncertain whether competition existed or not.

A further factor inhibiting a good flow could have been the requirement of security and secrecy, which the majority of respondents saw to be the reason for not sharing knowledge and information. This was contrary to the earlier impression created by the reports that information flowed freely in the organization. It also reflects the concern of Barth (2001) for a balance between the need for security and the free flow of information.

Most of the respondents seemed to feel that the organization did not reward employees fully for contributions to corporate knowledge. This runs counter to the advice of Bartol and Srivastava (2002), Lunney (2002) and Gross (2001) who all emphasized the importance of rewarding knowledge sharing. In addition, respondents were generally uncertain about whether assessment of contribution was on an individual or group basis, or both. Bartol and Srivastava (2002) and Gross (2001) had indicated that in order to promote sharing, the emphasis should be on group contributions, and Goman (2002) had proposed that rewards should consequently be structured accordingly.

In general, however, most respondents felt that access to the right information and knowledge had improved over the last year in the NZDF.

Barriers to knowledge and information sharing

With regard to the factors that respondents believed would discourage the sharing of information and knowledge, some 112 suggestions were forthcoming. These were then refined into 11 broad categories: remuneration; organizational environment; time and resources; training and education; information technology; management practices; information quality; information access; information security; people's beliefs, fear and attitudes; and information awareness. Table IV depicts the results of responses to this question.

The categories of barriers into which most responses fell were: training and education; information security; and beliefs, fears and attitude towards information and knowledge sharing.

With regard to the need for security of information, in a closed information environment such as the NZDF, information dissemination is often on a need to know basis. The premise is that the fewer people who receive the information, the lower the risk of it falling into the wrong hands. Therefore much information is classified according to pre-determined information security regulations.

Table IV Categories of barriers to knowledge and information sharing

Barrier category	*Percentage of responses*
People: beliefs, fears and attitudes	33.9
Training and education	10.7
Management practices	3.6
Information awareness	3.6
Information quality	3.6
Information technology	5.4
Information access	7.1
Information security	17
Remuneration	0.9
Organizational environment	4.5
Time and resources	9.8

However, many respondents felt that lack of training in these security classification and dissemination procedures, and the consequent lack of confidence, was the reason some employees withdrew from sharing information. In addition, some respondents noted the lack of sufficient security between technological systems and between departments. To prevent security breaches, some respondents added that staff often over-classified and over-compartmentalised information.

As noted by Barth (2001), poor security can compromise the competitive position of an organisation; but too much security can also be detrimental to the organization. Furthermore, Barker (2003) and Barth (2001) both identified people as being the biggest problem with regard to security, and they emphasized the need for appropriate training.

Lastly, certain beliefs, fears and attitudes of staff emerged as an important group of barriers to sharing. One of the most common problems was the perception that knowledge is power. Some respondents mentioned that some staff felt that by sharing they would lose control, competitiveness and power. Another reason was that some employees had low self-confidence about the knowledge or information they had. They were afraid of making mistakes and/or feared being exposed or ridiculed. Further barriers were a lack of interest in sharing, a fear that others would take credit for their work, and a perception that other people's information or knowledge was irrelevant to them. With regard to all of these, it is worth noting Stevens' (2000) comment that it is just being human to look out for ourselves, whether it is to protect ourselves from harm, or to prevent someone from being better than us.

Barriers to using others' knowledge and information

With regard to the factors that respondents felt would discourage staff from using others' information and knowledge some 89 suggestions were presented which were refined into eight broad categories: training and education; information technology; management practices; information quality; information access; information security; people's beliefs, fear and attitudes; and information awareness. The responses can be seen in Table V.

It is notable that the top three groups were: training and education, information quality; and beliefs, fears and attitude towards sharing.

In comparing Tables IV and V, apparently information security is considered more important when sharing and information quality is more important when using information.

As with barriers to sharing information and knowledge, the lack of training on security issues and classification regulations and procedures appeared to be a barrier to using knowledge and information. Respondents also commented that one of the main problems was that often people were afraid to use certain information due to a lack of knowledge on the classification type of that particular piece of information. Another problem was the inability to decipher or extract useful information from large amounts of data in the information systems. This highlights the importance of easy to use tools that Davidson and Voss (2002) had emphasized with regard to information and knowledge usage.

Table V Categories of barriers to using others' knowledge and information

Barrier category	*Percentage of responses*
People: beliefs, fears and attitudes	33.7
Training and education	11.2
Management practices	4.5
Information awareness	9.0
Information quality	23.6
Information technology	2.2
Information access	9.0
Information security	6.7

Poor information quality can be a barrier to knowledge management (Skyrme, 2002; Stoddart, 2001). In this case, it emerged as one of the main barriers to the usage of others' knowledge and information. From the results, relevance, accuracy, credibility, completeness and currency were some information quality attributes that the respondents often found lacking. In addition, information overload was another problem. As Davidson and Voss (2002) had noted, it is crucial to understand that quality and not quantity of information is what is important to users.

Similarly to sharing, perceptions, beliefs and attitudes of different people can be a barrier to usage of others' information and knowledge. Independence, pride, the ''not invented here syndrome'', lack of trust and acceptance of others' knowledge and information, personal conflicts of opinion or characters, the perception of being in a special and unique situation, and fear of asking because others might think they were incompetent, were some of the pertinent barriers suggested by the respondents. This emphasizes the caution of Skyrme (2002), that encouraging people to use others' information and knowledge can be a challenge.

Suggestions for promoting sharing

In terms of what the respondents perceived management should do to promote a sharing culture in the NZDF, 72 different suggestions were forthcoming. These were then grouped into categories according to the three components of best knowledge management practice. These components were: the right information and knowledge feeding the organisation; the right technology to store and communicate that information and knowledge; and the right culture to motivate employees to contribute and reuse knowledge and information (Davidson and Voss, 2002).

The majority of suggestions (61.6 per cent) centred around the need for management to invest more into nurturing and improving the motivation of employees to share their knowledge, and to integrate the acquired knowledge into their daily work. A suitable work environment with the right culture and good morale was required.

The more common suggestions fell into the following groups. Examples of typical responses are provided for each group:

1. Balance the number of staff and workload to allow time to share – ''Employ the right number of people to meet the workload thus allowing more time to disseminate/share information''.
2. Provide proper rewards and recognition for sharing – ''Give credit where credit is due''.
3. Effect a change in the attitudes of the management, so that they:
   - should be impartial and open to all suggestions from everyone regardless of levels and ranks – ''Get away from the idea that it must be right because a person in favour says so'';
   - trust their employees – ''Management needs to improve relations with staff, e.g. trust'';
   - acknowledge that people are more important than technology – ''Relearn that people and not systems are key''; and
   - ''lead by example''.
4. Promote more accepting and all-inclusive of contributions from everyone – ''Be more open and 'joint' in our approach to activities''.
5. Facilitate more inter-department, inter-level, and inter-organization interaction – ''Have more frequent opportunities for staff at all levels to discuss issues''.
6. Value staff contributions – ''All staff need to feel their input is both valued and accepted''.
7. Create an open and accepting culture – ''The creation of an environment where staff can feel safe to provide constructive criticism of work issues''.

"Overall, it would appear that the main barriers to knowledge and information sharing were the exaggerated need for security, lack of training, and beliefs and attitudes of the staff."

8. Direct knowledge and information seekers to appropriate knowledge and information sources – ''Produce an experts database with points of contact on various topics''.
9. Promote sharing by creating a suitable working environment, incentives, more cooperation, policies, core values, mission statement etc. – ''Break down the current structural barriers''.

The next largest group (21.9 per cent) of the suggestions indicated that management should invest more into better and more secure technology. Employees sought a quality information system, which was:

- easy to use – ''Accessing through extant technology can be trying at times'';
- designed to support rather than ''dictate'' – ''I sometimes feel as though technology seems to drive what and how we need to do things rather then assisting us in what we need to do'';
- secure – ''Provide the right secure information management equipment to the right people''; and
- built on a standard platform to enhance efficiency and effectiveness of sharing – ''Streamline the information highway by having the same systems working on each network''.

Finally, 16.4 per cent of the suggestions indicated that management should invest more into educating and training the employees. These suggestions focused on:

- educating employees on the awareness of knowledge and information – ''Increase understanding of what different departments do so people are aware of what should be shared'';
- training on the better use of available technology – ''Provide training to allow personnel to access shared databases''; and
- educating and re-educating on security issues and procedures – ''Promote training – instigate a two-yearly security refresher course''.

Although these suggestions provide valuable input for management, it is important that they heed the caution of Davidson and Voss (2002) and balance of all these three critical components and their intersection with one another.

Discussion

Overall, it would appear that the main barriers to knowledge and information sharing were the exaggerated need for security, lack of training, and beliefs and attitudes of the staff. While the formal guidelines with regard to security appeared to be very firmly entrenched, the organizational policies with regard to knowledge sharing did not appear to be promoted as strongly. This was manifested in the lack of, or ignorance of, the training in this regard, appropriate performance measures and rewards, and a general organizational culture, which facilitated an open, sharing environment.

On the other hand, the emphasis on security seems to have created a slight ambiguity in the attitudes of the staff members. While trust emerged as a strong core value of the organization, this was tinged with feelings of not quite trusting the information received

from others, the quality of the systems, the quality of the information residing in the systems, and also sometimes not trusting the value of one's own knowledge or information. The commitment of management was also questioned as a result of not apparently providing the wherewithal to facilitate the trust in an environment requiring such high security. Ultimately, people and their beliefs, attitudes and values, seemed to be at the core of most issues.

As with the barriers to sharing, the suggestions on how to facilitate greater knowledge and information sharing in the NZDF reflect what has been documented in the literature. Many of the suggestions are practical and relatively easy to implement, given the appropriate resources, and the outcomes can be measured. This would refer particularly to training, information security and information quality.

On the other hand, changing aspects such as attitudes of management are more difficult to effect and measure. Firstly, it is difficult, but not impossible, to change attitudes. Secondly, the survey captured perceptions, and perceptions of others' attitudes can often be erroneous. There were, however, some specific suggestions such as the facilitation of more inter-level, inter-departmental interaction, and the provision of transparent reward and recognition programmes which could help to change attitudes, or perceptions thereof.

What appears to emerge is the need for knowledge and information sharing initiatives to operate with an holistic approach to an organization, rather than with a compartmentalized approach which does not take into account the conflict that can arise between the various demands such as the need for security and the need for an easy flow of knowledge and information.

Furthermore, in an organization such as a defence force, where coordinated, concerted, flexible action is often called for, it is best to provide very specific guidelines and training in these in order to minimize uncertainty and resultant uncoordinated efforts. Because knowledge and information is so critical, the same would apply in this regard.

Recommendations

Arising from the research and the indications from the literature, the following recommendations would serve to enhance the knowledge and information sharing within the ''closed-information environment'' of the NZDF.

It would appear that although the management might well be embracing a policy of knowledge and information sharing, they have not promoted it sufficiently – possibly taken it as a given as they have become familiar with it. However, staff turnover and new staff arrivals must be accommodated and all efforts must be made to ensure that mechanisms for sharing are put in place and do not rely solely on individuals for promotion of policies

It is thus recommended that management overtly and proactively promote a knowledge sharing culture and that to do this they:

1. Put mechanisms in place to support this, such as:
   - ensuring that guidelines, policies and procedures surrounding knowledge and information sharing are firmly and formulated clearly and promoted proactively;
   - changing the reward system to acknowledge knowledge sharing, both individually and in groups, so that the notion that knowledge is power is not seen as an ultimate strength;
   - recognizing and judging all input, based on merit rather than personal source, and in doing so, making allowances for mistakes. However, this should be tempered with an emphasis on accuracy; and
   - creating times and places for informal exchange of information and knowledge, for instance, mandatory weekly staff luncheons or social meetings after work.
2. Lead by example, and not simply pay lip service to the idea of knowledge and information sharing.

3. Ensure that technical systems are put in place which:
   - are fast and easy to use;
   - prevent certain information being accessed by unauthorized staff, and prevent certain information being input into specific systems by staff;
   - provide evidence of information currency, accuracy, completeness. This can be done by providing dates of contributions and comments from users as to the usefulness of, or problems with, the information;
   - are designed to prevent overload of information, for example by sensitive application of metadata; and
   - ensure the ability to speedily extract the necessary information.
4. Ensure that training is provided for all with regard to:
   - the policies of information sharing;
   - the use of the technical systems;
   - the training should be ongoing with regular (at least every two years) refresher courses; and
   - the training should be mandatory.

Conclusions

This study was undertaken in order to gain some insight into the knowledge and information sharing within the NZDF, as an example of a closed information environment. Using a survey, current practices and policies were explored, as well as the barriers to information sharing. Based on suggestions of the interviewees as to how the knowledge and information sharing could be improved, and also on the indications from the literature, a number of recommendations are made. These focus especially on galvanizing management to more actively promote knowledge and information sharing, and to put mechanisms in place to ensure this. A focus is also on requirements of appropriate technical systems and on the definite need for regular training with regard to the relevant policies and the use of the technical systems.

In terms of the differences between organizations operating in a closed information environment and in a normal business environment, it would seem that a closed information environment acts as an extreme example of what most organizations experience. The need to engender and facilitate trust amongst staff members in the face of the need for tight security is the same for most organizations. The only thing is that the consequences of not doing either are much more dire in an organization such as a defence force. Finding the balance, as Barth (2001) observed, is the challenge, and all the more critical in a closed information environment.

While most research on knowledge management and knowledge sharing, has been conducted in organizations operating in an normal business environment, it is suggested that organizations operating in closed information environment can provide valuable insights into knowledge management and, in particular, knowledge and information sharing. This has especially been the case in the study of strategy, and a similar approach could be adopted

“In terms of the differences between organizations operating in a closed information environment and in a normal business environment, it would seem that a closed information environment acts as an extreme example of what most organizations experience.”

in knowledge management. When consequences are more critical, practice will become more finely honed.

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Knowledge elicitation in reliability management in the airline industry

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Abstract

Purpose – *The purpose of this paper is to identify the appropriate method, demonstrating with a prototype model, of how knowledge in reliability management can be elicited from individuals as well as a team.*

Design/methodology/approach – *The approach is to elicit the tacit knowledge of the reliability engineers through narratives and cognitive mapping. With a sufficient number of cognitive maps, patterns are revealed and an aggregate cognitive map for all participating members is produced, which helps to summarize various approaches and procedures that can be taken in handling different reliability management issues.*

Findings – *The work provides a real-life example to support the stages of learning from the individual, the group to the organizational level as described in the theoretical Learning Framework.*

Research limitations/implications – *Many knowledge management programs failed for various reasons. One common pitfall is that they are either too ambitious or too vague in the scope, methodology of their deliverables. To be successful, the project objectives should be linked to the business needs that lead to solving their business problems.*

Practical implications – *A prototype is developed in the organization of expertise knowledge in a bottom-up manner in the building of a corporate memory from individuals to team level in the reliability management in an airline company.*

Originality/value – *This is the first study in the airline industry to capture the know-how and experience of its reliability engineers in the form of congregate cognitive maps so as to facilitate team learning and the building of organizational memory. It is the first in the airline industry to adopt this methodology for developing its own procedure manuals. The model was implemented successfully in the Engineering Division of an airline business in order to handle their reliability management issues.*

Keywords *Reliability management, Knowledge management, Airlines, Cognitive mapping, Narratives*

Paper type *Conceptual paper*

1. Introduction

This study is a joint project between the Department of Industrial and Systems Engineering of The Hong Kong Polytechnic University and the Engineering Division of the Hong Kong Dragon Airlines Limited (Dragonair). The Engineering Division started its first knowledge audit project in 2002, which was to identify its knowledge flow, knowledge inventory and collaborative culture. This project is another attempt to capture and document the knowledge and skills of its experienced staff in the reliability management unit.

Reliability engineering normally focuses on the identification of the root cause of a problem and tackles the problem by altering the design and process to improve product reliability or reduce the occurrence of failures. However, reliability management is different from reliability analysis. Airline reliability management seldom exercises the Failure Mode and Effect Analysis (FMEA) or Fault Tree analysis types of technique that are usually performed by manufacturers and suppliers of aircraft bodies and components. Airline reliability management aims to minimize operational disruption, uphold the service and safety level

for its passengers and at the same time maintain the commercial viability of the whole business. It takes a systems approach to considering different ways on how to maintain safe operations and help reduce the operating costs. The knowledge issue is both technical and non-technical. For example, the staff in an airline needs to explain to the public the cause of an incident in order to maintain the reputation of the airline. In case of suspected failure of aircraft components which may affect safety, they have to assess the degree of the impact on flight safety and on the disruption of the flight schedule, and make important decisions on the level and scale of inspection and maintenance to be done, and its timing, to ensure that the safety standards are not compromised. At the same time, they have to minimize any adverse effects on maintenance costs and delay of flights.

In this paper, a method in making visible the mental model of staff has been revealed. It demonstrates how tacit knowledge can be elicited from individuals and make it available to a team and then elicit it from the team and make it available to the whole organization.

2. Objectives of study

The building of a knowledge repository to store real-life reliability cases handled by their experienced staff is valuable to Dragonair. There is no need for new staff to reinvent the wheel when handling similar cases as they can reuse past knowledge as a reference for decision-making, and much time will be saved. A repository can further help improve the efficiency of staff in performing their daily work. Dragonair has to establish its internal reliability procedure in order to obtain the E2 Design Approval. E2 Design Approval allows an airline to do modifications to aircraft, systems and equipment in both the avionic and structural fields. Airlines can design modifications from changing the seating layout and installing photo luminescent floor path lighting, to installing new avionic systems. This can further minimize airline operation distractions since the airline has the right to do certain non-critical modifications on aircraft to save costs. The overall objectives of this project are:

1. To build up a knowledge repository in order to facilitate knowledge retrieval and reuse.
2. To retain valuable experience/knowledge from serving staff.
3. To shorten the learning cycle for new employees.
4. To promote a positive knowledge sharing culture among employees.
5. To help staff members to reflect on their experiences.

3. Knowledge elicitation through the use of narrative technique

According to Schreiber *et al.* (2000), knowledge elicitation comprises a set of techniques and methods that attempt to elicit knowledge of a domain specialist through some form of interaction with that expert. It is a process of extracting knowledge. Traditionally, the tasks involve finding at least one expert in a certain knowledge domain and conducting in-depth interviews with him or her.

According to Snowden (2000), the challenges in performing knowledge elicitation are that:

- Knowledge can only be volunteered; it cannot be conscripted.
- We always know more than we can tell, and we will always tell more than we can write down.
- We only know what we know when we need to know it.

One of the techniques of eliciting knowledge is the use of narratives. The word ''narrative'' is derived from the Latin word ''gnarus'' and the Proto-Indo-European root gnu, ''to know'', it came into English via the French language and it is used in a number of specialized applications. It is an interpretation of some aspect of the world that is historically and culturally grounded and shaped by human personality (Fisher, 1984). Narrative is an account of a sequence of events. It is a story describing situations and characters according to a timeline, in a context, which can either be fictional or non-fictional.

> **"In this paper, a method in making visible the mental model of staff has been revealed."**

Narrative can be a story or an anecdote. According to dictionary.com, a story is an account or recital of an event or a series of events, either true or fictitious. It refers to a retelling of events that led to an outcome, which is of value to certain audiences (MSDN Academic Alliance Developer Centre (2005); while an anecdote is a brief tale, which narrates an interesting or amusing incident. It is always based on real life, an incident involving actual persons in real places. It can be a story of personal experience. However, over time, modification in reuse may convert a particular anecdote into a fictional piece. As stated by Snowden (1999) and Gabriel (2000), anecdotes are typically oral and ephemeral. In order to build more contexts into a narrative, the ASHEN model of Snowden is adopted to help practitioners to formulate some stimulating questions when conducting interviews or focus groups.

4. Cognitive mapping – visualizing the mental model of complex issues

Business is only possible when there is an expectation of shared meaning between parties. As long as the expectations are congruent, and the eventuality agrees with the expectation, business continues. Therefore, in order to cope with it, it is suggested that new objects or experiences be compared with those that users are familiar with and then patterns can be identified and categorized into existing categories. Cognitive mapping is one of the solutions for transferring knowledge in a dynamic way.

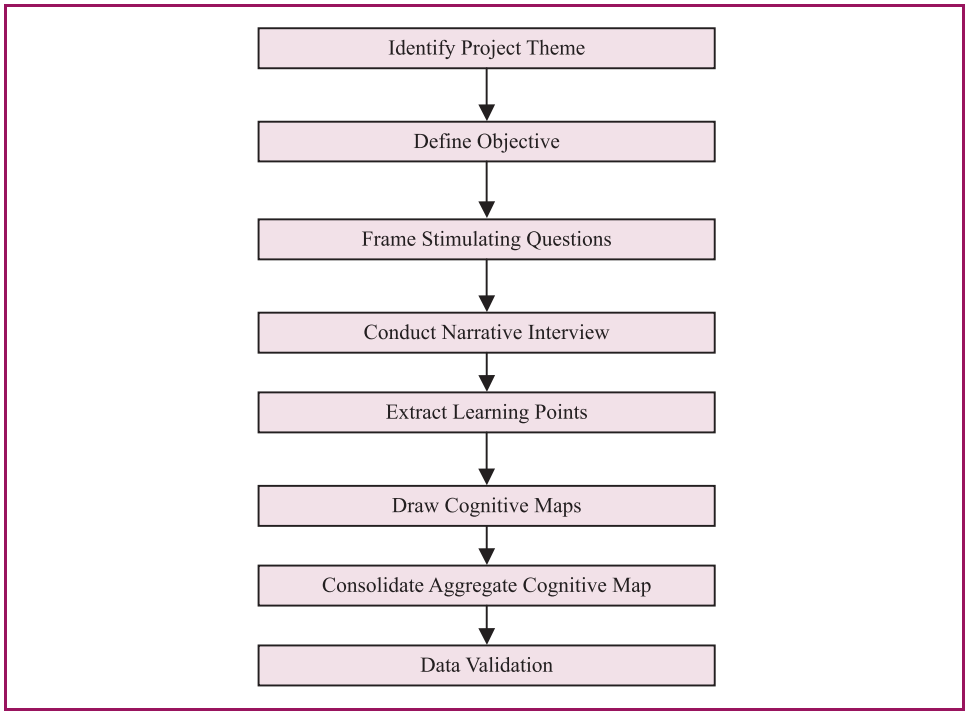
Cognitive maps are directional graphs and thus they have their historical origins in graph theory, which was formulated by Euler in 1736 (Biggs *et al.*, 1976). Axelrod (1976) was the first one to use cognitive mapping to show the causal relationships among variables as defined and described by people, rather than by the researcher. Since then, many studies have used cognitive mapping to look at decision-making as well as to examine people's perceptions of complex social systems.

Cognitive mapping, a technique, which has been developed over a period of time, can serve a variety of purposes such as helping to structure, analyze and make sense out of messy or complex data for problem solving. It can also be applied when conducting interviews by visualizing the mental models of interviewees. It is used as a note-taking method during interviews or acts as an effective interview device to structure a complex problem. Alternatively, it can be used to record transcripts of interviews or other documentary data in a way that promotes analysis, questioning and understanding of the data. Whilst cognitive mapping is often carried out with individuals on a one-to-one basis, it can be used with groups to support them in problem solving. Cognitive mapping may also be defined as a process composed of a series of psychological transformations by which an individual acquires, codes, stores, recalls, and decodes information about the relative locations and attributes of phenomena in their everyday spatial environment (Downs and Stea, 1973). Axelrod (1976) stated that cognitive mapping can help in evaluating the reasoning of people and avoid unnecessary simplification of complex decision environments. In order to allow decision-makers to examine their reasoning, practitioners can lay bare the structure of their thoughts and the connections between their beliefs by the use of cognitive maps since cognitive maps can harness the power of vision to understand complex information ''at-a-glance''.

5. Methodology

The main focus of this project is on how to elicit knowledge from the experience of people. Figure 1 shows the whole knowledge elicitation process.

Figure 1 The knowledge elicitation process



Phase 1: project theme identification

Project theme identification is a very important process because whether the project is successful or not depends heavily on choosing a right project theme, which will bring great influence to a company. Since this is a pilot run, it is important to identify an area that is crucial to the company. For this is a knowledge elicitation project, the area should be one that requires much experience to perform in, while the situation should be complex and dynamic.

In order to identify the pilot area, a brainstorming session was held among the management staff during which they were asked to identify the areas that need to make use of knowledge management technique to help them capture and retain their existing knowledge. After that, they had to identify an area that the experience captured would be crucial and critical to its business based on the ''impact to the organization if knowledge is lost'' and the ''Need for knowledge retention''. Management ranked the options and selected the most critical process to start with first.

In this project, Aircraft Reliability Management was chosen as the theme. This is a unique area in the airline business and not many successful airlines in the world have captured experiences and cases in handling reliability management in a systematic manner.

Phase 2: defining objectives and identify scope

The objectives to be accomplished need to be clearly spelled out. To identify the scope of the project, a boundary can be set once the project scope has been identified. This can help to limit the scope of the project so that it will be easier to control.

The objectives for this project are set as follows:

- To develop a methodology for capturing knowledge about airline reliability management.
- To identify the decision making process in reliability management.
- To provide guidelines for staff to follow then handling cases concerning reliability.
- To build up training materials based on the recorded stories.

Phase 3: framing stimulating questions

Although applying the narrative techniques in capturing knowledge free flow of information is allowed, it is important to have a set of questions at hand in order to guide and stimulate the participates to talk about their experiences. In order to obtain good results, the questions should be open-ended. This can encourage participants to say more and elaborate their answers with more details than they would if left to their own devices. Sometimes, questions that include some emotional terms can trigger the participants to tell more. Probing questions may include some emotional words such as ''frustrating'' and ''exciting'', so that it will stimulate their thoughts and allow them to tell more of their experience and make the narratives more contextual. Also, during the interview, it is suggested that the practitioner should try not to interrupt the participant as this may destroy the original idea the participant wants to talk about. Also, we may try to put participants into situations or allow participants to answer in a third party's identity. This can help them to express their experience in a more effective way and they will not be afraid of telling others about what they did wrong before. Most importantly, never ask a direct question since asking a direct question will limit the answer that the participants can give.

Phase 4: conduct narrative interviews

With the set of questions ready, narrative interviews can be done with the chosen participants. This is the most critical and difficult part in the whole project since staff can reflect on their own experience and share experiences among themselves. In order to capture the knowledge from each narrative and allow users to retrieve them, narratives will be recorded and transcribed into scripts. However, before the interviews, the practitioner has to declare clearly to the participants the objectives and purposes of the interview in order to minimize any possible misunderstandings, which will prevent them from expressing themselves freely.

Phase 5: extraction of learning points

Learning points will be extracted and these will be shared among the staff through a document management system where they can retrieve the detailed information about each narrative. In order to make the narratives easier for users to read and digest, learning points are extracted from each narrative. The learning points are the key messages that have to be passed to users. They should be concise and precise but should not affect the context of the narratives. Making them thus, can help to create a hierarchy out of which the practitioner can construct a cognitive map.

To demonstrate with an example, a narrative on ''Windshield cracking'' is presented here. First of all, the sentences or phrases which are related to the same topic are contained within two strokes thus: '/' as shown in the following passage:

> *An example of anecdotes on windshield cracking*
>
> An A320 aircraft windshield cracked during flight resulting in an in-flight return. / This is a media sensitive issue which if made known to the public will affect the reputation of Dragonair, therefore the windshield was immediately replaced. / Through detailed analysis of the life data of all previously failed windshields, we have come up with some expected life limits for the windshield which are much lower than the life limits claimed by the manufacturer for its products. / Investigation revealed that the failure was due to moisture ingression into the windshield which caused arcing inside the windshield and resulted in the windshield shattering. / Immediate action was taken to identify the high-risk windshield according to the life limits of the windshield. / After negotiation with PPG, the windshield manufacturer, a replacement program was carried out to retrofit the high-risk windshields within 2 weeks time. / Other than that, a long term improvement action was adopted. We have reviewed our windshield inspection frequency, / clarified the windshield inspection failure limits, / re-written the inspection job card contents to make it more easily understandable / we have added colour pictures where possible to help engineers easily recognize the windshield serviceability and failure standard. / Also, the communication and reviewing process on the inspection results have to be enhanced / and we have reviewed the windshield design with PPG and Airbus to seek for product improvement. / PPG finally came up with a modified windshield with an improvement to prevent moisture ingression. / All windshield inventory has been purged and replaced with the modified windshield. / Now, all the windshields will undergo on-going monitoring as the result of new product reliability improvement policy.

During the whole process, PPG, SRT, Airbus, Prakash and Steve have been involved and all the investigation reports are very important to resolving this issue.

After the sentences have been separated into spaced intervals, learning points are extracted. These are presented in the following list.

Windshield cracking

Aircraft Type: A320

Failure:

- An A320 aircraft windshield cracked during flight.
- Resulting in IFR.
- Media sensitive when known to public.
- Will affect the reputation of the airline.
- Windshield on that aircraft was immediately replaced.

Investigation:

- Through detailed analyzing of the life data (KA) of all previously failed windshields, we came up with some expected life limits for the windshield which are much lower than the manufacturer's claimed life limits for their products.
- Investigation revealed that the failure was due to the ingression of moisture into the windshield, which caused arcing inside the windshield and resulted in the windshield shattering.

Solution:

- Immediate action was taken to identify the high-risk windshield according to the life limits of the windshield. After negotiation with PPG (windshield manufacturer) a replacement program was carried out to retrofit the high-risk windshields within two weeks' time.
- Long-term improvement action to be taken:
  - Review our windshield inspection frequency.
  - Clarify the windshield inspection failure limits.
  - Rewrite the inspection job card contents to make it more easily understandable and add colour pictures to help engineers easily recognize the windshield serviceability and failure standard.
  - Enhance the communication and reviewing process on the inspection result.
  - Review the windshield design with PPG and Airbus to seek for product improvement.
  - PPG should finally come up with a modified windshield with improvement to prevent moisture ingression.
  - All inventories have to be purged and replaced with modified windshields.
- Still under ongoing monitoring of the result of new product reliability improvement.
- Involved parties: PPG, SRT, Prakash, Airbus, Steve.
- Documents: investigation reports.

"One of the techniques of eliciting knowledge is the use of narratives."

After the learning points have been extracted, cognitive maps are drawn. This is described in the following section.

Phase 6: construction of cognitive maps

Cognitive maps can harness the power of vision to understand complex information ''at-a-glance''. The primary function of the brain is to interpret incoming information to make meaning. It is easier for the brain to make meaning when information is presented in visual formats. This is why ''a picture is worth a thousand words''. Therefore, after collecting a sufficient number of narratives (stories or anecdotes), cognitive maps will be drawn based on each narrative and each of them will be validated with the corresponding narrators. Cognitive maps can also bring to the surface and organize concepts and relationships that are normally taken for granted. This can facilitate organizational activities by simplifying complex domains.

Constructing a cognitive map is a powerful technique used to structure, analyze and make sense of accounts of problems. It produces a graphic representation of how a participant thinks about a particular issue or situation and so makes it easier to understand.

Let us continue with the Windscreen example used in the above section. With the help from the reliability engineers, several actions are identified and improvements are made in order to prevent the windshield from cracking, such as through the process of ''analysis on the life data'', the ''actual life limits'' of the windshields are identified. The verbs in the descriptive sentences, e.g. analyze, reveal, replace etc., can also be identified as the process leading to the determination of the level one consideration, i.e. the actual on-wing service life limits of the windshields. Based on the identified process and the level one consideration, the first step in building the cogitative map is shown in Figure 2.

As a consequence of identifying the actual on-wing service life limits of the windshield, it is logical to review the installation life of the whole fleet. Therefore, ''identifying'' the ''high-risk windshield'' is the second step in our reliability management consideration and thinking process. A retrofit program is then determined by considering the material and spare-part support and the availability of maintenance ground time. Sometimes the airlines may have to coordinate with the windshield manufacturer or even the aircraft manufacturer to retrieve the worldwide stock to support this retrofit programme. However, in the example it may be too detailed to identify the spare-part support and coordination with vendors and aircraft manufacturers. Therefore, the higher level triggering of identifying a ''retrofit program'' is selected as the knowledge point that a reliability engineer should consider in handling a reliability problem. The cognitive map can now be developed with level two and onward steps of knowledge points as shown in Figure 3.

More Level one, two and onwards knowledge points can be further expanded by using a ''flowering-out technique'' from the remaining narrative. For example, reviewing the windshield inspection frequency, i.e. ''reviewing'' the current ''Aircraft Maintenance Programme'', ''reviewing'' the ''jobcard contents'', providing ''clearer jobcard instructions'' and adding ''colour pictures'', ''clarifying the windshield inspection failure limits'' can help to easily identify the serviceability of the windshield well in advance before it fails and causes disruption to the operations. Through this exercise, all these fallback items have been

Figure 2 The first stage in constructing the cognitive map

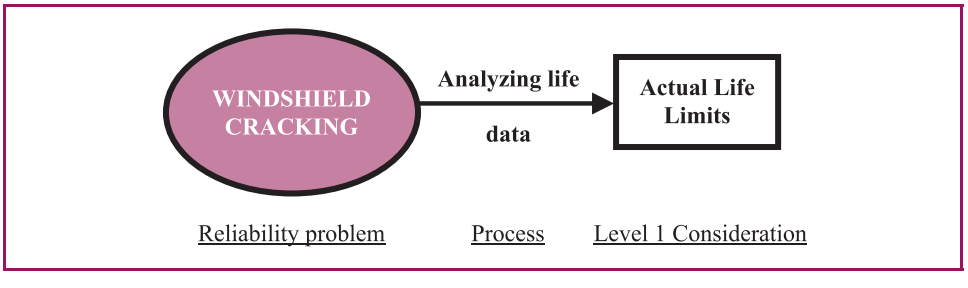
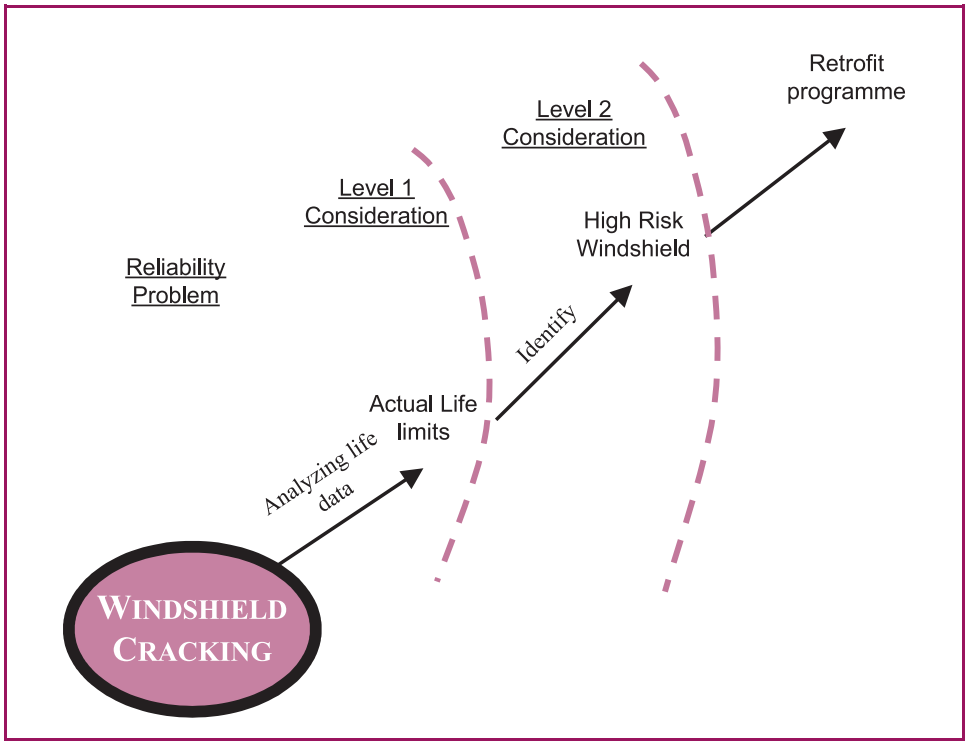
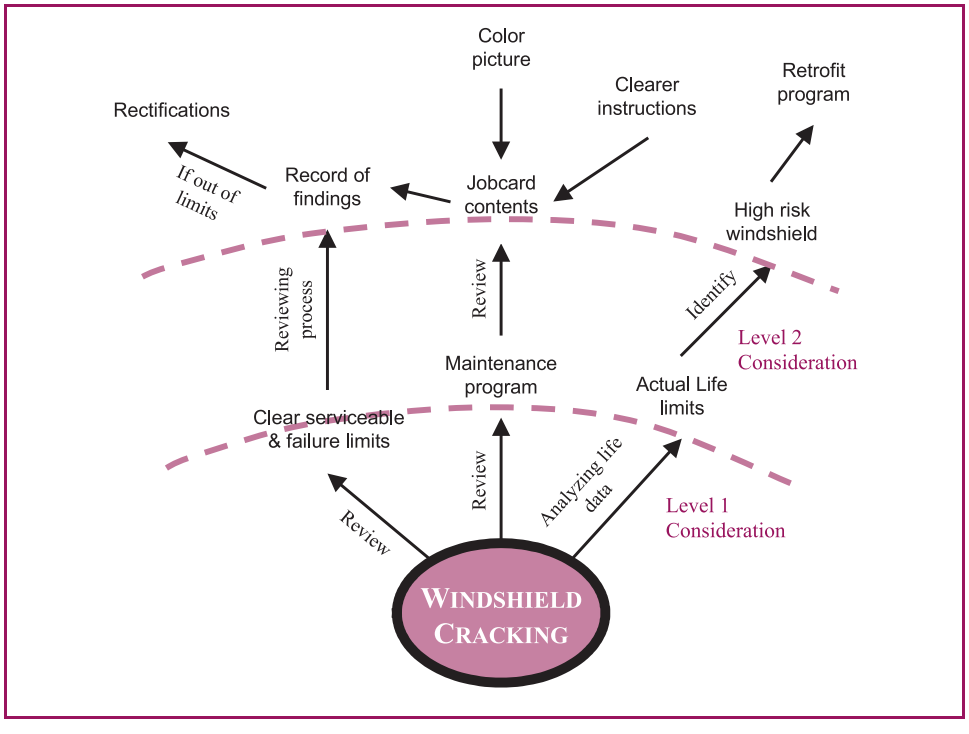


Figure 3 The second stage of building the cognitive map



identified and the defective windshield, in accordance with the inspection findings, is ''rectified''. Following the identification of all these items, a better picture of the cognitive map can now be drawn. This is shown in Figure 4.

