KNOWLEDGE RISK FACTOR ASSESSMENT: DESIGN AND EVALUATION

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Knowledge Risk Factor Assessment:

Design and Evaluation

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CERTIFICATE OF ORIGINALITY

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Abstract

Knowledge plays a more important value-creation role in the new economy and is the critical success factor of most enterprises today. Knowledge management (KM) is a discipline to study the acquisition, storage, organization, retention and sharing of knowledge in an enterprise or organization. When the organizational knowledge is mismanaged, it can cause problems or serious threats to the operation or even the sustainability of an enterprise. On the other hand, enterprise risk management (ERM) has long focused on physical or financial risk rather than intangible risk like loss of knowledge which is equally important for the survival of an organization. Therefore, this research was a natural outgrowth of the two disciplines of recent times in an attempt to address what is lacking in both when it comes to knowledge-related risk. It was an exploratory research and adopted an evidence-focused approach built on the principles derived from KM and ERM.

There were two main parts in this study. First, the status and awareness of how knowledge risk is handled in enterprises and what perceptions of knowledge risk staff in an organization held were explored. This was achieved by conducting semi-structured interviews with KM professionals. Secondly, the research moved on to develop a method called the KRFAM (Knowledge Risk Factor Assessment Model) to assess the risk factors of several common kinds of knowledge risk which were

identified in the forgoing interview. The evidence-focused model consisted of two levels of assessment of risk factors. The Level 1 assessment was carried out through a survey approach. In the Level 2 assessment, to arrive at data which were more evidence-based, the survey participants were asked to recall relevant facts, data and information before attending a face-to-face interview with the researcher who then guided and assisted participants to go through the evidence to give a belief degree. The collected assessment data from both levels were then processed by the Evidential Reasoning (ER) approach, to provide adjusted ratings, which therefore reflected more reliably the actual situation.

The model was pilot tested in three companies of different business natures related to toys and consumer products, construction, and energy industries. They came up with various ratings on their knowledge risk factors which were expected, and different degree of mismatch between their perceived ratings (from Level 1 assessment only) and adjusted ratings (which were the modelling results from both the Level 1 and Level 2 assessments under the ER approach). The discrepancies could be explained by a better understanding of the risk factors and the evidence from their company practice, of which they might not be have been aware before the Level 2 assessment. All of them found the assessment to be useful and it enabled them to have better insights into the knowledge risk factors involved. The evidence-focused approach adopted has made the knowledge risk factor assessment more reliable and could be a valuable tool for companies to identify and launch their KM initiatives.

Publications Arising from the Thesis

Journal Paper

Tsang, H. W. C., Lee, W. B., & Tsui, E. (2016). AHP-Driven Knowledge Leakage Risk Assessment Model: A Construct-Apply-Control Cycle Approach. *International Journal of Knowledge and Systems Science (IJKSS), 7*(3), 1-18.

Book Chapter

Tsang, H.W.C. & Lee, W.B. Mitigation of Knowledge Risks in Open Innovation. In S. Durst, S. Temel, H. A. Ferenhof *Open Innovation and Knowledge Management in Small and Medium Sized Enterprises*, World Scientific. (Accepted for Publication)

Conference Paper

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Award

Tsang, H.W.C. (2016) Best Paper and Presentation in the PhD and Masters Colloquium, The 8th European Conference on Intellectual Capital, Venice, Italy, May 12-13, 2016

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List of Abbreviations

AHP – Analytical Hierarchy Process

AAR – After Action Review

CAS – Casualty Actuarial Society

CKO – Chief Knowledge Officer

CoP – Community of Practice

COSO – Committee of Sponsoring Organizations of the Treadway Commission

C-Space – Culture Space

GICS – Global Industry Classification Standard

ER – Evidential Reasoning

ERM – Enterprise Risk Management

IC – Intellectual Capital

IDS – Intelligent Decision System

IT – Information Technology

IP – Intellectual Property

KMO – Kaiser-Meyer-Olkin

KM – Knowledge Management

KRFAM – Knowledge Risk Factor Assessment Model

MAKE – Most Admired Knowledge Enterprise

MSCI – Morgan Stanley Capital International

NDA – Non-disclosure Agreement

OECD – Organization for Economic Co-operation and Development

OPM – Office of Personal Management

PCA – Principle Component Analysis

R&D – Research & Development

RM – Risk Management

SMEs – Small and Medium Enterprises

The DIKW model – The Data, Information, Knowledge and Wisdom model

Chapter 1 Introduction

1.1 Research Background and Motivation

A large proportion of activities in business are enabled by the use of knowledge, skills and experience possessed by employees and stakeholders. Academics, professionals and business leaders in many fields have realised the importance of knowledge and its role in driving the competitive advantage of organizations (Bollinger & Smith, 2001; Johannessen & Olsen, 2003; I. Nonaka & Takeuchi, 1995; Quintas, Lefere, & Jones, 1997). This is especially true for companies which are knowledge-based such as information technology, financial services, health care and consulting firms. The values of these organizations do not depend very much on their physical assets but rather on the special knowledge they have acquired. There have been well-documented studies on the importance of knowledge to the well-being and healthy growth of a company, e.g. Grant (2002) and Wiig (1997).

To take advantage of the knowledge asset, it must be properly and effectively managed by organizations. However, most knowledge management (KM) processes at present focus on eliciting, capturing, recording, organizing, retaining and sharing knowledge. The benefits these activities bring to an organization often cannot be realised in the short term, and these benefits are difficult to be converted into financial values (Clark & Soliman, 1999; Davenport, De Long, & Beers, 1998;

Yew Wong, 2005), making KM of low priority for most organizations and its significance and value difficult to be understood by corporate top management. Thus, KM in organizations is not widespread and confined mainly to large corporations. KM as a whole still needs a lot of momentum to be put into the main-stream of business and professional practice, especially in the area of strategic and long-term planning.

At the same time, the global financial crisis in made top management realise that financial risk on a global scale can be fatal to the sustainability of organizations and must be kept under strict control 2008 (Aebi, Sabato & Schmid, 2012; Kirkpatrick, 2009). In addition, the occurrence of global hacker attack on or the rapid widespreading of computer virus infection in corporations, large or small, governments or even high technology organizations or large international data centers all have made them aware that ineffective cybersecurity can paralyse operations immediately without pre-warning signs (Kshetri, 2005; Tutton, 2010). These risks are changing the corporate risk landscape. However, few realise that data and information loss or leakage is only a part of the threat that can bring about disastrous outcomes. The risk associated with improper management of organizational knowledge, that is, knowledge risk, is of equal importance if not less. Top management nowadays is more willing to put more attention, interest and resources to enterprise risk management (ERM) (Arena, Arnaboldi & Azzone, 2010; Liebenberg & Hoyt, 2003). If corporations are more aware of knowledge risk, there would be potentially more incentives for top management to implement KM. This sets the motivation for the study on knowledge risk in this research.

In practice, there are times when knowledge is not used or managed efficiently or even improperly in an organization, creating issues, teething problems or sometimes threats which undermine the organization's immediate operations, short-term profits, medium-term growth or even long-term sustainability. These potential undesirable events or dangers caused by knowledge in such situations are called knowledge risk. Knowledge risks, can occur at any level of the organizational hierarchy or any location in an organization. Examples are many, such as leaking out confidential business knowledge to external parties or even competitors, and losing subject expertise in R&D. These may cause financial distress to organizations such as loss of customers, decreased profits or lowered operational efficiency. Knowledge risk may be further divided into several types or categories. In the literatures, the most commonly reported ones are leakage and loss of knowledge. Up till present, research work on the nature of these risks and their control measures are still far from sufficient (Ahmad, Bosua, & Scheepers, 2014; Daghfous, Belkhodja, & C. Angell, 2013; Durst, Bruns, & Henschel, 2016; Frishammar, Ericsson, & Patel, 2015; Lepak & Snell, 2002; Mohamed et al., 2007; Trkman & Desouza, 2012). Substantial, organized and balanced treatment of knowledge benefits and risks together in theory and practice should be advocated and pursued.

Similar to other business risks such as fire risk, building security risk, foreign exchange rate risk and investment risk, knowledge risk in an enterprise must be dealt with systematically and effectively. However, the most common ERM frameworks in the field, such as the two by the Committee of Sponsoring

Organizations of the Treadway Commission (COSO) (COSO, 2012) and the Casualty Actuarial Society (CAS) (CAS, 2003), do not cover or support knowledge risk specifically. Thus, practitioners do not have the proper guidelines and references to manage knowledge risk effectively. On the other hand, in typical risk management, four phases are involved, namely, "risk identification", "risk assessment", "risk response", and "risk monitoring and reporting" (Aloini, Dulmin, & Mininno, 2007; Hallikas, Karvonen, Pulkkinen, Virolainen, & Tuominen, 2004; Zhi, 1995). As research in knowledge risk is at the start-up stage, the identification and assessment phase are chosen to be the target of study in this exploratory research. Also, assessment will provide information about how risks are being handled or understood at present and give indications about what mitigations or preventive measures can preferably be taken in the future. The perception of knowledge risks and its risk factors, followed by assessment of knowledge risk factors were the focus of this exploratory research.

1.2 Research Objectives

The successful management, running and operation of companies are essential to the sustainability of a healthy economy in maintaining employment and prosperity. In doing so, a company faces different kinds of risks which could be events inside or outside the company causing damage, harm, loss or other undesirable impacts to the company. These risks must be properly realised and prevented in order to minimise or eliminate the potential impacts on the business operation or profits.

Therefore, risk management, which is about the effective ways to identify, mitigate, prevent, measure, report on and monitor the business risks in a firm, is essential in order to provide a safe, stable and sustainable environment to meet business objectives in the short as well as long term.

However, knowledge risk, referring to risks arising from erroneous KM such as know-how loss, being pervasive by their nature in different departments in an organization, has not received sufficient attention from managers and practitioners in management and organizations. At the same time, the area of knowledge risk and its management is still under-researched (Trkman & Desouza, 2012). Most research only deals with management of a single type of knowledge risk each time, for example, projects conducted by Durst and Wilhelm (2013), X. Jiang, Li, Gao, Bao, and Jiang (2013), Jennex (2014), and Tsang, Lee, and Tsui (2016). These knowledge risks need to be studied and managed, which in turn requires the support of conceptual theory and systematic practice in order to provide a solid, sound foundation for effective risk measures and assessment. To enable an effective and efficient allocation of resources, instead of tackling different kinds of knowledge risk in silos, an integrative approach to management of knowledge risk would be more appropriate and cost-effective.

One possible way is to assess the risk factors of knowledge risk where risk factors are situations which may increase the consequences or likelihood of the occurrence of a risk. The risk factor approach has been adopted by many scholars like Akindele

et al. (2004) who studies the risk factors of critical investment projects. It is considered that risk factors are appropriate for an exploratory research and are easy and natural to be understood by the intended respondents who are not knowledgeable in regard to risk. Therefore, a systematic and all-encompassing way to assess the main types of knowledge risk by assessing risk factors is targeted. Specifically, the risk factors of various types of knowledge risk were to be identified and assessed. However, when considering whether to adopt the survey approach in assessment, it is noted that its major weakness is unavoidable subjective responses (Slater, 1999), which are given based on the perceptions of participants. Also, the questionnaire can only produce standard answers and cannot collect related in-depth information (e.g. facts, figures or examples) from respondents. A method to overcome these two shortcomings is by means of an interview to elicit belief degrees (strengths of evidences) from the respondents for subsequent modelling under the evidential reasoning (ER) approach as well as to collect other relevant information. ER has frequently been employed in assessment or analysis in many areas by scholars such as J. Wang, Yang, and Sen (1995), J. B. Yang, Dale, and Siow (2001), Y. M. Wang, Yang, and Xu (2006) and Zhang, Deng, Wei, and Deng (2012). Those specifically in the risk area include risk analysis (Deng, Sadiq, Jiang, & Tesfamariam, 2011), internal control risk assessment (Mock, Sun, Srivastava, & Vasarhelyi, 2009), and e-commerce risk assessment (Khokhar, Bell, Guan, & Wu, 2006).

In view of the above, three objectives were identified for this study:

i. To find out how practitioners perceive knowledge risk, its risk factors and assessment, and to what extent they consider knowledge risk as important
ii. To design an assessment for the risk factors of major dimensions of knowledge risk using the survey method
iii. To enhance the survey method with the evidential reasoning (ER) approach

Case studies were conducted to trial implement the designed assessment to evaluate the knowledge risk factors in three reference sites. The achievement of these objectives was to serve as road signs in the starting portion of a long road to effective knowledge risk strategy, planning and management. Potentially, this study will bring new approaches to conventional KM and raise its awareness in the business sector.

1.3 Organization of the Thesis

The thesis is organized into seven chapters. Chapter 1 provides the introduction, motivation and objectives of the whole study. Chapter 2 then describes the theoretical backgrounds for a number of core concepts used in the study covering their definitions, classifications and past studies: knowledge, knowledge

management, risk management and knowledge risk. Next, in Chapter 3, the various research methods at different stages of the research are presented and these include research paradigms, overview of the research, qualitative and quantitative methods. In particular, the chapter describes the proposed Knowledge Risk Factor Assessment Model (KRFAM) and the Evidential Reasoning (ER) Approach. Chapter 4 goes on to the details of an interview study to find out the perception of knowledge risks and its risk factors in organizations. In Chapter 5, the design of survey questions for assessing knowledge risk factors is described in detail first, followed by statistical analysis of the first level of assessment data collected from the survey, and the construction of interview questions for the Level 2 evidence-based validation. In the following chapter, Chapter 6, the findings and discussion of three case studies using the proposed KRFAM are presented. Comparison between the three companies involved is also made. Finally, conclusions, significance, limitations and future work of the whole research are addressed in Chapter 7.

Chapter 2 Literature Review

2.1 What is Knowledge?

The word 'knowledge' is one of the most common words used in all disciplines. In order to understand what knowledge risk is, there is a need to review the meanings of knowledge, difference between data, information and knowledge, and the types of knowledge.