Figure 4 Stage three in building the cognitive map



At the end of the narratives, the need to seek for ''product improvement'' is highlighted, together with the windshield manufacturer and the Airbus. Finally a new type of windshield was introduced with several improvement ''modifications'' implemented. This modified windshield was slowly retrofitted into the whole fleet. At the same time the whole inventory store was ''reviewed'' to identify all pre-modification windshields which were ''purged'' and replaced with new post modification type windshields. All newly installed post modification type windshield would undergo an ''on-going monitoring'' process to ensure that they would not cause any further problems. All these steps have now been implemented into the final cognitive map (see Figure 5) of windshield cracking to demonstrate the use of all the knowledge points that have been gathered from this narrative.

Phase 7: consolidation of knowledge into an aggregate cognitive map

This aggregate cognitive map as shown in Figure 6 can connect together and organize dispersed organizational knowledge. When a number of cognitive maps are available, patterns can be revealed and they can be combined to form a congregate cognitive map. The first level of the aggregate cognitive map shows the first step that an engineer has to take when he/she comes across a reliability related problem. After identifying the first step, users can follow the next suggested step by following the nodes in the map; or the first step may trigger some new ideas to help the users to solve the problem. The information in this map has to be validated again by grouping the participants together and allowing them to modify the map until they think it makes sense to all of them. This is described below.

Phase 8: data validation

A focus group exercise will be conducted in order to validate the data in the aggregate cognitive map. The map will be modified until the group participants comes to a consensus which makes sense to them all. This group data validation is done in the format of a knowledge café. A knowledge café is a kind of focus group, which provides a relaxing environment for participants to discuss matters freely in an informal way. The purpose of conducting this knowledge café is to validate, in a collective manner, the information in the

Figure 5 Stage four in building the cognitive map

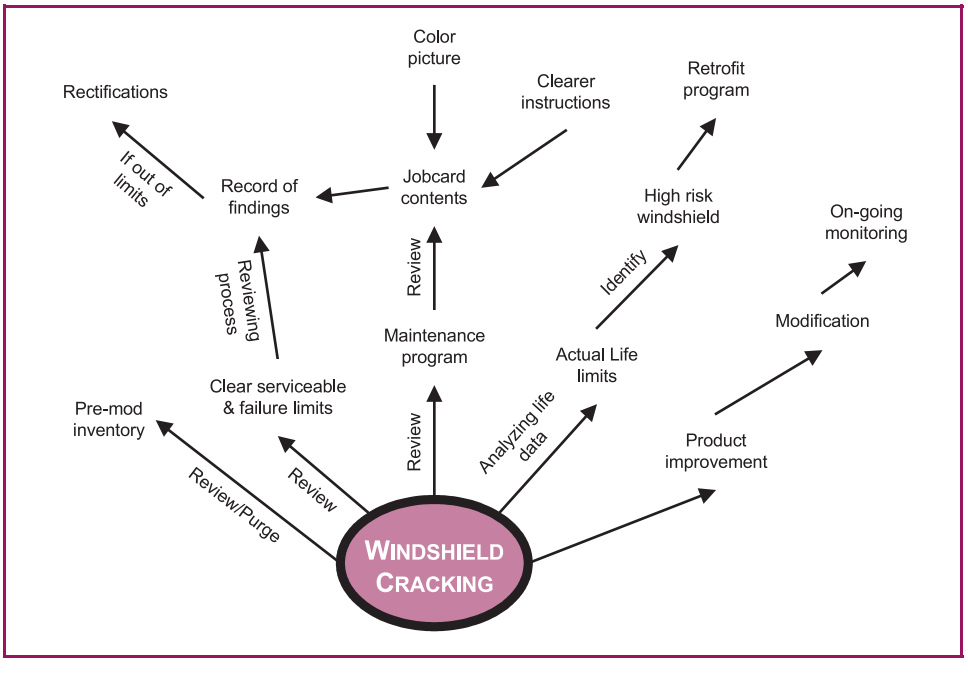
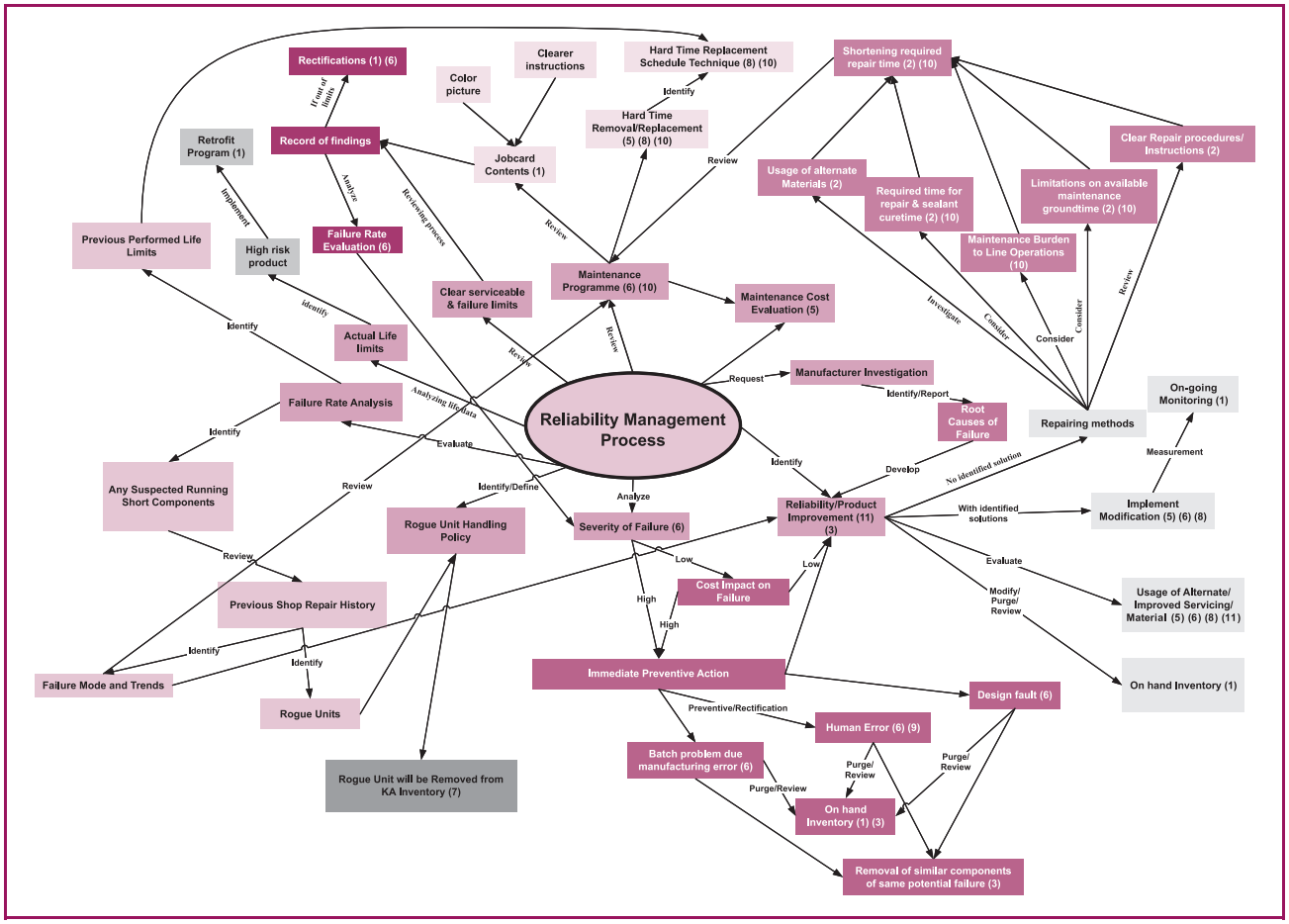


Figure 6 Aggregate cognitive map



aggregate cognitive map that was developed by combining the individual cognitive maps that were drawn based on the narratives at the earlier stage.

The objectives of validating the aggregate cognitive map are as follows:

- To review, validate and refine the congregate cognitive map.
- To share the skill/technique and knowledge related to reliability management.
- To act as a means to align the skills of all staff on reliability management.
- To provide a sense of ownership to staff and get their buy-in.

6. Discussion

Many knowledge management programmes have failed due to various reasons. One common pitfall is that, they are either too ambitious or too vague in their scope, methodology or deliverables. To be successful, the project objectives should be linked to the business needs that lead to the solving of daily problems. The collecting and sharing of know-how of experience in reliability management in Dragonair serves as a good demonstration of how to build a corporate memory through team and organizational learning. This study does not only illustrate how knowledge can be elicited through a combination of the narrative approach and the ASHEN model (Snowden, 1999). It is also a good example of the stages of learning from individual, group to the organizational level as described in the 4 ''I''s Framework, as well as the Senge's five disciplines (Senge, 1990) in the building of a team mental model and team learning.

> **"Cognitive mapping is one of the solutions for transferring knowledge in a dynamic way."**

6.1 The 4 ''I''s framework of organizational learning

As shown in the 4 ''I''s framework, four associated processes link three levels of analysis and define learning within organizations: intuiting, interpreting, integrating and institutionalizing. Intuiting and interpreting occur at the individual level; interpreting and integrating at the group level; with integrating and institutionalizing occurring at the organizational level. Verbs are used to describe the four processes as they are intended to capture both a cognitive and behavioral perspective of learning.

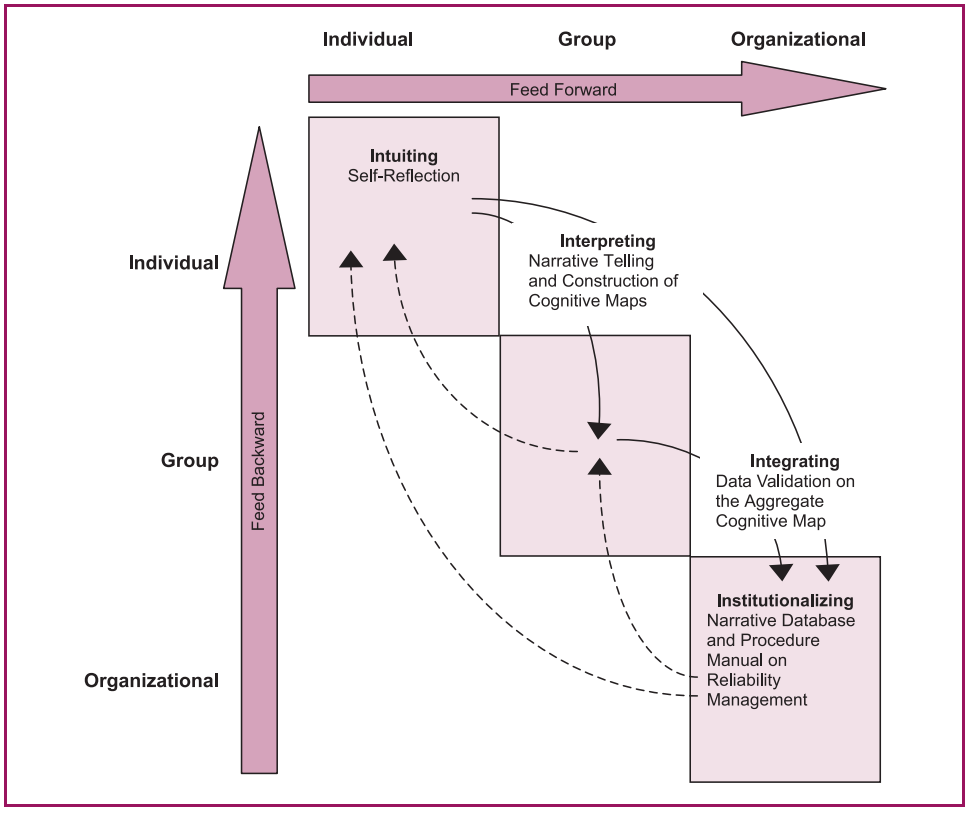
Intuiting is the preconscious recognition of patterns and/or possibilities inherent in a personal stream of experience. This only affects the intuitive behavior of individuals but will not affect others since they have not interacted with others yet. The second stage of the learning process is interpreting. It is the explaining of an insight or idea to one's self and to others. This process goes from the preverbal to the verbal and requires the involvement of language.

Integrating is the third stage of the learning process. It is the process of developing shared understanding amongst individuals and the taking of coordinated action through mutual adjustment. Dialogue and joint action are crucial to the development of shared understanding. The last step of institutionalizing is the process of ensuring that routinized actions occur. Tasks are defined, actions specified and organizational mechanisms put in place to ensure that certain actions occur. Institutionalizing is the process of embedding learning that has occurred by individuals and groups into the institutions of the organization including systems, structures, procedures and strategy.

In this project, the process of eliciting knowledge from individuals through narrative telling involves the re-collection and invoking of a personal stream of experience, which is the intuiting stage. The translation and extraction of the personal experience into meanings and insights both involve the creation of concepts. The extraction of concepts and the inter-relationship of concepts through cognitive mapping, which can be termed interpreting, help to make the ideas explicit and easily communicable to other people. No integration can occur unless the individual mental model is made explicit and shared by other team members. The consolidation of individual cognitive maps into the aggregate cognitive map helps to develop a shared understanding. Everyone can see their own contribution as well as the relationship of their reasoning to that of others, and this gives a better overall picture of the problem concerned (reliability management in this case). The validation of the aggregate cognitive map through group discussion and arbitration enhances the integration process (the third stage in the 4 ''I''s model) and enables all team members to see both the ''trees'' as well as the ''forest''.

This process of integrating is often ad hoc and done in an informal manner. However, the combining of individual maps into an aggregate map provides a structured and systematic method of integrating individual experiences. The successful validation and endorsement of the aggregate cognitive map to be built into the procedures and guidelines signifies the institutionalizing of the knowledge for re-use and training in the organization. This is done by transforming the aggregate cognitive map into words, which will turn into a procedure manual in the end. Other than that, all the narratives are stored in a repository where people can take them as references in the future. The sequence of the 4 ''I''s model is re-drawn in Figure 7 to illustrate the sequence of the learning process in knowledge elicitation from the individual, group, to organizational level. In the figure, it should be noted that the steps of learning from individual, group to organization is not a one-way process. Whereas individual experience will give rise to collective experience, which in turn can also

Figure 7 From individual cognitive map to aggregate maps in the 4 ''I''s Learning Framework



affect the perception of individuals, as all effective learning process is always dynamic and non-linear in nature.

6.2 Comparison with Senge's model of organizational learning

According to Senge (1990), personal mastery, systems thinking, mental models, shared vision and team learning are the five disciplines of a learning organization. Among these, team learning is critical to organizational learning for the following reasons:

- People learn more effectively when they interact with others and learn together as a team.
- Team learning is synergistic, so team learning is more important than individual learning.

Team learning does not mean that group members attend classes and seminars together, or receive the same instructional materials. One of the fundamental issues for effective team learning is enabling team members to share mental models. Without the sharing of ideas, thoughts, values, and assumptions among team members, learning does not occur at the team level. This is the fundamental difference between team or collective learning and individual learning. The making of mental models explicit among team members and sharing of them is one of the most crucial processes to achieve team learning. Despite its wide acceptance, there have been relatively few cases reported in the published literature with detailed data and detailed processes to illustrate how this model can be built and shared on an industrial problem.

In Senge's work (1990), systems thinking is adopted to help individuals see how things are interrelated to each another, and promote mutual understanding among team members. In other words, systems thinking helps to build a ''correct'' mental model of the complex phenomenon under study. There are many ways of building a mental model. Mental models

are simplified representations in the mind (unspoken words) of real or imaginary situations that support understanding, reasoning, and prediction. A mental model is also sometimes referred to as a mental representation, a schema, a cognitive map, etc. It is not necessarily associated with visual images. It can be the internal thought processes in the form of a set of condition-action rules that explain how the real world acts. Mental models are not values, beliefs or prior experience, but they are affected by these factors, and play a significant role in bringing about thoughts and rules through reasoning.

Both systems thinking and cognitive mapping are different ways of constructing mental models. The cognitive map used in the Dragonair project provides a relatively low cost but effective tool to capture the reasoning among team members in handling reliability management issues.

Therefore, in order to shorten the learning curve, visualizing the mental models of different people in the form of cognitive maps can help them to disseminate their implicit knowledge in a simple but effective way. The subsequent building of the aggregate cognitive map enables view and insights of individuals to be extracted and combined with those views and insights of others to form a picture of the whole situation. In the use of systems thinking to build a team mental model, all members participate simultaneously in brainstorming the factors involved and in examining their interconnectedness through the drawing of a causal loop diagram. The emphasis while making mental models is on seeking and cultivating new insights and new ways of looking at things.

The methodology adopted in Dragonair is a balance between eliciting existing knowledge from individuals, sharing their knowledge through the aggregation of cognitive maps or group maps, and on the generation of knowledge or insights through the group activity in which team members discuss the validity of the aggregate cognitive map. Whether systems thinking or cognitive mapping should be adopted depends on the nature of the problem. For the purpose of extracting and building on existing experiential and procedural knowledge, cognitive mapping is more appropriate than systems thinking for building the corporate memory. On the other hand, systems thinking will be a more powerful tool for understanding and constructing new knowledge.

An organization can be termed a successful learning organization when it has set up learning systems within the organization that will enable it to mobilize the talents in the organization and has motivated the staff to contribute their knowledge to the corporate memory. The Dragonair case was a good example of how such a learning system can be built in a real industrial setting.

7. Conclusion

A good case is shown on how tacit knowledge is elicited from narratives in the form of cognitive maps from a group of staff in the Engineering Division of an airline company. This activity also helped to build team learning and a good knowledge sharing culture.

The power of narratives

People always unintentionally or intentionally hide what they do not want to disclose when people ask them direct or close-ended questions about how they manage a problem situation. They will rarely elaborate on the points that they mentioned in their responses. However, people are more willing to share if they are asked to tell narratives about their own experience since they have to talk about the cause and effect of what happened in order to make the narratives complete. Narratives can sustain the interest of potential users of the information, gain attention from people who listen to or read the narratives told by others. Narratives can also illustrate the subject matter with human interest. Hence, the learning process can be enhanced. New insights are gained among the participants during the narrative capturing process.

Building a knowledge-sharing culture

This project is the first in the airline industry to adopt this methodology to develop its own procedure manuals on reliability management and it demonstrates a good case of eliciting knowledge through the application of narrative techniques, construction of individual cognitive maps and the consolidation of the aggregate cognitive map. The aggregate cognitive map helped staff to solve complex reliability issues in a systematic manner. It has triggered the thoughts of people and helped them to have a wider and more comprehensive scope of thinking. It provides them with insights into the nature of reliability which they may have missed in the past.

The process of knowledge elicitation reported here illustrates well the various stages of the 4 ''I''s learning framework of organizational learning. It incorporates individual learning through self-reflection (intuiting) and narrative telling (interpreting) and provides organizational learning by building the aggregate cognitive map and by sharing the same mental model among team members (integrating) and also in developing the procedure manuals (institutionalizing).

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Further reading

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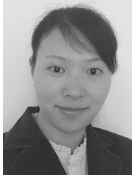
Chinese cultural influences on knowledge management practice

Jin Tong and Amit Mitra



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Abstract

Purpose – *The purpose of this study is to explore national cultural influences on knowledge management (KM) practices within Chinese manufacturing enterprises.*

Design/methodology/approach – *A qualitative case study in four steps was conducted within a Chinese mobile phone company (referred to as Lotus). Data collection was based on observations and in-depth interviews.*

Findings – *It was discovered that employees in Chinese manufacturing enterprises like to keep their knowledge implicit and are willing to share it informally. A series of factors derived from Chinese culture such as hierarchy consciousness, fear of losing face, a sense of modesty, competitiveness and a preference for face-to-face communication, can act as barriers to KM initiatives within Chinese manufacturing organisations. Trust in intra-personal relationships among employees can partly mitigate the impact of the above cultural characteristics. However, at a macro organisational level there is still need to share tacit knowledge using explicit/formal KM approaches.*

Research limitations/implications – *Though knowledge mapping is recommended as a feasible means to promote formal knowledge sharing within Chinese organisations, evidence showing the efficacy of such a method are only grounded in related literature here. Therefore, practical experimental evidence should be collected in future research.*

Practical implications – *KM strategies proposed for an organisation based in China should take revealed cultural influences into account.*

Originality/value – *Few studies have explicitly concentrated on KM within Chinese organisations. The present study provides useful information for academics interested in cultural issues in KM and impartial advice for knowledge managers within Chinese enterprises.*

Keywords *Knowledge management, Knowledge mapping, Culture, China*

Paper type *Research paper*

1. Introduction

Nowadays, practitioners and academics working on knowledge management (KM) are increasingly aware of important linkages between KM and competitive advantages of an organisation. From the perspective of this research, competitive advantage will be synonymous to unique selling feature of products of an organisation. Many firms that embrace KM as a key organisational policy often act as leaders in their business area. Their success shows the importance and necessity of effective KM for an organisation. The concept of KM from a subjective perspective has been introduced into China only in the 1990s, though ''knowledge'' has been discussed at length in ancient Chinese philosophical literature. KM in most Chinese organisations is still at an initial stage. Only few studies have explicitly concentrated on KM within Chinese companies. The limited research that exists in this area lacks cultural explanations of current KM practices within Chinese organisations. In order to contribute to this topic, the present paper intends to investigate how Chinese national cultural values affect current KM practices within Chinese manufacturing organisations.

The authors achieved the above research purpose by conducting a case study in Lotus. Lotus is a recently created mobile phone manufacturing company in China. It was established by a group of 15 working professionals within the mobile phone industry who decided to come together in 2005. Lotus designs and manufactures tailor-made mobile phones and other wireless terminal products for markets in China, South America and Europe. Their clients are brand manufactures, mobile phone distributors and small-medium sized wireless product operators. With respect to the management mode and employees' perceptions toward KM, Lotus can be a very representative case for Chinese manufacturing organisations.

This paper is structured as follows. The next section explains key concepts in KM and reviews the theoretical background of related topics of this study. The third section describes the research methodology used in the present case study. The fourth and fifth sections present findings of the case study and analyse them from a perspective of Chinese cultural influences. The sixth section stresses the need of formal KM approaches within Chinese manufacturing organisations by revealing potential KM issues within Lotus, and recommends an explicit KM strategy – knowledge mapping. Finally the paper concludes with observations and remarks.

2. Theoretical framework

The significance of this study is emphasised by highlighting important concepts and related issues in KM. Discussion within literature review reveals several gaps within this research area and raises a number of research questions for subsequent study. Examples grounded from the case of Lotus were described to explain adapted theories.

2.1 Knowledge and knowledge management

The existing literature has many different definitions of KM. Van der Spek and Spijkervet (1997) recognise KM as explicit control and management of knowledge within an organisation aimed at achieving the company's objectives. Though every organisation holds knowledge, its benefits are only consistently realised if it is explicitly managed (Skyrme, 2002). A common challenge faced by most Chinese organisations is improving upon relative low productivity through explicitly managing existing knowledge. The present case study was envisaged within such context.

Since Polanyi (1962) extracts the essence of Plato's original definition of knowledge and treats it as ''Justified true belief'', the debates surrounding this definition have been the driving force of many researchers' work. However, it is widely agreed that ''knowledge'' can be split along different dimensions. Existing knowledge classification schemas (e.g. Spender, 1996, 1998; Blackler, 1995; Snowden, 2003a, 2003b; Newell *et al.*, 2002) within organisation studies more or less build on the premise suggested by Polanyi (1962), distinguishing between tacit and explicit knowledge (see Stenmark, 2002). Tacit knowledge is more subjective and experience based, consequently cannot be expressed easily. It always includes cognitive skills and technical skills. Explicit knowledge, on the other hand, is more rational knowledge that can be easily captured and communicated.

By adopting Polanyi's terminology, Nonaka and Takeuchi (1995) developed their SECI model that obtained widespread acceptance within the research community. Nonaka and Takeuchi (1995) identified four knowledge conversion modes through which knowledge was created: socialization (tacit to tacit process), externalisation (tacit to explicit process), internalisation (explicit to tacit process), and combination (explicit to explicit process). Based on this SECI model, many researchers have attempted to develop tools and methods to convert tacit knowledge into explicit knowledge (e.g. Sparrow, 1998). However, lack of successful examples of doing so in practice made KM researchers rethink about the sense and the feasibility of such an externalisation process (e.g. Blackler, 1995; Stenmark, 2002; Snowden, 2003a, 2003b; see Tong and Mitra, 2008). Stenmark (2002) believed that making tacit knowledge into explicit is not impossible, but it is difficult, costly and not always necessary and desirable. The SECI model largely ignores the fact that ''we can know more than we can

tell'' (Polanyi, 1962, p. 136) and we always tell more than we can write down (Snowden, 2003a).

Blackler's (1995) knowledge framework ingenuously avoids such paradoxical nature of knowledge (see Snowden 2003a, 2003b) by adapting conventional assumptions about the location of knowledge (i.e. knowledge resides in bodies, routines, brains, dialogue or symbols; cf. Collins, 1993). Blackler (1995) suggested that there are five different types of knowledge:

1. embrained;
2. embodied;
3. embedded;
4. encultured; and
5. encoded.

Knowledge at both individual and social level has been taken into account in this framework. Given the fact that Lotus staff's perception toward KM is still at a primitive stage, Blackler's (1995) framework is the most straightforward one to be introduced. Table I provides descriptions of each type of knowledge and examples explored in the present study at Lotus.

2.2 Current trend of knowledge innovation

Drucker (1993) has provided an interpretation of the shift of knowledge application. He describes that knowledge applied to tools, processes and products in the eighteenth century was the basis of the economic system based on the development of ''technologies''. Later, in the early years of this century, knowledge started getting applied to human work. Regarding Blackler's (1995) work, it involves the systematic development of systems with embedded knowledge in that period. Now, it was followed by the trend that knowledge is being applied to knowledge itself. In the terminology of Blackler's (1995) framework, Drucker's (1993) points can be taken to imply that embrained and encultured knowledge are advanced (higher level of) knowledge within an organisation's knowledge innovation.

Table I Knowledge examples within Lotus adapted using Blackler's (1995) framework

Type of knowledge	*Description*	*Corresponding examples in Lotus*
Embrained	Embrained knowledge is ''dependent on conceptual skills and cognitive abilities'' (Blackler, 1995: p. 1031). It is created to deal with novel problems	Individual design engineer's skill and ability to produce solutions for problems emerged in product design processes
Embodied	Embodied knowledge refers to ''know-how'' knowledge and was maintained to solve familiar problems. It is action-oriented and is only partly explicit	Experienced design engineers, skilled operators on the product line, and qualified marketing staff normally know how to solve problems (that they have experienced before or they have already known the solution) in their daily work process. The practical thinking during such problem solving process remains implicit
Encultured	It is tacit at social level and ''refers to the process of achieving shared understanding'' (Blackler, 1995, p. 1024)	Employees' shared perceptions and understanding toward ''team work'', ''motivation'', or other specific issues
Embedded	Embedded knowledge ''resides in systemic routines'' (Blackler, 1995: p. 1024). It is tacit only when the systemic routines are implicit within the organisation	The standard operation procedures or machine manual handbook used by operators. It is explicit embedded knowledge The customised design procedures with R&D team. These procedures have been kept implicit as informal routines in Lotus. So the embedded knowledge in such routines remains tacit
Encoded	Encoded knowledge is information conveyed by signs and symbols. Obviously, it is explicit knowledge	Programs, data records, etc.

Encoded, embodied, and embedded knowledge are at lower level, but are an indispensable basis of an organisation's development. KM focus in most organisations in developed countries has been shifted to effectively managing embrained and encultured knowledge. The historic knowledge innovation progress in Drucker's (1993) work clearly described knowledge evolution in companies within developed countries. However, many developing countries, like China started this progress relatively late. With rapid economic development over the past 25 years, most Chinese manufacturing organisations are at the stage at which massive fundamental (lower level of) knowledge has not been effectively managed. This is also one main reason of decreasing productivity in Chinese organisations, especially technology-based manufacturing organisations. Analysis in subsequent chapters in this paper will confirm that such a KM situation exists in Lotus.

One outstanding contribution of Blackler's (1995) framework is that different types of knowledge dominate in different types of organisations. He insisted that more expert-dependent organisations will rely on embodied knowledge, while more knowledge-routinised organisations will depend more heavily on embedded knowledge. More dynamic and innovative firms will concentrate on either encultured knowledge if they are a communication-intensive firm or embrained knowledge if they are primarily dependent on individual employees' skills, experience, and expertise (Blackler, 1995; Newell *et al.*, 2002). As a recently formed organisation, Lotus is still attempting to improve its management in every aspect to sustain development. Its future orientation has been identified as a dynamic and innovative wireless product design house, rather than ''a mobile phone manufacturing factory''. Such long-term objective requires Lotus to effectively manage its fundamental knowledge, before it can truly rely on its embrained or encultured knowledge.

2.3 Implications of culture for KM

The term culture may refer to two dimensions in the context of KM – organisational culture and national culture (Ford and Chan, 2003). It has been reported through a number of research projects that organisational culture is one of the most important conditions leading to a successful KM project (e.g. Davenport and Prusak, 1998; De Long and Fahey, 2000). To create a supportive organisational culture is increasingly recognised as a major challenge for many companies aimed at effective KM (Gold *et al.*, 2001).

Hofstede's (1980) theory explains that an organisation's culture is nested within a national culture. Ford and Chan (2003, p15) argue that ''organisational culture can act as a mediator for national culture and knowledge management processes.'' Several prior studies (e.g. Ardichvili *et al.*, 2006; Chow *et al.*, 2000; Ford and Chan, 2003; Holden, 2001) have made important contributions on national cultural influences on people's behaviours in knowledge sharing within multi-cultural organisations. Chinese national culture has been discussed extensively in these research studies because it is a representative cultural component within a multi-cultural organisation. Nevertheless, no prevailing research had specially looked at the influence of Chinese national culture on KM practice in a Chinese manufacturing organisation. Based on the research gap discussed above, the following three questions were identified for the present case study:

Q1.
How does Chinese national culture influence KM practices in a Chinese manufacturing organisation, (if it does influence KM practices)?

Q2.
What are the key cultural elements affecting knowledge management practices in a Chinese manufacturing organisation?

Q3.
Do the above key cultural elements have negative or positive impacts on knowledge management practices?

"An important concept deeply related to *Guanxi* (a network of relationships) is 'trust.'"

2.4 Chinese cultural values and enterprise management

It is widely agreed that the predominant social fabric of Chinese culture is the Confucian value system, which mainly refers to a number of doctrines stressed by Confucius (about 551-499 BC) and his followers (e.g. Bond, 1991; Pun *et al.*, 2000; Redding, 1993). As a moral system, rather than a religion, Confucianism attempts to ''establish harmony in a complex society of contentious human beings through a strong and orderly hierarchy'' (Park and Luo, 2001, p. 456). It highlights the sensitivity to hierarchy and the maintenance of social order via micro-units of a society, such as families and organisations (Lo, 1997). Therefore, Confucianism is at the root of Chinese culture, the key element of which is ''hierarchy''. Pun *et al.* (2000) summarised that ''people focus and relationship building'' (Pun *et al.*, 2000, p. 330) is one of the most outstanding characteristics of Chinese enterprise management as the consequence of Confucianism (see Bond, 1991). It emphasises that the individual does not exist independently but in a network of relationships, which is called ''*Guanxi*''. Park and Luo (2001, p. 455) believe that ''*Guanxi* is a critical factor in firm performance in China''.

Traditional Chinese cultural values pervasively influencing on the management mode and organisation is one of the outstanding characteristics of Chinese organisations (see Pun *et al.*, 2000; Bond, 1991; Lo, 1997; Su *et al.*, 1998; Watt, 1999). In the present research, the specific Confucian cultural elements influencing KM practices within Lotus will be explored.

2.5 The importance of trust

An important concept deeply related to *Guanxi* is ''trust''. Trust can be defined as ''the willingness of a party to be vulnerable'' (Dirks and Ferrin, 2001).The importance of trust is generating increased interest in KM. Prior researchers delineate trust as one of the most important aspects of a supportive context for KM (see Dodgson, 1994; Von Krogh *et al.*, 2000; Abrams *et al.*, 2003). It was suggested that a supportive organisational culture works together with trust to enable effective knowledge work (e.g. Brown and Woodland, 1999). With respect to prevalent Chinese cultural systems, trust can certainly be identified as an important cultural factor (Alston, 1989). As a result, instead of further proving the undoubted relationships between trust and organisational culture, the present research through field work in Lotus intends to indicate powerful effects of trust in the context of Chinese culture. The following question hence will be answered in this paper:

> *Q4.*
> What are the effects of trust on Chinese cultural influence on knowledge management practices?

2.6 The concept of knowledge maps

Given the KM practices within Lotus (see details in later sections), an explicit KM approach – knowledge map is proposed as the first activity Lotus should undertake to effectively managing its massive implicit knowledge. Vail (1999) defines knowledge maps in the context of KM as follows:

> A knowledge map is a visual display of captured information and relationships, which enables the efficient communication and learning of knowledge by observers with differing backgrounds at multiple levels of details. The individual items of knowledge included in such as map can be text, stories, graphics, models, or numbers (Vail, 1999, p. 10).

Davenport and Prusak (1998) simply described the principal purpose of knowledge maps, which is to show people where to go when they need expertise. It is more reasonable to

create a knowledge map, rather than ''making do with accessible but imperfect answers or spending time tracking down better knowledge'' (p. 72). It is widely agreed that good knowledge maps would enhance KM within an organisation (e.g. Davenport and Prusak, 1998; Gordon, 2000; Wexler, 2001).

Among different types of knowledge maps (see Eppler, 2001; Vail, 1999; Wexler, 2001; Tong and Mitra, 2008), the procedural knowledge map has been frequently researched and used in existing knowledge mapping projects. This type of knowledge map has particular advantages in managing knowledge resident in dynamic business processes (see Kim *et al.*, 2003; similar to ''knowledge application map'' and ''knowledge development map'' in Eppler, 2001). Another widely applied type of knowledge map is social network map (also known as ''Social Network Analysis'' or ''Organisation Network Analysis'';, e.g. Liebowitz, 2005; Krebs, 1998). Liebowitz (2005) clearly explains the potentials of social network mapping and presents a practical guide of constructing such maps in an organisation. Analysis in later sections will show that the above two types of knowledge maps are actually ideal tools to overcome existing KM difficulties faced by Lotus.

3. Research methodology

Theoretical review indicates that the topic of the present study is a contemporary issue and the research questions are more of a ''how'' and ''why'' nature, not of a ''what'' nature, so a case study methodology was adopted (Yin, 1994). To ensure that adequate care was taken in structuring and analysing the case, four steps were followed:

1. *Learning day* – The learning day is designed to help employees to have a common understanding of KM, and the purpose of this case study. It was arranged at an organisational day trip, so the researchers could communicate with all employees in a relaxed environment.

2. *Observation at the workplace* – The observation at work place lasted three days, in order to have an overview of knowledge flows within Lotus, and identify the key interviewees for in-depth interviews. Furthermore, observation was useful for the researchers to get familiar with the potential interviewees' working language.

3. *In-depth interviews with the management team and selected employees* – The interviewees included the chief manager, R&D director, human resources manager, five R&D design team leaders, and ten selected general employees. Questions were asked in all interviews aiming to explore in-depth information on pre-defined topics. Interviews with the management team were conducted with intention of collecting a few examples of critical knowledge sharing incidents across Lotus, and exploring the organisational policies and rules linked to these incidents. Current situation of executing KM related organisational policies within Lotus was also investigated from the managers' point of view. Findings summarised from the management team interviews were validated by ten general Lotus employees in later interviews. Given the fact that 80 per cent of employees at Lotus head office are R&D staff and the role of the R&D department to this organization's KM practices is decisive, 10 selected general employees are all from five different teams under R&D department. They were previously identified as either key knowledge contributors or major knowledge receivers within Lotus knowledge flows, which were visualised through researcher's observations at work place and interviews with the management team. Three of those ten selected interviewees are recently recruited employees, while the other seven had been working in Lotus for a while. Interviews with general employees were designed to investigate their perceptions towards knowledge sharing with colleagues, their attitude to organisational sharing policies with Lotus, and their preferred knowledge sharing behaviour at the work place. As this study aimed to investigate Chinese cultural influence on KM, the focus of those conversations on planed topics in interviews was from the cultural perspective. Each interview lasted approximately one-and-half hours. The language used in all interviews is Chinese Mandarin. The interview contents have been tape-recorded and subsequently transcribed and translated into English.