2.1.1 Meanings of Knowledge

The meaning of knowledge can be viewed from different perspectives as shown in Table 2.1. For the purpose of this thesis, knowledge is seen from the management perspective.

Table 2.1 Meanings of knowledge from different perspectives

Perspective	**Meanings**	**References**
Everyday English	"Understanding of or information about a subject that you get by experience or study, either known by one person or by people generally"	Cambridge Dictionary (2017)

	"Facts, information and skills acquired through experience or education; the theoretical or practical understanding of a subject"	Oxford Dictionary (2017)
Philosophy	Knowledge is justified true belief, and the justification is based on evidence or reasons.	Prosser (2007)
Management	*Resource-based view:* The firm's sustainability depends on its resources and knowledge is described as a strategic asset of a firm potentially being a part of what is responsible for its competitive advantage, long-term growth and sustainability.	Halawi et al. (2005), Meso and Smith (2000) and Wernerfelt (1984)
	Knowledge-based view (extension of the resource-based view): Knowledge creates value and sustainability is dependent on the capability to create knowledge-based assets which enable core competencies.	Grant (1996), Grant (2002), Halawi et al. (2005) and Pemberton and Stonehouse (2000)
Economics	Knowledge is seen as the fourth factor of production after land, labour and capital. In the information era, it becomes the	Grant (1996) and Khan (2014)

	most important factor accounting for the competitive advantage of a firm.	

2.1.2 The Data, Information, Knowledge and Wisdom (DIKW) model

A simple way to understand knowledge is to understand the four-layer model (DIKW model) which, starting from the base of the triangle, consists of data, information, knowledge and wisdom as shown in Figure 2.1. The origin of the model is not known, yet, it has been widely used and is well-understood (Wallace, 2007). The triangle later includes a layer added by Ackoff (1989) between the knowledge and wisdom layers – the understanding layer. In greater detail, data are symbols which represent the attributes of objects like table, apple and events. Information refers to data having been processed for a specific purpose to create outputs which are more useful than the data. It usually refers to answers to "*who", "what", "when", "where"* and *"how many"* questions. Knowledge is the application of information. For example, instructions and answers to "*how-to"* questions are knowledge. Understanding refers to explanations of matters, and wisdom refers to judgement.

Bellinger, Castro, and Mills (2004) explain wisdom further and contend that it combines all the other four layers and codes of behaviour like moral and ethical codes. It enhances understanding and goes beyond understanding. It seeks difficult answers but sometimes it cannot get any answers. It is judgement of right or wrong, and good or bad. They consider that the understanding layer is not required and in

fact, understanding plays the role for transitioning from one layer to another. In their view, data represents a statement of facts with no relation with anything. Information contains understanding of relationships between data such as cause and effect. Knowledge represents a pattern recognised and is concerned with predictability of matters that will happen. Wisdom contains understanding of principles being embedded inside knowledge and making up the essence of knowledge.

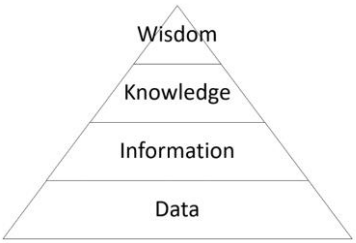

Figure 2.1 The data, information, knowledge and wisdom (DIKW) model

Some researchers hold the view that information is also part of the knowledge of an organization. But for the purpose of this thesis, 'information' and 'knowledge' are separate concepts so as not to confuse with the field of information management. Nevertheless, whenever knowledge is codified (into manuals, policy, guidelines, etc.), it would become information.

2.1.3 Types of Knowledge

There are many ways to classify knowledge. The commonly referred ones in literatures are highlighted below.

Tacit and explicit knowledge

One of the most well-known classification is the distinction between tacit and explicit knowledge. Tacit knowledge is based on personal experience and practice. It is not documented, usually kept private, and is action-oriented (E. A. Smith, 2001). It is transferred between two parties by their close contact and in non-standardised process (I. Nonaka & Takeuchi, 1995; Polanyi, 1966). On the other hand, explicit knowledge is codified and stored in print or electronic media. Its transfer from one party to another is in a known, predictable and systematic process (I. Nonaka & Takeuchi, 1995; Polanyi, 1966; E. A. Smith, 2001). Though tacit knowledge is not always very valuable, it usually requires intense socialisation to acquire it. Explicit knowledge is often very valuable but can still be easy to acquire (Polanyi, 1966) or transfer by documents like manuals and blueprints (Dhanaraj, Lyles, Steensma, & Tihanyi, 2004). It should be noted that once tacit knowledge is elicited and codified, it becomes explicit – visible, reusable and crystallised (I. Nonaka, Toyama, & Konno, 2000). If it is then operationalised, it becomes an important asset of an organization known as structural capital. One of the important function of knowledge management in organizations is to convert the tacit knowledge of its staff to explicit knowledge such that it could be re-organized, stored, retrieved and shared among its employees (see Section 2.2.1).

In the framework by Edvinsson and Sullivan (1996), they offer a similar view in which there are two types of knowledge classified – codified and tacit. The former consists of knowledge which are codified and represented by means of texts,

diagrams, images which are stored in hard copy or electronic media which take the form of articles, songs or music stored in audio format, or films in video format. Examples are computer programs, instructions manuals, blueprints, speeches and documentary films. (The codified knowledge is the explicit knowledge referred to by other scholars earlier.) On the other hand, the latter consists of skills and experiences which are difficult to express clearly and precisely in any medium of storage but are contained in tasks actually done by people for oneself or an organization. Examples are: drawing skill, decision making ability and selling experience.

SECI model

The conversion between tacit and explicit knowledge is illustrated in the SECI model (I. Nonaka et al., 2000). In this model, the four modes of knowledge creation through the interactions between tacit and explicit knowledge are explained. The interaction, known as knowledge conversion, expands and enhances both. In the first mode, known as socialisation, the conversion is from tacit knowledge to tacit knowledge. New tacit knowledge is created through sharing experience because tacit knowledge is not formalised and exists in a specific time and space context, making acquiring tacit knowledge be only possible by living or working together or in other environment where close social relationships exist, for example, traditional apprenticeship. In the second mode, externalisation, the conversion is from tacit knowledge to explicit knowledge whereby tacit knowledge is made explicit and crystallised, and new explicit knowledge can thus be shared. Concept

creation in product development is an example of this. In the third mode, combination, the conversion is from explicit knowledge to explicit knowledge, and the new explicit knowledge is usually more valuable and complex. Typically in an organization, external and internal explicit knowledge are often combined and processed to create new knowledge. In the last mode, internalisation, the conversion is from explicit knowledge to tacit knowledge. By the internalisation process, explicit knowledge is shared throughout the organization, acquired by its members and finally converted to individual tacit knowledge. This is exemplified in "learning by doing" which occurs when, for example, an employee learns the repair procedures documented in a manual and his/her performing the procedures many times results in experience gained which is tacit knowledge.

In brief, knowledge can be retained in an organization through the organization of various activities such as socialisation (meeting, discussions, dialogue, etc.), externalisation (speeches, presentation, demonstration, etc.), combination (text mining, business reporting, editing, etc.) and internalisation (observation, memorizing, tutoring etc.).

Boisot C-Space model

The Culture Space (C-Space) model developed by Boisot (1987) is another model offering a different viewpoint. It views knowledge from two distinct perspectives: codification and diffusion. The first is about the extent to which knowledge is encoded or converted to text, image, audio, video or other formats such that

knowledge can be reused, edited, enhanced, tagged, indexed, searched or acted upon by other means or for other purposes. The second is about the extent to which knowledge is stored, processed, applied or be associated with other knowledge-related actions within a defined boundary. A quadrant diagram is drawn in which the x-axis is for the diffusion perspective (either *undiffused* or *diffused*) and the y-axis is for the codification perspective (either *uncodified* or *codified*). Therefore, four quadrants can be identified which is a knowledge classification scheme consisting of four categories: personal knowledge for *uncodified* and *undiffused*; proprietary knowledge for *codified* and *undiffused*; public knowledge for *codified* and *diffused*; and common sense for *uncodified* and *diffused*.

Warner and Witzel (2004) further explain these four categories of knowledge. The first category is public knowledge which is codified and widely available in many media for easy or ready use. Proprietary knowledge, the second category, is highly codified but not shared with others and has an owner who can be a person or an organization. It is not shared in order that the owner can protect his/her interest or rights to the knowledge which can be competitive advantage and copyrights, for example. The third category, personal knowledge, is not shared and uncodified, which restricts its use within a defined boundary of an organization or a person. In fact, as personal knowledge is uncodified, sharing of any form, if any, is difficult or ineffective to do. The last one is common sense which is uncodified but shared and is the relatively more difficult to understand among the four categories. One good example of common sense is the corporate culture of an organization which is formed over the years by the corporate values, corporate strategies, the beliefs

and behaviours of past and present staff, the history the organization has gone through and others. The staff are aware of and share the corporate culture, communicate and perform tasks in ways influenced by corporate culture which is difficult to be codified exactly.

For an ordinary organization, among these four categories, proprietary knowledge and personal knowledge are to be protected to reduce the risk of loss or leakage. First, access to proprietary knowledge must be restrictive and only the properly authorised persons with the required access rights can retrieve or use pre-determined parts of proprietary knowledge according to the sensitivity of knowledge and security control policy. This protection is particularly needed for organizations taking part in business collaborations with partners in which certain part of corporate knowledge is shared for mutual benefits. Second, proper knowledge retention measures must be implemented so that the expertise, special knowledge/skills or valuable experiences can be retained in an organization before an employee resigns or retires, preventing loss of knowledge.

Conceptual vs Procedural knowledge

When describing knowledge, knowledge can be said to be conceptual or procedural. Conceptual knowledge is a set of different items of information and the relationships between them (Hiebert & Lefevre, 1986). The relationships are cognitive (Groth & Bergner, 2006) and can be considered as conceptual understanding (McCormick, 1997). Procedural knowledge can be explained by

referring to examples in which procedural knowledge is applied. In mathematics, procedural knowledge consists of two types of knowledge (Hiebert & Lefevre, 1986). The first type is familiarity with symbols representing mathematical ideas and syntactical rules in connecting these symbols to represent something meaningful while the second type is rule or algorithm used to solve mathematical problems. Another example of procedural knowledge is instrumental understanding which is regarded by Skemp (1976) as "rules without understanding". In technology, "knowing how to do something" is procedural knowledge (McCormick, 1997). Ordinary terms like process and strategic thinking consist of actually different levels of procedures. Procedural knowledge can be found abundantly in modelling, system approaches, project planning, quality assurance and optimization in the technology domain. In general, procedural knowledge appears to be more easily defined than conceptual knowledge. Conceptual knowledge needs to be learned with meaning involved while procedural knowledge may not.

Exploitative vs Reflective knowledge

From another perspective, knowledge can be said to be exploitative or reflective (Yip, 2015). Exploitative knowledge refers to basic knowledge which is used in doing different kinds of things like swimming (a physical skill) and presentation in meeting (a cognitive skill). It can also be found in business processes or technical procedures used to accomplish an objective. Exploitative knowledge can be codified or non-codified. On the other hand, reflective knowledge, however, concerns with and enables judgment and belief. It is about interpreting and adding

further meaning to information. Judgment and belief are manifested in what, how and why a person does with events and come about with an understanding of the context in which the two are present together with other related matters. It can be found in ways of thinking, moral principles upheld, business decisions or corporate values.

2.2 Corporate Value of Knowledge Management (KM)

In this section, the role of knowledge management (KM) in organizations, processes and methods in KM and the problems of launching KM in firms are discussed.

2.2.1 Role of KM in organizations

In the running of any business, there are activities and changes in knowledge resident in employees and the organization. Knowledge may be created, acquired, renewed and applied, which must be managed well to meet short-term and long-term business requirements. The discipline concerned is known as knowledge management (Quintas et al., 1997) and can be considered as a set of processes or practices of developing abilities in knowledge activities in an organization (E. W. Ngai & Chan, 2005). In greater detail, knowledge management involves the identification and communication of both tacit and explicit knowledge embedded in people, processes, rules and regulations, plans and strategies, products, services, and others – individually contained in different business units of the organization (Bollinger & Smith, 2001). It also involves other aspects like knowledge validation,

presentation, storage and distribution, and is closely linked to the creation and update of core competencies (Bhatt, 2001). Other areas covered by knowledge management may include selecting, organizing and distilling knowledge (Herschel & Jones, 2005).

The need for knowledge management in organizations has risen rapidly for a number of reasons. First, the nature of many jobs is changed from being routine and labour-intensive to being creative and knowledge-intensive. This trend is very prominent especially in knowledge-intensive business sectors such as consultancy, R&D, medical, education, marketing and ICT (Information and communication technology). Second, knowledge is replacing land or machines as the most important factor in an organization's competitive advantage (Bollinger & Smith, 2001; Grant, 1996; Johannessen & Olsen, 2003; I. Nonaka & Takeuchi, 1995; Quintas et al., 1997; Wiig, 1997). Third, the widespread adoption of the Internet and other new technologies in business and society, and the availability of vast and rapidly growing amounts of knowledge and information over the Internet and other media have called for more effective ways to manage knowledge. Lastly, changes in business environment such as faster product life cycles in many industries, promoting good, consistent work practices across geographically dispersed business units in an organization, quick and effective decision making, and loss of talents through employee turnover and retirement are challenges faced by today's organizations which have made excellent knowledge management more important than ever (Du Plessis, 2005).

There are several views of the objectives of knowledge management system. Wiig (1997) regards that the objectives of knowledge management system are to enable an organization to have success and gain visibility in the market and to maximise the value of knowledge assets. In the second view, Davenport and Prusak (1998) suggest that most knowledge management projects serve one of these three objectives: (1) to demonstrate the importance of knowledge in an enterprise and help it have more corporate visibility, (2) to promote knowledge-oriented culture whereby people proactively search for, produce and share knowledge, and (3) to construct a user-friendly knowledge infrastructure in which people are connected to many people through interaction and collaboration with the right tools and encouraging environment in time and space. On the other hand, Du Plessis (2005) divides the objectives into three areas: high level business functions, intelligent enterprise, and efficiency improvement. In the first, knowledge management is to support business strategies and objectives implementation, competitive advantage realisation, innovative culture establishment and intensification, and wide collaboration practice. In the second, knowledge management aims at creating intelligent enterprise by effective knowledge retention in the organization and its members, accurate forecast of critical opportunities, and rapid growth of organizational knowledge base. In the last, it endeavours to increase efficiency or organizational capacity by improving decision making process, problem solving, productivity, corporate or individual knowledge leveraging, and customer service. The better customer service objective is also mentioned by Bollinger and Smith (2001). In brief, knowledge management aims to facilitate an organization to create, acquire, store, classify and share knowledge. It also facilitates the conversion of

human capital (knowledge, skills and experiences of employees) into structural capital (recorded knowledge stored in systems) which is retained in an organization unaffected by employee turnover. At the same time, it has another objective to improve efficiency, raise service quality and shorten learning curve.

2.2.2 Processes and Methods in KM

Grover and Davenport (2001) divides the knowledge process into three sub-processes: (1) knowledge generation which refers to knowledge acquisition and development, (2) knowledge codification which refers to converting knowledge to an accessible, usable and shareable format, and (3) knowledge transfer which refers to moving knowledge from where it is generated or codified to the place it is applied and used. On the other hand, Bhatt (2001) divides the same process into different sub-processes. First, knowledge is created. It is then followed by validation in which an organization evaluates and reflects on the relevance of knowledge to the organization's business. Next, in knowledge presentation, the organization finds out the ways to show knowledge to organization members. What follows is knowledge application in which knowledge is used in processes, products and services. In the final sub-process, knowledge is distributed or disseminated to users in need of it for sharing and reuse.

Knowledge acquisition and capture

The common tools/methods for knowledge acquisition and capture are: (1) business intelligence, and (2) expert database.

One good example of knowledge acquisition process is business intelligence (BI). Business intelligence is the use of data mining techniques to identify and summarise useful information for management or operational purpose which are stored in a very large database of corporate data, leveraging the rich functionality, high reliability and flexible scalability of today's database management systems (Cody, Kreulen, Krishna, & Spangler, 2002). Business intelligence can also be considered as the technologies that collect data by warehousing and analyse data by online analytical processing (OLAP) to improve the decision-making process and outcomes in an enterprise (Herschel & Jones, 2005).

One good application of knowledge capture is the expert database. In human resources management, an organization should maintain and update a database, called expert database, which stores the educational qualifications, working experiences, specialties, expertise, skills and talents of employees so that management can efficiently search for the best employee for a job newly created or left vacant by a resigned or retired employee. In this way, not only the organization will benefit from such a database, so will the employees who can have more opportunities to develop and use their talents and potential capabilities. Employee morale and satisfaction will also be increased in the organization. At the same time,

organizations should establish access to external expert database (by subscription or free of charge) storing similar information and the contact details of experts in different kinds of business or industry to identify the best person for an internal job should no internal replacement be found. Three examples of such external expert database are described as follows. The first is an expert database which stores searchable research faculty expertise in energy, the environment and sustainability established by The Pennsylvania State University (PennState, 2017). The second expert database is called The International Bureau (IB) Expert Database which stores detailed information about experts in different disciplines. It allows self-registration by experts so they can make themselves accessible by potential parties interested in their specialties (Interantional Bureau, 2017). The third database is known as The European Knowledge Centre for Youth Policy (EKCYP). It contains records of experts in the area of youth matters. Experts can register themselves to make information about their specialised knowledge, skills and experiences available online. It supports relationship building between youth practitioners, policy-makers and researchers (EKCYP, 2017).

Knowledge organization and retention

The common tools/methods for knowledge organization and retention can be divided into four categories: (1) filing and taxonomy, (2) content management, (3) knowledge repository, and (4) knowledge portal.

Knowledge must be organized properly for effective use to meet business needs. One way is to set up a taxonomy which is a set of terms appropriately selected for a subject field. It facilitates efficient storage of and fast access to knowledge in a central store. Taxonomy is a Knowledge Organizations Systems (KOS) which is specially developed for a specific domain of knowledge according to the intended use in a particular environment (Hlava, 2012).

Content management system is one of the common tools to organize information (Duffy, 2001). The basic units for organization are objects formed as a result of information broken by topic and tagged by XML (Extensible Markup Language), rather than BLOBS (binary large objects) or documents. The objects with tags facilitate search to produce more results which are also more relevant to what is intended to search, improving information sharing and reuse. The XML-enabled tags make dynamic linkage between documents by different criteria for publishing to web browser or other platform internally or externally. Over time, content management system will be enhanced, and indexed contents by keywords, topics, concepts or contexts would be commonly available for more efficient access.

The third tool/method is called knowledge repository. In an organization, many activities, tasks or projects take place throughout the entire organization. Achievements are accomplished and valuable knowledge or experience is gained but at the same time mistakes may be made and lessons are learnt. The good and the bad can be recorded in an organized manner in a case format and stored in a

corporate repository of knowledge for other staff to access and learn from them (Van Heijst, Van Der Spek, & Kruizinga, 1997). If the case offers valuable lessons and helpful knowledge, more staff will access them for application in work. It is possible that the case histories are distilled and become formal knowledge of the organization appearing in manuals and rule books, which are in turn stored in the same repository.

In many organizations, a knowledge portal is set up to become the first place to visit to obtain or search for information or knowledge for shared use in operation by staff who access the portal probably through a browser interface (Benbya, Passiante, & Belbaly, 2004). Usually, the portal is connected to a number of internal systems which provide the needed information or knowledge in a common, user-friendly format for use, which is achieved by format conversions done transparently to the staff concerned. A portal can also be one of the locations for knowledge generation and exchange.

Knowledge sharing and reuse

The common tools/methods for knowledge sharing and reuse are: (1) after action review, (2) communities of practice, (3) center of excellence, and (4) knowledge café.

After action review (AAR) (Schindler & Eppler, 2003; Wiig, 1999) is usually employed upon completion of a task or project to go through what have been done,

what results have been obtained or what mistakes or ineffective practices have taken place. The purpose is to learn from what has happened, share knowledge and experience gained and identify future improvement opportunities. AAR may occur in a project meeting with the presence of all team members.

Communities of practice is a method commonly and regularly adopted by staff of an organization (Fischer & Otswald, 2001; Kimble & Hildreth, 2005). Its aim is for more experienced and senior staff to share knowledge or practice relevant to a project or task with other new or less experienced staff who may learn from their counterparts. The members can also be peers sharing similar motivation, work goals or job responsibilities. In so doing, the interactions help establish relationships among the involved participants which are beneficial to future collaboration or joint work. Normally communities of practice are ongoing communication platform inside an organization.

Center of excellence is another method for sharing and reuse of knowledge (Walker & Christenson, 2005). In the center of excellence of an organization, best practices and cross-project, cross-team, cross-organization or cross-industry benchmarking information are shared and reflected on for improvement and learning objectives.

Yet another tool/method is knowledge café which is a kind of group discussion session involving several to a few hundred participants (Wiig, 1999). During the session, a topic is presented with its background, what and how knowledge matters

are done and what results are obtained. Small groups (about five participants) are formed to discuss what have been presented and the implications to them for about 15 to 30 minutes. Then the groups are disassembled and new groups are formed in a random manner. Same discussions are carried out and this cycle is repeated several times. Afterwards, summaries are collected and presented for the benefits of all participants. Further informal discussions may continue for several weeks among some of them. Huang (1998) regards knowledge café as a team dialogue and collaboration tool.

2.2.3 Problems of Launching KM in Organizations

The implementation of knowledge management systems in organizations is still not widespread and this can be explained. Most systems focus on capturing, organizing, retaining, disseminating and sharing of knowledge, which do not bring alertness and financial implications to organizations to justify initial investment. Usually, the knowledge management initiative takes a long time for its returns to be appreciated by top management when in fact efficient, effective management of knowledge assets is a critical success factor for growth and competitive advantage especially in the global knowledge-intensive era. What makes the situation more undesirable is that the benefits of knowledge management system are difficult to quantify or measure financially (Clark & Soliman, 1999; Davenport et al., 1998; Yew Wong, 2005). This situation makes the top management not put knowledge management in the strategy priority list or planning and lack of management support often results,

leading to difficulty in getting the financial and human resources required to launch knowledge management successfully.

There are other barriers to successfully implementing knowledge management systems. Some practitioners have questioned the true benefits of such system (Bollinger & Smith, 2001). The system is often regarded as requiring too much manpower, capital, time and effort to set up and maintain. Many staff are not so willing because of busy work to spend time and additional efforts on tasks related to setting up and learning the system such as documenting team or work process. At the same time, they have difficulty in understanding some of the technical details, aspects or jargons during learning how to use the system. Some not user-friendly features caused by limitation of technology also discourage them to use it. Furthermore, some consider that the system adds to existing information overload and some lower-level staff do not think they need the system for their work. At a more personal level, barriers also exist. Staff may be reluctant to share their knowledge out of fear of losing ownership or benefits derived from their own knowledge, for example, value or sense of importance to the organization, status, ability in competing with colleagues and promotion prospects.

The knowledge risk as conducted in this study will add to a new perspective to alert interest for organization to pay attention to the way they manage their corporate knowledge as this implies a financial consequence of its poor management. The argument of which is set forth in details in Section 2.4.3.

2.3 Risk Management (RM)

Managing knowledge risk should also be part of risk management (RM). In this section, a review of what risk is as well as the phases of RM and its benefits to enterprises is addressed below.

2.3.1 Definitions of Risk

In everyday English, risk is defined as "the possibility of something bad happening" (Cambridge Dictionary, 2017) or the "situation involving exposure to danger" (Oxford Dictionary, 2017). In enterprise risk management, risk has been defined in a number of ways (Deloitte & Touche LLP, 2013). Traditionally, risk is defined as a function of impact and likelihood (COSO, 2012) and this is the definition adopted in this study. The former is about the adverse effect the event may impose on an organization whereas the latter is about how probable the event will take place. Zhi (1995) defines risk mathematically as the product of impact of the adverse event multiplied by probability of occurrence of the event.

$$R = P \times I$$

where R is the level of risk, P is the probability for the risk to occur and I is the impact of the risk.

On the other hand, Dickinson (2001) defines risk as the extent of deviation of business results from the corporate strategy of an organization. Deloitte & Touche LLP (2013) defines risk as potential loss caused by events affecting corporate

objectives' achievement. For a specific risk like strategic risk, Mohammad and Sykes (2012) define it as an uncertainty or opportunity arisen as a result of strategy execution.

Closely related to risk are risk factors which are defined as something that increase risk or susceptibility (Merriam-Webster Dictionary, 2017). The risk factors may or may not be casual. For example, age is a risk factor of heart disease. In research or practice, risk factor is a concept widely used in, for example, epidemiology research and business risk management. In the medical field, risk factor refers to a characteristic or circumstance of a person which increases the probability of his/her getting a disease or a health problem according to the World Health Organization (WHO) (WHO, 2017). Tobacco, alcohol, overweight, unsafe sex and unclean water are common risk factors of health. In enterprise risk management, risk factors are often employed in modelling studies. For example, in the Causal At-Risk Models (COSO, 2012), risk factors of uncertainty in cash flow or earnings are modelled in detail to predict and better manage impact of risk factors on future cash flow or earnings, which is more effective than extrapolating past relationships in a proforma approach.

2.3.2 Classifications of Risk

In enterprise risk management, there are two well-known risk models: COSO model and CAS model. The first is developed by The Committee of Sponsoring Organizations of the Treadway Commission (COSO) (COSO, 2012), which

consists of five professional bodies and has developed a comprehensive framework for corporate risk management and internal controls. The COSO framework classifies enterprise risk into four categories: strategic risk, operations risk, reporting risk and compliance risk, which correspond respectively to the four corporate objectives: strategic objective; operations objective, reporting objective and compliance objective in enterprise risk management. Strategic objective are objectives at the highest level based on the corporate mission; operations objective deals with the efficient and effective use of resources; reporting objectives are to meet the reliable reporting needs of an enterprise at different levels of management and operation; and compliance objectives are to make operation and management at all levels comply with internal audit and control, internal and external rules and regulations in addition to regulatory requirement and local or international laws.

Another model is the Casualty Actuarial Society (CAS) model. CAS members are professionals in insurance, finance and risk management (CAS, 2017). CAS classifies risk into four categories (CAS, 2003), namely: (1) hazard risk (e.g. fire, property damage, windstorm, theft and personal injury); (2) financial risk (e.g. interest rate, exchange rate, credit, liquidity and hedge); (3) operation risk (e.g. employee attrition, product safety, process change, IT security and project planning); and (4) strategic risk (e.g. reputation, innovation, competition and regulatory requirement)

In this research, the main focus is knowledge risk in organizations, which refers to risk arising from ineffective practice or mismanagement of knowledge, for example, knowledge loss and knowledge obsolescence. Comparing the two models, two common categories of risk can be found: operations risk and strategic risk. However, the two common risks identified do not refer to exactly the same risks in scope and actual attributes even though the same names are used. Both models in fact have different focus or goal. The COSO model is focused more on internal control (as a means to mitigate risk, etc.) and the CAS model is more focused on nature of risk which calls for specific risk response tailored to the concerned nature. Even with the diversities in the two models, knowledge risk is not addressed above the acceptable level in both models when knowledge risk is a significant risk in any organization, especially those which are knowledge-intensive. Knowledge risk, as one of the enterprise risks, can be considered operation risk by COSO or CAS classification. However, knowledge risk such as knowledge loss is ubiquitous throughout an organization and can occur in any department, team or project and at different point in a business or production process, which makes it quite different from other typical enterprise risks like exchange rate risk which is handled by finance personnel in a standalone and focused manner. On the other hand, knowledge risk can also be a strategic risk by the two models' own classifications. If an organization is still making use of outdated market trend data or competitors' information because there is error or inefficiency in the market knowledge update, the impact can be very serious. In fact, accurate and timely market and competitor knowledge is part of the strategic components of an organization in strategy formulation. Thus, it can be seen that knowledge risk is quite different from other

typical enterprise risks, be it operational or strategic, in nature, space and management process, making enterprise risk management theory and practices not wholly applicable to knowledge risk. Knowledge risk should, therefore, be studied on its own while taking advantage of the enterprise risk management discipline.