4. *Findings validation* – Regular meetings were held to ascertain validity of findings. At the same time, consultations with the management team on findings created opportunities to introduce necessary KM improvement to business processes. The study process also resulted in consensus and commitment of research participants on formal KM approaches. It was agreed that creating knowledge maps will be their first KM activity.

4. Current KM practice within Lotus

Like other Chinese manufacturing organisations, the majority of workforce in Lotus is the workers in the manufacturing department, which routinely creates several product lines. However, the nature of business determined that R&D department plays a decisive role for the company, in order to survive within keen competition with other similar organisations, Lotus needs to possess an experienced R&D team capable of leveraging competitive advantages.

4.1 Informal knowledge sharing

There are approximately 50 design engineers in R&D department. During the daily work process, their own knowledge gaps forced them to obtain new knowledge from other resources. However, knowledge sharing within this department primarily depends on informal approaches, such as social events (staff dinner together), seeking personal assistance from others, etc. The IT support team has set up a website for all employees, which facilitated an online forum, document storage, and messages from the company's leadership. In general, IT support staff attempted to design the organisational website as a formal knowledge sharing facility. But the use of the site is not encouraging. Embedded functions in this website are rarely used. When the researchers for this study interviewed anticipated users of this website, most of them even did not know the existence of such functions.

The researcher found the non-use of the web site the result of a deeper cultural orientation. Unlike most successful organisations in developed countries, the potential of IT is not fully exploited within Lotus. Most staff members use the organisation's intranet to send email, chat online with colleagues, or use web search engines to get information. R&D engineers work on PCs everyday to design products by using relevant software. However, administration staff uses their computers to do paper work. For instance, instead of creating a HR database, HR department is still using paper-based folders to maintain employee records. There are no standard written working procedures within any department, though most employees are familiar with their work process because of their work experiences in the field. R&D engineers do not maintain problem solving records or any database to manage their design work processes. The traditional training method – of one master supervising one apprentice is still being used in Lotus. When new staff is employed, a mentor (a senior staff member) is assigned by the HR department to assist the new member with any problem he/she may have during the work process. These examples evidently indicate that in Lotus, information technology has been only used as a supplement for daily manual work, but not as an essential platform for work at the general management level.

While organisations in developed countries are trying to avoid the trap of excessively depending on IT to manage their intellectual capital, Lotus does not truly recognise the vital function of IT in its KM. Due to low effective usage of IT, massive fundamental knowledge (including encoded, embodied, and embedded knowledge explained in section 2.1) has been kept implicit within Lotus, although such knowledge is normally explicitly managed through IT in organisations of developed countries. Table II below compared the expected status (or normal states in organisations within developed countries) of fundamental knowledge and the actual status of it in Lotus.

*4.2 Social networks (*Guanxi*)*

The emphasis of social networks (*Guanxi*) is a primary feature of Lotus. As a young company, senior managers prefer to employ staff with some experience within the mobile phone industry. All employees are encouraged to recommend suitable candidates from

Table II Comparison of knowledge status

	Expected (ideal) status	*Actual status in Lotus*
Encoded	Explicit	Partly implicit *Evidence*: knowledge that should be uploaded to web site, or stored in formatted documents and databases are still managed informally
Embodied	Partly explicit	Mostly implicit *Evidence*: the absence of problem-solving records results in rich embodied knowledge in Lotus having been kept personally. Current training approach does help experienced staff pass their embodied knowledge to younger employees. But knowledge transfer through such means is informal and knowledge dissemination is relatively slow
Embedded	Explicit when the systemic routines are explicit	Mostly implicit *Evidence:* the customised design procedures with the R&D team have been managed implicitly as informal routines in Lotus. So knowledge that resides in these informal routines is still implicit

among their friends and old colleagues in previous jobs. Therefore, most employees are expected to be part of their own social networks prior to joining the organisation. Good personal relationships help them to track down information they need. Heavy dependence on social network in knowledge sharing prevents Lotus staff from realizing any potential risks of keeping knowledge implicit (see Table II), as knowledge exchange among their existing social networks seems quite efficient. For instance, the software team, who design the driver programs for the mobile phone hardware devices, does not have any obvious barriers in knowledge sharing among team members. Their responses at the interviews reveal that most software team members have personally known each other before they started work in Lotus. As a result, all members have a clear mind about where to go when they need knowledge or expertise.

Later interviews show that similar situations also exist in other departments. Because of such strong social networks in Lotus, employees had an invisible ''expert network'' or ''knowledge map'' stored in their mind. Many interviewees express that seeking knowledge-oriented help via social networks is normally their first choice when they cannot solve work problems by themselves.

5. Influence of Chinese culture

During the study it was found that Lotus employees like to keep their knowledge implicit and are willing to informally share some of it. Obviously, to a certain extent, management mode and organizational policies had influenced such KM practices within Lotus. Without support and encouragement from organisational policies and the management team, knowledge-sharing activities always do not have high execution priority. When such activities conflict with other organizational policies (such as bonus/competition policy in Lotus), KM is always situated in an ambivalent organizational environment. However, the focus of this case study is the influence of Chinese culture. The affects of different Chinese cultural characteristics on knowledge sharing preferences of Lotus staff have been repeatedly pointed out in the interviews.

5.1 Key Chinese cultural characteristics

The present research uncovered several Chinese cultural elements, which can actually affect employees' behaviour in knowledge related actions.

5.1.1 Hierarchy-conscious. Chinese cultures retain more hierarchy structures and traditions than western countries. The following response from one interviewee represents many employees' perceptions toward the influence of hierarchy consciousness of their knowledge sharing behaviour:

> We all have been taught to respect elders at a very early age. So at work places, I think everybody knows that we should respect not only the people who are older than you, also the senior employees who have a higher position or started working here earlier than you, even sometimes these ''elders'' are actually biologically younger than you.

Because of this social belief, junior employees (younger, lower-position, or newer staff) are expected to follow seniors' advice. Seniors are supposed to teach or pass on their knowledge and experience to juniors in organisations. Lotus' mentoring policy for new recruitment has facilitated employee's hierarchy consciousness. One employee expressed his opinion thus:

> I think this traditional teaching method [one master, one apprentice] can force me to learn knowledge from an experienced staff member fast. But because he is my teacher, and I am new staff, I do not really want to disagree with his out-of-date suggestions or express my own ideas. He will not like it.

In other words, following seniors' suggestions is the right way to show juniors' respect to them in Chinese society. But this situation causes an ''unequal'' knowledge sharing environment, because knowledge within the company flows from top to bottom only.

5.1.2 Fear of losing face. The previous interviewee pointed out that some older members are unwilling to hear different opinions from juniors. The reason is that older employees have fear of losing face. As a new staff mentor, he will be embarrassed if his apprentice disagrees with him:

> I believe that nobody likes to be embarrassed in public. But this is a little bigger matter for the old employees.

The young/junior employees also expressed their concern of face saving:

> Sometimes I do not want others to know that I do not know something. I felt I am losing face, and my competitors have begun to know my weaknesses. Of course, I am not just hiding it, because I will always try to complement this part of knowledge and skills during my spare time.

However, knowledge acquisition in this situation is obviously not efficient. Due to fear of losing face, precious working time can be wasted.

5.1.3 Modesty. An old Chinese saying states that ''there will be always a higher mountain than the one you have seen''. It highlights that we should have the sense of modesty because there will be always somebody who knows more than you do. In Chinese society, it is not recommended to express your own opinions too much in public. Due to this, some Lotus employees are not willing to share their ideas through the online forum of the organisational website. Cultural expectations related to modesty were an important influence on participation in knowledge sharing within Lotus. Of course, the sense of modesty can be an advantage factor to encourage senior staff to obtain new knowledge from juniors, as it can help them overcome the fear of losing face.

5.1.4 Competitiveness. In Lotus, most employees believe that knowledge is their power. It is widely agreed that the more knowledge an employee has, the higher position he/she should get in the company. Keeping their own knowledge implicit (in their mind) is safeguarding their position within the organisation. General employees would not like to share knowledge with their colleagues, unless they feel that to do so will not affect their hierarchical position within the firm. One interviewee explained:

"During the study it was found that employees like to keep their knowledge implicit and are willing to informally share some of it."

> In China there are too many people trying to cross ''the single narrow bridge'', so the competition is really high. Everybody has to struggle for their career target. If you and I are competitors at workplace, then I will not share what I know with you, as this might be a good or the only chance to defeat you. People are selfish in this sense.

Traditional Chinese cultural expectations encourage competitiveness. There is no doubt that competitiveness can increase employees' commitment to their work. But meanwhile, it also creates a harmful atmosphere, in which employees would not like to share knowledge with their fellow workers, colleagues or career competitors.

5.1.5 Preference for face-to-face communication. Unexpectedly, preference for face-to-face communication was found to be another factor, which contributes to lower participation in online knowledge sharing within Lotus. One interviewee argued:

> I felt that I always can get more information through face-to-face conversations. I think most people can expect more sincerity and respect from you when you ask them face-to-face. And in this way, normally they will not refuse you even when they don't really want to tell you the answer. We both have to care about our faces . . .

Knowledge seekers' sense of modesty makes them prefer to ask for help through face-to-face communications, as they believe this is the right way to show adequate respect to the person they asked. It also helps knowledge providers gain more ''face'', because face-to-face communications is a formal channel to show their knowledge and ability.

The effects of intra-personal trusts

The above Chinese cultural characteristics act as barriers to KM initiatives within Lotus to various extents. However, the present research also shows that strong intra-personal trust increases employees' motivation in sharing their knowledge. It can partly mitigate negative impacts of summarised cultural factors.

In Lotus, most employees are either good friends or old colleagues from previous jobs. Because of strong intra-personal trust among them, knowledge flows within each employee's personal social network are quite fluent. People will not be afraid to lose face in front of the person they trust. The sense of modesty cannot be an obstacle to express personal opinions among a group of close friends. Competitiveness among people who trust each other loses its preponderance. They believed that they will still be treated fairly and respectfully when passing their knowledge to the person they trust. The word ''family'' has been emphasised by several employees in interviews for this study. All employees regard the company that they work for as a big family, and all colleagues are family members. The emphasis of a ''family'' concept within Lotus is helpful in building trust among colleagues who could facilitate knowledge sharing.

6. The need for explicit KM approaches

Though intra-personal trust actually protects Lotus from obvious knowledge sharing obstacles, at the macro organisational level there is still need to manage knowledge using explicit KM approaches.

6.1 Potential issues of keeping knowledge implicit

It is effective to informally share embrained and encultured knowledge (see Table I) through social network since such knowledge cannot be fully codified. However managing fundamental knowledge (encoded, embodied, and embodied knowledge) in the same informal way is not a wise choice.

With the expansion of mobile phone market, an increasing number of products have to be designed at the same time. Without a standard R&D design procedure, employees may waste time in redoing the same job (e.g. some reusable driver programs have been written repeatedly in Lotus). Therefore, explicating such embedded knowledge is required to improve employees' work efficiency and minimise the production duration. Furthermore, rich embodied knowledge in Lotus needs to be formally managed. Without a written record of solved problems during the work processes, mistakes can be repeated and

> **"Chinese cultures retain more hierarchy structures and traditions than Western countries."**

solution-seeking time can be longer than expected. It is also necessary to produce standard staff training material to effectively pass on necessary knowledge as well as reduce new staff training time. Any formatted documents can also become written evidence for future analysis of one project's success or failure.

According to Lotus's recruitment plan, more inexperienced staff (e.g. new graduates and people who have never worked in this field) will be employed in order to increase saving on the HR budget. These potential employees will not have any social networks when they join the organisation. Their own expertise is unknown to others. Seeking knowledge through currently implicit means cannot be efficient any more. In this case, formal KM approaches are the only effective way to facilitate knowledge sharing in a future shape of Lotus.

6.2 The efficacy of using knowledge maps

The adopted KM approach should not just be able to effectively manage the existing knowledge, but it can also respect Chinese cultural expectations and promote personal trust among employees. According to the description in an earlier section (theoretical framework), knowledge mapping can be a feasible tool.

During the researchers' observation period at work place, a set of knowledge maps were constructed to visually display knowledge flows within Lotus. As a personal preference, knowledge maps were used as a tool to assist the researchers' quick knowledge audit within *Lotus*. Constructed knowledge maps simply gave an overview of how knowledge has been shared within Lotus, without requiring full details on what kind of knowledge has been shared. Those maps gained great attention from Lotus management team at the finding validation meetings. Given the fact that all formal KM approaches should start with a knowledge audit within the organisation, knowledge auditing across all sectors within Lotus is essential. Knowledge maps' contributions to knowledge audit in the researchers' earlier work persuaded the Lotus management team to use such a tool.

Subsequently, the researchers theoretically analysed the efficacy of using knowledge map as a formal KM approach within Lotus, especially its advantages in respecting Chinese cultural expectations and promoting personal trust among employees. A knowledge map may not contain knowledge, but point to veritable knowledge elements (Davenport and Prusak, 1998). Such unique function can optimally comply with potential map users' preference of keeping knowledge implicit. The anticipated knowledge maps can play the role of ''family trees'' within Lotus. The visibility of knowledge locations (experts) within knowledge maps logically provides opportunity to extend employees' existing social networks. While exchanging knowledge through face-to-face communications, intra-personal trust can be enhanced. Liebowitz (2005) has explained how to create knowledge maps by using SNA (Social Network Analysis) methods. Given the heavy dependence on social networks at Lotus, visualising them and constructing knowledge maps by analysing these networks could be a time-saving and high-return KM activity. Not only social network maps, procedural knowledge maps also can be constructed. Knowledge structures within a procedural knowledge map and the relationships between different knowledge resources within the map can display different work flows (e.g. R&D design processes) in Lotus. By following these structured routines, managers can easily capture required knowledge in business processes and manage them formally, such as producing formatted documents, creating databases, etc.

In short, above logical arguments indicate that using knowledge maps is a feasible KM choice for Lotus.

7. Conclusion

Though current KM practice within Lotus demonstrates that strong trust in intra-personal relationships can partly mitigate the negative influence of several Chinese cultural characteristics, there is still need for explicit management of fundamental knowledge (embodied, embedded and encoded knowledge) at a macro organisational level. Analysis shows that constructing knowledge maps through social network analysis and work process break down can be a feasible action to explicitly start KM in Chinese manufacturing enterprises. Of course, organisations need to provide supportive KM policies and qualified KM practitioners to constantly foster such KM strategy. The present research can help related academicians and practitioners to sharpen their view on current KM practice in Chinese manufacturing organisations, and to understand implications of Chinese cultural expectations for KM. Future research will focus on the practical process of knowledge mapping within Chinese manufacturing organisations, and the effectiveness and impacts of such method on the organisation's KM practices.

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Knowledge-based anti-money laundering: a software agent bank application

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Abstract

Purpose – *Criminal elements in today's technology-driven society are using every means available at their disposal to launder the proceeds from their illegal activities. While many anti-money laundering (AML) solutions have been in place for some time within the financial community, they face the challenge to adapt to the ever-changing risk and methods in relation to money laundering (ML). This research seeks to focus on ML control and prevention, which aim to automate the monitoring and diagnosing of ML schemes in order to report suspicious activities to banks.*

Design/methodology/approach – *The research adopted the technology of intelligent agents to provide a more adaptive, flexible, and knowledge-based solution for AML.*

Findings – *Based on the analysis of monitoring, diagnosing, and reporting of ML activities occurring in electronic transactions, several types of intelligent agents are proposed and a multi-agent framework is presented for AML. Furthermore, business knowledge such as business rules and strategies are extracted from AML practice, and applied to the design of individual agents to make them act autonomously and collaboratively to fulfil the goal of ML detection.*

Practical implications – *The proposed multi-agent framework is a stand-alone system, which can be integrated by banks to combat ML. Although it is a uni-bank framework at present, it can be extended to multi-bank application in the future.*

Originality/value – *The research explores the approach of applying an intelligent agent for knowledge-based AML in an electronic transaction environment for banks. By separating business logic from the business model, such a business-rules approach can enhance the flexibility and adaptability of the agent-based AML system.*

Keywords *Knowledge management, Money laundering, Intelligent agents*

Paper type *Technical*

Introduction

Since the mid-1980s, money laundering (ML) has been increasingly recognized as a significant global problem, with serious economic and social ramifications (Camdessus, 1998). Today, ML has become a key funding mechanism for international religious extremism and drug trafficking, and curtailing these illegal activities has become an important focus of governments as part of their ongoing wars on terrorism and drug abuse. Following the terrorist activity of September 11, 2001, there has been an increased focus in the United States and across the globe on the prevention of ML and terrorist financing. Increasingly, anti-money laundering (AML) systems are being implemented to combat ML. However, the traditional fixed-rule-based solutions suffer from a number of drawbacks, such as ineffective thresholds, high false positive problem, lack of pattern recognition function, and insufficient data processing capability.

In our research, we focus on ML control and prevention, which aim to automate the monitoring and diagnosing of ML schemes in order to report suspicious activities to banks. With a view to providing a knowledge-based solution for AML, we propose to apply the technology of intelligent agents to deal with the possible ML schemes in the electronic

transaction environments in a single bank. Given specific knowledge and capabilities, intelligent agents are capable of dealing with complex problems and vast amounts of information collaboratively in dynamic and unpredictable environments. Moreover, based on previous research and experimental results, some properties of intelligent agents, such as reactive and proactive behaviors, are directly applicable for tracking abnormal transactions in a systematic and goal-driven manner (Wang *et al.*, 2002; Wang and Wang, 1997).

AML is a complex process involving many entities, where activities are delegated to a society of both autonomous and collaborative intelligent agents. Data collecting agents are responsible for collecting data of electronic transactions. Based on such data, monitoring agents may keep track on the transaction processes. When a possible ML scheme is detected, a diagnosing agent will be initiated and attempt to identify the problems. According to the output from the diagnosing agent, a reporting agent will report to the appropriate personnel. Our proposed multi-agent framework is a stand-alone system, which is integrated with the bank systems. The software agents only capture the transaction data from the bank operational system, and will not interrupt normal banking operations.

In order to achieve a knowledge-level resolution, intelligent agents are developed with specific knowledge such as business rules and business strategies to reason about business actions for ML. Business rules are extracted from AML practice, and applied to the design of individual agents to make them act autonomously to fulfill the organizational goals. By separating business logic from the business model, such a ''business rules'' approach can enhance the flexibility and adaptability of our agent-based AML solution.

The remainder of the paper is organized as follows. The next section briefly reviews the relevant literature on ML, AML, AML systems, and intelligent agent theory. Then the approach of applying intelligent agents into knowledge-based AML is investigated. Following this approach, we develop a multi-agent system framework for AML. The final section addresses our contribution as well as the future work.

Background

Money laundering and anti-money laundering

Money laundering (ML) is a term usually used to describe the ways in which criminals process illegal or ''dirty'' money derived from the proceeds of any illegal activity (e.g. the proceeds of drug-dealing, human trafficking, fraud, embezzlement, insider trading, bribery, theft or tax evasion) through a succession of transfers and deals until the source of illegally acquired funds is obscured and the money takes on the appearance of legitimate or ''clean'' funds or assets (HM Treasury, 2004). ML is a diverse and often complex process that need not involve cash transactions. ML basically involves three independent steps that can occur simultaneously (IFAC, 2002):

1. *Placement* – the process of transferring the proceeds from illegal activities into the financial system in such a manner as to avoid detection by financial institutions and government authorities.
2. *Layering* – the process of generating a series or layers of transactions to distance the proceeds from their illegal source and obscure the audit trail.
3. *Integration* – the unnoticed reinsertion of successfully laundered, untraceable proceeds into an economy.

The International Monetary Fund (IMF) estimates that the aggregate size of ML in the world could be somewhere between 2 and 5 percent of global gross domestic product (GDP) (FATF, 2008b). According to Celent Communications (2002), the amount of illicit funds traveling through ML channels is estimated to grow at an annual rate of 2.7 percent. However, the full magnitude of the problem is still not known with any certainty.

Recent years have witnessed a growing number of highly publicized money laundering scandals involving major international providers of diversified financial services and their correspondents in ''off-shore'' jurisdictions, such as Russia, other former Soviet Republics,

> **"In order to achieve a knowledge-level resolution, intelligent agents are developed with specific knowledge such as business rules and business strategies to reason about business actions for money laundering."**

Latin America and the Caribbean (IFAC, 2002). In response, governments and legal authorities in various jurisdictions have issued an accelerated level of pronouncements and taken other enforcement steps focused on combating ML and related financial crime. In 1989, the Group of Seven Industrial Democracies (G-7) created a global ML watchdog organization called the Financial Action Task Force (FATF). In 1990, the FATF issued its first annual report, containing its *FATF 40 Recommendations*, which are a most important set of international AML standards and they have been a substantial motivation in facilitating government AML initiatives. An important element and theme of the *FATF 40 Recommendations* is the KnowYourCustomer (KYC) or enhanced due diligence principles. KYC guidelines require or recommend developing a keen understanding, through appropriate due diligence, of whom the true beneficial owners and parties to transactions are, the source and intended use of funds and the appropriateness and reasonableness of the business activity and pattern of transactions in the context of business (IFAC, 2002). In addition, FATF also recommended implementing Suspicious Activity Reporting (SAR) models, record keeping, and AML controls as part of overall AML regimes.

However, there are as many methods to launder money as the imagination allows, and the ML schemes being used are becoming increasingly sophisticated and complex as technology advances (CICA, 2004). Although KYC and SAR are spreading across the globe in forms ranging from best practice, ''soft law'' and even hard law, the money launderers are forced to change their methods to some degree. ML is becoming increasingly difficult to detect. In an effort to detect potential ML schemes, many financial institutions have deployed AML detection solutions and enterprise-wide procedural programs. These solutions work by establishing fixed rule-based thresholds by analyzing how certain established usage scenarios comply within those boundaries. Most financial institutions will establish a threshold based on a set monetary value for each transaction and detecting specific ML patterns and user scenarios that breached those thresholds. The shortcomings associated with these solutions are summarized as follows:

- They possessed an inherent inability to detect ML schemes of smaller amounts that may come in under a defined threshold limit. For instance, in investigating the financing behind 9/11 events, it was discovered that the terrorists had made frequent transactions of small sums that were below the usual cash transaction reporting thresholds (Moorman, 2004).
- The problem of false positive, which means there are transactions over a set limit that are marked as suspicious but in fact they do not represent any existing identified risk to the institution, was prevalent.
- There were no learning or generalization abilities. Although those fixed-rule-based systems have some pattern recognition capabilities, they cannot learn or generalize new patterns and they can only match patterns that they already know. As new ML schemes developed, many of these solutions were unable to adapt to uncover them, providing criminals with new avenues to circumvent detection and the law.
- There was insufficient and inconsistent checking. Transaction volumes in the financial instructions are very large and the sizes are increasing (Wicks, 2001). The current systems do not have enough capabilities to check every transaction in a comprehensive and consistent manner. Too few checks are costly in terms of undetected ML activities.

ML detection and prevention are notoriously difficult (Wicks, 2001; Horobin, 2001). Due to the complex nature of financial products, services, and ML itself, ML is dynamic and it adapts over time according to changing conditions. Patterns of behavior change as money launderers become aware of the techniques being used to combat them. Given such behavior, business knowledge about AML extracted from current up-to-date AML practices will play a critical role in achieving automation of AML. Fixed rules can be applied to mitigate against certain extreme behaviors and to enforce defined regulations. However, embedding static rule-based systems into electronic transaction environments does not provide adequate safeguards to combat ML. KPMG (Byrne, 2005) suggested a risk-based approach is the only way to identify potential ML transactions. It is therefore vital to tackle the problem using a risk-based approach, as well as the technology that adapts, so that systems can be dynamic in the way that they respond to changes in the patterns of ML.

Intelligent agents

The development of intelligent agents (IAs) and multi-agent systems (MASs) has recently gained popularity among IS researchers (Franklin and Graesser, 1997; Jennings, 2000). Although there is no universally accepted definition of the term ''agent,'' and indeed there is a good deal of ongoing debate and controversy on this very subject, the central point of agents is that they are autonomous: capable of acting independently, exhibiting control over their internal state. Wooldridge and Jennings (1995) suggest a precise description of agents; one that may be widely adopted in artificial intelligence communities as well as general computing areas. An agent is defined as a computer system that is situated in some environment, and is capable of autonomous action in that environment in order to meet its design objectives (Wooldridge and Jennings, 1995; Wooldridge, 2002). Furthermore, agents are able to act without the intervention of humans or other systems: they have control both over their own internal state, and over their behavior (Wooldridge, 1999). An intelligent agent (IA) is one that is capable of flexible autonomous action in order to meet its design objectives, where flexibility includes properties such as autonomy, social capability, reactivity, and proactivity (Wooldridge and Jennings, 1995; Wooldridge, 2002). A generic agent has a set of goals (intentions), certain capabilities to perform tasks, and some knowledge (or beliefs) about its environment. To achieve its goals, an agent needs to use its knowledge to reason about its environment and the behaviors of other agents, to generate plans and to execute these plans. A MAS consists of a group of agents, interacting with one another to collectively achieve their goals. By absorbing other agents' knowledge and capabilities, agents can overcome their inherent bounds of intelligence (Jennings and Wooldridge, 1998).

The concept of IAs has increasingly become important in artificial intelligence, computer science, and e-commerce. In recent years, there has been considerable growth of interest in the design of a distributed, intelligent society of agents capable of dealing with complex problems and vast amounts of information collaboratively. Since agent technology provides flexible, distributed, and intelligent solutions for business process management, researchers have proposed to design and develop numerous IA-based systems to support business processes management in dynamic and unpredictable environment (Jennings *et al.*, 2000; Zhuge, 2003). It is proposed to use IAs for business data monitoring, in which IAs are deployed with specific domain knowledge, and they can intervene on behalf of business analysts by being able to perform limitless, error-free routine calculations and interpretation rapidly to the precise requirements of business managers (Wang *et al.*, 2002; Wang and Wang, 1997).

Many examples of agent-based research related to knowledge management (KM) have been developed (Jennings and Wooldridge, 1996; Turban and Aronson, 1998; Shen *et al.*, 2001). For example, Elofson *et al.* (1997) proposed a community of IAs to facilitate knowledge sharing in an environmental scanning process. Wu (2001) proposed the use of IAs for KM, which focused on the coordination of multi-agent supply chains and auctions. Aguire *et al.* (2001) proposed a multi-agent-based knowledge network. Roda *et al.* (2003) proposed an agent-based system designed to support the adoption of knowledge sharing practices within communities. Li *et al.* (2006) proposed an agent-based buddy-finding

methodology, and tested it in a context involving sharing musical-knowledge. When intelligent agents are applied in knowledge-based systems, they are more capable of reactive and proactive behavior, and they are equipped with social ability in the sense of cooperation, coordination and negotiation. To be more useful in complex real-world domains, the agents are flexible in terms of their problem-solving skills, communication capabilities, and utilization of internal knowledge and data.

ML is a complex and ill-structured problem. According to Bui and Lee (1999), a multi-agent framework is necessary to support a comprehensive knowledge management system faced with uncertainty, complexity, and ill-structured problems. Therefore, IA technology is a suitable approach to an intelligent AML control architecture. IAs are able to analyze all transactions and accounts, and also have corporate authority to access any data that might be relevant. The reactive behavior of agents enables them to perceive the suspicious behavior occurring in the transactions and respond in a timely fashion. The proactive behavior enables agents to uncover wrongdoing by finding suspicious patterns of behavior hidden within voluminous data, and to separate those problem patterns from normal everyday events.

IA-supported knowledge-based anti-money laundering

As noted before, IAs equipped with specific domain knowledge and their properties of autonomy, reactivity, proactivity, and social ability are well suited to business monitoring applications that perform limitless, error-free routine calculations and interpretation rapidly to the precise requirements of business managers. Here, we will illustrate how to apply IAs into the electronic environment to realize a knowledge-based solution for AML.

Knowledge-based intelligent agents

In a multi-agent system, software agents are proposed to perform some tasks autonomously on the user's behalf, which means that they can act independently of humans. It is essential to design a set of autonomous type of behaviors for the agent class, including reactive, proactive, and cooperative behavior. Both autonomous and semi-autonomous agents rely on knowledge or data which is the agent's perception or awareness of its environment. Various kinds of intelligence are supported by this kind of data. It usually concerns rules, which are the user's expression of preference of policies followed by the agent to complete its task (Caglayan and Harrison, 1997). In order to fulfill the organizational goals and objectives, business rules to conduct business activities play an essential role in governing peoples' behavior. These business rules may form an important part of the knowledge base for software agents to perform delegated tasks on the user's behalf (Liu *et al.*, 2001). Once the rules are understood, captured and represented in the form of logic, they will serve as a basis for building intelligent agents to perform rational activities.

Business rules are a formal expression of knowledge or preference. If-then rules have become the most popular form of declarative knowledge representation used in artificial intelligence applications (Giarratano and Riley, 1998). Knowledge represented as if-then rules is easily understandable, in contrast to knowledge represented in predicate logic. Rules are declarations of the type *if* < condition > then < action >, that means if the < condition > is true then the < action > should be executed. The execution control of these rules is done through a separate inference mechanism which tests each rule against existing facts in a working memory, generating new facts in it – or executing some procedural code associated with the rule – when a matching occurs. This process is

"The reactive behavior of intelligent agents enables them to perceive the suspicious behavior occurring in the transactions and respond in a timely fashion."

repeated recursively until a specific goal is reached or there are not any more rules in the rule database that can be triggered.

Business rules capture

Rules statements are a key element in defining the intentions and the needs of the business, as well as an important type of presentation of business knowledge. In this research, we capture the business logic in the form of rules from AML practice, such as from the *FATF 40 Recommendations*, government legislation documents, financial institution reports, etc. These AML rules can be used by intelligent agents to monitor, diagnose, and report possible ML schemes. Two example rules for ML monitoring are:

1. IF a customer OR a person publicly associated with the customer, has a questionable background OR is on any of the Sanctions Lists, THEN this customer and associated transactions are recorded as possible money laundering.
2. IF a customer's account has wire transfers that have no apparent business purpose to or from a country identified as a high money laundering risk or a bank secrecy or ''tax haven'' THEN this customer and associated transactions are recorded as possible money laundering.

Business strategies in business rules

Business rules specify a series of clear statements about the logic underlying a business, each of which represents a small unit of knowledge. At a high level, business rules could be classified under one or more concerns, such as controlling workflow, reducing business risk, making efficient use of resources and improve customer service (Morgan, 2002). Accordingly, while designing rules for intelligent agents to perform AML activities, we may not merely focus on those rules to control monitoring, diagnosing and reporting activities, but also consider some business strategies to improve the efficiency of AML. For instance, while the transaction monitoring agent executes validation on transaction details, it is not quite efficient to go over all the components in each transaction to ensure that details are correct before being communicated externally. Instead, this monitoring agent may focus on the validation of several critical components such as client ID, transaction type, transaction date, value data, counter party, and etc. Furthermore, sometimes special types of transactions that take specific care of that situation are more likely to be a potential ML scheme. We may consider providing additional attention to some kinds of transactions based on a risk-based approach such as:

- transactions with cash value at or above a certain figure (i.e. large amount transaction);
- transactions with a special transaction type (i.e. high-risk transaction types defined by FATF, such as wire transfer);
- transactions with a special counter party (i.e. high-risk customers and business entities, like casino owner or somebody from high-risk countries); and
- transactions of certain frequencies (i.e. high frequency transactions suggest high-risk customer behavior).

Dynamic business rules

Most agents rely on knowledge about the environment that has been built by the designer. Furthermore, due to the increased complexity and uncertainty in today's environment of organizations and markets, the agent needs to be able to adapt to the dynamic world. In dynamic-rule-based agents, it usually implies the agent's ability to automatically modify the rule base in some way, so-called dynamic business rules. Agents can derive rules from the user and environment, and then incorporate the new rules into their behaviors. Such agents need access to historical databases or logs of events, which can be analyzed for emerging trends or correlations. For example, some ML activities are related to one specific counter party or one specific transaction type. The transaction monitoring agent may find this kind of correlation after data analysis on ML history, and accordingly adjust its monitoring policy to pay more attention to the transactions related to this specific counter party or transaction type.

Multi-agent framework for anti-money laundering

After the above discussion on the application of IAs for the knowledge-based AML solution, we now develop a multi-agent framework of AML in electronic transaction environments for banks.

Deployment of intelligent agents

Before applying multi-agent technology into the AML solution, we need to decompose the process of AML into several autonomous stages, in which each agent is delegated a particular task to exhibit its goal-oriented and reactive behavior, and to cooperate with other agents to pursue their goals. The process of AML usually consists of the phases of data collecting, ML risk monitoring, behavior diagnosing, and suspicious activity reporting (FATF, 2008a) (see Figure 1).

Data collecting involves internal and external data collection. ML monitoring is composed of client profile assessment (complying with FATF's customer identification) and a transaction risk measurement. Accordingly, the taxonomy of intelligent agents required for AML is outlined in Figure 2, in which several intelligent agent classes are applied to provide a set of AML functionalities for existing financial institutions. The requirements of the stages of the AML process (as outlined in Figure 1) are clearly evident in the categories of agents specified in the taxonomy of Figure 2. For example, the Data Collecting Agent is specialized

Figure 1 Anti-money laundering process

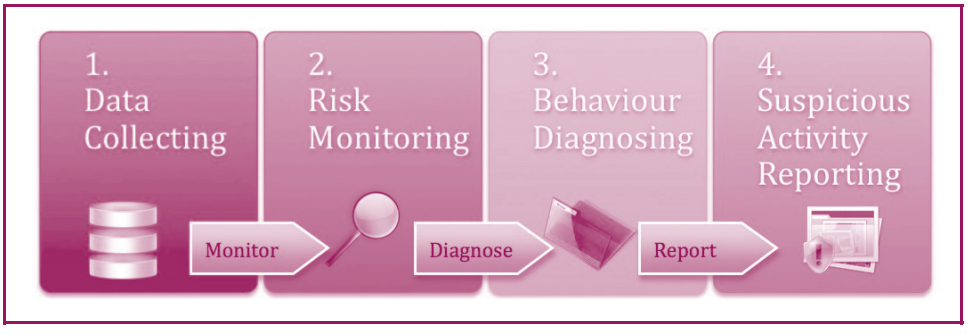
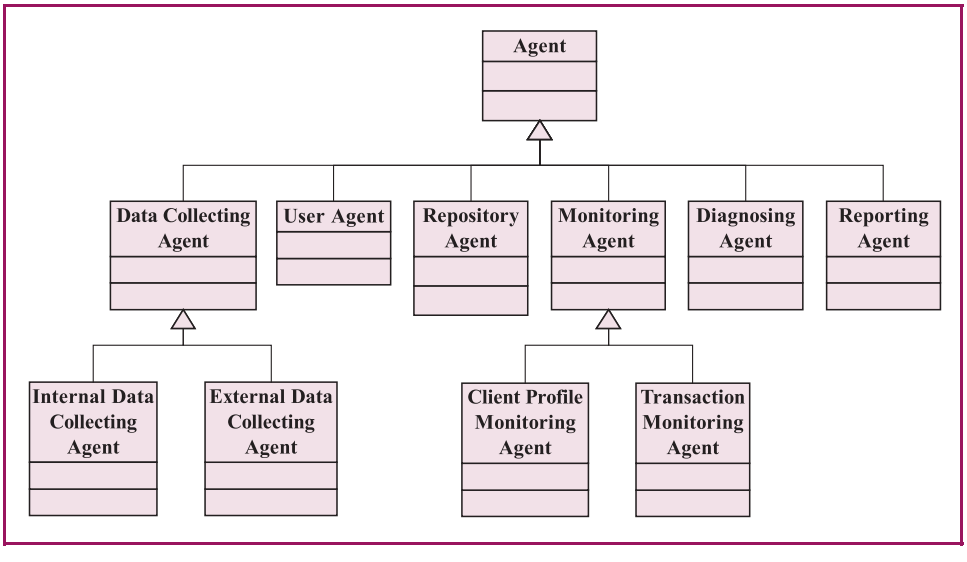


Figure 2 Agent hierarchy for anti-money laundering



> **"Both autonomous and semi-autonomous agents rely on knowledge or data which is the agent's perception or awareness of its environment."**

into an internal data collecting agent and an External Data Collecting agent. The details of these agents are described in the following subsection.

Multi-agent system architecture

The value of any AML solution has to be based on its ability to uncover suspicious financial activities by identifying the specific individuals or organizations that may be involved (Menon and Kuman, 2005). However, given the complex nature of ML prevention controls, an automated solution cannot attach suspicion to any activity detected – it can only detect activity worthy of analyst interpretation. Human ML expertise is required to determine if that activity is suspicious and worthy of reporting. Therefore, the optimum way to implement ML prevention controls is as a synthesis of human expertise and automated intelligence. In this research, the automated system performs the detection work, raising alerts for transactions deemed suspicious (in terms of the suspicious activity report) to the humans concerned. The human analysts perform investigations into the cases that are raised.

There are two ways to develop the AML solution:

1. we can reengineer existing banking systems to support AML functions; or
2. we can develop an independent AML system to link with the existing applications through which all client and transaction data would pass during its lifecycle.