2.3.3 Phases of RM and its Benefits

Traditionally, risk management (RM) focuses on conventional risks such as financial risks and environmental risks. Financial derivative products and insurance products are usually the means to cover the exposures to the two kinds of risks respectively. Enterprise Risk Management (ERM) deals with risks in enterprises as well and is usually implemented together with internal audit and control. A typical enterprise risk management system consists of a number of phases: context analysis, risk identification, risk analysis, risk assessment, risk response, monitoring and review, and communication and consulting (Aloini et al., 2007). Zhi (1995) suggests that the phases are risk classification, risk identification, risk assessment, and risk response. Hallikas et al. (2004) also propose a similar set of phases. In greater detail, risk identification is the process of finding out events or situations which may cause potential uncertainties in the future so that risk actions can be performed proactively (Hallikas et al., 2004). While Zhi (1995) also describes this phase, he mentions at the same time the need to classify potential risks before identification. In the assessment phase, risks are evaluated to determine the required management actions and are prioritised as well. The probability of occurrence and potential impacts are estimated from the enterprise perspective utilizing the

enterprise's experience and that of others. In the next phase, appropriate risk responses are developed, including "risk transfer", "risk taking", "risk elimination", "risk reduction" and "further analysis" (Hallikas et al., 2004; Zhi, 1995). Finally, in the monitoring phase, risks are continually monitored to detect any changes in the probability of occurrence and impact or to predict new ones. One way to do this is to monitor the business environment in terms of customer needs, competitors and partner strategies, and technologies (Hallikas et al., 2004). The phases of RM are summarized in Table 2.2.

Table 2.2 Phases of risk management

Phase	**Description**
1	Risk identification
2	Risk assessment
3	Risk response
4	Risk monitoring

C. W. Smith and Stulz (1985) argues that risk management can increase the expected value of an organization by reducing the likelihood of financial distress. Later, total risk management proposed by Andersen (2008) responds to market forces beyond the management control of an organization to increase performance. Relationship between total risk management and performance has been verified empirically for knowledge-intensive organizations in particular. Andersen (2008) further argues that if a firm is more capable in reducing the negative effects caused

by risks, it will be less susceptible to changes in environment or market, protecting earnings as a result.

In recent years, the importance of risk management is viewed and studied from a newer perspective. Risk is regarded as an integral element of any business processes to bring benefits, referred to as values, to an organization. COSO (2012) state that value is a function of risk and return and the better way to manage risks is not to avoid it altogether but to include it proactively in a business decision. The emergence of risk-value relationship represents an important change in risk management and can be seen in the corporate investment example. Poor risk management in a firm will discourage outside parties to make investments, especially long term, in the firm for fear of its problematic financial positions or even bankruptcy (Andersen, 2008). If the risk management is effective, more external investments are attracted. Some of these investments may require the establishment of special relationships between the outside parties and the firm in order that the firm can create value critical to the firm's long-term sustainability. In this case, the outside parties become partners involved in the actual running of the firm, a situation seen by Andersen (2008) as an important advantage of sound risk management particularly in the knowledge-based industries. The major benefits of RM are summarized in Table 2.3.

Table 2.3 Major benefits of risk management

Benefits
1. Creating/increasing values for the organization
2. Responding to market needs to increase performance
3. Being less affected by external changes
4. Attracting more external investments

In the evaluation of knowledge risk in this thesis, risk factors of a risk are considered and assessed instead of impact or likelihood of a risk. Both impact and likelihood are critical information about a risk. However, they are difficult to determine and measure in many instances, which is the same as what the interview participants have said about risks in their organizations in the knowledge risk interview included in this research (see Chapter 4). On the other hand, a set of appropriate risk factors in general describes or reflects a risk more richly and fully in coverage scope and depth than impact or likelihood. The number of factors can be optimised depending on the need and the context. Therefore, this research adopts the risk factor approach in assessing knowledge risk, not much different from other studies of enterprise risks.

2.4 Knowledge Risk

In this section, the meanings of knowledge risk, the past studies on knowledge risk and major dimensions of knowledge risk identified are discussed.

2.4.1 Definitions of Knowledge Risk

According to Trkman and Desouza (2012), knowledge risk refers to an event which decreases the value or benefit of knowledge operationally or strategically for parties involved in knowledge activities in an organization. They regard knowledge risk as part of enterprise risk. Other scholars view knowledge risk as undesirable events arising from knowledge practices (Durst et al., 2016; Tantau & Paicu, 2013). In this research, however, knowledge risk is defined in a more encompassing and rigorous manner as issues, potential problems or even threats that occur as a result of knowledge being mishandled or mismanaged in organizational practice. Knowledge risk, like any other conventional risks, needs to be properly managed to decrease its impact on organizational performance or likelihood of occurrence.

The present situation is that although knowledge becomes more critical to business, knowledge risk is seldom mentioned in the literature and very little research work has been done on it (Durst et al., 2016; Trkman & Desouza, 2012). Other scholars have similar findings. The papers on extensive literature review in the field of knowledge and knowledge management conducted also reveals that knowledge risk is a rarely researched (Trkman & Desouza, 2012). Scattered and isolated studies on

knowledge risk have taken place, for example, on knowledge shortage (Perrott, 2007).

Massingham (2010) argues that knowledge risk management would benefit from the work already done in enterprise risk management which deals with conventional risks. The researcher further argues that knowledge risk management is the intersection between knowledge management and enterprise risk management. Similarly, Durst et al. (2016) describe knowledge risk management as a systematic process of identifying, analysing and responding to risk occurring during the phases of knowledge management such as creation, application and retention.

2.4.2 Previous Studies on Knowledge Risk

At present, studies on knowledge risk are still not many in the knowledge management literatures, especially on the empirical assessment of knowledge risk. The assessment studies below on knowledge leakage and knowledge loss, are illustrative of what have done in research. Durst et al. (2016) have done a systematic review of papers on knowledge risk management published before October, 2015 by two major academic databases – ProQuest and Web of Science. They find 24 such papers which are published between 2001 and 2014. The majority of them (14) are empirical and the rest are conceptual, theoretical, commentary or modelling-based. The general finding of their review is that the papers are about very early stage of research, attempting to gain understanding of knowledge risk management and no uniform approach has been found.

The study of X. Jiang et al. (2013) is about potential knowledge leakage to business partners in firms taking part in strategic alliance. One purpose of which is for the benefits of knowledge sharing. In this study, knowledge leakage is conceptualised as a multi-dimensional construct and the measurement scale is developed by using the research instrument development procedure based on Song, Bij, and Weggeman's study (as cited in X. Jiang et al., 2013). In so doing, a literature review, including the study of Das and Teng, and Norman (as cited in X. Jiang et al., 2013) in particular, was performed to identify items for measurement. In-depth interviews with five managerial staff responsible for strategic alliance were arranged to develop the required measurement items. Five scholars who were very knowledgeable in strategic alliance were invited to verify the measures. A pilot survey with 20 managers followed and statistical techniques were applied to finally arrive at eight-item scales to measure the three dimensions of knowledge leakage. The measures capture participants' perception of knowledge leakage risk, their partners' likely attitude and behaviour towards knowledge leakage and knowledge leakage caused by their own behaviours. It is noted that only one type of knowledge risk is involved in the whole study.

In another study done by Tsang et al. (2016), a knowledge leakage risk assessment model is proposed. Basically, the assessment starts with the construction of a hierarchy of knowledge leakage which looks like an organizational chart. The hierarchy may show the functional parent-child relationships between different departments at various levels in the organization or it may show the hierarchical parent-child relationships between headquarters, branches and offices by location.

The more important one is the hierarchy of different types of knowledge leakage risk occurring in an organization. The purpose of such a hierarchy is to facilitate the assessment of knowledge leakage risks of a group of elements (child) starting at a certain level first and obtaining the knowledge leakage risk of the parent above that level by aggregating those in the concerned group at the lower level. As the undesirable effects of knowledge leakage of elements (child) on their same parent vary, weighting factors are introduced so that risk of child elements can be aggregated in proportion to obtain the weighted risk of the parent. The weightings of elements in the same group are obtained by AHP (Analytic Hierarchy Process) which is an algorithm making use of pair-wise comparisons. The end-result is that through the hierarchy structure and AHP, if the risk of child elements is known, the risk of parent element one level up the hierarchy can be calculated automatically. If this 'rolling up' aggregation is repeated for each level, the overall knowledge leakage risk of an organization is obtained. The risks at different levels of the hierarchy can be used for risk mitigation performance comparison between two types of knowledge leakage risk, two different time points or between two branches, for example. In the paper, many other application areas of the above approach are also described.

Durst and Wilhelm (2013) describe a tool for SMEs (small to medium-sized enterprises) designed to find out the distribution of a particular type of knowledge in individual staff in a business unit or the organization as a whole. In the study, a static knowledge map was created after interviewing 14 members of a printing company in Germany. This is part of the larger research on the impact of knowledge

loss due to employee turnover or long-term absence. The tool calculates a 'knowledge at risk' score which helps the enterprise to get more information and understanding of members holding knowledge critical to the department or organization, the criticality of the knowledge concentration in certain members and the reasons for criticality. Management can thus produce effective programmes to replace or retain key staff to reduce the employee turnover threats in an orderly and timely fashion. The tool is simple to use but powerful in functionality.

Jennex (2014) proposes a methodology to assess knowledge loss risk arising from a resigned or retired employee leaving the organization. Three kinds of ratings are involved in the methodology: "impact of loss", "likelihood of loss" and "quality of knowledge source" causing the loss. How to rank different kinds of knowledge loss risk is also described. It provides guidelines to follow to identify potential knowledge loss and what actions to take to retain the knowledge before it is lost. The organization will therefore make better decisions when allocating resources to cope with such knowledge loss. The pilot study is carried out for one organization only but the results indicate potential benefits from generalizing the findings in the future.

Lee, Suh, and Lee (2014) has developed a metric to measure knowledge drain risk caused by a member who leaves a community of practice (CoP). They study two cases whose high knowledge drains are different: the departing member being an active network leader and the departing member being an isolated expert. The

metric considers network influence (obtained by network analysis) and knowledge levels of members. The metric is applied to real-life online CoP and has demonstrated in the case study that it can provide relevant information about members whose departure may result in high knowledge drain in CoP either because of strong network influence or because of inactive network participation. The findings help practitioners to identify members who may be potential agent for knowledge drain as well as actions to reduce the vulnerability of CoP exposed to knowledge drain.

The above five previous studies share a common characteristic of dealing with one type of knowledge risk at a time only. The present research focuses on assessing risk factors of major dimensions of knowledge risk described in the following (Section 2.4.3) comprehensively and systematically.

2.4.3 Major Dimensions of Knowledge risk

Based on the reviews on knowledge, knowledge management, knowledge risk and its assessment, four knowledge risk phenomena are identified after an organization takes ownership of knowledge. In other words, knowledge may be lost or leaked and it may as well become obsolete or inadequate for use over time. As a result, the four common dimensions of knowledge risk identified are: knowledge loss risk, knowledge leakage risk, knowledge obsolescence risk and knowledge shortage risk. In the semi-structured interview which explores the present status of knowledge

risk with knowledge management professionals, the professionals were also of the same opinion (see Chapter 4).

Knowledge leakage risk

There are various definitions of knowledge leakage risk but in essence they are similar. Knowledge leakage is intentional or accidental knowledge lost to unauthorised parties inside or outside an organization (Ahmad et al., 2014; Annansingh, 2012; Frishammar et al., 2015; X. Jiang et al., 2013). The leaked knowledge can be product knowledge, corporate strategies, marketing plans or many other types of organizational knowledge.

Knowledge leakage can occur in different situations. A disgruntled employee may leak knowledge in his/her possession to unauthorised internal or external parties because of feeling very dissatisfied with how the organization has treated him/her (Ahmad et al., 2014). If an organization has collaboration, alliance or partnership with other organizations, knowledge leakage may occur more easily and frequently as a result of increased joint activities (Ahmad et al., 2014) or the necessary knowledge sharing (Frishammar et al., 2015). For example, knowledge leakage may occur in a company's supply chain involving customers and suppliers because their close participation is required (Aggestam, 2016). Another source of knowledge leakage is insecure information systems in organizations which are compromised by external intrusions or hackers, resulting in knowledge being made available to unauthorised personnel and causing harm though the knowledge is still

inside the organizations. If a firm owns intellectual property (IP), knowledge leakage may also occur as a result of improper management of IP.

In the majority of leakage cases, the impacts of knowledge leakage are negative. Ahmad et al. (2014) quotes examples of impacts caused by knowledge leakage such as drop in revenues, increased costs, loss of productivity and damage to reputation. However, in some much less common situations such as 'leaking' knowledge intentionally to external parties beyond what is required by collaboration or sharing knowledge with external parties to get some perceived advantages like improved relationship, the impact is positive instead (X. Jiang et al., 2013; Mohamed et al., 2007). Knowledge leakage is common in different business functions and activities in an organization (Tsang et al., 2016). Knowledge leakage risk has been under-researched for a long time (Ahmad et al., 2014; Frishammar et al., 2015; Mohamed et al., 2007).

Knowledge loss risk

Knowledge loss risk can be defined as the risk of losing knowledge intentionally or unintentionally which is accumulated in individual employees or organizations and gained through organizational activities (Perrott, 2007). DeLong (2004) mentions that knowledge loss risk could occur expectedly or unexpectedly in individuals, groups of individuals or at the whole organization level, causing negative impacts and incurring costs immediately or at a later time. One common cause of knowledge loss is staff turnover. The loss of staff may be due to staff resignations, retirement

or the less common ones like illness, accidents or deaths (Durst & Wilhelm, 2013). The kinds of knowledge loss can be specific expertise, work practices, decision making criteria or company history of successes and failures (Daghfous et al., 2013). Massingham (2008) argues that the lost knowledge may even be unique or difficult to re-create. Parise, Cross, and Davenport (2006) regard that knowledge loss due to employee turnover is a serious problem.

Other examples of knowledge loss can readily be found. For example, knowledge loss in service specifications which are otherwise complete causes severe service quality problems in a service organization, resulting in inexperienced service staff and serious customer satisfaction problems (Daghfous et al., 2013). Knowledge loss also occurs when there are failures to capture knowledge during the course of business in knowledge repositories like hard copy and electronic database. The staff may also forget the knowledge or where the knowledge is stored (Jennex, 2014). Durst and Wilhelm (2013) quote an example of relational capital (one of the three components of intellectual capital, IC, of a firm) loss when an employee responsible for client relationship leaves the firm together with his/her intimate knowledge and relationship developed over the years while in the firm.

Knowledge loss can as well cause other issues or problems. DeLong (2004) regards that organizational productivity is certainly affected when organizations try to 'reinvent' the knowledge once possessed but now lost. Also, Daghfous et al. (2013) make the remark that knowledge loss can incur potentially high costs, making

knowledge retention and other protection measures highly relevant in organizations. Jennex (2014) even predicts that the problem of knowledge loss in organizations will loom large as the economy increases in vitality. That is why Kamph (2007) calls for organizational actions on the prevention of such loss. To prevent knowledge loss, one way is to codify knowledge and store it in a medium, which is especially effective to deal with staff's tacit knowledge retention issue (Prencipe & Tell, 2001). On the whole, however, there is still far from enough research work done on knowledge loss in terms of study of its nature, identification, mitigation or prevention measures (Daghfous et al., 2013).

Knowledge obsolescence risk

Knowledge obsolescence risk refers to potential undesirable impact caused by a part of knowledge in use which generates no or diminishing value because of change or progress taking place inside or outside an organization. As the market changes rapidly nowadays in terms of technology, business environment, customer needs and expectations, and competition pressure, a firm must act fast to respond effectively to this situation to maintain competitiveness and high quality of its products or services (Bernard, 2000). In many business sectors, advances in information technology have accelerated this change when new digital products or services are introduced (Lucas & Goh, 2009). Kodak's failure to quickly to adopt and capitalise on digital photography when its traditional and world-famous photo-finishing knowledge has become obsolete is a classic example of a victim of knowledge obsolescence (Lucas & Goh, 2009). Another example is Nokia's

sluggish response to touch-screen smartphone introduced by Apple in 2007 which has easy-to-use operation procedures and handy, useful apps. This has caused its downfall and ultimate failure when its once flagship features mobile phone still cling to obsolete hardware and software technologies (Alcacer, Khanna, & Snively, 2014; Burrows, 2011).

Knowledge obsolescence can be caused by a number of factors. Notably in a technological enterprise, if R&D (Research and Development) investment is insufficient, technology used products or services can become outdated within a short time. R&D refers to activities to increase technological or scientific capability of an organization which will be commercialised and applied to create new or improved products or services to enhance the business performance (Hagedoorn, 2002). R&D is essential for innovation to take place in an enterprise when innovation will ultimately benefit the enterprise. The positive correlation between innovation and business performance has in fact been shown (García-Zamora, González-Benito, & Muñoz-Gallego, 2013). Besides R&D and innovation, to counter knowledge obsolescence, organizations can hire external consultants to add external knowledge to the existing knowledge base (Sharma, 1997) or form partnerships with outside organizations to take advantage of the special knowledge and skills of partners' staff without hiring their own staff (Lepak & Snell, 2002).

Knowledge shortage risk

Knowledge shortage refers to the potential impact which may occur when the existing knowledge base of an organization cannot meet the present or future business requirements. The shortage can happen in scope, depth, applicability, quality or other attributes of knowledge possessed by employees or embedded in the organization's systems, processes and culture. For example, a programmer who is proficient in writing programs for the mainframe may be deficient in programming skills for cloud applications; and a successful brick-and-mortar retail business may find itself shortage in the essential knowledge to open and operate an online shop.

It is found that in manufacturing or service provisions organizations, business performance depends much more on knowledge, skills and experience held by employees than their systems, documentation and structures (Mohamed, Mynors, Grantham, Walsh, & Chan, 2006). This should be generally true for other types of organizations, implying that the focus of knowledge shortage is on the employees who may be the cause or victims of the insufficiency phenomenon. As it is the usual case, knowledge shortage often comes about when an employee is not willing or not encouraged to learn more in work to increase their capability to meet new personal or organizational challenges in the future.

To deal with knowledge shortage in an organization as a whole effectively, many scholars suggest fostering the right learning culture and making it a learning

organization. According to Senge (2014), a learning organization focuses not only to build new competencies but also to make a mental/psychological shift in individual staff and in teams. In such an organization, the learning culture makes employee learning a critical and integrated part of all business activities performed by employees day-to-day (Marquardt, 2002). The employees are motivated and influenced by the learning atmosphere to actively expand their adaptive and regenerative capacity to create knowledge, innovations or other values together in a cross-functional manner, minimizing the occurrence of deficiency in knowledge required for organizational competitive advantage, sustainability and growth (Hung, Yang, Lien, McLean, & Kuo, 2010; Senge, 1990; X. Wang, Yang, & McLean, 2007). Pan, Wang, and Weisbach (2015) regard that the learning culture is an important part of organizational culture.

The human resources management is required to provide adequate, high-quality training and development programmes to staff to enhance their knowledge and skills and this makes lack of certain knowledge in staff less likely (Takeuchi, Lepak, Wang, & Takeuchi, 2007). In addition to learning at the organizational level, from the human resource management perspective, employees with special knowledge, experience or skills, especially talents or very outstanding performer, should be given more resources than usual to help them develop their potential to the fullest on their own initiative. The need for effective talent management to develop special expertise for the benefit of organizations has increased (Lepak & Snell, 2002).

Chapter 3 Research Methodology

3.1 Research Paradigms

In general, there are two paradigms available for researchers to choose from – interpretivism and positivism – which are considered exclusive to and incompatible with each other (Roth & Mehta, 2002; Weber, 2004). In the first paradigm, the real world can only be studied subjectively and is regarded as a collection of interactions between people, and between people and their environment; and qualitative methods such as interviews, field studies and others are used to collect data to study a problem. In the second paradigm, the real world can be studied objectively because it consists of unchangeable rules, discovered or not yet discovered, which can explain events taking place all the time around people. The methods to use for this paradigm are quantitative, including questionnaires, statistical analysis and descriptive methods. Researchers who use only one of the two paradigms take the view that the qualitative and quantitative methods cannot be mixed to solve a problem but other researchers do not think the same (Bryman, 2003; Onwuegbuzie & Leech, 2005) and champion the more pragmatic mixed approach that combines the two paradigms to more effectively deal with real-world problems which are involved, complex and unpredictable at times (Mingers & Brocklesby, 1997). It can be said that the mono-type method approach (either qualitative or quantitative) has quite restrictive application compared to the mixed one. The mixed paradigm is

more pragmatic and embodies more solution approaches as it takes advantage of both types of methods (qualitative and quantitative) by integrating their strengths and unique features in terms of perspectives, data collection methods, analysis methods and techniques of induction and deduction (Johnson, Onwuegbuzie, & Turner, 2007). High quality encompassing descriptive contents – the qualitative advantage, and objectivity – the quantitative advantage, can coexist in a research project, as stated by Johnson et al. (2007).

3.2 Overview of the Proposed Research

In this research study, since knowledge risk research and practice are still in the beginning stage and the pilot study is quite explorative, a mixed paradigm is embraced. Both qualitative and quantitative research methods are adopted to achieve the objectives set so as to leverage on the advantages of both types of method. The proposed research can be divided into four stages.

In Stage I, an extensive literature review (see Chapter 2) is performed to review the concepts of knowledge, knowledge management, risk management, and knowledge risk. In Stage II, semi-structured interviews with knowledge management professionals are used to understand their views on knowledge risk and the present management of knowledge risk in the organizations they work for. In particular, it serves to identify the major dimensions of knowledge risk and its risk factors, and validate that the findings are consistent with those reported in the literatures (see Chapter 4). The results in the interview and literature review are then consolidated

and interpreted for consideration of the next stage of the research – Stage III. In Stage III, a two-level assessment (Level 1 and Level 2) is designed to assess risk factors of the four dimensions of knowledge risk identified previously (see Chapter 5). Also, a model, namely, Knowledge Risk Factor Assessment Model (KRFAM) is developed to convert the raw data obtained from the two-level assessment into numerical ratings for convenient interpretation and analysis using the Evidential Reasoning (ER) Approach. The research methods applied, and the mechanism in/calculations behind the proposed KRFAM are illustrated in the following sections – Section 3.3 to Section 3.6. Finally, in Stage IV, the proposed assessment of the knowledge risk factors is trial implemented in three reference sites and the findings are discussed (see Chapter 6).

3.3 Research Methods to Identify the Dimensions of Knowledge Risk and its Risk Factors

Semi-structured interviews with knowledge management professionals were conducted to collect information on how various kinds of knowledge risk were perceived in stage II of the research as described in Section 3.2. In particular, it is used to identify the major dimensions of knowledge risk and its risk factors, and validate the outputs against the present literature review findings. The reasons for selecting semi-structured interview as the research method, the format of the interview, data sampling method and interview data analysis approach applied are

described in this section. For the details on the interview question design, and findings and discussions, please refer to Chapter 4.

Semi-structured interview

Though the importance of knowledge in the fast-growing knowledge-intensive economy is well-understood today, knowledge management is still a less practised and less familiar field to many business practitioners alike when compared to organizational management or strategic management. Knowledge risk is an even newer term or concept to most people and thus its critical role in organizations is poorly understood or appreciated. This makes knowledge risk management a quite remote concept to grasp in many organizations.

A semi-structured interview was adopted for the given circumstances and purpose intended, according to what was put forward by J. Yin and Jamali (2016) and others in a similar situation. In fact, it is a qualitative method. The reasons for adopting a qualitative approach are the same as those given by Diefenbach (2009). First, it has the potential to enable in-depth inquiry (R. K. Yin, 2004) and is in the middle between "informal" and "formal" or "standardised" and "non-standardised" (Bernard, 2000), allowing more mental space for the interviewer and interviewees to express themselves with less restriction and more openness in the interview process. Second, during the interview, their short distance apart, eye contacts, facial expressions, and body gestures (in addition to the main vehicle of dialogue – spoken words) all help make their communication of views, thoughts, vague ideas, strong

arguments or sometimes emotions more effective than say a questionnaire hard copy which they are asked to answer in the survey approach. Third, as the set-up of the interviewing environment is friendly, their minds are closer literally, implying that both the interviewer and interviewee can discuss, investigate and examine the interview topics at hand more interactively, engagedly, productively, and critically (Morehouse, 1994).

Before the actual interview, an interview guide was prepared first to set out the procedures, what to cover and focus on, what questions to ask, and background information to be familiarised with, as largely suggested by King, Cassell, and Symon (1994). The anticipated discussion would be centered on the research topic and the contents are based on existing facts identified and shaped by the literature review results. In each area of the contents, the questions to ask were developed with reference to the suggestions of Boyce and Neale (2006) and Millwood and Heath (2000), being straight-forward, objective, facts-based, open-ended and at times probing as required to maximise the quality and contents of returned answers. (Refer to Section 4.2 for the interview guide developed.)

As far as the interview process is concerned, it followed the suggestions made by Veliyath, George, Ye, Hermanson, and Tompkins (2015). However, the guide also included the feature put forward by Shaw and Huang (2005) as well as J. Yin and Jamali (2016) that the interviewer can side-track to a related, specific aspect by asking additional ad-hoc, unscheduled questions to probe or investigate further to obtain more useful and finer details should the interactions with the interviewee

prompts such course of action. In fact, the guide did not suggest strict observation of the pre-determined sequence of discussion but instead emphasised the importance of efficiency, effectiveness and overall perfromance of the whole process and the quality of responses from interviewees, as suggested by Brunold and Durst (2012).

Data sampling method for this semi-structured interview

The focus of purposive sampling is on the depth of information to be collected and a relatively small sample size (both features are appropriate for this study) can therefore be acceptable. To ensure a high level of consistency and reliability in handling and treating sampling data, the sampling method also calls for the same researcher to conduct all the interviews, perform very carefully and detailedly data collection, and clean up and update field notes as soon and as completely as possible, as suggested by Velu and Stiles (2013). Therefore, purposive sampling was chosen for this interview round and the participants selected were conversant in knowledge management with relevant practical experience. (Refer to Section 4.3 for the background of the interviewees.)

General inductive method for interview data analysis

After each interview was finished, the recorded dialog was transcribed and a summary was prepared by making use of the suggestions proposed by Miles and Huberman (1984). A form was used to document emerging theme possibly coming up as more interviews were conducted, useful ideas captured, variables identified,

and what issues to follow up in the following interviews. The raw data in the interview notes and transcripts were interpreted and analysed using the general inductive approach, a three-stage process, based on past similar work by Thomas (2006), Velu and Stiles (2013) and J. Yin and Jamali (2016).

First, the raw data of each interview were re-arranged according to a common format for ease of reading, comparison and more consistent and systematic interpretation. In the form, common thematically related chunks of data were put together and then classified into different categories using open coding. Reading, interpreting, cleaning up, consolidating, summarizing and inducting were carried out a number of times until the distilled data were found to be satisfactory for the next stage.