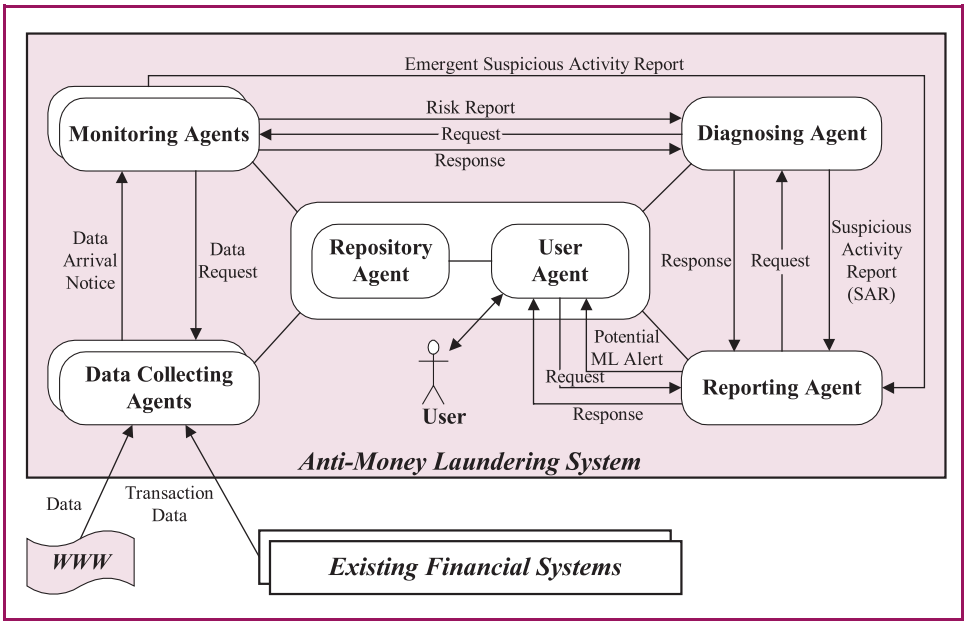
Our work is to use fundamentally the second approach by employing a financial institution's internal resources to build software capabilities that can interact with their existing legacy systems. There are three reasons for choosing an add-on AML approach. First, our proposed AML solution can capture the data from the banking system without any interruption to normal banking operations. Second, our proposed AML solution is a stand-alone system. It can integrate flexibly to any banking legacy systems. Third, reengineering an existing banking system to support AML functions is a too complex, time-consuming, and costly. Therefore, it is more feasible to choose an add-on AML solution approach.

Based on the analysis above, the AML process diagram (see Figure 1), and the deployment of intelligent agents in the previous subsection (see Figure 2), we outline the framework of our multi-agent based AML system in Figure 3, in which a society of intelligent agents is applied to provide a set of functionalities for AML in electronic transactions.

The agents are distributed in the departments of banks involved in AML; they communicate with each other through the Internet. All of these agents work autonomously and collaboratively in the multi-agent environment. Each agent focuses on its particular task such as data collecting, monitoring, diagnosing, and reporting without inventions from outside. By drawing on other agents' knowledge and capabilities, agents can overcome their inherent bounds of intelligence and work collaboratively to pursue their goals.

The behavior of an agent is based on an internal model of the agent consisting of a knowledge base, operational facilities, and a correspondence between the external application domains. Generally, development of an agent considers an agent knowledge base, its operational facilities and its external interface. Knowledge is required by each agent to perform its internal and external activities. It consists of knowledge for particular tasks, resource status information, information about other agents, and the like. The operational facilities execute different functions and provide collaboration with other agents;

Figure 3 Multi-agent framework for anti-money laundering



they are the central control and action part of an agent. A dynamic rule engine is usually an important operational facility, which provides a means for applying simple, dynamic-rules-based reasoning to emergence of new facts in the agent's world and for using this reasoning capability to decide what the agent should do next. The external interface envelops an agent and provides access to it via a well-defined interface, and it is also the primary conduit for communication between agents.

The User Agent acts as an effective bridge between the user and the computer. It can make the human-computer interface more intuitive and encourage types of interactions that might be difficult to evoke with a conventional interface. In our system, this agent enables users to view the current state of the financial transactions and ML monitoring, diagnosing, and reporting processes and allows them to convey their own judgments, opinions, and arguments relative to ML detection to the rest of the bank. The agent also enables the corresponding users to issue requests to the other agents in the system. The Repository Agent plays an important role in our approach. Although there is no need for centralized storage of all knowledge regarding AML, there could be one consistent knowledge repository that maintains and integrates all information related to the monitoring and analysis tasks. In this way, the various agents that make up the system can exchange knowledge regarding entities involved and deal with ML in a collaborative manner. In our approach, the Repository Agent may contain and manage several kind of information, e.g. real time banking transaction data for monitoring, risk reports for further diagnosing, reports for suspicious activities that have been detected, etc. Such shared information about banking transactions and suspicious activities may form an important base for agents' collaboration in banking AML.

The Data Collecting Agents enable the system to collect data internally and externally. In particular, the Internal Data Collecting Agent is in charge of acquiring real-time data from existing banking systems for the client profile assessment, transaction risk measurement, and further behavior diagnosis and reporting. Several kinds of data related to possible ML schemes are required for ML prevention controls, such as client profiles, financial transaction details, account reference data, client reference data, historical statistics, etc. On the other hand, the External Data Collecting Agent retrieves open data from ML watchdog agencies, national government, and other authorities. The data includes international standards, official thresholds, watch list, legislations, etc.

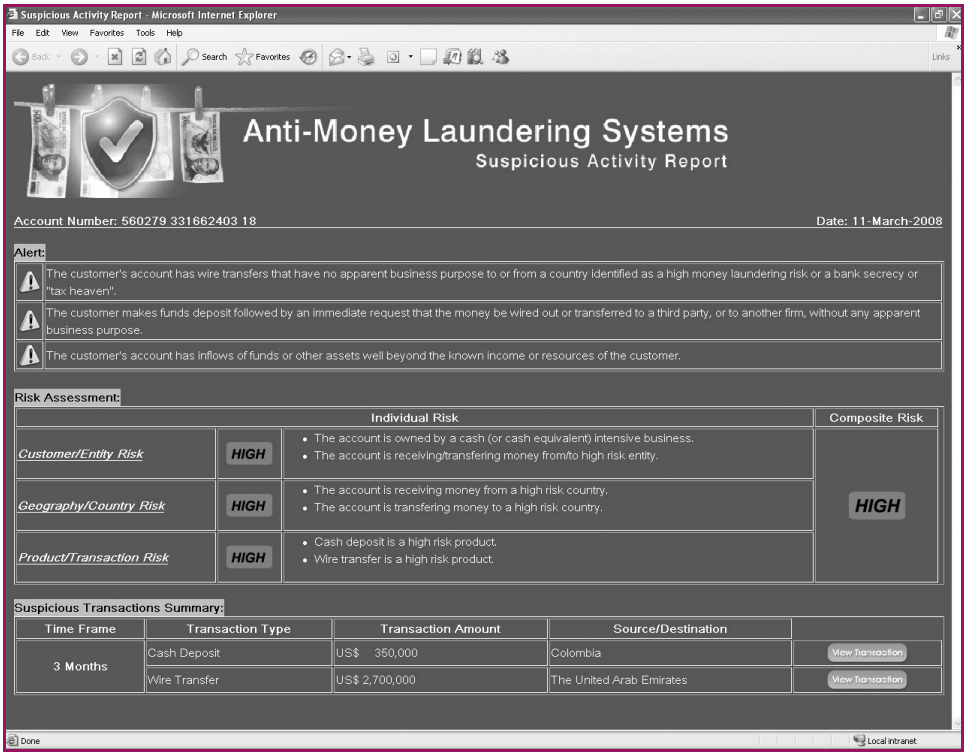
Two kinds of Monitoring Agents include Client Profile Monitoring Agent and Transaction Monitoring Agent, are proposed in our system to monitor potential ML schemes on a client-by-client, transaction-by-transaction basis. Both agents comply with the global-accepted core policy for effective ML controls – KYC (KnowYourCustomer). The Client Profile Monitoring Agent is to assess a wide variety of detailed information relating to the client's account, typically collected at the time that the account is opened. The agent provides a single view of the client profile incorporating all of the various financial relationships that the account has an affiliation with. The types of analytical activities that are part of the agent client profiling processes include, but are not limited to: watch list name screening, high risk country alerting, financial source or channels, business relationship, and political affiliation. Each client is classified into different risk profiles. And based on the client risk classification, the agent determines the frequency and the intensity of monitoring. The Transaction Monitoring Agent is to identify transactions that pose the greatest risk for potential ML activities. Transaction determined to be of a higher risk can vary from organization to organization based on their product-type lines and types of business. For instance, the risk associated with transactions from a bank would be different from those associated with an insurance agency or a securities firm. In general, the transaction risk behavior include, but are not limited to (Menon and Kuman, 2005): rapid movement of funds in or out of the account, sudden activity into a previously dormant account, frequent changes to an account, recurring transactions, hidden account relations, offsetting trades, settlement and/or standing instructions of an account, the movement of funds without a corresponding trade, and the deposit of excess collateral into an account.

Normally, if a questionable client profile or an unusual transaction is captured by the Monitoring Agents, a risk report will be issued and sent to the Diagnosing Agent for further investigation. However, an emergent suspicious activity report (SAR) could be issued to be reported to the user for instant action. When receiving the risk reports from Monitoring Agents, the Diagnosing Agent will start its diagnosing process to investigate the complex behavior that is commonly associated with ML schemes. This agent may conduct analysis on risk reports from Monitoring Agents and request any additional information if necessary to examine the cases. The agent allows financial institutions to detect wrongdoing by finding suspicious patterns of behavior that may be hidden behind large volumes of financial data.

When the Diagnosing Agent identifies unusual or suspicious behavior, a suspicious activity report (SAR) will be automatically produced and sent to the Reporting Agent. Figure 4 shows a screenshot of a SAR. Then the Reporting Agent will present and communicate a potential ML alert to the appropriate compliance personnel through the User Agent for case management investigation and action. Alternatively the Reporting Agent will automate or take a specific course of action, for example, interfering with standard operations to block a particular suspicious transaction. Cases for investigation are filtered and prioritized based on the severity of the alert. The Reporting Agent is able to support the business process to assist with suspicious case investigation. It does this by providing evidence of client activity and information, ensuring the case officer has all of the relevant customer intelligence at hand. If necessary, additional information is requested from Diagnosing Agent. This allows them to make a fact based decision and it also demonstrates regulatory due diligence in the process. The Reporting Agent also facilitates combining the automatically generated alerts with suspect manual reports, to build the case for investigation. The reporting facilities within the Reporting Agent provide a complete tracking system and audit trail for managing actions in response to detected events or suspicious behavior. Such comprehensive reporting allows the financial institutions to demonstrate compliance to the AML rules and adherence to the regulatory requirements.

Moreover, the Monitoring Agents run scheduled scans for all accounts and transactions by using the data-mining techniques (property of agent's proactivity). The Monitoring Agents will monitor the complex suspicious customer activity and rank the customers according to degree of suspicion of ML. After the unknown patterns are understood, they are sent to the Diagnosing Agent to identify suspicious events that build over time, and to separate them from everyday events and transactions in order to target the offending behavior. In addition,

Figure 4 Screenshot of suspicious activity report in anti-money laundering system



when the previous unknown complex ML schemes become known ML schemes, they will be stored in the Repository Agent for future monitoring and diagnosing.

Conclusion

This paper explores the approach of applying intelligent agents for knowledge-based AML in electronic transaction environment. A conceptual framework for a multi-agent system based on AML process is developed, in which various classes of intelligent agents are proposed to provide a set of functionalities for AML in electronic transaction environment for banks. In order to make software agents act autonomously and collaboratively to fulfill the organizational goals and objectives, business knowledge such as business rules and business strategies are extracted from AML practice, and applied to the design of individual agents. A generic structure for rule-based agents is also outlined, in which business logic is separated from business model with a view to enhance the flexibility and adaptability of such kind of rule-based system.

Following this framework, we have started to build a prototype in Java so that agents can run on heterogeneous platforms and make use of lightweight applets as temporary agents. After the implementation, a number of ML cases will be built based on the real-world cases for prototype evaluation purpose. Evaluation of the prototype consists of two parts. First, semi-structured interviews will be conducted with the AML experts to collect their feedback on the prototype. Their feedback will be used to refine the prototype. Second, a laboratory experiment(s) will be conducted to evaluate the prototype effectiveness in terms of AML decision support.

Our proposed system focuses on internal data monitoring in one bank, which lacks the capability to monitor multi-bank transactions. ML is becoming more and more complex, which includes multiple banks, financial institutions, countries, etc. How to share data and knowledge between these multiple entities is becoming an important issue. Out future work will explore such multi-entity involved AML solution.

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Knowledge management and knowledge creation in academia: a study based on surveys in a Japanese research university

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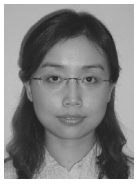

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Abstract

Purpose – *This study aims to pose one major research question, i.e. why and how to use knowledge management methods in order to enhance knowledge creation in academia – at universities and research institutes?*

Design/methodology/approach – *The paper defines KM in academia as any systematic activity related to support and enhancement of the creation of scientific knowledge and achievement of research goals, including both social process and relevant computer technology tools. Two surveys and case studies were carried out to achieve the research purpose at Japan Advanced Institute of Science and Technology (JAIST). The first survey focused on knowledge management in academia and investigated the current KM situations, special and diverse requirements from researchers. The second survey concentrated on supporting the creative processes of academic research and investigated which aspects of knowledge creation processes should be supported in particular. Based on survey findings, the practical solutions are further presented aimed to improve the creative environment for scientific knowledge creation.*

Findings – *The findings from the first survey showed that the KM obstacles reflected on various aspects: technological support, the people involved in creation activities, laboratory cultural, and so on. The seven most critical questions and three most important questions were evaluated by responders with respect to academic knowledge creation process in the second survey.*

Research limitations/implications – *The study advances the belief that knowledge management (KM) is applicable not only in industrial and market organizations, but also in academia.*

Practical implications – *With respect to the survey results, it is suggested that a creative environment in academia should be enhanced from both ''soft'' and ''hard'' aspects under the guidelines of a systems thinking framework for KM in scientific labs. From the soft side, by using personalization strategies, a knowledge-sharing culture has to be built in labs to facilitate scientific communication, debate and team work. From the hard side, by using technology strategies, a practical example is presented in JAIST concerning the implementation of the hard aspect of creative environment. It is hoped that the research can launch further debate and prompt practical steps to help research institutes or universities improve their management and increase the research efficiency.*

Originality/value – *An essential point is that the study is based on the feedback from knowledge creators in a typical knowledge creation organization, which makes the analyses and conclusions more comprehensive and persuasive from both the theoretical and practical points of view. The research not only explores some hidden or tacit problems existing in academic knowledge management and scientific knowledge creation, but also proposes solutions for scientific knowledge creation that were found to be valuable by university management.*

Keywords *Knowledge management, Surveys, Universities, Knowledge creation, Japan*

Paper type *Research paper*

1. Introduction

Research on knowledge management (KM) came into being in the early 1990s. With the growth of information technology and knowledge economy, KM has gained very strong and quick development in the business field in past more than decade and enjoyed an emerging popularity across disciplines and industries. Methods and stimulation of creation of

knowledge and technology are gaining increasing attention in scientific research and practice.

The School of Knowledge Science at Japan Advanced Institute of Science and Technology (JAIST) is the first school established in the world to make knowledge creation the core of its scientific research. At this graduate school, KM research is focusing on knowledge conversion theories, knowledge-systematizing models and methods for the development of creativity.

As we know, universities and research institutes constitute social academic communities that play a vital role in creating and transmitting scientific knowledge, which is the fundamental source and driver for societal progress and development. Thus, enhancing the scientific knowledge creation process in academia will have a significant impact. At the School of Knowledge Science of JAIST, we are conducting research relating to the systems and environment that best support knowledge management and knowledge creation in academia. It aims at enabling researchers to achieve robust innovation in research frontier of natural sciences. For this purpose, we should first know: for example, what are the current situations and hidden problems of KM in academia? What are the most critical and most important problems in the processes of scientific knowledge creation? What aspects of knowledge creation process should we support particularly? And then, it is possible to think about how we should implement knowledge management initiative and improve the creativity environment in academia.

According to case study methodology (Yin, 2003), this study adopts case study in combination with doing the survey. We considered JAIST to be a representative research institute for our study and conducted two surveys respectively (Tian *et al.*, 2006a, 2006b). By using comparison, classification, cross tabulation, and other analysis methods, some tacit issues and hidden problems have been discovered in the first survey on knowledge management in academia. In the second survey, we concentrated on supporting the creative processes of academic research and investigated which aspects of knowledge creation processes should be supported in particular. By using a multiple criteria formulation and reference point method, we extracted useful information and knowledge from the database of survey results. In the paper, a knowledge creation continuum (data-information-knowledge spiral) and a systems thinking framework for KM in scientific laboratories were proposed, which provide important implications for us to build a creative environment to support scientific knowledge creation in practice. The research not only first explores some hidden problems existing in academic KM and scientific knowledge creation, but also proposes solutions for scientific knowledge creation that were found valuable by university management.

The rest of this paper is organized as follows. Section 2 recalls the arguments of knowledge hierarchy, proposes a Data-Information-Knowledge spiral and presents the processes of scientific knowledge creation – Triple Helix Spiral. Section 3 is an overview of two surveys, their goals, instruments, and important findings. We further discuss the survey results and classify them into four important factors with respect to the management and creation of scientific knowledge in Section 4. Section 5 gives the practical examples in terms of the implementation of creativity environment. Finally, section 6 contains brief concluding remarks.

2. Knowledge and scientific knowledge creation

Data, information and knowledge: hierarchy and spiral

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In many KM literatures it is often pointed out that it is important to distinguish between data, information and knowledge. Most notably in IT writings, some authors address the question of defining knowledge by distinguishing among knowledge, information and data. The generally accepted view treats data as raw facts that become information as data is put into context and combined into meaningful structures, which subsequently become knowledge as meaningful information is combined with experience and judgment. This view sees data

as a prerequisite for information, and information as a prerequisite for knowledge (Tuomi, 1999).

However, the assumption of a hierarchy from data to information to knowledge with each varying along some dimension, such as context, usefulness, or interpretability, does not survive a critical evaluation. Zack (1999) argues that data can be considered as facts or observations whereas information is data in a context; knowledge is information that is accumulated and organized in a meaningful way. Tuomi (1999) makes the iconoclastic argument that the often-assumed hierarchy from data to knowledge is actually inverse. He argues that knowledge exists which, when articulated, verbalized, and structured, becomes information which, when assigned a fixed representation and standard interpretation, becomes data. As such, raw data do not exist – even the most elementary piece of ''data'' has already been influenced by the thought or knowledge processes that led to its identification and collection. Consistent with this view, Alavi and Leidner (2001) state that information is converted to knowledge once it is processed in the mind of individuals and knowledge becomes information once it is articulated and presented in the form of text, graphics, words, or other symbolic forms. Braganza (2004) also propose a knowledge-information-data (KID) model based on a case study, which suggests knowledge leads to information which determines data. It reversed the commonly accepted hierarchy, which assumes that knowledge is a product of data and information. Moreover, the discussion about a proper justification of beliefs becoming knowledge – see Wierzbicki and Nakamori (2006) – shows that knowledge can be properly justified only when using some other, prior knowledge, stemming mostly from the intellectual heritage of humanity; thus the concept of knowledge is inherently circular. We summarized above arguments and represented the main standpoints in Figure 1.

With respect to the discussions on knowledge hierarchy, we posit that data-information-knowledge form an iterative cycle which emphasizes a feedback mechanism that may either produce an action step to create knowledge or produce a reassessment of the kinds of knowledge needed to take an effective application (see Figure 2). For instance, in the work of basic science research, the data gathered from the experiments by the agent (researcher) A is raw data and facts; if the agent A puts them in context through interpretation, causes or relationships, then data becomes information; the findings based on an analysis, induction, synthesis and validation of experimental results become the knowledge of agent A. To agent A, the new knowledge can be a base and the background to effectively observe, explore or derive new data and begin next

Figure 1 The hierarchical Data-Information-Knowledge

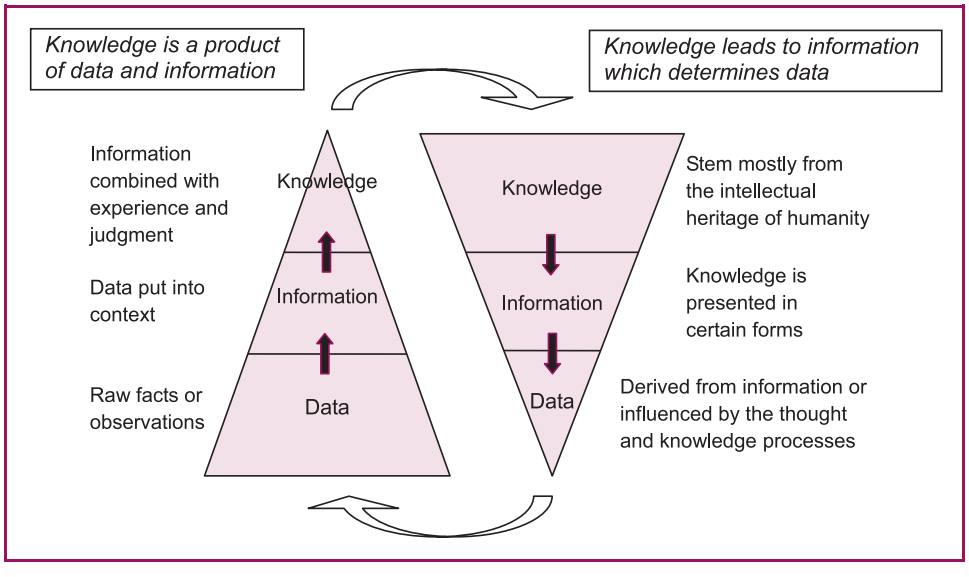
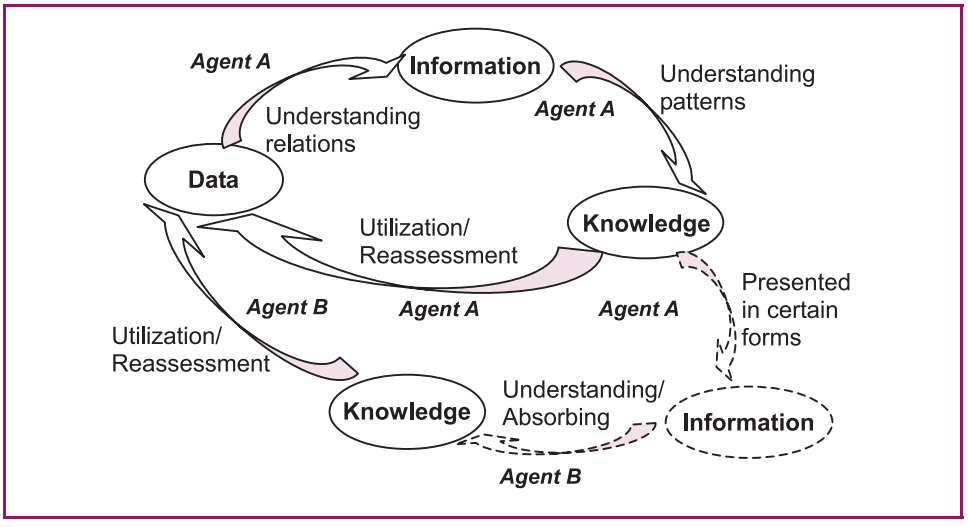


Figure 2 The data-information-knowledge spiral



data-information-knowledge (DIK) cycle. And the agent A also could share it with someone else, e.g. agent B, through presenting it as information in appropriate contexts, for example, documents, language, or creation of designs and tools. The embracer (agent B) either internalizes it as his/her knowledge or uses the new tools to discover new data or derive research data from former work – another cycle begins. Above processes happen continuously and could start from any one of three nodes (Data-Information-Knowledge). Thus, DIK cycle is a spiral. There are effective means for engaging appropriate people in sharing information, its discussion and debate, in order to further refine, synthesize, and reflect on the information and probe it for a further understanding.

For better understanding of Data-information-knowledge spiral, we illustrate it with the processes of our two surveys as a practical example. Our first survey focuses on KM in academia. The answers of the questionnaire given by the respondents are firstly collected as raw data. By relating the answers with their corresponding questions, we get the respondents' opinions, which are important information for us to do further analysis. By using statistic analysis, comparison, classification, correlation analysis and other methods, some tacit issues and hidden problems have been discovered. These new understandings in academia thus become our new knowledge. Based on the findings (new knowledge) gotten in the first survey, we design another questionnaire and conduct the second survey, which concentrates on supporting the creative processes of academic research. New data are collected by the second survey and another data-information-knowledge cycle begins. The survey results are published in some papers and presented in some conferences (here knowledge are transformed into information), which makes it possible for other researchers to discuss and/or debate them with us. In case of that our findings are well understood and accepted by the other researchers, these findings would become their knowledge and probably would be cited and/or used in their future research by any of possibility; In another case that if they do not trust our results, they may do some similar work to test it. In either of the two cases, a new cycle would be initiated. In addition, we want to emphasize that the implementation of the first survey was based on the understanding of existing KM researches. Thus, the data collected from the first survey are actually derived from knowledge. That is the reason that we argue the DIK spiral can start from any one of three nodes (Data-Information-Knowledge).

In Figure 2, we ignored the Information as the intermediate existing in the direct flow of knowledge to data, because the information here is created from knowledge through a process of articulation and externalization and could be shared in symbolic form, natural language or acts. In other words, explicit knowledge is another name for information here. In Figure 2, from data to information to knowledge, it is the process of knowledge internalization

> **"The assumption of a hierarchy from data to information to knowledge with each varying along some dimension, such as context, usefulness or interpretability, does not survive a critical evaluation."**

(i.e. immersion of explicit knowledge into tacit or intuitive knowledge). When knowledge is documented, transmitted and saved as information by means of physical entities, such as books, paper, CDs and database, it is the process of knowledge externalization. Namely, it is the explication process of tacit knowledge, which is one of the key problems of KM. It gives us important implication when organization develops computer systems to support knowledge management. To the system designer, the problems not only have to be viewed from the point of someone trying to understand data stored in computer system, find it and make sense of it, but also have to think about how to articulate knowledge and save it in computer system.

Therefore, the creation of knowledge usually starts with a new combination of diverse data, information, knowledge, but further involves interactions between tacit and explicit knowledge (Nonaka and Takeuchi, 1995). The capability of such interaction depends on the creative abilities of individual as well as on the context. If appropriate methods or techniques are used to support the process of scientific research, it is possible to raise the performance and effects of creativity. But first of all, we should understand the processes of knowledge creation.

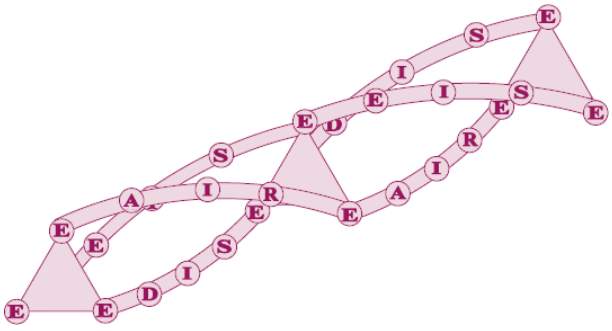
Scientific knowledge creation

In recent years, many theories of knowledge creation for the needs of today and tomorrow have been developed. We might call them micro-theories of knowledge creation (Wierzbicki and Nakamori, 2006), as distinct from the philosophical theories of knowledge creation on the long term, historical macro-scale that usually, however, does not necessarily help in current knowledge creation. All such micro-theories take into account the tacit, intuitive, emotional, even mythical aspects of knowledge. Many of them can be represented in the form of spirals of knowledge creation processes, describing the interplay between tacit and explicit or intuitive and rational knowledge, following the SECI spiral (Nonaka *et al.*, 2000).

In Wierzbicki and Nakamori (2006), an integration and synthesis of micro-theories of knowledge creation takes the form of so-called Creative Space – a network-like model of diverse creative processes with many nodes and transitions between them, starting from a generalization of the SECI Spiral (Nonaka *et al.*, 2000). Many spirals of knowledge creation can be represented as processes in Creative Space; one of the interesting observations is that we should distinguish between group-based, market or purpose-oriented, industrial organizational knowledge creation processes – such as the SECI Spiral, or its Occidental counterpart called the OPEC Spiral (Gasson, 2004), or an older and well known organizational process called brainstorming that can be also represented as a DCCV Spiral (Kunifuji, 2004) – as opposed to academic knowledge creation processes, describing how knowledge is normally created in academia and research institutions, such as road mapping I-system spiral (Nakamori, 2000; Ma *et al.*, 2004), especially, Triple Helix Spiral (see Figure 3).

The Triple Helix Spiral describes most essential elements of normal academic research (where the adjective normal is used in the sense of Kuhn, 1962), which combines three spirals: Hermeneutics (gathering scientific information and knowledge from literature, web and other sources, reflecting on these materials and interpreting them), called by us the EAIR (Enlightenment – Analysis – Immersion – Reflection) Spiral; Debate (discussing in a group research under way), called by us the EDIS (Enlightenment – Debate – Immersion – Selection) Spiral; Experiment (testing ideas and hypotheses by experimental research),

Figure 3 The Triple Helix of normal academia knowledge creation



Source: Wierzbicki and Nakamori (2006)

called by us the EEIS (Enlightenment – Experiment – Interpretation – Selection) Spiral. These spirals can be performed separately; for example, research in humanities (history, literature, etc.) concentrates on Hermeneutics; but also other sciences, even technology creation, need hermeneutic reflection and interpretation of written scientific literature. Technology creation and most hard sciences, but also some parts of social sciences, use Experiment; all academic knowledge creation uses Debate. Since all of these spirals begin with generating an idea, a transition from individual intuition to individual rationality, called the Enlightenment effect (illumination, aha, eureka), they can be combined into a Triple Helix of normal knowledge creation, typical for academic work.

These three spirals contained in the Triple Helix do not exhaustively describe all what occurs in academic knowledge creation, but they describe most essential elements of academic research: gathering and interpreting information and knowledge, debating and experimenting. Moreover, these spirals are individually oriented, even if a university and a laboratory should support them; e.g. the motivation for and the actual research on preparing a doctoral thesis is mostly individual. This is a notable difference from organizational knowledge creation processes, which are motivated mostly by the interests of a group, such as the SECI Spiral. Obviously, the Triple Helix model helps in a better understanding of some intuitive transitions in these spirals and makes possible testing, which parts of these spirals are well supported in academic practice and which require more support.

3. Survey study and findings

Our target institute is a relatively new (1990) Japanese national institute, established to do research at the highest levels in selected fields of science and technology. We considered this institute to be a representative research institute for our study, because:

- It consists of three schools: material science (MS), information science (IS) and knowledge science (KS). In term of scientific knowledge creation, they are typical representatives for the study of basic, information, and interdisciplinary science.
- It enrolls only Master's students and doctoral students. From this point of view, it is more like a knowledge creating organization than a general educational organization.
- There is a high proportion of foreign students (more than 10 percent) and scholars in JAIST.

Based on these properties and advantages, it is possible to contrast the data by nationality, by student's status, or by school, which makes our analysis and conclusions more comprehensive and reliable.

We conducted two surveys respectively on the first half of 2004 and the second half of 2005. Considering comparability, the survey public and instrument were same in two surveys. All

students (doctoral students and master students), postdoctoral fellows and research associates/assistants were included in both surveys. We did not include professors because we considered that they were a different group who used quite different methods to do their research as compared with our designated respondents, which would make it difficult to get valuable information from the same questionnaire (Dreyfus and Dreyfus, 1986)[1]. Considering foreign students that occupy a certain percentage in the survey population, we published English and Japanese questionnaire on JAIST intranet when we released two different surveys. In addition, since the laboratory is an academic space devoted to work and study, and it is a basic organizational entity for most researchers, we considered the laboratory as the basic unit in which we investigated knowledge management and knowledge creation in academia. We hope the survey results can provide reference points for JAIST management concerning the conditions required for KM and scientific creativity.

The first survey on KM in academia

The first survey focused on Knowledge Management in academia and sought to provide a snapshot of the situation in JAIST. We considered many contributing factors to be investigated, such as knowledge management technologies, personal IT skills, cooperation environments, laboratory knowledge management (LKM), knowledge sources for research, life environments, and so on (Tian *et al.*, 2006a). By using statistic comparison, classification, correlation analysis, and other analysis methods, some tacit issues and hidden problems have been discovered in the first survey on knowledge management:

- There is a serious disparity in the technical supports and average personal IT skill between the different schools at JAIST, which largely hinders efficient and effective knowledge management and sharing among some researchers.
- Many respondents are not familiar with or have not understood the function and advantage of IT tools in the process of managing knowledge.
- Self-study is the most important factor for responders in scientific knowledge creation; cooperation has not been recognized or emphasized enough.
- Many responders feel that they are not sufficiently supported in forming ideas and lack scientific dispute.
- The problem seen by responders as the most difficult one varies with respect to their different status. For instance, master students thought that acquiring necessary knowledge and information was their biggest difficulty; but Ph.D. candidates selected how to find new ideas in their research subjects as the biggest problem.
- There is no systemic KM framework for the scientific research in the lab. In this case knowledge is highly fragmented and inefficient to access what, when and where needed.

The second survey on creativity support in academia

Our first survey concentrated on general phenomena of KM in academia, which first explored the current situation of KM and the existing and hidden problems in scientific knowledge creation. Our second survey concentrated on detailed questions of knowledge creation and investigated which aspects of knowledge creation processes should be considered first and particularly and how to discover and measure such aspects. A long questionnaire included 48 questions was prepared corresponding to five topics: conditions for gathering scientific materials and ideas; conditions for experimental work; conditions for discussing ideas and research results; conditions for creating ideas; conditions for planning research. The three types of questions were designed. The first type was assessment questions, assessing the situation between students and at the university; the most critical questions of this type might be selected as those that correspond worst to a given reference profile. The second type was importance questions, assessing importance of a given subject; the most important questions might be considered as those that correspond best to a reference profile. The third type was controlling questions, testing the answers to the first two types by indirect questioning revealing responder attitudes or asking for a detailed explanation. By using a multiple criteria formulation and reference point method, we

extracted useful information and knowledge from the database of survey results (Tian *et al.*, 2006b). The seven most critical questions and three most important questions were evaluated by responders with respect to academic knowledge creation process. The following issues have been found needing most improvement by the responders:

- Because of language reasons, difficulty in discussing research questions with colleagues from other countries.
- Ease of sharing tacit knowledge.
- Critical feedback, questions and suggestions in group discussions.
- Organizing and planning research activities.
- Preparing presentations for seminars and conferences.
- Designing and planning experiments.
- Generating new ideas and research concepts.

Three subjects have been consistently chosen by respondents as most important for scientific creativity support:

1. Learning and training in how to do experiments.
2. Help and guidance from one's supervisor and colleagues.
3. Frequent communication with the group.

4. Discussions of survey findings

The findings from the first survey showed the KM problems reflected on various aspects: knowledge processes, technological support, the people involved in creation activities, laboratory cultural, and so on. The results of the second survey helped us to understand what aspects of the knowledge creation processes should be given more attention and support. We further refined the findings and classified them into four important factors in terms of the management and creation of scientific knowledge. They are:

1. knowledge source;
2. technological infrastructure;
3. organizational variables; and
4. knowledge creation processes.

Knowledge source

In the process of knowledge management practice, improved knowledge sharing is the most difficult problem (Hendriks, 1999). The quality of the knowledge to be transferred/learned (tacit versus explicit) affects knowledge sharing (Nonaka and Takeuchi, 1995). Sharing knowledge includes two transitions: one is the explicitation of tacit knowledge; the other is the internalization of tacit and explicit knowledge. Because of disparate characteristics of two categories of knowledge, we should treat them differently. Goh (2002) suggested that tacit knowledge demanded a ''softer'' and more interpersonal means of transfer but explicit knowledge required a ''harder'' and more technologically driven approach.

Davenport and Prusak (1998) proposed five types of knowledge, which correspond to the source of each: acquisition, dedicated resources, fusion, adaptation, and knowledge networking. Putting them into academic research context, acquired knowledge relies heavily on intellectual heritage such as literature database, library; scientific research laboratories selves are good examples of dedicated resources, in which the researchers with same or similar academic background work together for specific purposes; research corporation crossing organizational boundary or motivated by individual interests are fusion of academic research; adaptation means scientific research and technology innovation should be in the market place and reflect social requirement; knowledge networking is social network in

"If appropriate methods or techniques are used to support the process of scientific research, it is possible to raise the performance and effects of creativity."

which researchers share information and exchange idea in same knowledge base. Above five aspects could be the sources of scientific knowledge.

Associated with the i-System Model (Nakamori, 2000), if we hope to solve problems (Intervention), usually we can search required knowledge from three important dimensions – scientific, social and creative dimensions (intelligence, involvement and imagination). And then we construct the new knowledge or systemic knowledge (Integration) from above three fronts. Usually, researchers can get support and help from four knowledge sources to finish this process: their supervisor or professor's guidance and advice, their colleagues' cooperation and help, self-study, and help from outside scholars. In the first survey, in order to discover the importance of different knowledge source to various research activities, we listed five main research activities according to i-system methodology: ''confirm research subject'', ''acquire necessary knowledge and information'', ''understand social and practical significance'', ''find new idea'', and finally ''write paper''. We found, for all research activities except ''understand social and practical significance'', researchers regarded individual study as the most important factor[2]. At the same time, we found, to master course students, how to acquire necessary knowledge and information was their biggest problem. It reminded us that young researchers needed the support to enhance their efficiency and ability of self study.