Second, the relationships between two or more categories found in the first stage were identified and classified into dimensions, which is a higher order of classification. The resulting two sets – categories and dimensions – were validated against relevant literature to ensure that there was no overlapping between the dimensions and the dimensions together represented all the data collected during the interview. This process was done recursively until no more new dimensions were identified. The number of references and intensity of support of each category and dimension would be found by this validation exercise and be used to determine which more significant ones were to be retained.

In the final stage, a model or theory or conclusion was developed which could explain the relationships, categories, or dimensions being arrived at as well as any structures, concepts, themes, processes or experiences embedded in the underlying interview data. The net results of the above process would then be used to support findings, and conclusions to be made for the whole study. (Refer to Section 4.4 for the findings and discussion arrived at using this general inductive approach.)

3.4 Research Methods to Design a Two-level Assessment of Knowledge Risk Factors

As mentioned, in stage III of the research, a two-level assessment was designed to evaluate knowledge risk factors of an organization – Level 1 assessment checklist and Level 2 evidence-based validation. The research methods for the design of the Level 1 and 2 assessments are discussed below.

3.4.1 Level 1 Assessment Checklist

Level 1 assessment makes use of a survey approach as the research method to assess risk factors of various dimensions of knowledge risk identified in stage II. For the details on the construction of the survey questions, please refer to Section 5.2. The following focuses on the description of the statistical tests used to ensure the validity and reliability of the survey.

To ensure the suitability of the survey in Level 1 in a statistical sense for subsequent use and analysis, the content, discriminant and convergent validity, and reliability of the survey were checked by two statistical tests – Principal Component Analysis (PCA) and Cronbach's alpha test. To collect sufficient data for these two tests, the questionnaires were administrated both in hardcopy and online forms to maximise the reach and response (Keane, Smith, Lincoln, Wagner, & Lowe, 2008). As mentioned, this study was an exploratory study, so a large database was relatively difficult to build from which to extract a random sample. Rather than distributing the questionnaires to a pre-determined number of target companies obtained usually from a recognised database, a sample of convenience was selected. This method is suitable for exploratory research. It has also been adopted by previous scholars like Franco and Haase (2015) when no large database can be built upon.

As knowledge risk is quite a specific and new topic, professionals mainly in KM (e.g. KM experts, KM practitioners, KM master degree students) were invited to join the study. The list of participants was created by the author in the scope of the previous connections or networks accumulated mostly in the KM field through various studies, projects or activities conducted. They could be assumed to be as more knowledgeable than experts in other areas and should be regarded as the key informants on knowledge risks of their respective company.

According to Campbell (1955), in the key informant approach, the informants should assume positions in the companies making them quite knowledgeable in the

research topic, and they are helpful and can communicate with the researcher reasonably well. These informants need not be representatives of the companies in the sample in the statistical sense. In this study, the informants invited should have met Campbell's rules. Because the informants are knowledgeable in the research topic, their depth of knowledge, being experts in their specialties and willingness and capability to help should make their responses to the survey very worthwhile to take notice of at least, if not to take them seriously. Generalisation of their responses may not be prudent but drawing obvious or easy-to-make observations from the convenience sample as is the case in this study should not be ignored or treated lightly (Holbrook & Schindler, 1989). On the whole, the convenience sample combined with the key informant approach is consistent with the objectives of this study and its strengths should increase the confidence in analyzing and interpreting the sample results.

When all the questionnaires were returned, the data were processed by Principal Components Analysis (PCA) and Cronbach's Alpha to ensure the validity and reliability of the data for subsequent analysis.

Principal Components Analysis

Principal Components Analysis (PCA) is a process which reduces a set of variables to a smaller one consisting of artificially created variables known as principal components in such a way that most of the variance in the original set is retained, redundant question items are removed, and the remaining items are reclassified into different groups. This test validates that the questions in a particular resulting group

(now called a component) measure the underlying construct originally intended and the scores in the group can be added to obtain an average which is representative of the group. It is this average which is used in the later analysis.

Cronbach's Alpha test

In principle, Cronbach's Alpha is a test which measures the internal consistency or reliability of a set of variables by determining to what extent the variables in a group measure the underlying construct. The variables in this research were the question items in the questionnaire's dataset. The test was done after the PCA to generate a Cronbach's alpha value for a group indicating to what extent the average of scores of items in this group can be used reliably in analysis. The value should exceed 0.6 for exploratory research (Nunnally, 1978) which was the case in this research. Also, the corrected item-total correlation, the Pearson correlation between the specific item and the sum of all the other items, should exceed 0.3. (Refer to Section 5.2.3 for the results of PCA and Cronbach's Alpha test.)

3.4.2 Level 2 Evidence-based Validation

Level 2 adopts a structured interview approach as the research method to overcome the weakness of Level 1 assessment – subjective responses. In Level 2 assessment, a validation in the form of an interview is conducted to validate the results obtained in Level 1. The ratings in Level 2 are in fact belief degrees (strengths of evidence) under the Evidential Reasoning (ER) approach, which are given based on the relevant evidence elicited during the interview. For the explanations of belief

degrees and ER approach, please refer to Section 3.6. For details on the constructions of the interview questions, please refer to Section 5.3.

The structured interview form is applied in Level 2 assessment instead of a semi-structured one used in stage II of the research (see Section 3.3). In a structured interview, interviewees are presented with the same set of questions asked in the same order; thus, answers are more reliable, as stated in the structured interview guide by the Office of Personal Management (OPM) of the Government of the United States (OPM, 2008). Also, more in-depth data can be collected through a structured interview (Klenke, 2016). This makes structured interview a suitable research method to validate the responses in Level 1 assessment (the objective of Level 2 assessment). At the same time, the author (as the interviewer) followed the OPM's guide (OPM, 2008) to take notes as much as possible and avoid giving negative feelings to the interviewees through any facial expressions or body language.

3.5 Development of a Knowledge Risk Factor Assessment Model (KRFAM)

In structure, the model has three layers. Starting from the top, the three layers are: (Layer 1) knowledge risk of an organization, (Layer 2) dimensions of knowledge risk, and (Layer 3) associated risk factors for each knowledge risk dimension as in Figure 3.1.

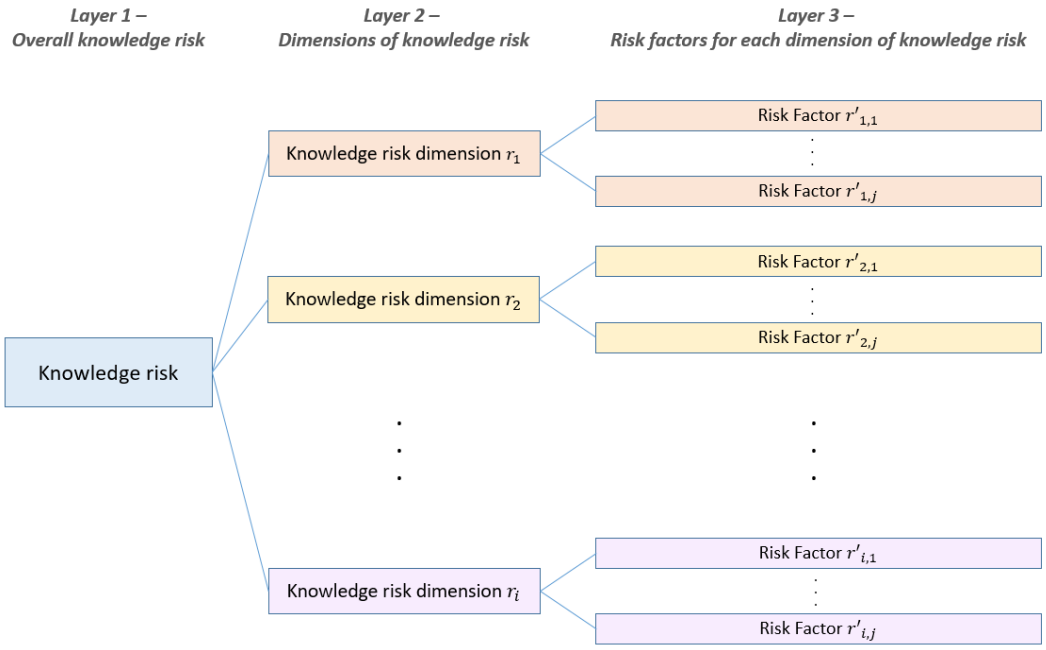

Figure 3.1 Hierarchy of the Knowledge Risk Factor Assessment Model (KRFAM)

Functionally, the proposed Knowledge Risk Factor Assessment Model (KRFAM) aims to convert the raw data (input) obtained from the two-level assessment – Level 1 assessment checklist and Level 2 evidence-based validation (see Section 3.4) into usable ratings (output) through an appropriate aggregation method for subsequent analysis. In particular, through this model mechanism, three types of ratings are generated as the output – (1) overall knowledge risk factor level, (2) risk factor level for each knowledge risk dimension, and (3) risk factor score for each risk factor, corresponding to Layer 1, Layer 2 and Layer 3 of the model respectively as shown in Figure 3.1. There are two versions of the model. The basic version is known as KRFAM version 1.0 which converts raw data from Level 1 assessment only into usable ratings collectively known as perceived ratings (i.e. perceived overall knowledge risk factor level, perceived risk factor level for each knowledge risk dimension and perceived risk factor score for each risk factor) using the simple

averaging method (conventional way for analysis) for aggregation. The refined version is known as KRFAM version 2.0 which models the data obtained from both Level 1 and Level 2 assessments using the Evidential Reasoning (ER) approach (see Section 3.6 for details) as the aggregation method to output adjusted ratings (i.e. adjusted overall knowledge risk factor level, adjusted risk factor level for each knowledge risk dimension and adjusted risk factor score for each risk factor). The meanings and calculations of the three types of output are explained in the following.

KRFAM version 1.0

In KRFAM version 1.0, only the raw data from Level 1 assessment are incorporated. In other words, only the Level 1 assessment is performed by means of a checklist type of survey to assess the knowledge risk factors of an organization. Each risk factor carries several questions used for assessment. (See Section 5.2 for details.) The average of the individual question scores of each risk factor is known as perceived risk factor score. The average of perceived risk factor scores for each dimension of knowledge risk is known as perceived risk factor level, and the average of all perceived risk factor levels is known as perceived overall knowledge risk factor level. Mathematically, the various values can be expressed as follows.

Suppose there is a set of I dimensions of knowledge risk:

$$R = \{r_i, i = 1, \dots, I\} \quad (1)$$

The set of relative weights of a given dimension of knowledge risk, r_i, is:

$$\omega = \{\omega_i, i = 1, \dots, I\} \tag{2}$$

with $0 \leq \omega_i \leq 1$ and $\sum_i^I \omega_i = 1$

Also, there is a set of *J* risk factors for a given dimension of knowledge risk, r_i:

$$R' = \{r'_{i,j}, j = 1, \dots, J\} \tag{3}$$

The set of relative weights of the *J* risk factors for a given dimension of knowledge risk, r_i, is:

$$\omega = \{\omega_{i,j}, j = 1, \dots, J\} \tag{4}$$

with $0 \leq \omega_{i,j} \leq 1 \; and \; \sum_j^N \omega_{i,j} = 1$

And there is a set of *N* assessment scores assigned to a group of questions assessed to a given risk factor:

$$Q = \{q_{i,j,n}, n = 1, \dots, N\} \tag{5}$$

The risk factor score of a given risk factor is given by:

$$Perceived\ Risk\ Factor\ Score, s_{i,j} = \frac{\sum_{n=1}^{N} q_{i,j,n}}{N} \tag{6}$$

The mean of the concerned risk factor scores forms the risk factor level of a given dimension of knowledge risk, r_i.

$$Perceived\ Risk\ Factor\ Level, l_i = \frac{\sum_{j=1}^{J} \omega_{i,j} s_{i,j}}{J} \quad (i = 1, \dots, I) \qquad (7)$$

The mean of the risk factor levels concerned is then the overall knowledge risk factor level.

$$Perceived\ Overall\ Knowledge\ Risk\ Factor\ Level, K = \frac{\sum_{i=1}^{I} l_i}{I} \quad (i = 1, \dots, I) \qquad (8)$$

Note that the relative weight of each risk factor and that of each dimension of knowledge risk are both assumed to be equal in this exploratory study.

KRFAM version 2.0

In KRFAM version 2.0, the raw data from Level 1 and Level 2 assessment are modelled using the Evidential Reasoning (ER) approach, meaning that both Level 1 and 2 are conducted. As mentioned, the objective of Level 2 assessment is to address the identified shortcoming of Level 1 assessment – unavoidably subjective responses. In fact, in Level 2, an interview is conducted during which relevant evidence, facts and examples are elicited and collected from the interviewee through the help of a set of interview questions. Based on this evidence, an informed judgement of the degree (called belief degree) to which a response at Level 1 is

close to the truth is made. This assignment of belief degree is done for the individual risk factor scores. The pair of risk factor score (from Level 1) and belief degree (from Level 2) is then modelled using the Evidential Reasoning (ER) approach to generate an adjusted risk factor score (which reflects the actual risk situation better). The adjusted risk factor scores for each dimension of knowledge risk are then aggregated to generate the adjusted risk factor level. Again, the same approach is used to synthesise all adjusted risk factor levels to generate the adjusted overall knowledge risk factor level. The meaning of belief degree and the aggregation process under ER is described in the next section (Section 3.6). The adjusted ratings are more reliable and usable because the adjustment relies on the consideration of relevant evidences.

Note that the relative weight of each risk factor and that of each dimension of knowledge risk are also both assumed to be equal as well in KFRAM version 2.0 in this exploratory study.

3.6 Evidential Reasoning (ER) Approach

The Evidential Reasoning (ER) approach developed by Professor Yang Jian Bo and his team (J. B. Yang & Sen, 1994; J. B. Yang & Singh, 1994) in the 1990's is used in the aggregation process in the KRFAM version 2.0. It is a generalisation of the Bayesian theory (Deng et al., 2011), based on the Demspter-Shafer evidence theory (Shafer, 1976), and extensively applied in approximate reasoning and information aggregation (Deng et al., 2011), and assessment or analysis in different areas.

Examples of assessment/analysis specifically of risks include: e-commerce risk assessment (Khokhar et al., 2006), internal control risk assessment (Mock et al., 2009), risk analysis (Deng et al., 2011) and risk management of sea ports (Mokhtari, Ren, Roberts, & Wang, 2012). Examples of assessment of management areas include self-assessment of excellence (J. B. Yang et al., 2001), assessment of strategic R&D projects (Liu, Zhou, Yang, & Yang, 2008), group decision analysis (Fu & Yang, 2010) and performance assessment of departments in a company (Fu & Yang, 2012). Examples of security assessment are: information security in power communication assessment (Nordstrom, 2008), maritime security assessment (Z. Yang, Wang, Bonsall, & Fang, 2009) and e-commerce security assessment (Zhang et al., 2012). Examples of assessment/analysis of engineering aspects are: safety analysis (J. Wang et al., 1995), transformer condition assessment (Tang, Spurgeon, Wu, & Richardson, 2004), dissolved gas analysis (Spurgeon, Tang, Wu, Richardson, & Moss, 2005), environmental impact assessment (Y. M. Wang et al., 2006), bridge condition assessment (Y. M. Wang & Elhag, 2008), new product assessment (Chin, Yang, Guo, & Lam, 2009), failure mode and effects analysis (Chin, Wang, Poon, & Yang, 2009), condition assessment of power transformers (Liao et al., 2011), and energy efficiency assessment (Yao, Yang, & Li, 2012).

Basically, ER starts with a list of options (or values) from which a user of ER will choose to best describe the particular characteristic of an attribute (or criteria) as a result of assessment. What makes ER different from other normal approaches in such selection/assessment is that the user can assign a belief degree varying from 0

to 1 to an option the user chooses to express the degree of believing that the option is close to the facts based on available evidence. This enables the user to give more information regarding or supporting the selection. It often happens that the user has difficulty to choose a definite option (or value) with full confidence because of lack of facts or the context of the selection is highly complex (J. B. Yang, 2001). In another situation, the selection of an option or value at the beginning may only be a subjective decision. The belief degree further provided could be used to adjust the selection after more objective data or information is known (J. B. Yang et al., 2001). The option (or value) selected and the associated belief degree are known as a belief structure and are represented as {(option, belief degree)}. In fact, the user can choose more than one options and assign a belief degree to each option if the user considers that such treatment is the best to reflect the real situation. For example, for two options chosen, the belief structure becomes {(option-1, belief degree-1), (option-2, belief degree-2)}, given that the sum of belief degree-1 and belief degree-2 is between 0 and 1 (both inclusive). This is known as a distributed assessment. It can be seen that such belief structure works best if the user has difficulty in selecting only one option from two adjacent options which look nearly the same. In ER, if belief degree = 1, the assessment is said to be complete; if $0 \leq$ belief degree < 1, it is incomplete.

The algorithm used in the ER approach (Ngan, 2015; Y. M. Wang et al., 2006; J. B. Yang, 2001; J. B. Yang & Sen, 1994; J. B. Yang & Singh, 1994; J. B. Yang & Xu, 2002) is described as follows.

Assume there is a set of *P* attributes:

$$a = \{a_i, i = 1, \dots, P\} \tag{9}$$

The set of the relative weights of the *P* attributes is:

$$\omega = \{\omega_i, i = 1, \dots, P\} \tag{10}$$

with $0 \leq \omega_i \leq 1 \; and \; \sum_i^P \omega_i = 1$

Also, the set of possible grades (or options or values) for each attribute is:

$$G = \{G_n, n = 1, \dots, N\} \tag{11}$$

Thus, the distributed assessment of a given attribute, a_i, can be expressed by:

$$S(a_i) = \{(G_n, \beta_{n,i}), n = 1, \dots, N_i\} \tag{12}$$

with $\beta_{n,i} \geq 0 \; and \; \sum_{n=1}^{N_i} \beta_{n,i} \leq 1$

where $\beta_{n,i}$ is the belief degree to the grade, G_n, assessed to the attribute, a_i

To aggregate the distributed assessments, first, the belief degrees can be transformed into basic probability masses. The algorithm behind the transformation process illustrated below is taken from Y. M. Wang et al. (2006), in particular, Equations (11) to (14):

$$m_{n,i} = m_i(G_n) = w_i \beta_{n,i},\ n = 1, \dots, N; i = 1, \dots, P \quad (13)$$

$$m_{G,i} = m_i(G) = 1 - \sum_{n=1}^{N} m_{n,i} = 1 - w_i \sum_{n=1}^{N} \beta_{n,i}\,, \qquad i = 1, \dots, P \quad (14)$$

$$\bar{m}_{G,i} = \bar{m}_i(G) = 1 - w_i, \qquad i = 1, \dots, P \quad (15)$$

$$\tilde{m}_{G,i} = \tilde{m}_i(G) = w_i \left(1 - \sum_{n=1}^{N} \beta_{n,i}\right), \qquad i = 1, \dots, P \quad (16)$$

where $m_{G,i} = \bar{m}_{G,i} + \tilde{m}_{G,i}$ (17)

where $m_{n,i}$ represents the basic probability mass to the grade, G_n, assessed to the attribute, a_i, $m_{G,i}$ represents the basic probability mass to the universal set of grades, G, assessed to the attribute, a_i, $\bar{m}_{G,i}$ represents the relative importance of other attributes, $\tilde{m}_{G,i}$ represents the incompleteness assessed to the attribute, a_i. and w_i is the relative weight of attribute a_i.

Second, the basic probability masses can be synthesised. The synthesis process illustrated below is taken from Y. M. Wang et al. (2006), in particular, Equations (15) to (20).

$$\{G_n\}:\ m_{n,I(i+1)} = K_{I(i+1)}\left(m_{n,I(i)} m_{n,i+1} + m_{n,I(i)} m_{G,i+1} + m_{G,I(i)} m_{n,i+1}\right) \quad (18)$$

$$m_{G,I(i)} = \bar{m}_{G,I(i)} + \tilde{m}_{G,I(i)}, \qquad n = 1, \dots, N \quad (19)$$

$$\{G\}: \tilde{m}_{G,I(i+1)} = K_{I(i+1)}\left(\tilde{m}_{G,I(i)} \tilde{m}_{G,i+1} + \tilde{m}_{G,I(i)} \bar{m}_{G,i+1} + \bar{m}_{G,I(i)} m_{G,i+1}\right) \quad (20)$$

$$\{G\}:\ \bar{m}_{G,I(i+1)} = K_{I(i+1)}\left(\bar{m}_{G,I(i)}\bar{m}_{G,i+1}\right) \tag{21}$$

$$K_{I(i+1)} = \left(1 - \sum_{n=1}^{N}\sum_{\substack{t=1 \\ t\neq n}}^{N}\left(m_{n,I(i)}m_{t,i+1}\right)\right)^{-1}, \qquad i = 1,\dots,P-1 \tag{22}$$

$$\{G_n\}:\ \beta_n = \frac{m_{n,I(P)}}{1-\bar{m}_{G,I(P)}}, \qquad n = 1,\dots,N \tag{23}$$

$$\{G\}:\ \beta_G = \frac{\tilde{m}_{G,I(P)}}{1-\bar{m}_{G,I(P)}} \tag{24}$$

where β_n represents the belief degree to the grade, G_n of the aggregated distributed assessment and β_G represents the belief degree to the universal set of grades, G, of the aggregated distributed assessment.

The belief structure of the aggregated distributed assessment is expressed by:

$$S'(a_i) = \{(G_n, \beta_n), n = 1,\dots,N\} \tag{25}$$

A utility-based information transformation technique can then be used to transform the distributed assessment into the expectation of the assessment. The summary of which as shown below is taken from J. B. Yang (2001), in particular, Equations (57), and (59) to (62).

The estimated utility of a given distributed assessment for the attribute, a_i, is:

$$\mu\big(S(a_i)\big) = \sum_{n=1}^{N} \mu(G_n)\,\beta_{n,i} \tag{26}$$

For qualitative attributes, the estimated utilities of the grades are supposed to be equally distributed in the normalised utility space such that:

$$\mu(G_n) = \frac{n-1}{N+1}\ (n = 1, \dots, N) \tag{27}$$

For quantitative attributes, the estimated utilities of the values are approximated using the linear marginal utility function in the normalised utility space such that:

$$\mu\big(v_j\big) = \mu\big(v_{1,i}\big) + \frac{\Big(\mu\big(v_{N,i}\big) - \mu\big(v_{1,i}\big)\Big)\big(v_j - v_{1,i}\big)}{v_{N,i} - v_{1,i}} \tag{28}$$

The equivalent expectation of a given distributed assessment is then denoted by:

$$S'^{(a_i)} = \big\{\big(G_n, \beta_{j,i}\big), j = 1, \dots, N\big\} \tag{29}$$

where

$$\beta_{j,i} = \begin{cases} \displaystyle\sum_{n \epsilon \pi_j} \gamma_{n,i}\tau_{j,n} \quad for\ j = 1 \\ \displaystyle\sum_{n \epsilon \pi_{j-1}} \gamma_{n,i}\big(1 - \tau_{j-1,n}\big) + \sum_{n \epsilon \pi_j} \gamma_{n,i}\tau_{j,n} \quad for\ 2 \le j \le N-1 \\ \displaystyle\sum_{n \epsilon \pi_{j-1}} \gamma_{n,i}\left(1 - \tau_{j-1,n}\right) \quad for\ j = N \end{cases} \tag{30}$$

and

$$\tau_{j,n} = \frac{\mu(G_{j+1}) - \mu(G_{n,i})}{\mu(G_{j+1}) - \mu(G_j)} \quad if\ \mu(G_j) \le \mu(G_{n,i})$$

$$\le \mu(G_{j+1}) \quad for\ a\ qualitative\ attribute \tag{31a}$$

$$\tau_{j,n} = \frac{\mu(G_{j+1}) - \mu(v_{n,i})}{\mu(G_{j+1}) - \mu(G_j)} \quad if\ \ \mu(G_j) \le \mu(v_{n,i})$$

$$\le \mu(G_{j+1}) \quad for\ a\ quantitative\ attribute \tag{31b}$$

and

$$\pi_j = \begin{cases} \{n|\mu(G_j) \le \mu(G_{n,i}) \le \mu(G_{j+1}), n = 1, \dots, N_i\}, & j = 1, \dots, N-2 \\ \{n|\mu(G_j) \le \mu(a_{n,i}) \le \mu(G_{j+1}), n = 1, \dots, N_i\}, & j = N-1 \end{cases} \tag{32}$$

In this research, the Intelligent Decision System (IDS) was used to perform the aggregation and transformation process under the ER approach. It is a software package developed especially for handling uncertain problems under the ER approach (IDS, 2007; Xu & Yang, 2005) and is also used or suggested by scholars like J. B. Yang et al. (2001), J. B. Yang (2001) and Y. M. Wang et al. (2006).

Chapter 4 Identification of the Dimensions of Knowledge Risk and its Risk Factors

4.1 Overview

Generally speaking, knowledge is the most important intangible asset of an enterprise. It needs to be acquired, stored, used, enhanced and protected. Many companies have a vague idea of what knowledge management (KM) is, though they use KM and rely on KM to run their daily business. Risks of knowledge like knowledge loss due to staff resignation or knowledge leakage due to insecure information systems are quite familiar to all levels of employees in organizations.

The first systematic study explored how employees perceive and understand the various kinds of knowledge risk in business by interviewing them face-to-face in preparation for an in-depth study. The findings were used to identify the dimensions of knowledge risk and the associated risk factors, and to design and formulate a two-level assessment to evaluate the knowledge risk factors. This chapter includes the semi-structured interview design, data collection, findings and discussion.

4.2 Interview Design

The interview guide covered these areas: perception of risk and knowledge risk, examples of knowledge risk based on past experiences, causes, assessment, and mitigation of knowledge risk, and barriers to managing knowledge risk. For the principles guiding the design of interview guide, please refer to Section 3.3. The guiding questions were:

- What is your understanding of the concept of risk?
- What is your understanding of the concept of knowledge risk? How do you define it?
- Can you provide some examples of risks related to knowledge in a company/in your company?
- Can you provide some examples or explain the risks related to knowledge based on your understanding/experience/situation in your company?
- In what way do you think a company can/does your company evaluate knowledge risk?
- Traditionally, people measure risk in terms of likelihood and impact. Do you think the same approach can be applied in assessing knowledge risk (in your company)? Why?
- What are the factors that affect knowledge risk in a company/in your company?
- How should/are the risks related to knowledge be/being managed in a company/in your company? In other words, in what ways do you think a

company can/does your company combat knowledge risk, e.g. to prevent/mitigate the risk?

- How should a company/your company determine the risks related to knowledge to focus on?
- Who should make/makes the decision on the management of knowledge risk (in your company)?
- What impacts do you think there will be on a company/your company having knowledge risk?
- What are the benefits to companies/your company if they manage knowledge risk well? How should a company measure/How does your company measure these benefits?
- During the processes of knowledge risk management and implementation, what will be/has your company come across the/any barriers internally or externally?
- Do you think companies/your company now pays sufficient attention to knowledge risk?

4.3 Data Collection

As knowledge risk is still not commonly spoken of or well-understood among business practitioners, purposive sampling was adopted in this study rather than random sampling. The former is a non-random sampling in that the participants are chosen according to certain pre-determined specific criteria which were considered

appropriate for the purpose of the study concerned (Teddlie & Yu, 2007) (refer to Section 3.3 for details).

The list of interviewees was first compiled by searching the databases of past contacts of the authors which included knowledge management professionals having joined past seminars, conferences, courses, projects, studies, and/or other industry events. The next step was to confirm their willingness to participate in the interview. The position, working experience and industry inforamation of the actual participants are summarised in Table 4.1.