From above analysis, knowledge as the cornerstone for scientific creation, it self is the most important factor to effective KM implementation. We should firstly address the different knowledge source and knowledge types, and then treat the corresponding and right way to pursue them. A corporate listing of people who are knowledgeable in a particular area is one way of acquiring tacit knowledge, whereas a computerized knowledge map would be more relevant for explicit knowledge (Wong and Aspinwall, 2004). Likewise, face-to-face conversations, group meetings, academic seminar and forums are better for transferring tacit knowledge whereas shared lessons-learned databases, groupware and electronic data interchange are more appropriate for explicit knowledge. From that point, Information Technology (IT) shows its strong properties to support better knowledge acquiring and sharing. The second element of KM framework in laboratories is technological infrastructure.

Information technology infrastructure

The interlinked information technologies (IT) employed by an organization form its IT infrastructure. For KM, the role of IT infrastructure is to support knowledge repositories, enhance knowledge access and transfer, and facilitate the knowledge environment. It can also enhance the interaction of individual, group, organizational, and inter-organizational knowledge (Nonaka and Takeuchi, 1995). In business area, there is successful experience to implement IT-based knowledge management system to support and enhance the life cycle of organization's knowledge. Therefore, IT as knowledge enabling tools may also benefit the process of scientific knowledge creation in academia.

The survey results show that not only do the IT skills of the researchers themselves limit efficient personal knowledge management to some extent, but also that there exists unevenness of technical support among different schools (Information Science School > Knowledge Science School > Material Science School). The situation should be seriously regarded and improved. For better communication and cooperation, we should provide more technical support and help to researchers who are not familiar with basic network and

computer technologies/knowledge. On the other hand, some technological tools which are often regarded as effective tools for knowledge management in the business area are not recognized in academic laboratories, such as Data warehouse, Groupware, Video conference and BBS (Tian *et al.*, 2006a; Zyngier, 2003). It is to say the predominance of technology in promoting knowledge integrating, discovering and sharing has not yet been brought into play in a laboratory. For example, web-based knowledge repository for storing and sharing knowledge among researchers, Bulletin Boards System for discussing and communicating to capture the knowledge residing in the mind, an online videoconference for transferring and integrating knowledge among partners or experts they are in different cities. Therefore, a well supported IT infrastructure should be taken into account by research managers or organizers.

In addition, the application of technology also depends on the people and the support of the management, which are organizational issues. Organizational variables will effect the KM implementation.

Organizational variables

Our surveys revealed a significant difference between business and academia with respect to knowledge management and creation: researchers in academia regarded self study and the guidance of their leader (supervisor) as the first and second important factors, and put cooperation in a third place; while in business activities and projects, cooperation and team work is always regarded as one of the most fundamental factors. A related result also showed that near half of the respondents almost always worked alone. Compared with another question – ''when you encounter problems and feel depressed, could you get encouragement from others'', we found that the respondents who worked alone also got much less timely encouragement and help from others at the same time. As we know, timely outside encouragement and help is a very important factor in study, it can affect a person's mood and moral, and have a further impact on their study efficiency, performance, and achievement. Thus, from this point of view, we cannot say that cooperation is a trivial factor in scientific knowledge management and creation, but rather that is a weak point that should be reinforced and improved. This is related with the issue of organizational culture. The organizational culture includes the shared values, beliefs, norms, expectations and assumptions that bind people and systems (Galbraith, 1977). The organizational culture is particularly important in KM because it gives the people a stable and harmonious basis and helps them to adapt and integrate other variables with the environment. For instance, if a laboratory culture is open and encouraged to cooperation and exchange, in which there are more relational channels to support and nurture person-to-person communications and team cooperation.

Our survey also exposed some different requirements and obstacles between foreign researchers and Japanese on idea exchange. To foreign respondents, language was one of important reasons for inefficient or meaningless seminars. But to Japanese students, they mainly complained the atmosphere of discussion were not open and free. The reason behind the answers of foreign respondents is that at JAIST only master-lever courses require foreign students to have good Japanese language ability, but for doctoral courses students, English is enough. Thus, if a foreign doctor student who is not good at Japanese attends a seminar or group discussion, but the speaker can only speak Japanese (suppose the speaker is a Japanese Master's student and not good at English), undoubtedly that seminar will be meaningless and quite tedious for him. Unfortunately, this case is quite common because of the laboratory seminar regulations (61 percent respondents said they had regular meeting at least once a week). For the complaint of Japanese respondents, we believe that the common characteristics of Japanese culture may help explain this fact. As we know, the common impression of the Japanese is that they are well mannered, soft-spoken, and hard-working while maintaining a strict ranking concept in their minds. From this point of view, it is easy to see why very few Japanese respondents might think that seminars are open and free, especially when the speaker is an elder member and their professor is present wearing a serious expression. A discussion of national characteristics is beyond the scope of this study, but personal characteristic is important element for KM since human beings are an

inherent part of environmental system. In an organization, the members have similar backgrounds, education levels, and experience, it is likely they will have the same understanding of a mission (issue) and share a strategic similarity (Darr and Kurtzberg, 2000). Partner similarity existing in all members of an organization is likely to reduce barriers of knowledge sharing and enhance knowledge transfer. However, we also should care the contrary side of one thing: the distinction of partners also could inspire new ideas to some extent.

In addition, with respect to the complaints of tedious and useless seminar and discussion between the members who have the language obstacle, we think that some laboratories' regulations on seminars and discussions could be improved and made it more efficiently. It belongs to managerial issue. And there are also several unsatisfied problems belonging to managerial rules in labs were revealed by the survey, for example, the management of equipments, books and journals in lab, the training of equipment usage and the maintenance and management of lab's homepage.

Culture, people, leadership and managerial style, each of them has implications for KM efforts in organizations. We summarize them as Organizational Variables. There are other factors as necessary concern in different organizations and situations, but we did not analyze them in our research because of few related survey findings about them, for example, organizational structures, reward systems, organizational tasks, and so on. In KM research and practice, it has always been suggested the particular attention should be paid to organizational variables, without which the success of KM cannot be guaranteed.

Knowledge creation process

We introduced a Triple Helix of normal academic knowledge creation processes in the former section. A important conclusion from our two surveys is a partial empirical confirmation – not of the theory of the Triple Helix, because this just describes how academics normally create knowledge, but of the essential importance of three spirals of normal academic knowledge creation contained in the Triple Helix by most negative and positive evaluations: the Hermeneutic EAIR Spiral, the Experimental EEIS Spiral, and the intersubjective EDIS Spiral. We found the young researchers have the universal difficulties in three spirals when doing their researches: for instance, acquiring necessary knowledge and forming idea (EAIR Spiral), doing experiments (EEIS Spiral) as well as further debate and discussion (EDIS Spiral). Especially, the most critical difficulties for master students are ''acquiring necessary knowledge'' and ''doing experiments''; for doctoral students, it is ''finding the new ideas''. The lack of scientific dispute is a common and noticeable problem in whole respondents. In other words, knowledge life cycle is not smooth in the processes of knowledge creation. There are obstacles in knowledge acquirements, knowledge validation, and knowledge sharing, etc.

All in all, based on above discussions, a more inclusive, multi-disciplinary and integrated thinking is needed to promote KM implementation in academic labs, which should treat of three dimensions of KM strategies: managing information for knowledge creation, managing people creating knowledge, and managing knowledge creation processes. However, the great challenge is to use the findings to construct a Creative Environment that supports scientific creation in academia.

5. Enhancement of creative support in academia

Nonaka *et al.* (2000) state that *Ba* is a foundation of knowledge-creating activity, where dialectic dialogues and practices take place. The concept of *Ba* (Nonaka *et al.*, 2000) was first sought out to explain the energy that continuously drives the SECI process and defined as a dynamic context in which knowledge is shared, created and utilized, including physical space (office, meeting romm), virtual space (computer network services), and mental space (shared experiences and ideas). *Ba* is a Japanese word meaning place. The closest meaning of *Ba* in English words is environment. Knowledge creation is more efficient in *Ba,* in a creative environment.

Based on Triple Helix Spiral, the valuable findings from two surveys provide us particulars what we should improve in academic KM and the processes of scientific knowledge creation. DIK spiral as knowledge creation continuum provide a perspective for better understanding how to focus energy to improve knowledge creation, knowledge sharing, and academic outcomes in our case. A systems thinking for KM in scientific labs was taken into account, which should include the main factors of knowledge source, technological infrastructure, organizational variables and knowledge creation process. It can be seen as an effort to properly put all the organizational variables into best use together with the support of relevant information technology in order to facilitate the knowledge creation process, while focusing on the main research purpose of labs oriented towards the acquisition and creation of knowledge sources. This framework includes social aspects and information technological aspects, which can be regarded as one kind of environment for enhancing the management and creation of scientific knowledge.

Integrating the findings of two surveys in our study and *Ba* theory, we thought the Creative Environment that supports scientific creativity in academia should include both soft and hard environment. On the soft side, it should include individual and organizational issues as well as mental space, concerning all of human interactions; on the hard side, it includes the physical layout and information technological platforms. The broader meaning of this concept includes all creative working environments, in both scientific institutions and business organizations.

Enhance soft environment by using personalization strategies

Scientists as a group do have personality characteristics that distinguish them from social workers as a group. Understanding the personality of scientists will help us to see beneath the surface to the underlying motivations or needs that drive research behaviors, so as to manage laboratory and research personnel more effectively, and finally improve scientific knowledge creation. Cohen and Cohen (2004) summarized some studies that have attempted to identify the characteristics of scientists. The results indicate that as a special group, science and technical professionals are poorly attuned to the dynamics of their interactions with others and to the needs and feelings of those around them (Gemmill and Wilemon, 1997). That is because they are focused on technical and quantitative aspects more than the interpersonal and social aspects. Our surveys also reflected those features. For instance, cooperation and group work have not been recognized or emphasized; a lot of responders work alone and also get much less timely encouragement and help from others at the same time; there is not good enough critical feedback, questions and suggestions in group discussions, and so on. Fortunately, data from the scholarly studies are not all bad news for scientists. The studies also found that scientists were emotionally stable, impulse controlled, and open and flexible in thought and behavior (Feist and Gorman, 1998). That is to say, they have a high capacity, motivation, and willingness to learn and improve. What they need is the utility of improvement and the opportunity to learn. The enhancement of soft environment in research units will provide them such kind of opportunities.

Personalization strategies of KM initiation seek to develop networks of people for communicating ideas, which consider the culture factor within, which people share and communicate the knowledge they possess (Ladd and Heminger, 2002). Therefore, a knowledge-sharing culture is one key of ''soft'' issues to underpin knowledge management.

Knowledge sharing has been identified as a major focus area for knowledge management; it is related to communication. For individual researchers, communication is not enough; they have to check their ideas through debate. We have discussed scientific debate in *EDIS Spiral (*Wierzbicki and Nakamori, 2006), which has two layers: verbal and rational. Our surveys found many responders felt that they are not satisfied with the effectiveness of group discussion and lab's seminar and not sufficiently supported in scientific debate. Language is a critical obstacle to influence on discussing research problems with the colleague from different countries. Unrelated topic is another important factor to influence the effectiveness of discussion. Thus, promoting effectively communication and debate is absolutely vital in labs.

Depending on the format, laboratory academic meetings must be necessary for: showing how everyone's work relates to the others, informing what is going on in the lab, forcing members to organize and summarize their work, learning communication skills, and more important, solving research problems and getting feedback. The following laboratory meetings could be organized:

- *Formally regular seminar* is excellent for teaching how to organize and present and sell the story as well as discussing the difficulties in the work and getting suggestions and comment.
- *Seminar with outside researchers* who have similar research interests can provide critical ideas and fresh perspectives for learning and discussion.
- *Topic meetings or discussion* can be held for an actively collaborating group or for laboratory members with a common interest.
- *Literature review clubs* are used to discuss the relevant literatures, which are an excellent way to catch current research trends and teach critical thinking and making presentation.
- *Brainstorming meetings* are good way to integrate debate. ''There is an informal atmosphere, people are relaxed; each person's ideas are influenced by the others and are spoken without being modulated by thoughts of feasibility or expectations'' (Barker, 2002).
- *Laboratory relaxation meetings:* all members of laboratory get out of the laboratory to discuss research, which can be amazingly invigorating and effective. Of course, it is expensive and cannot be often organized. But for encouraging members work hard, it is necessary once in a while. At JAIST, some laboratories have the tradition to organize this kind of meeting one or two times once a year and get very good feedback.
- *Communication meetings* can be initiated informally by the members. Provide snacks and soft drinks. The purpose is not for discussing research, only for facilitating the communication among the members. It will help them understand one another, release the pressures and solve the problems in study and life.

About the language barrier in the process of knowledge sharing we found by the surveys, English-speaking seminars should be much more frequently used in JAIST, and Japanese students should be encouraged to use the English language more frequently. Help in the preparation of English presentations or papers for seminars or conferences is already available at JAIST, through the services of English tutors and an English paper editor, but perhaps it should be intensified even further. On the other hand, there are free Japanese classes opened for foreign students in a long time, but few of them attend it. Foreign students should get more encouragement to foster their passion of learning Japanese. Anyway, please never allow language problem to compromise the scientific content of the talk.

In the survey, there were a lot of complaints about not enough open discussion in group seminar. It is true that it is very difficult to communicate with an individual who does not respond to you and it will reduce the effectiveness of the seminar. This may result from shyness, or an inability to make small talk, or unrelated research topic, or fear of making a mistake in front of the supervisor. Therefore, the laboratory leader should arrange adapted meetings concerning idiographic situation. At the same time, there is an important point we should take notice. That is: since academic research is intrinsically motivated by individual goals and researchers and technology creators behave like artists (Wierzbicki, 2005), they naturally rather jealously guard their ideas. Thus, a good laboratory culture should promote knowledge sharing by convincing its members that a critical, open debate and an exchange of ideas with colleagues are advantageous to all of them. A necessary part of such culture is, for example, a strict code of recognizing the origination of ideas: if somebody thought of an idea first, she/he should be a co-author or at least be quoted sufficiently in publications. Knowledge management texts take for granted the fact that an industrial market organization has its vision and culture, shared by its members, who are thus motivated collectively and thus find it easier to share ideas. The situation in academia is different, more

individualistic, and the leader of a laboratory must promote vision and culture that would not only motivate the team, but also convince them that sharing ideas is advantageous.

Enhance hard environment by using information technology strategies

Hard environment includes the physical layout and information technological platforms. The physical layout is the location, size and type of working place. The design of the building and work areas is a critical aspect of infrastructure, because this design influences how people interact. Knowledge workers (researchers in our case) spend their time creating, discussing, understanding, giving feedback, forming ideas in their working place. When it comes to such activities, designing a space to support the freedom and flexibility of researchers is a key. Thus, the allowed and arranged collaborative spaces which support the social interactions and networks will enhance and improve the knowledge creation processes. JAIST already has brainstorming rooms, collaboration rooms, refreshment rooms, seminar rooms, even smoking rooms, etc., where researchers from different labs and various fields can communicate ideas freely. Therefore, we only emphasize IT-supported hard environment to benefit scientific knowledge creation here.

As a project supported by the JAIST COE Program entitled ''Technology Creation Based on Knowledge Science'', a computer-based Creative Environment (CE) has been implemented at JAIST. This system is based on the findings of two surveys in JAIST, on analysis of user requirements, and on models of Triple Helix of scientific knowledge creation and thinking of DIK Spiral. The following functions have been chosen:

1. Creative group communication environment:
   - Posting papers.
   - Debating panels.
   - Brainstorming panels.
   - Casual knowledge sharing.
2. Electronic environment for experiment support:
   - Electronic manuals for experiments.
   - Support of social experiments surveys.
3. Adaptive hermeneutic agents:
   - Help in web search.
   - Special search in texts-specialized text mining.
4. Planning and roadmapping systems.

The CE of JAIST consists of several sub-systems and tools for supporting scientific knowledge creation (Ren *et al.*, 2006): Electronic Library (EL), a knowledge storage tool which stores datasets, references and papers; an Adaptive Hermeneutic Agents (AHA), a special software tool with an intelligent interface, used in web search engines and specialized text mining, so it is also a knowledge acquisition tool; the Brainstorming tool, a software component for support of the DCCV Spiral (Kunifuji, 2004); Virtual Seminars, a web-based tool for making critical discussion; Web-based Group Debate Space (WGDS), a web space support for double debate, the researchers can start a new topic, give comments to other researchers, upload the related documents, subscribe to interesting topics, etc.; the Roadmapping system, a new solution for making personal scientific research roadmaps. Building the CE is an ongoing project, which has been implemented by using Java, JSP, Java Servlets, Struts, Tomcat, SQL Server 2000. Users only need a web browser, such as Internet Explorer or Firefox, and an internet connection to access the CE.

In CE system, subsystems of EL and AHA are information retrieval module, which help us store the articulated knowledge in a computer system as information in the form of data and make it easy to be found and understood. Subsystems of brainstorming tool, virtual seminar and WGDS try to transfer tacit knowledge into explicit one as the form of text, voice and

> **"The proposed Data-Information-Knowledge spiral provides an important perspective for thinking scientific knowledge creation processes."**

video. Thus, we can say we design the CE system based on an in-depth understanding of social, technical, and cognitive aspects of scientific knowledge creation.

6. Conclusion

In this paper, we define KM in academia as any systematic activity related to support and enhancement of the creation of scientific knowledge and achievement of research goals, including both social process and relevant computer technology tools. The study poses one major research question, i.e. why and how to use knowledge management methods in order to enhance knowledge creation in academia. Two surveys and case studies were carried out to achieve our goal. The findings from the first survey showed the KM obstacles reflected on various aspects: technological support, the people involved in creation activities, laboratory cultural, and so on. The results of the second survey helped us to understand what aspects of the knowledge creation processes should be given more attention and support. We further discuss four important factors with regard to the management and creation of scientific knowledge. The main contribution of the work is we present the analysis of the problem of KM and knowledge creation from a not fully explored yet perspective of applications in academic research. A proposal of a Data-Information-Knowledge spiral provides an important perspective for thinking scientific knowledge creation processes. Finally, we suggest enhancing creative environment in academia from both ''soft'' and ''hard'' aspects under the guidelines of a systems thinking framework for KM in scientific labs. From soft side, by using personalization strategies, a knowledge-sharing culture has to build in labs to facilitate scientific communication, debate and team work. From hard side, by using technology strategies, we present a practical example in JAIST concerning the implementation of hard aspect of creative environment, which is based on an in-depth understanding of social, technical, and cognitive aspects of scientific knowledge creation. Our work provides useful information for research and development of knowledge management in universities and research organizations. And we also hope our research can launch further debate and prompt practical steps to help research institutes or universities improve their management and increase the research outcome.

Notes

1. This is consistent with the arguments presented by Dreyfus and Dreyfus (1986) in their book *Mind over Machine,* where they show an empirical evidence that master experts make decisions quite differently than novices; we postulate here that this difference in the style of decision making is also reflected in a difference in the style of knowledge creation.
2. This finding constitutes also an empirical support for the distinction observed that knowledge creation processes in academia are mostly motivated by the interests of an individual, while organizational knowledge creation processes are motivated by the interests of the group.

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Using a KM framework to evaluate an ERP system implementation

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Abstract

Purpose – *Competitive advantage can be gained in several ways including gaining a knowledge advantage (K-Adv). This paper sets out to report on the first stage of broad study to assess the effectiveness of implementing an enterprise resource planning system (ERP) from a knowledge management (KM) perspective.*

Design/methodology/approach – *The study used a survey of a small but representative group to gain feedback in their experience of using the ERP system. Results are evaluated using a KM framework, the knowledge advantage (K-Adv) capability maturity model (CMM) tool that was initially developed for use by construction organisations to assess the impact of leadership and its supporting ICT infrastructure on the ability of people (by effectively creating, sharing, disseminating and using knowledge) operating in a highly dynamic business environment.*

Findings – *The K-Adv framework analysis for the study indicates that the ERP system was seen as a useful tool for cost management and that its deployment effectiveness is mainly dependent on human-to-human knowledge transfer about how to make the ERP system work. Also, how leaders in organisations facilitate and support people is a critical enabler of the ERP system deployment. The K-Adv CMM tool was useful in making sense of the degree of organisational maturity from a KM perspective.*

Practical implications – *The findings first highlight the usefulness of focusing on people-support in using the ERP adoption in this organisation's context and, second, they illustrate how a CMM tool like the K-Adv can be used to evaluate KM practices.*

Originality/value – *The likely effectiveness of use of an ERP is well-known. However, the originality of the paper is twofold. First, it explains effective ERP application drivers and inhibitors from a KM perspective. Second, it tests and adapts a tool that helps evaluate KM effectiveness and assists better understanding of how these practices are enacted from a cost management business unit perspective.*

Keywords *Knowledge management, Manufacturing resource planning, Construction industry, Project management*

Paper type *Research paper*

Introduction

There is a Chinese proverb from *The Art of War* – ''知己知彼,百戰百勝(*zhi ji zhi bi, bai zhan bai sheng*)''. If you know yourself as well as your enemy, you will come out of 100 battles with 100 victories (Sun and Clavell, 1983). This also applies to the business world because good application of knowledge management (KM) always puts the organisation into a potentially winning position. However, project managers find it extremely difficult to fulfil these requirements using only this basic information or knowledge. One problem faced by users of project management (PM) data and information is ''information overload''. Various strategies have been recently developed in an attempt to overcome such problems including increasing the extent of visualisation and graphic representation of information (Songer *et al.*, 2004). These tools are often part of an integrated system-wide information management system that also provide decision support tools, as well as other tools, that can be used to turn information into knowledge and to create, store, transfer and use it. Second,

> **"Good application of knowledge management always puts the organization into a potentially winning position."**

organisations often ''do not know what they know'' or else they do not know how to know what they do (or do not) know (O'Dell and Grayson, 1998; Sieloff, 1999).

Fortunately, there are information communication technology (ICT) tools that can assist project managers to improve information quality and facilitate KM. The scope of this paper is therefore focused on a case study evaluation of a specific ICT tool from a KM perspective that is used by a major regional construction contractor operating in Hong Kong. The purpose of this paper is to thus explore and present how that evaluation framework can be used to improve the use of an enterprise resource planning system (ERP) tools (with a specific focus on cost management) as a KM tool to help construction contractors better manage project control systems. We fully acknowledge that a technology system such as ERP is not of itself a KM system rather part of a strategy for adopting KM practices. Hansen, Nohria and Tierney (1999, p. 109) refer to this as a people-to-documents KM competitive strategy.

Porter (1985) suggests a cost competitive advantage can be achieved through a firm being able to deliver identical products and services (its deliverables) at a cheaper rate than its competitors. It could also use a differentiation competitive advantage to provide unique deliverables thereby gaining a differentiation competitive advantage. Also, it can be more customer-focussed in its deliverables to give its customers exactly what they demand. The company that was studied chose to gain competitive advantage through a cost advantage by improving its knowledge of its cost structures so that it could improve its cost management practices. It also believed that it could use an integrated information management system to help it generate and transfer knowledge about more effective cost management practices and thus offer a differentiation competitive advantage. Finally, it believed that by having an integrated cost management system that more effectively links its supply chain (so that efficiencies could be shared across that supply chain) the organisation could gain a customer focus competitive advantage. Its clients, supply chain partners and internal project team members could be viewed as ''customers'' to this cost structures knowledge. The case study company's leadership team decided to gain a cost competitive advantage through improved cost management of its own operations and that of its supply chain through adopting an integrated ERP system to help it link its own organisation with its major supply chain partners. An ERP can ease access and extract information through a common platform within the organisation and as we will show, it can also be used as an innovative KM tool. However, there is a need to create, maintain and manage a relationship with users to ensure that these ERP successfully deliver their promised goals (Akkermans *et al.*, 2003; Al-Mashari *et al.*, 2003).

This brings us to the interesting questions that are framed from a KM perspective to study the way that a cost management group within a large company values their experience of an ERP system and the way that this system was deployed to help improve its (cost) competitive advantage:

1. What are the drivers and barriers that can facilitate an ERP system to be effectively deployed to provide useful information that facilitates knowledge transfer about its cost management effectiveness?
2. At what level of capability maturity is the organisation placed to support ERP tools?

The way that we have chosen to answer these questions is to first briefly establish a theoretical framework that highlights and explains the drivers and barriers to accepting and using an ERP system. This will justify the approach used to answer the second question and also indicate how to assess and evaluate the effectiveness of using such ICT tools through

testing a framework that uses a KM capability maturity model (CMM) approach (Walker *et al.*, 2004). The CMM is then used to analyse and interpret data gathered through a survey of the ERP system users by a major regional construction contractor operating in Hong Kong. The scope of the paper is focused on a case study evaluation of the specific ERP tool used.

The paper is structured as follows. First having provided a brief introduction of the context for the paper, some theoretical issues addressed by the paper are then discussed. The case study details are then briefly described. Next, collected data from a pilot survey of current users of the ERP is presented that was undertaken to assess the system's current maturity level as perceived by those surveyed. Finally, a discussion of results and our conclusions are provided.

Theoretical issues underpinning the research

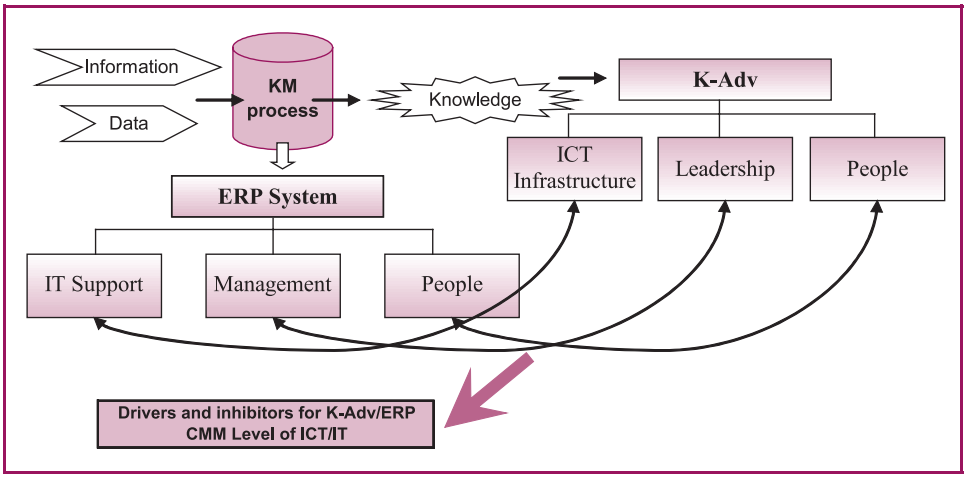
The literature review forming the theoretical basis of the research that was undertaken and reported upon here is summarised in Figure 1.

We first review the importance of converting useful information and data through an effective KM process into valuable knowledge and we suggest that an ERP plays an important role in this process. Knowledge provides a company with what Walker *et al.* (2004) describes as a knowledge advantage (K-Adv) over its competitor that is supported by three infrastructures; ICT, leadership and people. This is consistent with that required of ERP systems that call for IT support, management and people support.

Effective project cost management, for example requires access to accurate, current, and reliable data and information and is concerned with establishing processes to monitor and control budgets (Cleland, 1999). In the construction industry, project cost management is a highly intensive information and KM activity. It transforms information into knowledge required for decision making relating to expectations of parties in a supply chain; market intelligence; cost data and information about trade conditions; and knowledge assets that can be shared and enhanced relating to delivery methods/techniques, business models, opportunities for synergies etc.

Mathur *et al.* (1993) argued that information technology (IT) systems have been an increasing feature of its development over several decades because cost management is a highly information-intensive and knowledge-rich set of activities. There has been widespread acceptance that ICT is a key enabler of KM that enhances a firm's potential for gaining competitive advantage (Peansupap, 2004). KM, supported by an effective ICT infrastructure, can facilitate a competitive advantage in at least two ways – having a cost advantage or a differentiation advantage that allow firms to create share and use critical

Figure 1 Theoretical framework of this paper



"An Enterprise Resource Planning (ERP) system can ease access and extract information through a common platform within the organization and it can also be used as an innovative KM tool."

knowledge providing them with a K-Adv that distinguishes them from their competitors (Walker *et al.*, 2004).

Each member of a project team generally possesses information and knowledge that can benefit their projects. To maintain the PM intellectual property, organisations must provide the vehicles for capturing data and information and then disseminating it to the various parts of the project team. Knowledge transfer between individuals and groups has been argued to occur through a process of social interaction where tacit knowledge becomes explicit and is then codified and absorbed into organisational routines (Nonaka, 1991; Crossan *et al.*, 1999) this proceeds in a feed forward and feedback knowledge flow with power and influence being exercised throughout this process to embed cultural norms and organisational rules and routines that mediate the effectiveness of this knowledge use (Lawrence *et al.*, 2005). Further, Szulanski (1996) found that various organisational and individual factors also contribute to what he called ''knowledge stickiness'', that is the slowing down of easy and effective knowledge transfer. One important element of knowledge stickiness that is relevant to this study is the way that organisations can create a work environment that creates barriers to knowledge transfer or facilitates its flow. Many of these driver and barriers to knowledge flow are common to effective use of KM tools such as an ERP (Peansupap, 2004; Peansupap and Walker, 2005).

People need to be assisted by well-integrated technology and appropriate business processes to be optimally effective when transferring and reframing knowledge. A good way to do this is through communities of practice (COPs), where people personally interact in groups that share trust and passion and are willing to volunteer this knowledge to each other. COPs help people to share knowledge and skills and help sustain its members through their obligation to exchange knowledge and provide access to shared insights about their work practices (Wenger *et al.*, 2002). Effective COPs can reduce knowledge stickiness through providing supportive learning environments (Szulanski, 1996). Data and information can then be re-framed to reflect its current context and use and become enhanced to form knowledge through this process. The way that KM is approached is therefore becoming critically important in the project business model. Those organisations that can better harness their knowledge in their projects are more likely to realise competitive advantage from doing so.

Zack (1999) argues that knowledge is strategic and can be characterised in many ways. Popular knowledge taxonomies distinguish between tacit and explicit, general and situated context-specific, and individual and collective (Nonaka, 1991). Codified (explicit) knowledge can be effectively transferred with the support of an efficient ICT system. Knowledge that is difficult to codify (that remains in a persons' head or is embedded in their habits and ways that they automatically undertake their work) is called tacit knowledge. People best transfer and reframe this kind of knowledge through personal interaction in groups that are willing to volunteer this knowledge to each other. ICT can allow these COPs to assemble in a virtual space and to exchange knowledge and work together. Jewell and Walker (2005), for example, provide a construction COP industry case study of how an ICT application assisted in this type of knowledge work.

Hansen *et al.* (1999, p. 109) argue that KM can be seen as following two primary strategies; codification and personalisation. Codification involves the collection, coding and storage of data, information and knowledge that is accessible by others with appropriate access rights.

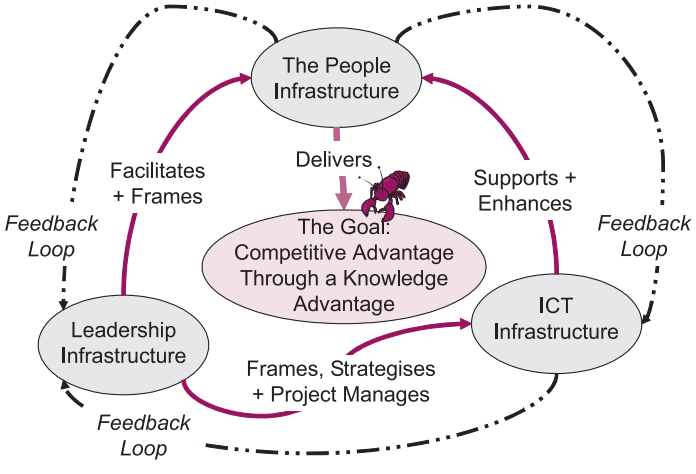
Personalisation provides for information sharing by osmosis within the organisation; there are few formalised knowledge transfer processes in place and knowledge is personally passed between individuals. Each strategy has merit within an organisational framework, although for the success of a project based ICT solution, codification is required as it provides the framework for information and a formalisation of data and its value to both the individual and the organisation.

Whatever the KM strategy that is adopted, firms can develop what Walker (2005, p. 17) refers to as a K-Adv. This concept is presented in Figure 2.

Figure 2 clearly indicates that people drive the KM process using data, information and knowledge. Many organisations use ERP as their ICT backbone. Al-Mashari *et al.* (2003) described an ERP as customised standard integrated software applications that facilitate IT coordination in control aspects of management and other operational facets such as human resource management and logistics. An ERP also can integrate numerous PM control processes such as cost and time management. They are thus intended to be integrated production solutions that for manufacturing or project delivery. They also link to groupware that allows communication and coordination, joint problem solving and recording transaction histories. In this way they can be seen as facilitating (codified) KM in that they are capable of facilitating groups of people to solve specific problems (i.e. how to best manage project costs) and through the audit trail of data to trace the evolution of decision-making and its consequences.

An ERP is not a KM system but a tool that should reduce management effort in gathering, storing and using data or information so that greater effort and creative energy can be devoted to analysing and contextualising information and refining it into knowledge. Evidence of an ERP being used is indicative of a KM application being deployed rather than administrative effort is actual being unburdening. ERP tools should allow management energy to be directed towards knowledge-based activities of creating meaning out of information, transferring the significance of that meaning to others and using the refined knowledge to practically solve problems. This KM perspective of an ERP allows us to focus upon how ERP implementation effectiveness can facilitate KM initiatives so as to grasp space in a crowded corporate agenda for improvement, so that both efficiency and effectiveness are addressed. This resonates with the concept of gaining a knowledge advantage (Walker *et al.*, 2004; Walker, 2005).

Figure 2 The knowledge advantage concept



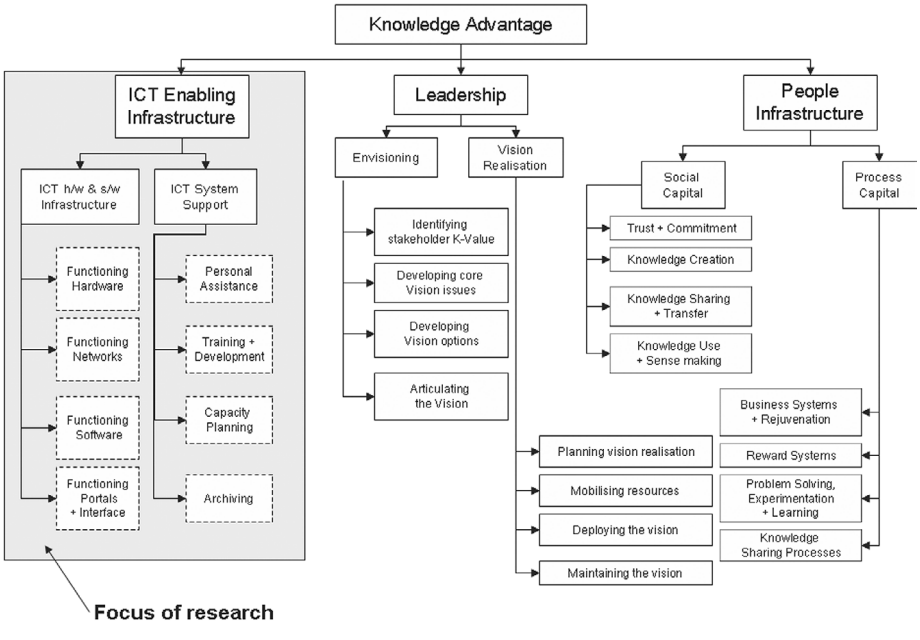
Source: Walker (2005, p. 17)

Figure 3 illustrates the K-Adv in more detail. Each of the three infrastructure elements is presented with their break down structure. The above elements are then linked into a capability maturity model (CMM) that helps to identify the level of maturity of the K-Adv implementation and adoption. For example, the high level element IT Enabling Infrastructure in Table I offers a CMM tool to categorise an organisation's maturity level. This is evidenced by observation, interview responses or any other investigative form of research into how KM is approached in the organisation from this perspective. Each infrastructure component and each element can be scrutinised in this way.

Using the K-Adv framework, it is possible for organisations to be assessed from the series of CMM tables for each K-Adv element. This enables gap analysis and from that, the organisation can develop a strategy to improve KM practices that will enhance its K-Adv. The framework is designed by first posing a relevant question – in this case ''how can the ICT enabling infrastructure support K-Adv''. This can be answered with reference to the evidence from ICT software and hardware support and ICT system support as illustrated in Figure 3. A series of word pictures provides a scenario of how each of the five maturity levels may appear. The shaded ''active adoption'' level was the picture that presented itself in the case of the research reported upon in this paper.

Many organisations are searching for ways to leverage the knowledge that they already have and thus sustain a high rate of continuous improvement. The optimum outcome is to create a combination of practices that is difficult to emulate. Even though an organisation may understand the benefits of KM as a useful weapon to be use against its competition, and it may work actively to sharpen its own K-Adv, its ability to effectively use its software and hardware may still be immature. Effective KM depends upon sound use of ICT infrastructure facilities; one of the useful ICT tools that can support people and KM practices is an ERP which is probably the most rapidly growing corporate IT applications area operations today, thousands of companies have implemented them or are in the process of implementing ERP (Akkermans *et al.*, 2003; Al-Mashari *et al.*, 2003).

Figure 3 The K-Adv elements



Source: Walker (2005, p. 22)

Table I Maturity levels of ICT enabling infrastructure

Maturity	*ICT s/w & h/w infrastructure*	*ICT system support*
How can the ICT enabling infrastructure support K-Adv by →	Developing an appropriate software and hardware infrastructure	Providing a proactive support for the ''people'' and the ''systems'' aspects of ICT
Inactive AWARENESS	Very low availability, functionality and reliability (20 per cent <), very old version of h/w (five yrs); No sharing of s/w. Incompatible packages used; Use of discs/CDs for data transfer; phone and paper used with supply chain; no access records or controls	Poorly resourced help facility; small number of tutorials or manuals; unaware of COP; mutual mentoring on problems; sporadic and crisis-based T&D; minimal external T&D; user needs not defined; no emergency procedures; systematic storage or security not planned
Pre-active INITIATION	Low availability, functionality and reliability (40 per cent <); old version of the h/w(three-five yrs); s/w Compatibility & h/w connectivity for one site only; only standard applications; low bandwidth connections; password access, but no tracking	Centralised help facility (e.g. call centre); web enabled resources (e.g. FAQs); wary approach to COP; rigid T&D (e.g. online tutorials); focus on current needs; inconsistent support to BUs; local focus on h/w & s/w synchronisation; global access to archives
Active ADOPTION	Medium availability, functionality and reliability (60% <); H/W Lags By (~ three years); task specific S/W Eg. estimating; cross-projects interoperability; servers with e-mails; moderate bandwidth; web applications; graded access	Almost adequate resources and feedback; well-resourced web and online help; passive encouragement to COP; network support and training reactively driven by the BU needs; planned, not necessarily current retrieval system; structured access to archives
Pro-active ACCEPTANCE ADAPTATION +	High availability, functionality and reliability, (90% <); h/w lag (three years); Web-based s/w for policy and knowledge; B2B links with supply chain; Hardwired groupware and utilities; High security systems	Online and staff-based diagnostic support; chat rooms to integrate COP; mentoring and experiential learning supported; life-cycle planning and h/w-s/w harmonisation at organisational level; well-indexed and needs based archival systems
Embedded ROUTINISATION + INFUSION	24/7 availability, 100 per cent functionality and reliability; h/w lag (1 < yr); Network integrates supply chain; active interaction; Wireless access; ERP systems; video conferencing; full tracking of security	24/7 expert help systems; industry-based COP; proactive T&D plans with links to education; ''Scenario planning'' for future needs; proactive approach to technology; system synchronised with supply chain; flexible and seamless access to archival systems

Notes: Software s/w, Hardware h/w, Training and development (T&D), Frequently asked questions (FAQs), Business unit (BU) – italicised row indicates this organisation's CMM level for its ICT infrastructure

However, as indicated in Figure 3, either general ICT or specific ERP investment decisions are not only about budgets and financial considerations but also about how people can interact and make decisions. ICT investment will only add value if resources are managed in a way that supports business needs, motivates employees and gives organisation the agility needed to respond to the business and market conditions. Zhang *et al.* (2005) argue that research indicates a low successful implementation ERP rate in China with many organisations not achieving their intended goals suggesting large difference in ERP implementation success rates between Western countries and China. The success or failure of an ERP may be affected by not being properly addressing the interest and concerns of stakeholders.

Stakeholders, those having a stake in the success of an endeavour, would include not only sub-contractors, suppliers, consultants and the client, but also project team employees (Bourne and Walker, 2005). In order to obtain ERP success, organisations should take into account their organisational culture as well as that of any groups that they interface with before taking an ERP implementation decision. While operational staff, managers and directors are all stakeholders, some frontline staff may find it difficult to input data on time leading to the organisation's interests not being met. Stakeholder management thus becomes complex. Organisations that believe that the ''only'' valid stakeholders with an interest are investors adopt a short sighted business success view. There is a need to create,

maintain and manage a relationship with a broader range of stakeholders to ensure that an ERP in fact supports sustainable project success through better KM (Akkermans *et al.*, 2003; Zhang *et al.*, 2005).

One of the authors is employed with a major Hong Kong (HK) contractor that uses an ERP so this company provided an ideal opportunity to conduct research to investigate how the ERP was being implemented – more specifically the drivers and inhibiters that determine successful adoption and use of the system.

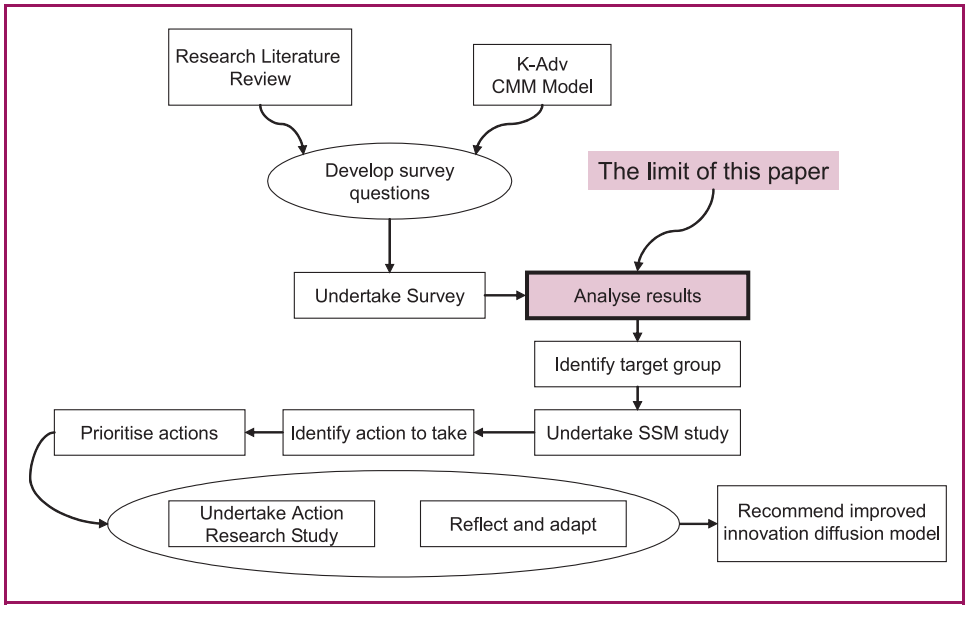
Research approach

The research approach is illustrated in Figure 4. The phase reported upon here used interviews and a research survey with plans for later phases using qualitative approaches and action learning.

A questionnaire was developed from a detailed analysis of the literature guided by the CMM presented by Walker *et al.* (2004). This provided a reasonable basis to understand the scope and scale of respondents' satisfaction and their attitude towards benefits and hindrances to using the ERP. This survey was initially tested to highlight potential problems associated with deploying the ERP innovation using a small random sample of representative respondents selected from the target organisation and then the pilot study was refined. This survey sought participants' opinion of the impact of factors associated with implementing the ERP generally in the organisation in Hong Kong.

Triangulation was designed into the research approach in a number of ways. First, the literature provides a general view across disciplines and industries. This review helps to answer research question one. Details of the K-Adv CMM tool developed by Walker *et al.* (2004) informed the nature of questions that could be asked in the pilot study and participant observation with detailed *ad hoc* discussions face-to-face and by phone plus access to organisational documentation provided data that addressed research question two. The cost control function of the firm suggests itself as an appropriate business unit to study because one key element of a firm's success is profitability and improvement in cost control reduces waste (cost) and provides potentially management differentiation competitive advantage through being perceived as being more effective. The CMM tool can be used in identifying the current ''as-is'' situation and developing an ideal situation at a specified future

Figure 4 The research approach



time. Gap analysis can then be undertaken and identification of actions that can be taken to improve a current situation to move it towards the idealised situation.

The purpose of this stage of the study was to find out how effectively the ERP was as a KM tool using the CMM tool to test and analyse results as indicated in Figure 4. Further stages of the study would follow but these are beyond the scope of this paper.

While it is difficult to be certain, the organisation's market intelligence suggested there are no HK construction companies currently using an ERP as their KM backbone system. Yin (1994) argued that a unique or highly unusual situation can provide an opportunity for a single case study company to be appropriate rather than choosing several cases. Further, the company under study was convenient to one of the researchers who is an employee and intimately involved in the organisation's cost management group in HK. While this may present potential bias, it also offers opportunities of deep insights. The pilot survey draws upon a wide range of staff and every effort was made to minimise potential bias. This case study data is based upon data that presents the experience of this leading HK construction company that was established in 1957 and has a history of innovative ICT use and so represents a potentially mature ICT-user organisation.

The pilot study context

The organisation's activities span the entire spectrum of building, civil engineering, foundation work, electrical and mechanical works as one of the leading construction companies in HK and Asia. It employs approximately 2,000 full-time staff, including 450 professional engineers and builders. The studied organisation has been building a wide range of construction projects and has an annual turnover of HK$2.5 billion.

The organisation's headquarter is in Hong Kong and it operates throughout Mainland China and Southeast Asia and its culture indicates that it appreciates the importance of KM. The company's ethos reinforces an attitude that it is unwise to compete with others by purely cutting costs and compromising quality, rather, it sees a more effective strategy is to sharpen its own knowledge advantage to differentiate itself based upon a service quality and effectiveness (rather than cost-efficiency) competitive advantage.

Effective KM, however, depends upon a ''people infrastructure'' supported by sound use of an ICT infrastructure (Walker, 2005). In early 2001, the organisation started to consider using an ERP platform for its ICT infrastructure to enhance its information management as part of its broader KM strategy. Through use of the ERP, different parts of the organisation aimed to use configurable information systems packages that integrate information and information-based process within and across-functional areas. The design and objective of the ERP was one of ''bridging'' and ''bonding'' parts of the organisation's information and knowledge resources. In terms of ''bridging'', different departments are linked by an ERP that facilitates developing a common ICT infrastructure for the benefit of integrating diverse business activities to enhance information flow. The system's design facilitates existing organisational process and allows possible improvements to be made to increase diffusion of information throughout the partner organisations. With respect to ''bonding'', it is intended to discourage self-interest dominating over collective interest through facilitating more effective knowledge sharing and joint decision making using the ERP as a platform for creating, sharing and processing information and storing and archiving data, information and codified knowledge. It is intended that the ERP helps to link people together to create internal bonds within the team that must be forged before embarking on integration of diverse organisational knowledge sets across the wider supply chain.

The ERP was put into operation during December 2002. The organisation was thus the focus of the case study and its cost management group in HK implementation was the unit of analysis.

The target organisational cost management unit had a staff of about 200 people with 50 potential respondents experienced with using the ERP from ICT staff, senior management and operational staff competent to provide reliable, valid and useful data at the May 2006 period when the survey was administered. Staff were asked to voluntarily participate and

complete the survey questionnaire. Of the 50 staff that could potentially take part in the survey, 18 were approached and agreed to respond. The choice of this group was determined on their willingness to participate in the research together with their special characteristics to ensure that perspectives gathered from the research would be balanced and as comprehensive as possible.

Results and findings

A total of 18 completed survey responses were received.

Respondents' profile

The special characteristics of the sample selected could be categorised as: having high levels of technical skill/knowledge; being involvement in the ERP; and being well experienced in both the industry and the organisation's ERP routines. The following descriptive statistics provide general demographic characteristics of the sample group:

- Three people were below 30 years old, 12 between 30 to 40 years old and three over 40 years old – most workers were in their earlier careers with extensive exposure to using IT in their education and work experience.
- 13 males and five females.
- 11 respondents have been working in the organisation for over ten years and seven less than ten years.
- Most of the respondents are Quantity Surveyors (including Managing QS, Senior QS, Senior Project QS, Project QS and QS) while Senior Accounts Clerk and Accounting Supervisors are fewer in number, six are operational staff, eight are senior officers or officers, and four are managers.
- 11 respondents work in the commercial department, five from finance and two from IT.

Respondents' perceptions of what an ERP theoretically delivers

Respondents were asked how they perceived the implementation of ERP in the organisation could general deliver benefits. The majority of respondents saw the ERP as an effective and accurate tool that should provide authorised people with real time on-line cost data information. Also, since cost data are provided on-line, then it is made available to various departments who need it concurrently and could also be made available in hard copy format. Hence, there is perceived increased organisational efficiency.

ERP cost analysis reports are generated in the desired format with more flexibility. At any given period, forecast and actual financial data can easily be compared. Cost review and control is moreover easily managed and ledgers can be more efficiency updated. Cost data are integrated into a common platform, which in turn makes data sharing among departments more systematic. The ERP therefore modernises and standardises business processes among departments in the organisation since cost data is monitored and controlled in the most efficient and accurate manner.

Respondents' expectations of what the ERP will deliver

Respondents were also asked what they expected of the ERP to improve the existing costing system. The respondents were able to compare their perceptions of the ERP actual delivery with their own expectations of the system. In general, respondents' perceptions were that the ERP will improve cost data control and management. Their expectations are summarised as follows.

First, respondents expected that the workload of various officers in the department who are in-charge of managing and monitoring cost data would be reduced. Since data is supposed to be available on-line, then it should also be possible for authorised individuals to access databases without difficulty of having to translate data into the ERP standard format. Information was also expected to be delivered accurately and on time. Reports should be easily generated by different departments and that this should enable quick cost checking and cost data monitoring. Data should be easily updated and provide procedural

> **"If adopted thoughtfully, the ERP can be used as a KM strategy to improve knowledge transfer and reduce knowledge stickiness."**

transparency since data should be made available to authorised people in the organisation. Filing space should be reduced – on-line information retrieval should create a paperless office.

With much of the routine information and data processing being handled electronically by the ERP, this should release people to engage more fully in KM activities such as anticipating and proactively problem-solving and more effectively contextualising information and transferring knowledge and using knowledge to improve the way that work is undertaken.

Factors considered in the ERP implementation

Six key factors considered as relevant to the organisation that were believed to affect ERP implementation and these were included in the questionnaire.

Table II indicates that respondents feel that efficiency is very important and is the most critical reason (factor) for ERP implementation. Survey results also reveal that respondents believe that ERP implementation can increase organisational competitiveness.

Implementation performance areas

Respondents were further asked to rate the ERP with respect to its performance enhancement to past non-ERP solutions in 13 areas of implementation.

Table III indicates that the respondents think that the ERP will promote excellent project control and communications performance. However, a few respondents felt unsure whether the ERP would result in excellent or poor project schedule, scope and management performance or improvement in external consultants and internal team performance. All respondents reported that their organisation provided an ERP implementation consultant/trainer to help them. ERP implementation was thus facilitated by consultants/trainers, introducing ERP functions, helping them to smoothly operate the ERP, train the internal trainer, standardize the customers' ERP implementation, and to provide a backbone ERP infrastructure platform.

Table II Factors considered in implementing ERP

	No. in scale							
Factors	*1*	*2*	*3*	*4*	*5*	*Total*	*Mean*	*SD*
Modernize the IT environment	3	10	4	1	0	18	2.17	0.79
Replace obsolete systems	5	10	1	2	0	18	2.00	0.91
Efficiency	14	4	0	0	0	18	1.22	0.43
Provide better management tools	10	8	0	0	0	18	1.44	0.51
Increase customer satisfaction	6	5	5	1	1	18	2.22	1.17
Increase organisation's competitiveness	9	8	1	0	0	18	1.56	0.62

Note: Scale: 1 = very high, 5 = very low

Table III Areas of ERP implementation (performance)

Areas	No. in scale 1	2	3	4	5	Total	Mean	SD
Software package	0	13	1	2	2	18	2.61	1.09
Project control	3	13	1	1	0	18	2.00	0.69
Project budget	1	8	4	5	0	18	2.72	0.96
Project schedule	1	5	7	5	0	18	2.89	0.90
Project scope	3	3	8	4	0	18	2.72	1.02
Project management	1	6	8	3	0	18	2.72	0.83
Communications	6	6	3	3	0	18	2.17	1.10
External consultants	0	1	7	4	6	18	3.83	0.99
Internal team	0	5	8	5	0	18	3.00	0.77
Training process	1	14	2	0	1	18	2.22	0.81
Technology infrastructure	0	8	4	6	0	18	2.89	0.90
Process redesign	1	9	3	5	0	18	2.67	0.97
Customisation	1	5	4	7	1	18	3.11	1.08

Note: Scale: 1 = very high, 5 = very low

ERP implementation problem areas

A total of 17 ERP implementation potential problem areas were identified and respondents were asked to rate each area according to the extent of their agreement of disagreement that these had been problems for them.

Table IV provides an overview of the responses relating to organisational and data issues, such as lack of financial resources, training issues, lack of internal expertise, lack of consensus among the institution's senior management, quality of the software, inadequate training, resistance to change and alignment between software and business process being a hindrance to effective ERP implementation. Most agreed that these issues presented problems in effectively implementing the ERP. Others partly agree that technical issues, lack

Table IV Problem areas with ERP implementation

Problems	No. in scale 1	2	3	4	5	Total	Mean	SD
Technical issues	8	8	0	2	0	18	1.78	0.94
Organizational issues	9	7	1	1	0	18	1.67	0.84
Data issues	12	5	0	0	1	18	1.50	0.99
Vendor not delivering promised functionality in a timely fashion	3	6	8	0	1	18	2.44	0.98
Lack of financial resources	7	4	3	3	1	18	2.28	1.32
Training issues	13	2	0	2	1	18	1.67	1.28
Lack of internal expertise	10	4	2	1	1	18	1.83	1.20
Lack of consensus among the business owners	5	7	3	2	1	18	2.28	1.18
Lack of consensus among the institution's senior management	11	2	4	0	1	18	1.78	1.17
Quality of the software	10	7	1	0	0	18	1.50	0.62
Lack of understanding on the capability of the software	6	10	0	2	0	18	1.89	0.90
Inadequate training	9	6	0	3	0	18	1.83	1.10
Inadequate communications strategy	5	3	10	0	0	18	2.28	0.89
Resistance to change	14	4	0	0	0	18	1.22	0.43
Alignment between software and business process	13	3	1	0	1	18	1.50	1.04
Customisations	6	5	7	0	0	18	2.06	0.87
Issues in working with external consultants	4	3	5	4	2	18	2.83	1.34

Note: Scale: 1= very high, 5= very low

of consensus among the business owners and lack of understanding on the capability of the software are also ERP implementation problems. A number of respondents could not determine whether these ERP implementation issues are problems or related to vendors not delivering promised functionality in a timely fashion, inadequate communications strategy, customisation, or issues in working with external consultants. One respondent further added that one possible ERP implementation problem is that reports turn out to be inaccurate at times, even after people have worked long hours entering data.

ERP effectiveness

This study also rated ten areas where effectiveness was increased or decreased over the previous non-ERP approach.

Table V indicates that staff or personnel effectiveness in using ERP has partly increased. The same result was found for packaged software use, internal applications and code, hardware and infrastructure, systems operations and management and consulting. The organisation's database, desktop products and services, training as well as help desk and user support, were found to have a stronger increased effectiveness through using the ERP. However two respondents commented that the ERP led to total administration costs increasing due to license fees, hardware, training and implementation and organisations spend more time in managing data in using the ERP.

Impact of the ERP implementation on the organisation's productivity

The implementation of the ERP did not appear to have a consistent positive impact on the organisation. Some respondents reported positively while others indicated several disadvantages. Updated financial information is provided on-line by the ERP, so a broader base of information is quickly made available to people who may need it. Reporting, planning and decision-making processes are made easy because needed information is immediately updated. Also, better communication is established among departments. Transparency in the organisation is improved and work is undertaken more efficiently. Working procedures and processes can be redesigned to fit organisational needs. However, some respondents reported that the ERP implementation resulted in on-site increased workload levels. They also report increased data entry and data verification workload. One respondent stated that the support software always had errors and therefore significantly impaired work process effectiveness with generated reports being useless to the organisation.

Suggestions for incorporating other ERP applications

Some respondents suggested that, ERP applications should include export and import of data from one software package to another as well as the inclusion of a data search function. Data analysis could include costs estimation to be performed using the system as well as

Table V Factors of the ERP solution affecting its implementation

	No. in scale							
Effects	*1*	*2*	*3*	*4*	*5*	*Total*	*Mean*	*SD*
Staff/personnel	7	9	1	1	0	18	1.78	0.81
Packaged software	6	7	5	0	0	18	1.94	0.80
Database	6	4	5	1	2	18	2.39	1.33
Internal applications and code	5	6	2	5	0	18	2.39	1.20
Hardware and infrastructure	4	7	6	1	0	18	2.22	0.88
Desktop products and services	9	3	6	0	0	18	1.83	0.92
Training	11	7	0	0	0	18	1.39	0.50
Help desk and user support	10	7	1	0	0	18	1.50	0.62
Systems operations and management	6	11	1	0	0	18	1.72	0.57
Consulting	5	10	2	1	0	18	1.94	0.80

Note: Scale: 1 = very high, 5 = very low

stock control and planning and tracking procurement flow. They also suggested that a centralized database should also be provided.

Discussion

Question 1 – What are the drivers for and barriers against facilitating the effective deployment of an ERP system to provide useful information that facilitates knowledge transfer about its cost management effectiveness?

As far as the implications for advancing the theoretical discipline of KM in construction industry is concern, the survey results suggest that a majority of the respondents identify that the ERP can effectively and accurately manage cost data in real time to allow people to engage in improved project cost control planning and decision making and storage and retrieval of information used for interpreting past actions. Thus the ERP facilitates better KM in the construction company. While the ERP implementation does not appear to have a positive impact to the organisations all the time, respondents are able to equate their perceptions of their expectations of what the ERP solution should offer with their own experience of how the ERP improves control and management of vast data bases of information that can be used to generate knowledge. This is positive for removing causal ambiguity so that cause and effect chains are clear and as Szulanski (1996) argued this can reduce knowledge stickiness.

As for those factors considered in the ERP implementation, the majority of respondents rate efficiency as the most critical factor and see providing better management tools as very important. These are in line with Cleland (1999) who argues that effective project cost management requires access to accurate, current, reliable data and information and is concerned with establishing processes to monitor and control budgets. According to Walker *et al.* (2004) when KM is supported by an effective ICT infrastructure, it can facilitate competitive advantage. This argument is compatible with the perception expressed by respondents that the ERP can increase the organisation's competitiveness.

Other problems identified by the pilot survey relate to data issues and alignment between software and business process, which are in turn related to software quality. Respondents also expressed concern about the help desk and user support, desktop products and services and training, and its impact upon effective use of the ERP. This is a stakeholder expectation management matter because of the need to create, maintain and manage a relationship with those people and groups with a stake to ensure the successful implementation of ERP (Akkermans *et al.*, 2003; Al-Mashari *et al.*, 2003). This raises KM issues about the way that this ICT tool was deployed in the department studied and the pilot results indicate issues consistent with that raised by a recent study (Peansupap, 2004; Peansupap and Walker, 2005). This is negative for removing what Szulanski (1996) referred to as an ''arduous environment'' so that the workplace systems and culture can increase knowledge stickiness.

Finally, some respondents suggest that further applications of the ERP should be implemented, e.g. exporting and importing data amongst different software; data analysing for estimation; stock controlling etc. This provides an encouraging and positive sign that people see the ERP as a useful tool for sharing, disseminating, and utilizing data that can generate knowledge to facilitate sustainable competitive advantage and facilitate better feed forward and feedback of knowledge (Crossan *et al.*, 1999; Lawrence *et al.*, 2005).

Question 2 – At what level of capability maturity is the organisation placed to support ERP tools?

Table I offers a CMM model to categorise a five maturity level of the ICT enabling infrastructure that can support a K-Adv. The organisation studied has actively invested significant resources for the ERP implementation. The results of the survey indicates that many respondents in the organisation believe that the ERP is capable of managing cost data and is able to match participant's perceptions of what the ERP delivers – their expectations are for the system to improve, cost control and data management and the organisation

considers efficiency as its most critical objective and feels that the ERP can increase the organisation's competitiveness.

Evidence from the organisation's internal communication indicates that it believes that communication performance is excellent post ERP implementation, and that training issues and resistance to change are very important issues yet to be fully resolved. Therefore, the organisation has actively engaged external consultants to provide staff training. The organisation understands the importance of effective help desk and user support, desktop products and services and training to effectively deploy the ERP and has endeavoured to deliver this assistance. Adequate resources and feedback, on-line help, network support and training are however, reactively provided. Some respondents suggest applying further organisational business functions to the ERP and this demonstrates that the organisation is actively promoting the ERP as a tool to facilitate sustainable competitive advantage through improved information management leading to KM activities.

In comparing the survey results to different capability maturity levels for deploying the ERP, the evidence indicates that the organisation has met the maturity Level 3. Table I states this level is characterised by ''almost adequate resources and feedback; well-resourced web and on-line help; passive encouragement to COP; network support and training reactively driven by the BU needs; planned, not necessarily current retrieval system; structured access to archives''. However, this is not enough for a market leader to be confident that it can retain its competitive position. The goal ahead should be to have a pro-active interaction and approach to technology. As far as the existing ERP is concerned, it should be synchronised with other business functions, e.g. integration with the supply chain system. To do this, the wider supply chain stakeholder's needs must be first identified. This would facilitate gap analysis to take place and from that, the organisation can develop a strategy to improve KM practices that will enhance its K-Adv across the organisation and its supply chain. This will also improve knowledge transfer and reduce knowledge stickiness.

Conclusions

Good application of KM puts the organisation into a potentially winning position. ICT tools can assist to manage information and knowledge data. An ERP is specific software tool used for cost management that helps construction contractors to better manage their cost data and to make improved cost management decisions through being better knowledge managers. If adopted thoughtfully, the ERP can be used as a KM strategy to improve knowledge transfer and reduce knowledge stickiness. The results of this study point to a broader theoretical development of KM as follows:

- An effectively deployed ERP tool provides not only valuable information processing capability to better control costs but it can also help identify ways to be more effective in dealing with its supply chain partners as well as improve its internal cost management reporting and decision making. This improvement in communication and decision making can improve the quality of its knowledge assets. The pilot study results, based upon the experience of the leading HK construction company using an ERP, demonstrate the potential effectiveness of an ERP from a cost management business unit's perspective as well as a KM tool.
- In order to deploy the ERP in KM, this innovation must be effectively diffused. This ICT diffusion process at the ERP implementation stage itself involves a KM process. The study also indicates that participants would prefer to operate ERP at a broader level i.e. how this KM tool can assist construction PM in other aspects, e.g. time management and risk management.
- The K-Adv tool provided a useful way to map the KM capability of the organisation from its ICT infrastructure perspective. It stimulated debate and reflection in participants and could be useful in identifying gaps in its KM strategy between an existing and planned for future state. This gap identification can then lead to further deliberation about how to bridge the identified gap.

Most respondents agreed that communications performance was excellent after the ERP was implemented. However, one-third of the respondents were dissatisfied with the performance of external consultants supporting the system. The majority of respondents agree that training and resistance to change are very important issues that external consultants could not significantly resolve. People are best at transferring and reframing ERP knowledge through personal interaction in groups that share trust and passion and are willing to volunteer this knowledge to each other. This is where a COP can help people share knowledge and skills and help sustain its members through their obligation to exchange knowledge and provide access to shared insights about their work practice (Wenger *et al.*, 2002).

We acknowledge several research limitations in this study, in terms of the doctoral research project being undertaken by one of the authors, results from this pilot study are not generalisable. However, it is useful to provide valuable insights into the messy and complex personal experience of people trying to make effective use of this ERP tool. These insights will be more richly explored in the next research phase and how the KM process of diffusion and adoption of this innovation can be better deployed.

This is a pilot study and a fuller cross organisational study would provide a more balanced picture of the KM capability maturity of the organisation and the tool while usefully tested could be further refined. The testing of this at one site only (the HK head office) is restrictive but the purpose of the paper was to pilot and explore ideas and this study provides a useful initial step. While this paper does not offer new insights into ERP systems *per se*, it does provide a case study of using a novel KM tool, the K-Adv CMM, and it does offer KM insights into an ERP from a KM perspective.

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The processes of knowledge management in professional services firms in the construction industry: a critical assessment of both theory and practice

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Abstract

Purpose – *Quantity surveying firms are characterized by their professional identity and knowledge-driven nature; knowledge is crucial to their success in the competitive and dynamic business environment. As knowledge management is still in its infancy in the construction industry and structured knowledge management processes have not yet been adequately deployed in the surveying discipline, this research seeks to focus on the implicit knowledge management processes being undertaken in professional quantity surveying firms in Hong Kong.*

Design/methodology/approach – *A framework of knowledge processes was developed from a detailed literature review in an attempt to enhance the knowledge flow in Hong Kong professional quantity surveying firms. The applicability and validity of the framework were verified by quantitative research methods. Based on the proposed process model, a questionnaire survey was then conducted to study the opinions of professional quantity surveyors on the details of these processes; the questionnaire was returned with a response rate of 42.6 percent out of 260.*

Findings – *From the findings of the questionnaire survey, the research confirms the six knowledge management processes in quantity surveying firms, namely acquisition, creation, storage, distribution, use, and maintaining. There is a general lack of specifically assigned staff for knowledge acquisition from external sources, knowledge acquisition having an overall mean value marginally below the passing point, and a relatively low reliance on external knowledge by these firms.*

Research limitations/implications – *The paper unravels some of the mysteries and difficulties of transferring knowledge both within and across projects. The findings can equally be applied in other project-based industries.*

Practical implications – *A clear policy/strategy governing the ways in which knowledge should be handled is far from prevalent in Hong Kong quantity surveying firms. The appointment of managers for knowledge aspects was only carried out by one third of the responding quantity surveyors. Despite the absence of such an appointment and policy, nearly half of the responding quantity surveyors can seek the necessary knowledge when they need it.*

Originality/value – *Although the study applies uniquely to quantity surveying professional services firms and may not yield an evaluation that is comparable with previous studies, it is hoped that the same survey instrument can be applied to other types of project-based professional services organizations in order to find out whether there are differences among different professions in terms of how they manage their organizational knowledge. In addition, these future studies can offer a benchmarking effect to firms providing customized professional services to clients.*

Keywords *Knowledge management, Professional services, Quantity surveying, Process planning*

Paper type *Research paper*

Introduction

Knowledge is increasingly regarded as a survival tool in a dynamic and competitive environment (Laudon and Laudon, 2000). Drucker (1993, p. 7) shared this view and stated in his text, ''Post-capitalist society'', that ''the basic economic resource is no longer capital,

natural resources, nor labor. It is and will be knowledge''. Therefore, there is a pressing need in every knowledge-intensive organization for knowledge to be well managed in order to cope with the shortcomings arising from the common uneven distribution of knowledge in these organizations. This is echoed by Nissen (2004, p. 186), who emphasizes that ''efficient knowledge flow is critical to enterprise performance''. In spite of its inherently crucial role, knowledge is often not managed in a systematic manner, and its contribution to firm success is commonly overlooked. These firms may hold the belief that investment in knowledge processes is unlikely to boost their business enough to generate proportionate financial returns.

In line with other knowledge-intensive organizations in Hong Kong, like accounting, engineering and legal firms, quantity surveying firms place heavy reliance on their wealth of knowledge in their business. In general, quantity surveyors perform an influential role in building and civil engineering projects by utilizing their knowledge and expertise in cost issues and contractual aspects and striving for the best value for their clients' investment. Despite the existence of variants in form and context, it is evident that this wealth of knowledge invariably injects substantial influence into the firms' operation and project deliverables. For instance, exchanges of ideas and discussions are normal scenes in corridors and across meeting tables. Reference to archives of useful cost data and contract document templates constitutes an almost indispensable process in the compilation of every contract document.

Quantity surveying firms not only are knowledge-intensive firms but also possess the characteristics of professional services firms. Theoretically, the issue of managing knowledge should have attracted much attention in quantity surveying firms, as only those that can best manage knowledge are able to preserve their competitive advantage (Hiebeler, 1996). To the contrary, little is known about the current practice adopted in quantity surveying firms. Worse, despite the emergence of various frameworks of knowledge management processes advocated by different scholars, there is so far no similar framework specifically representing how knowledge is managed in quantity surveying firms.

In view of the dominance of quantity surveyors practicing in both the construction industry and the surveying discipline and the intermingled relationship between knowledge and quantity surveying firms, a study of how quantity surveying firms manage knowledge seems to be of significant and practical importance. The overall aim of this research is to ascertain how professional quantity surveying firms in Hong Kong implicitly manage knowledge. The specific objectives of this research are:

1. to investigate the knowledge managing activities/actions generally undertaken in quantity surveying firms; and
2. to develop a conceptual framework of managing knowledge for professional quantity surveying firms.

Knowledge and professional services firms

Carr-Saunders (1966, p. 4) stated that:

> A profession may perhaps be defined as an occupation based upon specialized intellectual study and training, the purpose of which is to supply skilled service or advice to others for a definite fee or salary.

Similarly, professional services firms (PSFs) are knowledge-intensive organizations that provide expert advice and professional knowledge to clients (Løwendahl, 2000; Maister, 1997). The organizational assets reside in the experience and knowledge of staff, rather than in plant and equipment. The services offered by professional services firms often vary in nature so as to address diverse clients' needs and demands (Nachum, 1999; Maister, 1993). Despite the fact that the characteristics of professional services firms (PSFs) have not yet been clearly defined, they can be derived by analogy to the discussions on the definitions of ''professional'', ''professional organizations (firms)'' and ''professional service''. Tables I-III give a comprehensive collection of the assertions by various scholars on this issue. From the

Table I Characteristics of the professional

Scholars	*Propositions of the characteristics of ''professional''*
Six attributes to qualify for professional status (Bennion, 1969)	Requirement of an intellectual body of knowledge Work of an advisory nature Existence of a private practice A tradition of service A suitable code of conduct A governing professional institution(s)
A collection of definitions of profession (Løwendahl, 2000; Blau and Scott, 1962; Hughes, 1958; Vollmer and Mills, 1966)	A vocation founded in a body of knowledge, typically a higher (academic) education A vocation concentrated on the application of knowledge and experience to provide an altruistic service to clients A vocational organization based on a common code of ethics
Characteristics of a professional (Becher, 1999; The Monopolies Commission, 1970)	Practitioners apply a specialist skill to offer a specialized service The skill has been acquired by an intellectual and practical training in a well defined area of study The practitioners are organized in bodies which are concerned to provide machinery for testing competence and regulating standards of competence and conduct

Table II Characteristics of professional organizations/firms

Scholars	*Propositions of the characteristics of ''professional organizations/firms''*
Characteristics of a professional organization (Bots and Bruijn, 2002) Characteristics of professional organizations (firms) (Løwendahl, 2000)	Indivisibility of projects/services Highly situation-specific decisions More than 50 percent professional employees High priority for professional goals High degree of respect for professional norms Emphasis on creation as well as application of knowledge Professionals in charge of key decisions and activities

Table III Characteristics of professional service

Scholars	*Propositions of the characteristics of ''professional service''*
Characteristics of professional service (Løwendahl, 2000)	Highly knowledge-intensive, delivered by people with higher education High degree of customization High degree of discretionary effort and personal judgment by expert(s) Substantial interaction with client firm representatives Within the constraints of professional norms of conduct

tables, it is observed that the characteristics of professional services firms (PSFs) are somehow similar to those of knowledge-based organizations. To summarize the definitions of ''professional'', ''professional organizations (firms)'' and ''professional service'', four distinct features are identified, namely their knowledge-intensive nature, their advisory nature, the fact that their competence is governed by institutions, and the existence of a code of conduct regulating their behavior.

As illustrated in the following paragraphs, quantity surveying firms demonstrate the four essential characteristics of professional services firms.

Knowledge-intensive nature

A higher educational qualification is an element of professions (Løwendahl, 2000; Blau and Scott, 1962; Hughes, 1958; Vollmer and Mills, 1966). This is reflected in the common belief in the industry that a body of knowledge originates from academic study and practical training in professional services firms. Quantity surveyors' skills and expertise are thus the talent of quantity surveying firms and also contribute highly to firms' reputations. As a result, practitioners in these firms are associated with impressive academic backgrounds, supported by either accreditation of professional status from professional institutes or academic achievement in recognized academic institutions.

Advisory nature

It is claimed that altruistic and specialized services to clients are the core services of professionals (Becher, 1999; Monopolies Commission, 1970). Quantity surveying firms in Hong Kong are mostly private practices that seek to offer consultancy to clients in construction projects. The scope of their services is stretching beyond the traditional framework to suit clients' ever-increasing demands. In contrast to, for example, a toy factory, quantity surveying firms have to shape their products to adapt to different clients and business scenarios. Hence, the quality of situation-specific decisions (Bots and Bruijin, 2002) is a useful indicator to reflect the competence of a professional organization. To discharge their professional duties, quantity surveyors have to apply their knowledge and expertise to provide impartial and objective advice and analyses to clients. The quality of their decisions depends to a large extent on their appropriate exercise of expert discretion and professional judgment in relation to cost control and contract administration for construction projects. As a result, with clients' needs well communicated between clients' representatives and quantity surveyors in advance, clients generally receive excellent professional service from quantity surveyors.

Competence governed by institutions

It is essential to a professional service that a governing professional body is established to maintain the competence and control the standards of conduct of the profession (Bennion, 1969). Therefore, the title of chartered member is taken as a recognition of professional competence. The competence of professionally qualified quantity surveyors is well established and regulated by professional institutions, The Hong Kong Institute of Surveyors (HKIS) or The Royal Institution of Chartered Surveyors (RICS). The admission requirements of different grades of memberships are precisely stated and strictly followed. According to the rules of the Institutions, Professional Grade consists of Fellows (FHKIS, FRICS) and Members (MHKIS, MRICS). Although many practitioners claim to be quantity surveyors, the title of chartered quantity surveyor is only awarded to those who have passed the professional competence test set by the Institutions. Clients therefore have some assurance of the standard of the intangible service they are purchasing under this system.

Code of conduct

In addition to the grades of membership established in the Institutions, every member receives a copy of the Code of Conduct and Professional Ethics. Since quantity surveyors are often involved in managing confidential information, such as tender sums submitted by contractors in construction projects and payments to contractors for work done on site, they have to be fully aware of and abide by provisions in the Standard of Conduct and

"Quantity surveying firms not only are knowledge-intensive firms, but also possess the characteristics of professional services firms."

Professional Ethics. The Council of the Law Society (1974, pp. 1-2) further defines a profession as ''identifiable by reference to some register'', ''recognized as having a special skill . . . , the standards of skill being prescribed by the profession itself'' and ''voluntarily submitting themselves to standards of ethical conduct beyond those required of the ordinary citizen by law''. Similarly, the qualification of practitioners in quantity surveying firms is well controlled and recorded under the registers of the Institutions. Further, quantity surveying firms offer cost and contractual expertise to clients. The heavy reliance on the expertise and knowledge of staff sets a standard for outsiders to imitate. Freidson (1994) describes these kinds of professional services as esoteric services.

To summarize, the above discussions clearly illustrate that quantity surveyors are indeed professionals. Hence it can be concluded that, like other PSFs, quantity surveying firms also specialize in providing expert advisory services to the construction industry.

Research methodology

In order to inquire into the views of a wider spectrum of relevant respondents, it was proposed that questionnaires be sent to quantity surveyors practicing in professional quantity surveying firms. The literature review was the main reference guiding the formulation of the questionnaire. A set of questions was purposely developed with the aim of probing into the knowledge practices of various professional quantity surveying firms. A five-point Likert scale in combination with a list of closed-ended items was devised in the instrumentation design, to allow convenient quantitative expression of opinions by the respondents. The Likert scale was composed of an escalating scale from ''Low'' (strongly disagree) to ''High'' (strongly agree), with ''Neither agree nor disagree'' as the midpoint. The survey questions to the six processes were derived after consulting a wide variety of previous studies and are not included here due to space restrictions.

Since this research aimed to probe into the prevailing practice of Hong Kong quantity surveying firms in managing knowledge, it was considered that practicing professionals in these specific project-based firms would be ideal respondents. Hence the pool of quantity surveyors registered under the Directory of The Hong Kong Institute of Surveyors 2001-2002 and the List of Members 2004 of The Royal Institution of Chartered Surveyors constituted the population for sample selection. A total of 260 questionnaires were administered to quantity surveyors practicing in those firms. The composition of those selected was determined by a random ballot of the lists in the Membership Directories so as to guarantee a well graded distribution.

Owen and Jones (1994, p. 313) suggested that ''on average, a response rate of 20 percent of questionnaires returned without reminders is considered satisfactory, while 40 percent is exceptionally good''. Alreck and Settle (2004, p. 36) state that ''mail surveys with response rates over 30 percent are rare''. Based on the above views, the response rate of this questionnaire is well above the acceptable level. Of the 260 questionnaires dispatched, 111 questionnaires were completed and returned, which constituted 42.6 percent of the entire sample of quantity surveyors. Computer-aided statistical analysis was deployed in the data analysis process. All data collected by the questionnaires was input into SPSS.

Internal consistency, i.e. reliability assessments of the survey data, was measured by Cronbach's coefficient alpha. Nunnally (1978) recommended that survey data satisfy a minimum alpha, 0.70, to ensure acceptable data consistency. A higher value of Cronbach's

coefficient alpha implies greater data reliability. The Cronbach's coefficient alpha of the 83 question items in this survey is 0.9078, indicating consistency.

Research findings

Knowledge acquisition

External sources. As shown in Table IV, almost a quarter of the respondents indicated that knowledge was acquired by specific staff in their workplace. However, over one third of the respondents gave a neutral response, and 42 percent responded in the negative. From these responses, it can be deduced that only some quantity surveying firms in Hong Kong allocate sufficient resources to offer such provision, while the majority still lags a long way behind. It is worth noting that a considerable portion of the respondents chose to adopt a neutral stance, implying a failure to acknowledge the existence of such provisions. This uncertainty or perhaps frustration may arise from the absence of a clear demarcation of the duties of the responsible staff in respect of knowledge matters.

The degree of reliance on external knowledge import in Hong Kong quantity surveying firms deserves particular attention. Half of the respondents neither agreed nor disagreed with the statement, while negative responses amounted to approximately 34 percent of the total. Affirmative responses constituted the remaining 15 percent and thus the smallest proportion of the respondents in all five categories of responses. These findings imply that external knowledge import does not seem to be a vital element in the operation of quantity surveying firms. Perhaps existing stocks of knowledge possessed by quantity surveyors are broad enough to cover applications in most situations encountered in the course of their duties. New external knowledge may only be called for in a few cases and may seldom be involved in the firms' daily output.

It is commonly assumed that organizations tend to hire people who possess relevant knowledge. However, 45 percent of the respondents stated that this was not true in their workplace. Approximately 30 percent of them took a neutral stance, while the remaining 25 percent affirmed this assertion. These findings reflect an active measure generally adopted by quantity surveying firms to preserve their own unique work practice. Some large quantity surveying firms exhibit reluctance to take on employees with previous work experience in other firms. This attitude is understandable in view of the perceived difficulties of assimilating newcomers' long-established mental models and working styles into a firm's work practice. It also explains why most experienced staff of large quantity surveying firms have been nurtured by the firms since graduation, rather than being recruited externally.

Internal sources. As an alternative to external knowledge acquisition, internal knowledge acquisition is believed to be undertaken in quantity surveying firms to a certain extent. Job rotation, the reduction of valuable knowledge into writing at staff departures, and experience evaluations at project conclusion are common methods of internal knowledge acquisition. As depicted in Table V, a quarter of the respondents admitted that they acquired new knowledge by job rotation, while 18 percent of them indicated that measures were taken to

Table IV External knowledge acquisition

	Strongly disagree		*Disagree*		*Neither agree nor disagree*		*Agree*		*Strongly agree*	
	Frequency	*(%)*	*Frequency*	*(%)*	*Frequency*	*(%)*	*Frequency*	*(%)*	*Frequency*	*(%)*
Specific staff in my workplace are responsible for obtaining knowledge from external sources	16	14.4	31	27.9	38	34.2	20	18.0	6	5.4
My work output relies on knowledge input externally	7	6.3	31	27.9	56	50.5	13	11.7	4	3.6
Experienced staff are recruited externally	13	11.7	37	33.3	33	29.7	25	22.5	3	2.7

Table V Internal knowledge acquisition

	Strongly disagree		Disagree		Neither agree nor disagree		Agree		Strongly agree	
	Frequency	(%)	Frequency	(%)	Frequency	(%)	Frequency	(%)	Frequency	(%)
Job rotation is encouraged in my workplace	23	20.7	33	29.7	27	24.3	23	20.7	5	4.5
Experienced staff and staff approaching departure are invited to record their knowledge and experience	9	8.1	47	42.3	35	31.5	16	14.4	4	3.6
I learn lessons after project closure	2	1.8	18	16.2	24	21.6	47	42.3	20	18.0

encourage experienced staff to transform their knowledge into writing or the like. The remaining 60 percent affirmed their experience of knowledge capture in experience evaluations conducted at the conclusion of a project. From the statistics, it is evident that job rotation and positive encouragement to departing staff to reduce their knowledge into writing are rarely observed in quantity surveying firms. In terms of cost effectiveness, job rotation is undesirable in these firms due to its tendency to incur unnecessary learning cycles for newcomers and in order to vindicate the benefit of staff continuity from project inception to completion. In addition, effort may have been taken to encourage departing staff to record their knowledge, but in most cases the concerned staff member is deterred from doing so by a number of factors, such as preparation of handover arrangements, reduced loyalty to the firm, striving to conclude his duties within deadlines, etc.

Knowledge creation

Lu and Tsai (2004, p. 284) remind us that ''organizations have to focus on the creation of knowledge to prevent existing knowledge from becoming obsolete quickly''. Therefore, the respondents were requested to describe the atmosphere and attitudes towards new knowledge at both individual and organizational levels. The responses to these questions are tabulated in Table VI, which shows a number of observations as follows:

- approximately 40 percent of the respondents had been encouraged to explore alternative solutions for their current assignments in their workplace;

Table VI Knowledge creation

	Strongly disagree		Disagree		Neither agree nor disagree		Agree		Strongly agree	
	Frequency	(%)	Frequency	(%)	Frequency	(%)	Frequency	(%)	Frequency	(%)
I am encouraged to find alternative solutions for existing assignments in my workplace	2	1.8	21	18.9	44	39.6	31	27.9	13	11.7
Work-related suggestions are encouraged in my workplace	1	0.9	12	10.8	44	39.6	36	32.4	18	16.2
Existing knowledge is used to develop new knowledge in my workplace	1	0.9	6	5.4	43	38.7	45	40.5	16	14.4
I am encouraged to identify best practice for future use	1	0.9	11	9.9	36	32.4	45	40.5	18	16.2
I am encouraged to analyze success factors to enrich my knowledge	1	0.9	10	9.0	48	43.2	34	30.6	18	16.2
I am encouraged to analyze mistakes to enrich my knowledge	0	0.0	7	6.3	34	30.6	47	42.3	23	20.7

- almost 50 percent of them conceded that they were motivated to spell out work-related suggestions for their firms as a whole;
- over half of them had developed new knowledge from existing knowledge; and
- over half of them were encouraged to identify best practice for future use.

The responses demonstrate that there is a general awareness in Hong Kong quantity surveying firms of the value of new ideas and best practice. In their working environment, quantity surveyors were encouraged to suggest alternatives methods of performing the same/similar task(s), and to identify best practice for sharing.

Consistent with the statement by Gupta *et al.* (2004, p. 5) that an ''organization gains knowledge from its own experience and from the experience of others'', it is interesting to note that knowledge could be more satisfactorily enriched by evaluating mistakes in lieu of successes. This is well illustrated in Table VI, which reveals that 63 percent of the respondents were encouraged to evaluate mistakes, whereas only 47 percent were encouraged to evaluate successes. Possibly quantity surveyors are alert to the fact that any mistakes and negligence on their part would severely ruin the firm's reputation and attract unnecessary liabilities. This may explain why more knowledge is gained from experiences of failure.

Knowledge storage

Notwithstanding the overwhelming academic support for the need for knowledge to be processed and integrated prior to storing (Lee and Yang, 2000; Fischer and Ostwald, 2001), the findings of the questionnaires reveal something slightly different occurring in practice. Table VII shows that only approximately 50 percent of the respondents identified the existence of such processes in their workplace, and almost one third of them were suspicious of the presence of such arrangements. This may be attributed to the fact that quantity surveyors devote their attention and effort to their duties, unmindful of any non-work related aspects.

Even so, knowledge exists in a wide variety of formats in quantity surveying firms. As shown in Table VII, paper and electronic means were selected by 60 percent of the respondents as the most common modes of storing knowledge. Following them, the organization's routines/procedures and the human brain were also frequently used according to 39.6 percent and 36.9 percent of the respondents respectively. The response to the questions in this section reveals at the same time that firms' documentation and personal reference files were considered the destiny of knowledge by 60.3 percent and 45.9 percent of the respondents respectively. These findings reflect that knowledge stored in quantity surveying firms largely exists in the form of explicit knowledge, and is codified in a wide variety of media. On the other hand, implicit knowledge, which resides in human memory, is considered to constitute a relatively small majority. This concurs with the assertion of Tan *et al.* (1999) and Davenport and Prusak (1998), that explicit knowledge is stored by electronic databases and written documentation while tacit knowledge resides in individuals. It is observed that quantity surveying firms prefer to store a large portion of their knowledge in a form highly accessible by quantity surveyors as explicit knowledge and an organizational memory rather than a private individual asset. Their effort to compile their own office manuals or work standards to retain organizational knowledge and ensure knowledge accessibility is testament to this phenomenon.

Approximately two thirds of the respondents made similar observations as Dent (2004) and Bergeron (2003), that safeguards were put in place against unauthorized access to confidential information in quantity surveying firms, and nearly 32 percent of them even reported that measures were taken to record staff retrievals of some knowledge (refer to Table VII). However, the portion of respondents with a neutral stance on the recording of knowledge access was over 40 percent of the total. This may be attributed to the quantity surveyors' ignorance of matters unrelated to their duties and their reduced awareness of the knowledge provision in their workplace. The ease of searching for required knowledge often determines the ultimate success of a knowledge storage system. The results of the

Table VII Knowledge storage

	Strongly disagree		*Disagree*		*Neither agree nor disagree*		*Agree*		*Strongly agree*	
	Frequency	*(%)*	*Frequency*	*(%)*	*Frequency*	*(%)*	*Frequency*	*(%)*	*Frequency*	*(%)*
Data and information are selected and organized before being stored in my workplace	1	0.9	20	18.0	36	32.4	36	32.4	18	16.2
Knowledge is recorded by electronic means (soft copy) in my workplace	5	4.5	11	9.9	27	24.3	52	46.8	16	14.4
Knowledge is recorded in paper medium (hard copy) in my workplace	2	1.8	8	7.2	34	30.6	51	45.9	16	14.4
Knowledge resides in human memory (minds) in my workplace	8	7.2	17	15.3	45	40.5	29	26.1	12	10.8
Knowledge is kept in personal reference file(s)	7	6.3	19	17.1	34	30.6	35	31.5	16	14.4
Knowledge resides in my organization's routines/procedures	4	3.6	16	14.4	47	42.3	32	28.8	12	10.8
Knowledge is recorded in the form of documentation such as office manuals, work practice, in-house standards, lessons learned, etc.	7	6.3	14	12.6	23	20.7	41	36.9	26	23.4
Confidential/sensitive information has restricted access in my workplace	1	0.9	14	12.6	23	20.7	34	30.6	39	35.1
Access to some knowledge is recorded	9	8.1	20	18.0	47	42.3	29	26.1	6	5.4
I know where to find knowledge when I need it	0	0.0	16	14.4	28	25.2	47	42.3	20	18.0
I know who to ask for knowledge when I need it	0	0.0	6	5.4	28	25.2	54	48.6	23	20.7

questionnaires indicate that 60 percent and 69 percent of the respondents agreed or strongly agreed that they knew where and whom to approach for knowledge. Despite this, there is ample room for quantity surveying firms to enhance their provisions for locating knowledge in view of the limited absolute concurrence (20 percent) and considerable bewilderment and uncertainty (25 percent) of the respondents.

Knowledge distribution

As revealed in Table VIII, the methods of knowledge transfer most adopted by quantity surveyors embraced a wide spectrum. Mentoring topped the popularity list with the support of 63 percent of the respondents. Expert input into specific projects (62.1 percent), daily interaction (58.5 percent), electronic means (42.3 percent) and documentation (38.7 percent) followed closely behind. This trend is probably related to the unique capability of mentoring as advocated by Srikantaiah (2004, p. 372), namely that it ''facilitates the transfer of tacit knowledge from seasoned employee to new recruits''. These findings lead to an indirect inference that the type of knowledge broadly disseminated in quantity surveying firms lies predominantly in the ambit of tacit knowledge. As opposed to other mechanic means, knowledge transfers involving human interactions, namely mentoring, expertise input into specific projects and daily interaction, serve best to articulate tacit knowledge. Tacit knowledge is largely experience-based and includes insights and intuition gained through experience. Its transfer can hardly be conducted by written instructions. According to Nonaka and Takeuchi (1995), sharing of tacit knowledge is most effective through oral conversation and dialogues. On the other hand, knowledge distribution by electronic means

Table VIII Knowledge distribution

	Strongly disagree		*Disagree*		*Neither agree nor disagree*		*Agree*		*Strongly agree*	
	Frequency	*(%)*	*Frequency*	*(%)*	*Frequency*	*(%)*	*Frequency*	*(%)*	*Frequency*	*(%)*
Experienced staff in my workplace are encouraged to mentor new or less experienced staff	2	1.8	8	7.2	31	27.9	49	44.1	21	18.9
Knowledge gained from different projects is made accessible to all in my workplace	4	3.6	21	18.9	45	40.5	33	29.7	8	7.2
Knowledge is transferred by electronic means throughout the office	13	11.7	17	15.3	34	30.6	38	34.2	9	8.1
Knowledge is distributed through documentation in my workplace	5	4.5	19	17.1	44	39.6	36	32.4	7	6.3
Knowledge is shared by daily interaction with colleagues in the workplace, e.g. in the corridor, during lunch, in the pantry, at social functions	2	1.8	6	5.4	38	34.2	43	38.7	22	19.8
Knowledge is transferred by face-to-face means only	16	14.4	28	25.2	42	37.8	21	18.9	4	3.6
Staff who share knowledge receive rewards/recognition in my workplace	23	20.7	38	34.2	39	35.1	10	9.0	1	0.9
The office layout in my workplace encourages staff to share knowledge	11	9.9	27	24.3	41	36.9	22	19.8	10	9.0
Knowledge sharing is a measure of employees' performance in my workplace	24	21.6	40	36.0	35	31.5	9	8.1	3	2.7
Remote access to the workplace's database is provided	17	15.3	36	32.4	29	26.1	20	18.0	9	8.1
Staff with specific expertise are assigned to specific project(s)	2	1.8	7	6.3	33	29.7	49	44.1	20	18.0

and documentation was less frequently observed. This may be due to the relatively little emphasis placed on explicit knowledge sharing compared with the sharing of tacit knowledge. Although face-to-face sharing is highly promoted by Standards Australia (2001), only approximately 23 percent of the respondents observed that it was the sole channel of knowledge sharing in their workplace. This suggests that other methods of transfer, such as printouts and electronic means, are considered equally helpful by the respondents. On the whole, tacit knowledge seems to play a more crucial role in these firms. Notwithstanding the large demand for sharing by daily interaction, sole reliance on face-to-face transfer is rare in quantity surveying firms.

In respect of the facilities and provisions for knowledge sharing, the responses were generally not positive. An office layout that favors low partitions, doors, meeting rooms and a café catalyses knowledge sharing among the staff. However, one third of the respondents said there was no such office layout at their workplace, and 37 percent were even suspicious of its influence. Table VIII indicates that only 29 percent believed it would benefit knowledge sharing. Apart from this, remote access provision is another alternative that helps overcome the geographical impediment to knowledge transfer. However, it is evident that this technology has not been fully utilized in quantity surveying firms. Approximately half of the respondents were deprived of access to their organization repositories from remote sites, while only 26 percent of them could enter their organizational repositories irrespective of

> **"Quantity surveying firms prefer to store a large portion of their knowledge in a form highly accessible by quantity surveyors as explicit knowledge and as organizational memory rather than a private individual asset."**

their location and time, as shown in Table VIII. In view of the above, seating arrangement becomes agonizingly complex in terms of resolving the tension between the need to maximize the use of space and aesthetics and the demand for spatial and functional provisions for knowledge sharing. By the same token, more resources are required in terms of extra expenditure on installation and security should remote access be provided. Hence this initial investment and commitment often deter quantity surveying firms from providing these two facilities for their staff.

In Table VIII, serial transfer and near transfer (Dixon, 2000) denote two distinct processes with focus on knowledge transfer within the same team and to another team respectively. The responses to the questionnaires reveal that these processes are not satisfactorily executed in Hong Kong quantity surveying firms. It is evident from the responses that about 41 percent of the respondents remained uncertain about whether they were authorized to access knowledge from other projects, compared to 37 percent who indicated that they could get whatever they required without difficulty.

The obstacle to knowledge sharing lies in the absence of trust. There is a traditional belief that knowledge sharing will weaken one's personal competitive advantage. To break through this psychological barrier, different forms of motivation may help to a certain extent. Table VIII outlines the views of the respondents on this aspect. Offers of reward and incorporation of knowledge sharing into staff appraisals were viewed similarly. Approximately 55 percent of the respondents reported the absence of such arrangements, and only 10 percent acknowledged their implementation in their workplace. Perhaps the pressure of a heavy workload prevents quantity surveyors from promoting knowledge sharing. The top management of these firms are fully engaged with exploring new business opportunities, while the staff at working level are busy with their duties. Hence motivation by these means is rarely found in these firms' agenda and knowledge strategy.

Knowledge use

In line with Prokesch (1997)'s proposition that powerful use of knowledge is a business tactic to defeat rivals, over three quarters of the respondents were encouraged to refer to the knowledge/experience learned from previous projects and 71 percent of them utilized knowledge to solve problems, as indicated in Table IX. None of the respondents disagreed that they were encouraged to make use of knowledge/experience gained from previous projects. This clearly shows that knowledge is indispensable to problem resolution, and that most quantity surveyors accumulate their individual knowledge stock by assimilating the knowledge gained from previous projects. Another factor that arouses quantity surveyors' enthusiasm about knowledge from previous projects is its contribution to the evidential proof of their skills, experience and knowledge in their career development and internal promotion.

Despite the vital role of knowledge for the creation of knowledge and innovation (Hauschild *et al.*, 2001), only 41 percent of the respondents made use of knowledge to develop new products and services, and 44 percent of them failed to indicate their stance, as outlined in Table IX. This may be because the innovation of new services often requires the input of expertise and research techniques from the R&D sector or top management, so that most quantity surveyors may seldom or even never be involved.

Table IX Knowledge use

	Strongly disagree		*Disagree*		*Neither agree nor disagree*		*Agree*		*Strongly agree*	
	Frequency	*(%)*	*Frequency*	*(%)*	*Frequency*	*(%)*	*Frequency*	*(%)*	*Frequency*	*(%)*
I utilize knowledge to solve most problems that I encounter in my job	0	0.0	3	2.7	29	26.1	58	52.3	21	18.9
I am encouraged to apply knowledge/experience learned from previous project(s) to subsequent project(s)	0	0.0	0	0.0	22	19.8	64	57.7	25	22.5
I apply knowledge in developing new products/services	2	1.8	15	13.5	49	44.1	30	27.0	15	13.5

Knowledge maintaining

Knowledge is dynamic in nature and keeps evolving over time (Skyrme, 2001). From Table X, approximately half of the respondents confirmed that a specific staff member in their workplace was assigned to update and maintain the validity of the knowledge in the databases/libraries. Probably stemming from the above provision, 46 percent of the respondents were able to obtain the necessary knowledge when they needed it. It is therefore suggested that knowledge processing in quantity surveying firms generally fulfils the knowledge demand without hindering the daily work of quantity surveyors.

The interview results of Pavos (2002) reveal that quantity surveying personnel in South Australia admitted that they lacked sufficient time and tended to put added effort into running on-going projects and seeking future business chances. In light of this working environment, they encountered severe difficulties in dealing with managing knowledge. In line with this observation, about 40 percent of our respondents failed to observe a clear policy/strategy of managing knowledge in their workplace, and 27 percent could not even confirm the existence of such a policy. However, 36 percent of the respondents realized that their knowledge needs were properly dealt with by managers/senior staff. This is compared to 41 percent who could not figure out if such needs were specifically coped with. On the

Table X Knowledge maintaining

	Strongly disagree		*Disagree*		*Neither agree nor disagree*		*Agree*		*Strongly agree*	
	Frequency	*(%)*	*Frequency*	*(%)*	*Frequency*	*(%)*	*Frequency*	*(%)*	*Frequency*	*(%)*
Specific staff in my workplace are responsible for regular updating of knowledge in the database/library	8	7.2	17	15.3	23	20.7	41	36.9	22	19.8
Specific staff in my workplace are responsible for maintaining the applicability of the knowledge in the database/library	9	8.1	17	15.3	31	27.9	36	32.4	18	16.2
I am able to obtain the necessary knowledge when I need it	0	0.0	19	17.1	41	36.9	33	29.7	18	16.2
A manager/senior staff member is assigned to deal with knowledge needs	3	2.7	23	20.7	45	40.5	31	27.9	9	8.1
There is a clear policy/strategy in my workplace of how to handle knowledge	10	9.0	34	30.6	30	27.0	29	26.1	8	7.2

whole, Hong Kong quantity surveying firms appear to realize knowledge needs in the workplace, although they have failed to take positive strides toward the formulation of an overall policy in relation to knowledge management.

In the above discussion, the research hypothesis that affirms the underlying scope of knowledge managing activities in quantity surveying firms is justified. It is apparent that knowledge processes – knowledge acquisition, knowledge creation, knowledge storage, knowledge distribution, knowledge use and knowledge maintaining – operate in quantity surveying firms. They work to benefit these firms in a discreet manner and are seldom given explicit flags or labels. With such an intermingled relationship with the daily processes in these firms, the scope of managing knowledge may sometimes be overlooked by quantity surveyors.

The proposed framework of knowledge processes in Hong Kong quantity surveying firms

In the previous sections, the responses to each question item and their derivatives in each knowledge process have been thoroughly discussed. This section puts forward a direct inference of the validity of a proposed framework of knowledge processes in Hong Kong quantity surveying firms, based on the questionnaire findings. The mean value of each process is taken as the sum of the mean values of the question items of the knowledge process divided by the total number of question items of that process. For instance, the mean value of knowledge acquisition is 2.83, which is the quotient of the following arithmetic formula $(2.72 + 2.78 + 2.71 + 2.59 + 2.63 + 3.59)/6$. This applies to other knowledge processes – knowledge creation, knowledge storage, knowledge distribution, knowledge use and knowledge maintaining.

As depicted in the questionnaire design section, the questionnaire was specifically framed with the aim of affirming the scope of the six proposed frameworks of knowledge processes in Hong Kong quantity surveying firms. The wordings in the questions were normalized to account for the relatively immature recognition of managing knowledge processes in these firms. Technical terms, such as knowledge acquisition, etc., frequently adopted in academic literature were deliberately avoided and replaced by easily comprehensible and lay descriptions of scenes and examples in their working environment. For example, broad questions like ''Do you find knowledge acquisition in your workplace?'', were clearly dropped from the list. This was then transformed into discrete question items, including ''What do you seek?'', ''Where can you find it'', ''How can you get it?'', in a literally simple and direct format. Following this particular approach, a circle by a respondent on the affirmative responses for a question item would draw two inferences, not only representing his agreement with the statement, but also indicating that the relevant knowledge process, in the form of the behavior, examples and scenes as posed in the question item, exist in his workplace. In this questionnaire setting, it is reasonably envisaged that as a derivative of the associated question items, the overall mean values of the knowledge processes bear a larger representation than those of the individual question items. Unlike the overall mean values of the knowledge processes, those of the individual question items merely give an indication of their validity.

As such, Table XI summarizes the overall mean values of the knowledge process of the questionnaire responses. The figures were derived from the numerical responses of the question items on a five-point Likert scale (5 = Strongly agree, 4 = Agree, 3 = Neither agree nor disagree, 2 = Disagree, 1 = Strongly disagree). A threshold was set at point 3 (Neither

"However paramount the need, a clear policy/strategy governing the ways in which knowledge should be handled is far from prevalent in Hong Kong firms."

Table XI Mean values of the six proposed knowledge processes

Knowledge processes in quantity surveying firms	*Mean value*
Knowledge acquisition occurs in my workplace	2.837
Knowledge creation occurs in my workplace	3.555
Knowledge storage occurs in my workplace	3.492
Knowledge distribution occurs in my workplace	3.059
Knowledge use occurs in my workplace	3.757
Knowledge maintaining occurs in my workplace	3.270

agree nor disagree) to determine the existence of a knowledge process. In other words, a knowledge process with an overall mean value above the threshold was taken to exist at that respondent's workplace and vice versa. In Table XI, five of the knowledge processes – knowledge creation, knowledge storage, knowledge distribution, knowledge use and knowledge maintaining have values above the threshold, whereas knowledge acquisition, with an overall mean value of 2.837, is seen to fall marginally below the passing point.

Conclusions

It is apparent from the empirical work that the six knowledge processes – knowledge acquisition, knowledge creation, knowledge storage, knowledge distribution, knowledge use and knowledge maintenance – operate in quantity surveying firms. They work to benefit these firms in a discreet manner, and are seldom given explicit flags or labels. With such an intermingled relationship with the daily processes in these firms, the scope of managing knowledge may sometimes be overlooked by those who most need to practice it: quantity surveyors.

With reference to personal experience, colleagues' experience and personal networks remain the favorite mode of knowledge searches among quantity surveyors. Regarding the types of knowledge, cost data, forms of contracts and standard methods of measurement reportedly attract the most frequent visits by quantity surveyors in their searches. In some other industries, staff recruitment is also considered capable of bringing surges of new knowledge into organizations. By contrast, this effect is probably dampened by the reluctance of the majority of Hong Kong quantity surveying firms to introduce experienced recruits. This anomaly is further aggravated in the light of a general lack of specifically assigned staff for knowledge acquisition from external sources. The lack of popularity of these alternative modes of knowledge acquisition reflects a relatively low reliance on external knowledge by these firms. Other means of knowledge acquisition, such as job rotation or records of knowledge by experienced or departing staff, are similarly underused by these firms. Despite this, quantity surveyors generally agree that they gain knowledge from reviews at the conclusion of projects.

Hong Kong quantity surveying firms are fostering a culture that facilitates the creation of new personal and organizational knowledge. For instance, quantity surveyors are constantly encouraged to put forward more efficient alternative solutions and proposals for existing assignments and other work-related issues. In this way, existing knowledge is further developed or even sublimated in the knowledge creation process. Firms also encourage staff to identify their individual working practice and procedures as recommended practice for future use. Apart from these, analysis of precedents of successes and mistakes is revealed as a means of enriching organizational knowledge.

Knowledge in Hong Kong quantity surveying firms is arranged in quite a systematic form, so that data and information are selected and organized before being stored. Knowledge is mainly stored either on paper or by electronic means. Some data are transformed into organizations' routines/procedures and into memories in the human brain. Furthermore, knowledge which is reduced into paper documentation is generally made available to all staff instead of being kept as personal documentaries. It is hence suggested that knowledge in quantity surveying firms is being codified into explicit knowledge. Ultimately, this development in terms of on-knowledge storage is not free of flaws and inevitably requires

some protection. Explicit knowledge, which codifies the organizational wisdom, is famous for its susceptibility to malicious damage and pirating by rivals. Therefore, quantity surveying firms often impose restricted access to confidential/sensitive information. However, security protection, such as in the form of records of access, rarely works its way into these firms' protection strategy. Pleasingly, knowledge in Hong Kong quantity surveying firms is easily located by the intended knowledge users.

Mobilization of knowledge is also observed in quantity surveying firms. Mentoring ranks highest among the various methods of knowledge transfer. Other alternatives, such as the appointment of specific expertise to specific projects, daily interaction, electronic means and paper documentation, are slightly less popular. These findings in effect acknowledge the presence of tacit knowledge transfer. However, tacit knowledge can seldom be treated as the only object of knowledge transfer in these firms, since only a few can survive by sole reliance on face-to-face knowledge transmission. Regarding knowledge sharing, financial incentives may arouse the interest of the staff in sharing. Nevertheless, the findings suggest that neither monetary rewards to staff nor the incorporation of knowledge sharing into staff appraisals is put into play in Hong Kong quantity surveying firms. Besides this omission, the physical environment, such as the office layout, is not specifically designed by quantity surveying firms to enhance knowledge sharing. In addition, the provision of remote access to organizational databases is still rare in quantity surveying firms. Although knowledge in quantity surveying firms is generally accessible, there is ample room for improvement.

With regard to knowledge use, knowledge in quantity surveying firms is mostly used for problem solving. The purpose of product/service development is less frequently cited. Quite often, knowledge gained in previous projects is sought in order to be applied to current ones.

In light of the problem of obsolete knowledge, about half of the quantity surveyors described regular updates and maintenance of the validity of knowledge in their workplace. However paramount the need, a clear policy/strategy governing the ways in which knowledge should be handled is far from prevalent in Hong Kong firms. The appointment of managers for knowledge aspects is only carried out by one third of the responding quantity surveyors. Despite the absence of such an appointment and policy, nearly half of the responding quantity surveyors can access the necessary knowledge when they need it.

Though this study applies uniquely to quantity surveying professional services firms and may not be comparable with previous studies, it is hoped that the same survey instrument can be applied to other types of project-based professional services organizations in order to find out whether there are differences among different professions in terms of how they manage their organizational knowledge. In addition, these future studies can offer a benchmarking effect to firms providing customized professional services to clients. Further, the same survey instrument can be applied to other countries where the quantity surveying profession exists, so that comparisons can be made across borders for developmental purposes.

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An insight into knowledge management practices at Bangkok University

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Abstract

Purpose – *This paper aims to present how Bangkok University (BU) embarked on its knowledge management journey by examining how knowledge management processes could contribute to improve the educational environment by providing new styles of teaching and by increasing the relationships between faculty, students and staff.*

Design/methodology/approach – *The paper presents the reasons why Bangkok University started its KM initiative. It presents the adopted KM approach, the tools developed as well at the KM action plan.*

Findings – *The initial overall benefits emerging from the early stage of KM at Bangkok University are encouraging. The educational community has improved not only through the communication and cooperation between students and staff, but also through creating an environment that supports efficiently the cross-organizational learning and knowledge-sharing processes.*

Practical implications – *The KM experience of Bangkok University could be used by other universities or educational institutions as one approach/strategy/guidelines to launch a KM initiative.*

Originality/value – *Few cases of KM implementations in the university environment have so far been published.*

Keywords *Knowledge management, Education, Thailand, Communication technologies, Learning, E-learning*

Paper type *Case study*

Introduction

Over the last decade, the educational landscape has evolved from a traditional teaching environment to a highly open and dynamic knowledge-based environment. This is mainly due to the large adoption of computers, internet, intranet and instructional software applications on campus.

Therefore, the traditional teaching styles and methods might need to evolve too. Lately, this issue has raised debates on how higher education could cope with the new changes and thus introduce a certain level of innovative approach in the way teaching and learning processes are performed. Numerous requirements and challenges need to be overcome such as providing lecture anytime, anywhere or to increase and to improve the communication between the faculty, staff and students. The use of information and communication technologies (ICT) provides a mean to fulfill these issues.

Obviously the use of ICT is contributing to shape the way of how and where teaching and learning is taking place (Breiter, 2004). Following the trend, most universities and colleges have initiated development and adaptation of information system applications for educational purposes. Faculty have been encouraged to digitize their instructional materials and to use the provided information systems for interacting either with the administration or with the students (Seufert, 2002).

Additionally, the explosion of digital content and of online resources has contributed to the rise of new challenges that higher educational institutions need to face (Abdullah *et al.*,

2005). Many Academic institutions have been involved in the development and in the use of computer-supported cooperative work systems or e-learning systems (Ainslie, 2005; Thorn, 2001).

However, the sudden increase of available online teaching and learning material on campus has raised other types of challenges and requirements (van Merriënboer and Brand-Gruwel, 2005). These issues are related to the identification of methods or technologies supporting the processes of acquiring, storing, organizing, disseminating, searching, indexing and retrieving efficiently and successfully the available knowledge.

Furthermore, studies suggest that there is no obvious evidence that faculty and staff will use in an effective way the information communication technologies to perform their daily tasks. In fact, it is recognized that there is rather a latent or open hostility from some teachers or administrative staffs to exploit fully the functionality of information systems (McDermott and O'Dell, 2001).

Therefore, there is a need for more research in analyzing how information communication technologies (ICT) are used by higher education and how they can support the ambition of universities to move toward an e-campus (Thorn, 2001). However, the first analysis of current situations shows that even though ICT offers large possibilities, it also has some limitations in making academic institutions more competitive organizations. Therefore, it is important to consider that managing knowledge for academic organizations might be the right strategy to move toward a knowledge-based economy.

Until recently, surprisingly, ''knowledge management'' (KM) has not been a high priority for higher education. However, today there is a growing recognition that knowledge management can enable higher education to evolve more smoothly to a highly interactive and dynamic educational environment (Robson *et al.*, 2003).

Lately, following the new wave of using knowledge management concepts in the academic institution, the top management of Bangkok University (BU) has encouraged new research initiatives based on analyzing and encouraging KM practices within the whole organization. One goal of our research study aims to delineate a generic knowledge management framework that could be used by other higher education institutions in Thailand.

The following part introduces Bangkok University's context and environment as well as the necessary requirements to move toward an e-learning organization. The second part of this paper outlines the required relative background with a subjective interpretation of the phenomenon of knowledge management outputs for the academic world. The potential outcomes of knowledge management in academic context are as well discussed. The last part presents some of the knowledge and learning systems, developed internally at BU, and which are dedicated to the faculty, staff and students.

1. Knowledge management in an academic context

1.1 Knowledge and knowledge management (KM)

Until the end of the 1980s, academic institutions did not consider changing their traditional teaching and learning environments. The internet era and the rapid technological changes have opened up new horizons and new challenges in the educational world. Additionally to the technical context, fierce competitions amongst universities have led to redefine knowledge as their strategic asset and source of growth for both private and public institutions (Petrides and Guiney, 2002). Accordingly, more and more colleges and universities are turning into what is so-called a knowledge-based economy defined by Tso and Wu (1999) such as an economy moving toward greater dependence on knowledge, information, and high skill levels. The importance of knowledge-based organization is well recognized as a key element towards a competitive edge in the leading organizations (Alvesson, 2002; Edvinsson and Sullivan, 1996).

Literature in the field of knowledge management has proliferated in recent years as organizations attempt to address the shift from a production based economy to ''the practice of harnessing and exploiting intellectual capital to gain a competitive advantage''(Allix, 2003; Argote *et al.*, 2003; Barth, 2000).

> **"Several years ago, Bangkok University engaged in the in-house development of various information, knowledge sharing and e-learning systems."**

There is a consensus on agreeing that there is so far no one single definition of knowledge (Boisot, 1998; Dixon, 2002a). One popular definition of Davenport and Prusak (2000) defines knowledge as ''a fluid mix of framed experience, values, contextual information and expert insight that provides a framework for evaluating and incorporating new experiences and information''. Hunter (1999) focuses more on actionable knowledge and suggests rather ''Knowledge is information in the mind, in a context which allows it to be transformed into actions''.

According to Brooking (1999) knowledge is defined ''as information in context with understanding to applying that knowledge''. The wide-based knowledge definitions highlight that there are several forms of knowledge; tacit, explicit, implicit and systemic knowledge at the individual, group and organizational levels (Dixon, 2002b; Inkpen, 1996; Nonaka and Takeuchi, 1995; Polanyi, 1958).

Bassi (1998) defines knowledge management (KM) as the process of creating, capturing and using knowledge to enhance organizational performance, while Parlby (1997) delineates it as the discipline of capturing knowledge based competencies, storing and disseminating them for the benefit of the organization as a whole. In the context of this paper, we will adopt the definition ''knowledge management is an organized and systematic approach encompassing knowledge processes such as creation, usage, storage, sharing, transferring and retrieving knowledge in order to improve business performances''.

Now, if we relate these concepts to the academic context, we realize that one of the most important KM process concerns knowledge sharing mechanisms. In fact, observations of the current situation in campuses have led to conclusions that knowledge sharing processes are not integrated in the daily routines and are far from being an organizational reality (Zhao, 2001). In fact, educational environments are often engaged in huge duplication efforts (Robson *et al.*, 2003). For example, faculty are often involved in constantly re-creating existing teaching materials, instead of spending more time with students or doing research work. Obviously, new ways to work and to interact with all the academic stakeholders need to be re-designed or to take different shapes. Therefore, the implementation of knowledge management concepts provides a holistic approach contributing to the definition of a socio-technical framework for fostering the E-knowledge campus.

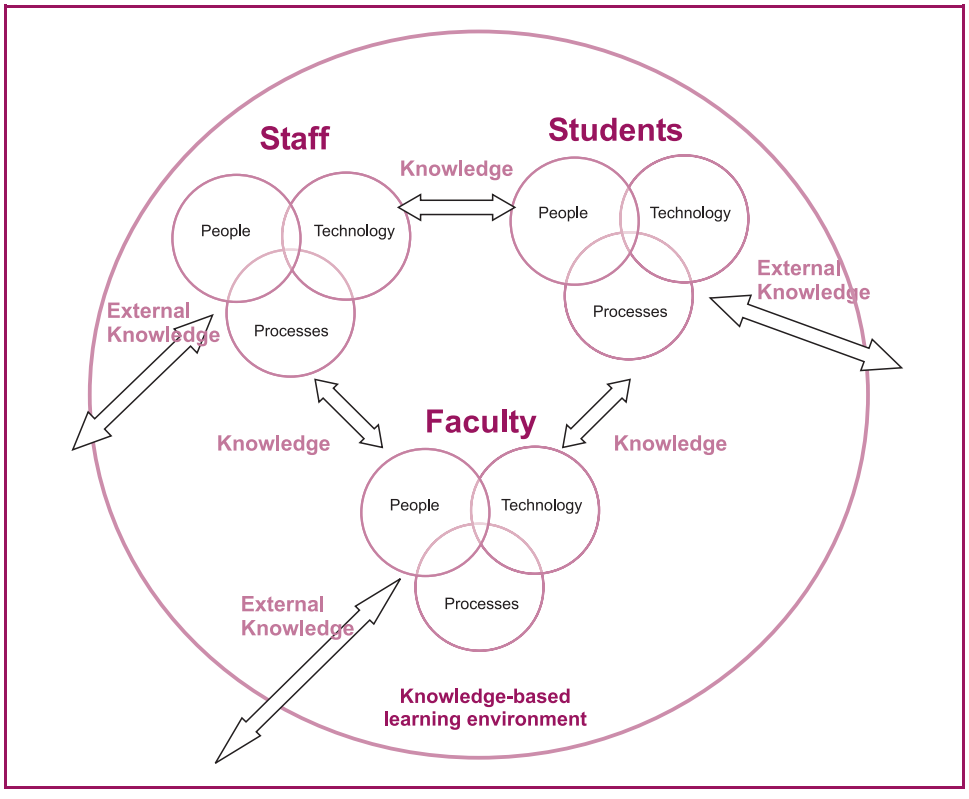
The following figure (Figure 1) highlights the inter-relationships between people, technology and the educational and administrative processes. The internal knowledge created within each node is flowing between each stakeholder such as students, staff and faculty members. Knowledge is also shared and acquired from the university's environment (partners, government, the internet, ...). All these interactions and knowledge flows constitute what we call a knowledge-based learning environment.

1.2 Research methodology

In order to understand the academic processes and the flows of knowledge within Bangkok University, we collected qualitative data via several interviews from different stakeholders. Additional data were collected by performing examination of organizational documents such as notes, reports, brochures, website contents. Participative observations were performed through seminars, informal meetings and discussions with faculty, staff and students.

Interviews were semi-structured and, according to the respondent profile, questions were opened or closed. Interviews and informal discussions involved different stakeholders such

Figure 1 Knowledge-based learning environment



as top management (vice-presidents), academic staff (deans, teachers, IT managers) and students.

The research question was to investigate the knowledge management practices at BU and based on their experience to delineate, a generic framework that could be applied to other educational institutions. We focused not only on the human strategy adopted by the university but also on how the use of ICT could support some of knowledge processes such as knowledge sharing and capitalization. The latter is very crucial in the academic world considering that knowledge is the most important asset for colleges and universities (Wong and Aspinwall, 2006).

Several years ago, Bangkok University had engaged in the in house development of various information, knowledge sharing, and e-learning systems. These independent and stand-alone systems were intended for various users groups (students, faculty, staff, online visitors). Several features of these systems play an important role in enabling knowledge processes by enhancing collaboration and cooperation between different stakeholders ranging from students to the top management.

The first phase of our project consisted in understanding how features of these systems could possibly support some knowledge processes such as knowledge sharing. Several interviews were conducted with the users. However, in order to provide a more comprehensive mapping of KM processes and ICT functionality, we are planning to collect more quantitative data by sending out extensive web surveys to users of the systems.

1.3 Bangkok University, context of study

Bangkok University is a well-established private university and it has been recognized as a leading education institution in Thailand for more than 40 years. Bangkok University encompasses 13 schools and offers courses both in English and Thai. Programs are offered for both Thai and international students and are leading to bachelor's and master's degrees in Business Administration, Accounting, Economics, Communication Arts, Sciences, Law.

> **"The fact that Bangkok University is a university hosting international programs and having international professors makes the sharing of knowledge more challenging."**

Lectures take place during day and evening times, seven days a week and are offered to part time and full time students.

Every year more than 6,000 students graduate. In order to cope with the increase of students, BU is expanding in terms of building new campus and in hiring new staffs.

More than 1,200 people are working full time or part time at the University. There are as well a consequent number of adjuncts faculty members and a certain number of international visiting professors.

The BU organizational structure is highly hierarchical and there are several levels in the administration with different positions at each school such as Chairpersons, Deans, Vice Presidents, Assistants to Vice-Presidents, etc.

BU is the only university in Thailand being certified ISO 14001. This certification as well as a strong emphasis on quality assurance reforms demonstrates its eagerness to continuously improve its performance as well as the quality of education at all levels.

Obviously, BU is a complex organization facing several challenges such as competition from other institutions in Thailand, an exponential increase of students, strong needs to adapt its curriculum every other year. In addition, it is crucial for BU to provide new lectures, to offer international programs and to strengthen cooperation/collaboration by establishing joint degrees or inviting international guest professors.

Furthermore, BU is becoming a distributed organization where studies and lectures are taking place in several different locations not only in Bangkok (two campus locations) but also in different neighboring countries.

Interviewing several leaders revealed that although having new adjunct faculty member is considered as a positive thing since they bring new impulses and a different vision and perspective, it can also be seen as a consumption of resources. This is mainly due to the fact that quite often lectures have to be recreated. Therefore, the consistency of lectures over years is harder to control.

The fact that BU is a university hosting international programs and having international professors makes the sharing of knowledge more challenging. The knowledge needs to be made available in two languages Thai and English. Roughly 10 percent of the staff/faculty/students do not speak Thai (only English).

Five years ago, the board of higher education of Thailand decided to make quality assurance a priority for all universities in Thailand. It defined many key performance indicators (KPI) to measure the quality of Thai universities. Three years ago it defined a new main KPI associated with the implementation of knowledge management. Most of the Thai Universities were strongly invited to implement a knowledge management plan, even though no clear indication or direction on how to proceed was given.

In order to cope with the stringent dynamics that dominate the BU life, and in order to meet the new governmental requirements, the university decided to initiate some knowledge management initiatives. The main remaining problem was how to get started? The Gantt chart below (Figure 2) summarizes the different phases associated with the implementation of KM at BU.

During the first phase various brainstorming sessions took place to better clarify and understand how KM could benefit the organization and improve the learning/teaching

Figure 2 Main phases of the BU KM action plan

Projects	Quarters				
	June-Aug 2006	Sep-Nov 2006	Dec-Feb 2006-2007	Mar-May 2007	June-Present 2007-2008
1. Brainstorming and creation of BU KM Plan Formal announcement	←	—	—	→	
2. Setting up KM Team & KM Center			↔		
3. Raise Awareness about KM at BU (Seminars)			←	→	
4. Fieldtrips for KM team to learn about KM success stories from other companies and universities in Thailand			←	→	
5. After May 2007- each department creates its own plans and implements it in its unit					↔

environment. A KM strategic plan was defined including a mission, keys to success, obligations, objectives, policies, tactics (see list below) as well as other planning guidelines.

Mission

- To become an internationally recognized learning organization with high standards of education.

Keys to success

- All the managers (Executives, Heads of Department, Faculty members and staff) and officers should be aware and understand the principles of KM and of Leaning Organization (LO).
- Head of Department and staff need to know how to apply KM in their departments.
- Efficiently use ICT to support KM and LO.
- Executives should develop policies and budgets to support KM.
- A culture and an environment must be present to facilitate knowledge sharing and use of it.
- Positive attitude to share their working experience and knowledge with each other.
- To have an efficient continuing evaluation system.
- To motivate and encourage everybody to learn more about KM.
- To develop a system and managerial mechanism to pursue the LO.

Obligations

- Encourage and develop everyone to learn and understand KM and LO.
- Support and build the culture of a LO leading to KM and innovation.
- To update the ICT to make it suitable for sharing knowledge inside and outside the organization.
- To build an efficient and high quality learning system and processes that will allow everyone to learn.
- To be the leader in contributing to the knowledge society and to develop various networks to share information nationally or internationally.

Objectives

- For the BU community (executives, professors, officers, students, and alumni) to become an effective learning organization.
- For the university to possess updated knowledge in different areas in order to become the learning source reference nationally and internationally.
- For the university to have information systems facilitating the spread of knowledge outside the organization.
- To become the leader in learning community building and for developing internal and external networks.
- To have an efficient KMS that will enable the integration of knowledge in order to learn and to innovate.
- To become a model of the learning organization.

Later on a KM team was created as well as a KM center. This center is under the direction of the Academic Affairs Office. Each department having different duties and responsibilities, they were asked to develop their own KM action plan following the KM master plan. The mission of the KM center is to support all departments in the endeavor to implement KM in their own environment. KM Seminars are offered, presenting new approaches, tools, techniques, technologies, ... These KM activities are offered both at the department level and also at the organizational level in order to keep an homogenous approach to KM. This is what we could call a ''glocalizational'' approach to KM where a global/general KM strategy is defined and each department can localize/customize their own approach.

One of the first urgent needs was to have the right technology to enable knowledge sharing and capture. In order to fulfill this need a KM ICT architecture and infrastructure were created. Using technology will allow to keep track of the educational resources development and consumptions, to foster information and knowledge flow within the organization, to provide a collaborative environment, to enhance cooperation and communication between faculty, students and administration and finally to facilitate the knowledge use and reuse.

Therefore, undertaken initiatives encompass the building of knowledge repositories, such as online courses, setting up collaborative tools such emails-forum-chat-video, knowledge mapping, coaching/mentoring and best practices.

However, even if an organization decides to launch some KM projects, the underlying question remains ''what can be expected from implementing any knowledge management initiatives at the institutional level?''

Obviously according to the business or academic context and the focus of the organization, we can already outline that there is no generic knowledge management output. The myriad of expected KM results described by either practitioners or researchers illustrates this fact (Anantatmula, 2005; Firestone, 2001).

Our research investigation at BU suggests some important outcomes of KM listed in Table I. The table presents as well a list of corresponding initiatives.

It is worth to mention that actually the knowledge management initiatives are undertaken at both formal and informal levels. The focus is not only at the technological level but also at the organizational one, like through competence building, culture change, setting up appropriate rewards and incentives structure.

"Among the several KM initiatives, the most important is to facilitate knowledge sharing between faculty members."

Table I KM outcomes for higher education

KM outcomes	*Meaning*	*Suggested Initiatives*	*Initiatives undertaken by BU*
Knowledge capitalization	Store, diffuse and reuse knowledge acquired during research or lectures creation	Build knowledge repositories Easy access to knowledge repositories Searching facilities Categorization	LMS and e-learning Databases Web servers Document management systems
Use or reuse knowledge	Make knowledge actionable Integrate knowledge into daily tasks and processes	Manage cultural change System of incitation and rewards Involve mentoring-apprenticeship Use existing lectures or research result	Communication Mentoring Offer training for using the knowledge repositories by the staff Rise awareness
Create knowledge	Generate new knowledge from previous ones (additive knowledge)	Understand the various knowledge conversion mechanisms Training – seminars-network-SECI model	Seminars Hire new staff Visiting professors Guest lecturers
Actualization of knowledge	Update knowledge according to external or internal environment	Benchmarking – internal and competitors Absorption of external knowledge: Seminars – publications – meetings – Training Systematic diffusion of new information	News diffusion via web site or MyBU Update contents Every other year, curriculum is revised Meeting-brochures distribution
Productivity	Increase employee productivity by saving time to solve problems, answer questions . . .	Use of appropriated ICT (web-repositories, communication tools, . . .) Provide socio-environmental framework for employees (satisfaction, motivation, office . . .)	Encourage staff to use the information systems Provide good working environment and facilities
Share knowledge and lessons learned	Diffuse knowledge among all employees to increase its value	Informal and formal networks Culture change management-Trust-motivation-Communications-Rewards system Use of ICT	BU online Knowledge Center, MyBU, URSA and e-learning modules
Identify and localize knowledge	Specify what BU knows and know where to find people and expertise	Relationship and communication map Competences yellow pages/knowledge map Employee expertise database	Competence description employee online but not for all Function and role description of staff on the web server
Knowledge acquisition	Integration of external knowledge	Training – seminars – hire of external visiting professors Communities of practice	Seminars – Training – Education Sending staff abroad for international education Guest lectures Consultants
Use the right infrastructure	Implement the appropriated ICT according knowledge, competencies and needs of employees	User requirements specification Align KM with business goals Set up the KM technological framework (e-mail – intranet – lotus notes, repositories . . .)	MyBU URSA Knowledge Center New systems on development
People's satisfaction and motivation	Obtain employees' memberships to collective objectives	Competences management Create a good working environment and climate Reward- incentives-motivation	Good working environment

Amongst the several initiatives, the most important is to facilitate knowledge sharing between faculty members. One usual strategy is to organize, on a regular basis, meetings and seminars. Another initiative, considered as very important by management and teachers, is network building. Networking is recognized as a very efficient means to share knowledge at intra/extra University levels. This is fostered for example by setting up ''student/teachers exchange agreement'' or ''joint degree'' with others national or international universities.

However, it is very central to consider the social and psychological aspects in the knowledge sharing mechanisms. For example, people should feel encouraged or rewarded to share knowledge and to work in teams.

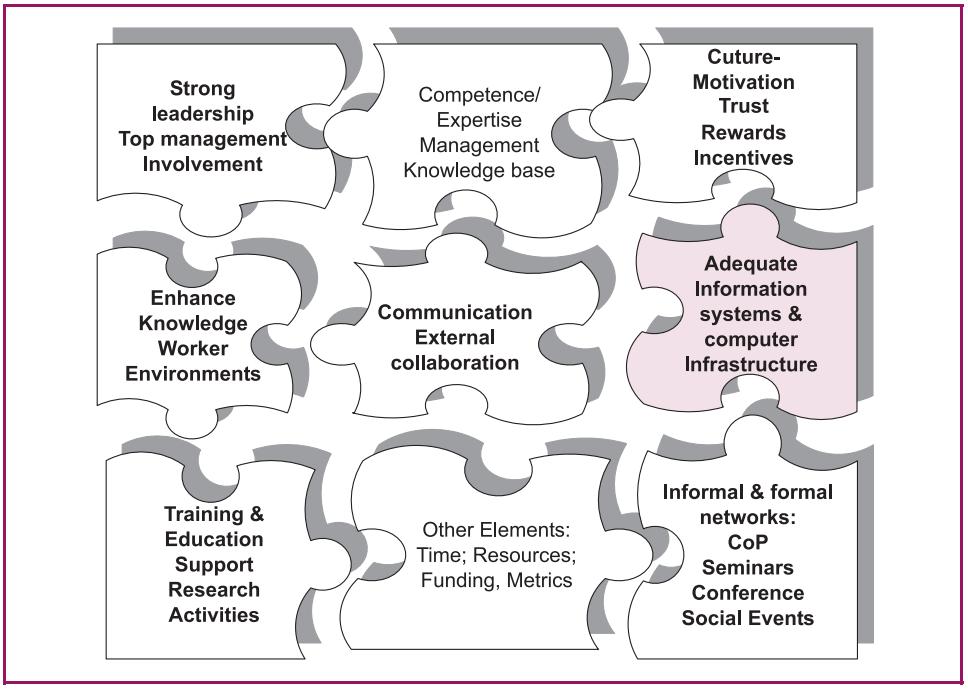
Another activity contributing to facilitate knowledge sharing consists in building knowledge repositories. However, this task means for faculty, potential additional workload by creating lectures or exercises that need to be digitized. Observations show that not everyone is engaged in this process. This is due of several factors such as lack of time, lack of incentives, fear of sharing, complex ICT tools, lack of motivations, etc.

Analysis of the data collected through several interviews has contributed to the delineation of a generic knowledge management Framework that can be applied for other colleges and universities. Figure 3 summarizes our findings.

In the next section of the paper, we focus on describing in details one key component that is ''adequate information system and computer infrastructure''

Over the last few years, Bangkok University has put a strong emphasis on building appropriate infrastructure as a mean to foster knowledge flow amongst faculty members, students and staff. A KM system should offer functionalities and capabilities to support a collaborative and a cooperative environment. Additionally, connectivity and communication anywhere and anytime are crucial in an e-learning environment. For instance, at BU communication between administration and students is improved by the use of mobile services. If in a last minute, a teacher cannot give a lecture, all registered students will get immediately a message on their cell phones. Student grades can as well be accessed just by sending text messages.

Figure 3 Generic KM framework



The next section discusses the socio-technical requirements for building such systems. The various knowledge management and e-learning systems are presented.

2. Concepts and requirements for knowledge systems

In order to understand how information communication technologies can play an important role in education, it is important to investigate how both human and technological requirements interact and contribute to the development of educational information systems. Indeed, consecutively to develop effective instructional processes, one should consider not only the goals, the needs and characteristics of teacher/students, but also content requirements and technical constraints. These different perspectives are captured into an e-learning process reference model represented in Figure 4 (Bechina, 2001).

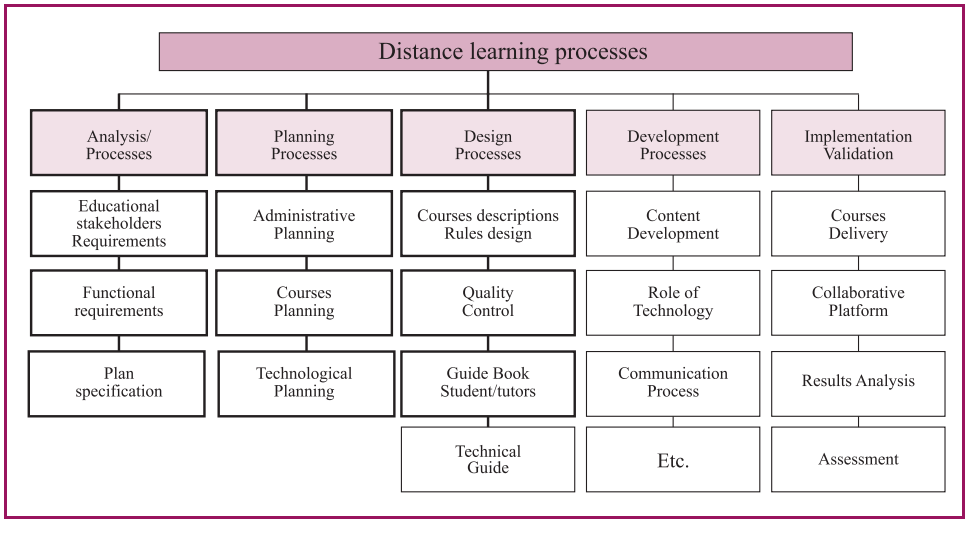
This generic model can serve as a basis for the development of educational information systems.

However, in this paper, we focus mainly on describing generic requirements that are summarized below.

Technical requirements

- Multi-media platform providing a large range of functionality for pedagogical resources such as storage, search, index, retrieve, organization and dissemination of documents and knowledge.
- Tools for buildings content constituted by pedagogical modules that can be gathered to form a course. Examples of modules: lecture-pictures-text-glossary-exercises-simulations tools-video, etc . . .
- Tool-suite for allowing integration of video, sounds, shared application, distributed white board, recording.
- Enable the synchronization of streaming audio, video, graphics, text, presentations, slides and dynamic links.
- Communication and collaboration tools such as chat, forum, email, video conference, shared calendars.
- Connectivity – high speed networks.
- Mobile feature integrated.
- Simple and easy user- interface.
- Authoring tools.

Figure 4 E-learning platform processes



- Security.
- Personalization feature.
- Etc.

Obviously, it is imperative to understand that the technical requirements fulfillment is not the only success factor in using ICT in the academic world. Indeed, it is crucial for the development of such educational systems to take into account other socio-organizational and pedagogical requirements.

One important need is to improve communication between the teacher and the students. Using ICT has proven to be very efficient; for example thanks to discussion forum or videoconference facilities, it is easier to stimulate better real time interaction. However, it is pertinent to question the effectiveness of the learning process (Richards, 2005). Will students learn better by using ICT? Do teachers need to rethink completely the design of their courses? What are the pedagogical impacts?

Furthermore, although almost all teachers are aware that the world wide web (WWW) offers a rich source of potential learning resources, there is still a latent hostility to use ICT (Müller *et al.*, 2007). This is due to several reasons ranging from technology skepticism to simple lack of motivations or time.

Socio-organizational requirements

- Involvement from faculty and staff during the system design phase.
- Communication about the use and the benefit of tools should be promoted.
- Training and seminars.
- Pedagogical impacts should be as well clearly assessed.
- Role of the teacher requires to be redefined as rather instructional designer (Christie *et al.*, 2002). This is due to the fact that a course cannot be delivered following the traditional outline. Thus there is a need to reconsider the learning design. Teachers are as well facing the challenges of keeping up with technical development and to prepare students for significant change in the learning process.
- Cost of both hardware and software need to be evaluated since it will influence the choice for either proprietary or free software. Which in turn means that in case of a choice of open source software, the IT skill of the personnel might need to be further developed.
- Sustainability is as a key factor since it is crucial to make sure that the initial costs last beyond the first investment. Sustainability is achieved for example by institutionalizing the changes or making sure that the investment is connected to a maximum return for the educational environment.
- Regulations, policy and standards have to be included in the strategic implementation plan.
- Organizational culture should not be neglected in the process.
- Motivation and trust should be enhanced by setting appropriate communication between all educational stakeholders such as teachers, students and academic staff.
- Etc.

Based on some of the requirements outlined above, Bangkok University has engaged in an effort to build appropriated educational systems. The next section describes some of their functionality.

2.1 Knowledge sharing and e-learning systems

The university has a large computer center (IT department) composed of more than 50 people. Amongst them, 30 people are software developers working essentially on maintaining and developing new functionality in the different educational systems. The rest

of the staff is assigned to various other tasks such as providing technical support and maintaining systems.

The size and the skill of the IT team have played a major role in the decision to develop all the educational systems in house relying mainly on open source software. The strategic decisions have been motivated in one hand by cutting down on license fees and in the other hand by reducing dependency from commercial vendors. Furthermore, opting for open source software and in house development allow a better control in the maintenance of the systems. Furthermore, it makes it easier to implement any additional requirements. Also, one obvious advantage of this strategic choice, resides in the fact that the IT competences and skills capacity remain at the university. It constitutes long-term investments that definitively influence the sustainability of the ICT use as a means to provide an open and dynamic e-learning and knowledge sharing environments.

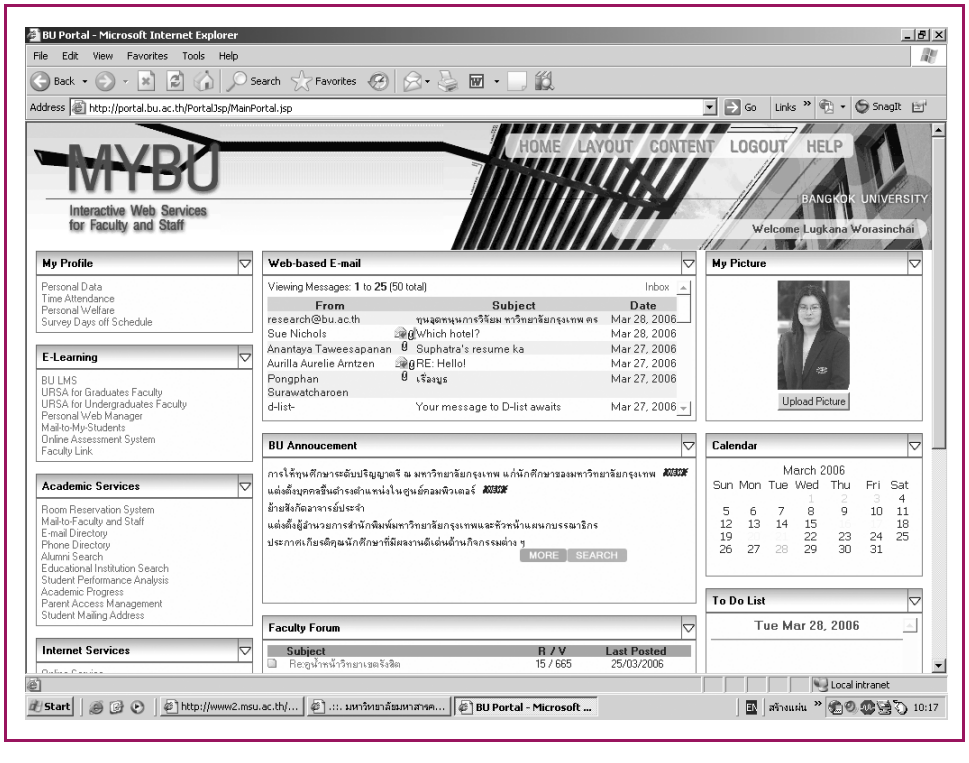
2.2 MyBU system a collaborative platform for academic and teaching staff

MyBU is a knowledge collaborative platform aiming to facilitate communication among teachers and academic staff, allowing them to work together more efficiently. By accessing the same collaborative portal interface, the learning community can access shared applications such as shared calendars. Flexibility and mobility of the users are insured since it is possible to access to the platform from any computer with a Web browser and Internet access.

Figure 5 represents the user interface of the platform and it is easy to see the nature of the services offered by MyBU that we list as follows:

- Web-mail service.
- Personnel information including pictures.
- Shared calendar.
- Discussion forum.
- Tasks to do for personnel use.

Figure 5 MyBU collaborative platform



- Online schedule.
- Direct access to other educational systems.
- Automatic email to students registered to the course if any.
- Access to the online assessment systems.
- Rooms reservation.
- Students performance analysis.
- Parent access management is a special service allowing the parents to follow the learning progress or the attendances of their children.
- Etc.

The collaborative platform MyBu represents an innovative learning environment where all the described services are integrated into a platform with just a single sign-on.

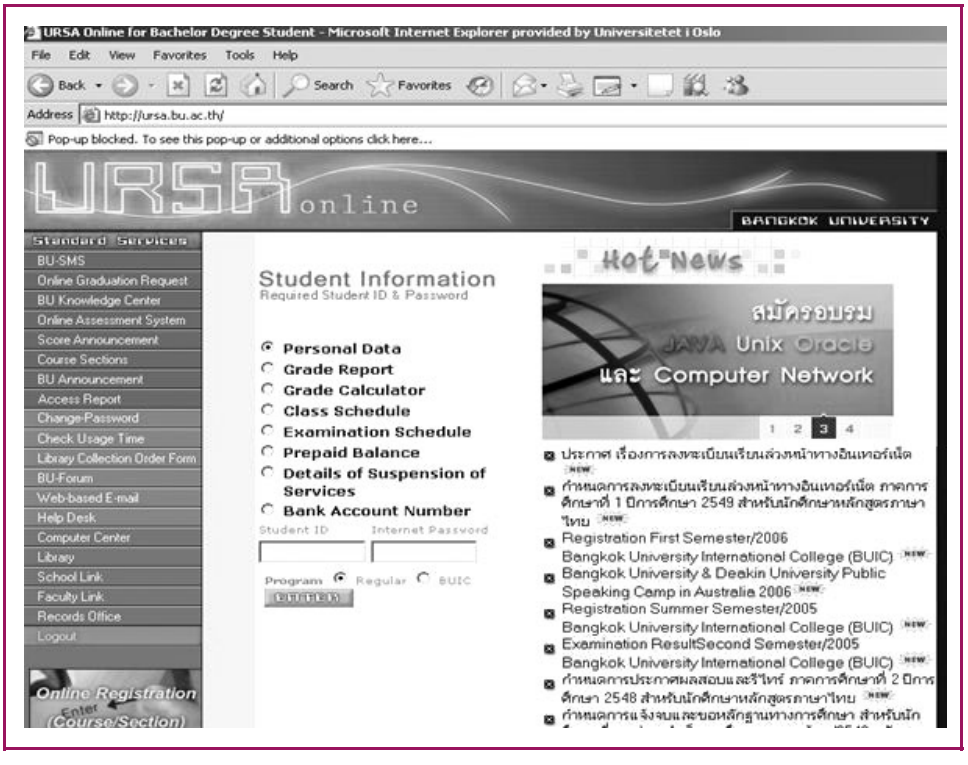
2.3 The URSA system

The computer center of BU has developed two URSA systems for both undergraduate and graduate students. The initial aim was to offer different services according to the specific requirements of both programs. The starting page displays news and information only related to each program. However in order to facilitate the maintenance and to decrease the cost, it is intended on medium-term to integrate the various systems into a single platform. An updated version is currently under development.

Figure 6 depicts the user interface of URSA for undergraduate students. The available services include:

- Online registration of the lectures – class and exam schedule.
- E-mail services.
- Grade report and calculator.

Figure 6 URSA for undergraduate students



- Online payment.
- Online request to be enrolled in graduate program.
- Online Library access.

One major feature that has been implemented lately in URSA for graduate students, concerns the mobile services. Students can get access to the different services via mobile phone, for example information about their grade or about sudden change in the class schedule. Soon students will be able to pay the registration courses fees via mobile phone.

The system offers additional services such as possibility to control the checklist for the degree plan or BU forum access, etc.

2.4 LMS (learning management system)

Bangkok University is using a learning management system (Figure 7) that was customized to its needs. Such system allows faculty and students to communicate, interact and exchange documents related to a particular class. Among the main features provided; Course information, Student list, Announcements, Forums, Documents, Exercises, Links . . . . We can notice that both the Thai and English languages are used on the interface of such system. Such system can be used as a knowledge repository where knowledge artifacts related to a course are stored and can be easily searched.

2.5 BUKC (Bangkok University Knowledge Center)

Recently most of the various ICT systems that BU developed were integrated in a single system called BUKC (Bangkok University Knowledge Center). Such system is available from the BU web site (www.bu.ac.th). Since one of BU missions of the BU KM strategy is to become a reference in term of a learning organization and for openly sharing its knowledge

Figure 7 Learning management system (LMS)

with the world community such system is not protected by password, anyone can have access to it. The knowledge system has different modules (Figure 8); an e-learning module, a link to the LMS system (previously described), an online assessment module, a video online module a links module and faculty links module and finally an e-paper module.

The e-learning module provides access to online courses and to some interesting topics to allow students and everyone to learn on their own at their own pace and during their favorite time. The online assessment module is used for course evaluation online. The video online module allows to view online some selected movies and documentaries. The link modules are links to faculty and school resources and finally the e-paper module provides access to the collection of academic papers published in BU Academic Journals. Each module contains sub menus that we will not be described in details in this paper but we encourage each reader to visit the site.

The integration of these various learning tools and systems provide an environment where learning and knowledge sharing can happen. BU is still at an early stage in the development of such systems and the next version of the Bangkok University Knowledge Center will integrate some social-networking tools that will bring knowledge sharing and collaboration to the next level. Since we recently entered the Web 2.0 era as well the KM 2.0 era we expect BU to provide in the coming years the Learning 2.0 platform that will allow our students, faculty, staff and communities to easily, freely, openly and efficiently learn from each other.

3. Temporary results, benefits and problems

Bangkok University is still at an early stage of its KM implementation. During the first phase, a strong emphasis was placed on developing and making available the right technologies that

Figure 8 The Bangkok University Knowledge Center

will enable knowledge sharing among the various stakeholders and among the various campus locations. This phase was critical in order to be able to start the second phase. During the second phase, just starting, each department is responsible to establish and to implement KM in their unit. Each department based on their need, culture and processes might take a different approach. The goal being to codify as much knowledge as possible and to facilitate and to motivate people to share their knowledge internally and externally. This is not an easy task. The main barriers at this stage are:

1. Work overload preventing people from contributing effectively in the creation of digital content, and from using effectively the various systems (even though KM is considered as a priority).
2. Lack of a clear KM roadmap.
3. Make the acquired knowledge available in two languages (Thai and English).
4. Motivate (and maybe initially to reward) people to codify their knowledge and to use these new technological systems. If we take as example the barriers that could prevent faculty to codified their knowledge, we could say that:
    - Faculty do not like to put their material online because they might not be confident with its content (fear of criticism), they might be afraid that someone will copy/still their work and there are often a lack of clear directions towards copyright and intellectual issues.
    - Many faculty and especially old professors do not know how to properly use the various knowledge systems available or they find it too difficult (not user friendly enough) (even though some training programs are offered regularly),
    - Building a course that is intended to be online is not an easy task. It differs completely from the traditional teaching format.
    - The extra work done by using such systems might not be well recognized and neither valued.
    - Lack of awareness of system availability and capability.
    - Etc.

Even though BU is at an early stage of its KM implementation some benefits have already emerged. For example, a better communication and knowledge sharing is happening between the two main campuses. Some learning resources are starting to populate the KM center repository. A better understanding of each department activities, needs and sub-culture has emerged from the initial assessments performed to appraise the extent to which KM could benefit each department. BU is strongly committed to make its KM initiative succeed and to share its experience and lessons learned to the KM and Education community.

4. Conclusion

This paper presented the results of the KM practices investigation at Bangkok University. This empirical investigation aimed at understanding how Knowledge Management was perceived and encouraged by different academic stakeholders. A framework mapping existing initiatives or systems with knowledge management processes was delineated.

A generic framework was presented with specific indicators that Colleges and Universities could focus on if they want to take the path of setting an innovative and adaptive learning environment.

Different systems composing the KM BU ICT systems were presented. The initial overall benefits emerging from the early stage of KM at BU are encouraging. The educational community has improved not only by the communication and cooperation between students and staff, but also by creating an environment that supports efficiently the cross organizational learning and knowledge sharing processes.

The team of the computer center is continuously working on improving the initial features developed in the early version of the KM tools. The continuous qualitative and quantitative

assessments of the systems' usages are necessary to measure its pedagogical impact and users' satisfactions. Therefore, a survey and furthers interviews will soon be conducted. The findings will serve as a basis for improving the systems.

In conclusion, this study shows that the use of appropriate information communication technologies can help universities to move toward a knowledge-based learning organization. The socio-organizational factors remain critical while designing and developing such dynamic learning environment. The use of Web 2.0 technologies (social tools e.g. Blogs, Wikis, Social networks . . .) will certainly bring a second revolution in the way that KM tools will support the next generation of learning tools.

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