Before the interview started, the interviewee was given an information sheet informing them of the purpose of the research, the format of the interview and what he/she was supposed to do. The researcher went through the sheet with the interviewee verbally and answered any queries he/she had. Then the interviewee was asked to sign a consent form which also included the guarantee that his/her identity was kept anonymous, and information and views expressed would not be released to any third party. The participant was offered the option to withdraw from the study at any time before, during or after the interview for any reason. (No one exercised this right throughout the study.)

A total of 11 interviewees participated. Each interview lasted between 45 minutes and 1 hour and was tape-recorded. Field notes were made by the researcher when necessary.

Table 4.1 Summary of demographic information of interviewees in the semi-structured interviews

Categories		**Frequency**
Job position	Manager	4
	Executive	3
	Officer	2
	Owner of business	1
	Director/Vice president	1
Working experience	More than 10 years	5
	5 to 10 years	2
	3 to 5 years	2
	1 to 3 years	2
Industry	Consumer discretionary	2
	Education	2
	Logistics	2
	Consultancy	1
	Consumer staples	1
	Health-care industrials	1
	Information technology	1
	Materials	1

4.4 Findings and Discussion

During the interview, the interviewees were asked questions from three broad areas: perception of risk and knowledge risk, examples of knowledge risk and management support. The purpose was to assess the current situation of knowledge risk handling in the organizations. The general inductive approach was used for the interview data analysis (refer to Section 3.3 for details) and thus seven areas – (1) understanding of risk and knowledge risk, (2) impact and likelihood of risk, (3) knowledge leakage risk, (4) knowledge loss risk, (5) knowledge obsolescence risk, (6) knowledge shortage risk and (7) management support were drawn up for the discussion below.

(1) Understanding of risk and knowledge risk

Though the interviewees were at different points along the path to manage knowledge risk in their own organizations, the interview sought to find out the commonality and difference in their perception and background understanding of risk and knowledge risk. In general, all had the correct perception of risk as events in the future which may cause problems, damage, danger or cause loss to an organization.

I think that though risk brings negative effects, it can be measured and prevented (Interviewee 12).

However, one of the interview participants raised the point that risk can also bring opportunities. This remark is similar to the view of COSO (2012), which regards that if risks are managed well, they can also become opportunites for an organization to take advantage of. This showed that some interviewees may understand risk better than others and think beyond the traditional perception.

All participants gave correct replies to the question asking them what knowledge risk is. Most of them could provide a knowledge risk example. The most quoted example was knowledge loss which happens when employees leave a company without the company properly retaining their knowledge before their departure, causing operational or possible business continuity problems.

The first example of knowledge risk which comes to mind is knowledge loss risk. Knowledge loss may be caused by employee turnover or improper documentation of knowledge (Interviewee 4).

Other types of knowledge loss mentioned included loss of business problem solutions and business contact information, which are quite similar to forgetting the reasons for making certain decisions and past stories of a company's successes or failures – mentioned by Daghfous et al. (2013). Such forgetting is regarded as knowledge loss by DeLong (2004).

(2) Impact and likelihood of risk

In general, the interviewees considered that knowledge risk can be measured in terms of impact and likelihood. Impact refers to the likely damage caused when the event leading to the risk happens and likelihood refers to the probability of the occurrence of the event. Such measurement follows that of the conventional risks like fire hazards or flooding (Williams, 1993). As expected, many thought that impact is more easy to consider and likelihood is quite difficult to determine in most cases. One of the interviewees said that if an employee leaves a company, the impact is reflected in the number of additional hours put in by the existing staff to do the work previously done by the left employee. However, she found it difficult to describe the likelihood of such case. Others thought that more data in a number of related areas are required to determine the impact and likelihood of a particular risk more closely to reality. The interviewees were active in expressing their opinions about the impact of knowledge risk upon an organization.

My company laid off quite many employees, including experienced staff, in one company-wide operation streamline programme. Colleagues had difficulty to continue to use some IT application systems because the very knowledgeable staff had already left. I was assigned to a team to retest the system to find out the logic of how the system worked and how to operate it correctly. The end-result was that some missing parts in the logic were identified but we could not figure out what really constituted the missing parts (Interviewee 12).

A similar situation happened in Delta Airlines when it took a downsizing of the company, thereby laying off many experienced mechanics (Parise et al., 2006).

Because several very experienced staff left, my colleagues and I needed to contact the overseas supplier to fix some urgent system problems, which really affected the operation efficiency of our department (Interviewee 8)

They mentioned a number of other impacts of knowledge risk, including reduction in efficiency and effectiveness of work, and drop in revenue. In particular, one interviewee mentioned the low growth caused by high knowledge obsolescence rate or delay in advanced technology adoption. Other scholars have described similar drawbacks like loss of efficiency and effectiveness of operation (Alexander, Bloom, & Nuchols, 1994; Dess & Shaw, 2001), resources wasted in reinventing the wheel (B. Jiang, Baker, & Frazier, 2009), loss of social capital in organization (Dess & Shaw, 2001), impacts on existing social relations (Pennings, Lee, & Van Witteloostuijn, 1998), and reduction in customer referrals (B. Jiang et al., 2009).

Some thought that the results of knowledge risks measures could be assessed by considering, for example, return on investment (for financial resources spent on mitigating or preventing risks), increase in revenues, or improvement in customer complaint handling.

(3) Knowledge leakage risk

Knowledge leakage risk refers to the potential problems or threats caused by unintentional, careless or unauthorised leakage of knowledge to inappropriate parties inside or outside an organization. The current situation, as said by one interviewee, was that many organizations do not pay sufficient attention to the risk. When the interviewees were asked about knowledge leakage risk, most of them mentioned first that the risk was related to internal controls and staff risk awareness in an organization.

The company should educate the staff on what they should and should not do in safeguarding knowledge (Interviewee 5).

They regarded that internal control policies should be set up and enforced to prevent knowledge leakage. Training should also be conducted. Then the information system security issue was raised by many of them during the interview. They consider that it is absolutely essential to have stringent IT security in place to protect the company databases against intrusion or attacks. One interviewee mentioned a simple procedure to follow to minimise leakage.

Staff should be required to set up a password for the PC screensaver (which is activated when a specified short time of no keyboard/mouse activity lapses) to hide information shown on screen and prevent unauthorised access (Interviewee 6).

A few interviewees also provided what they know about the importance of IP (intellectual property). They were of the opinion that legal rights to inventions or innovations are necessary to establish to protect the company's interest and prevent illegal use by competitors in the case of leakage.

The invention or innovation of a company is its assets (Interviewee 4).

Two other interviewees also offered their information or opinions. One interviewee said that the legal and compliance department of her company handles IP and another said that maybe IP is more relevant to technological companies.

It is quite usual for two or more companies collaborate in some joint projects or ventures in business to take advantage of each other's strengths or unique skills. However, the collaboration may increase the chance of leakage because there is an increased level of communication between partners and sharing of knowledge. Some interviewees suggested the use of non-disclosure agreements (NDAs) to protect involved parties' individual knowledge or information possessed. They also mentioned the importance of trust between parties in collaboration. One interviewee considered that for NDAs to be effective in practice, mutual trust should be established first.

(4) Knowledge loss risk

Knowledge loss risk refers to the potential problems, negative consequences or threats to an organization when knowledge originally possessed no longer exists inside the organization. The two most common factors affecting knowledge loss in an organization mentioned by the interviewees were employee turnover and retirement of key employee. Scholars like Caroline Martins and Meyer (2012), Daghfous et al. (2013) and Parise et al. (2006) also quote these two factors in their works. The third factor mentioned was ineffective knowledge retention measures to capture and codify knowledge.

If there is no comprehensive knowledge database set up and maintained to store various kinds of knowledge such as customer contact history, it would be difficult for the company to monitor growth and performance (Interviewee 7).

The interviewee agreed that tacit knowledge is more difficult to retain than explicit knowledge.

A lot of knowledge, especially tacit knowledge, is still stored in employees rather than knowledge systems (Interviewee 3).

Interviewees found that knowledge retention is not followed strictly by employees because they are too busy with more urgent or important tasks on hand already. The

interviewees considered that the management should set up a knowledge retention policy and procedural guidelines for all employees to follow as part of their work duties and allocate sufficient time for doing so. They preferred the top-down approach rather than the bottom-up as the former is more effective in this case but at the same time, they expressed concerns about management commitment, another factor of knowledge risk, in corporation-wide knowledge retention.

Management commitment is important because good knowledge retention programmes need many resources like IT systems and knowledge specialists (Interviewee 1).

The role of management is to encourage employees to share information, knowledge and so on (Interviewee 6).

But one interviewee expressed the opposite opinion.

A bottom-up approach may be preferred if the management shows no commitment (Interviewee 9).

At the same time, the interviewees expressed concern about employees' willingness or enthusiasm in regard to such efforts even with management commitment in place when employees think that knowledge retention is not the most pressing thing to do in daily work.

Other factors were mentioned very briefly: lack of sharing opportunities among staff during work (so that loss likelihood is reduced), user-friendliness and training issues with knowledge systems and fear of losing possessed exclusive knowledge to other staff. The last factor is mentioned by Thibaut and Kelley (1959) in their works.

(5) Knowledge obsolescence risk

Knowledge obsolescence risk refers to the potential problems which occur when some part of knowledge becomes outdated or no longer useful. Many interviewees agreed that rapid changes or advances in the market or technology account for knowledge obsolescence today.

I think knowledge obsolescence can be found by knowledge validation in knowledge management. Even knowledge acquired less than a year ago can become obsolete (Interviewee 4).

A company is required to be innovative and creative today, and first mover advantage may be gained (Interviewee 9).

An interviewee emphasised the importance of having the most up-to-date information on technology in the market in order to procure the latest equipment which may not become obsolete so soon. Another interviewee mentioned the Nokia failure in the smartphone market because Nokia could not enhance its mobile phone

technology fast enough. On the other hand, one interviewee expressed one less common remark that knowledge obsolescence can be an opportunity for faster knowledge renewal which benefits a company. This opinion is similar to that of the research work of Mohammad and Sykes (2012).

Knowledge obsolescence risk can be mitigated by collaborating with other companies in joint business projects because the collaboration enables the company to gain more knowledge by co-sharing of knowledge and skills with partners.

(6) Knowledge shortage risk

Knowledge shortage refers to the potential problems which arise because of employees not possessing the required knowledge to fulfil business needs. One interviewee thought that the impact of insufficient knowledge is beyond the organizational boundary.

If employees do not have sufficient knowledge to do their work, the market or society may be impacted (Interviewee 3).

Insufficient training was quoted by many interviewees as one of the causes of this risk. Learning culture in an organization was also mentioned by quite a number of interviewees to be a potential solution to the insufficiency problem.

... However, the success of a strong learning culture needs the support of top management (Interviewee 8).

The less mentioned potential solution was sound talent management whose objective is to provide the necessary support in training, resources and job contents so that talents can maximise and enhance their special gifted talents to serve the business needs.

(7) Management support

The interviewees agreed that knowledge risks are not receiving the attention they deserve in an organization, particularly from management.

Management is aware of knowledge risk but they do not know what to do with it. They would realise the importance of knowledge when they have lost it (Interviewee 1).

Management knows the existence of knowledge risk but they don't have time to manage it (Interviewee 10).

Management thinks that the present system is so secure that knowledge leakage is not possible (Interviewee 12).

The first two quotes show the indifferent attitude of an organization towards knowledge risk while the last shows the misunderstanding of management in knowledge leakage and that they are not aware of leakage happening because of human errors which cannot be prevented by the best secure system.

Management often would like to know hard financial figures to be convinced of any management actions, including knowledge risk management but the benefits of knowledge management are difficult to quantity financially. (Interviewee 3)

Interviewee 3 was not alone. His experience may be common in any organization. The fact is that knowledge risk management is best initiated from the top level of the corporate hierarchy for it to be effective and accepted by staff and it would be an uphill task if it is initiated by middle management.

Brief summary

The above outputs of the interviews gave the author a good overall view of the major concerns of knowledge risk in organizations, and validate that the four dimensions of knowledge risk and their risk factors identified in the literature review (see Section 2.4) are adequate in the exploratory stage of a suitable design of knowledge risk factor assessment. Most of the views from the interviewees accorded with the findings reported in the literature.

Chapter 5 Design of Assessment Questions on Knowledge Risk Factors

5.1 Overview

In a typical business risk management process, there are four stages: risk identification, risk assessment, risk response, and risk reporting and monitoring. Risk assessment is as important as the other three. In this study, a two-level assessment for knowledge risk factors was designed. The risk factors of four common and important dimensions of knowledge risk: knowledge loss risk, knowledge leakage risk, knowledge obsolescence risk and knowledge shortage risk, were evaluated systematically (see Figure 5.1). The four dimensions of knowledge risk, and the associated risk factors (which may or may not be casual) which increases the corresponding risk were identified based on the results of the literature review (see Section 2.4) and semi-structured interviews (see Chapter 4). Furthermore, as the semi-structured interviews conducted with knowledge professionals show, the interviewees expressed the opinion that it is quite difficult to measure impact or likelihood. Designing an assessment of the risk factors instead of the risk itself would be a good start in the early stage in the research of knowledge risk.

Up to the present, it is more frequent to find research which studies or assesses one type of risk – knowledge loss risk, for example. This framework goes further to assess the risk factors of a group of related knowledge risks together instead of one. This has the net effect of producing a more comprehensive assessment of the knowledge risk factors in an organization, contributing to prioritisation of risk and allocation of resources in risk management. In structure, the assessment consists of two levels – Level 1 assessment checklist and Level 2 evidence-based validation (see Section 3.4 for the research methods for these two levels). At Level 1, an assessment score of individual risk factors is obtained in a survey when participants give scores according to a pre-determined scale based on his/her general view or understanding. At Level 2, based on evidence collected instead, interviews are arranged during which interviewees review the individual results obtained at Level 1 by giving a belief score using a scale from 0 (very uncertain) to 1 (very certain). In this section, the design of questions used in these two assessments is explained.

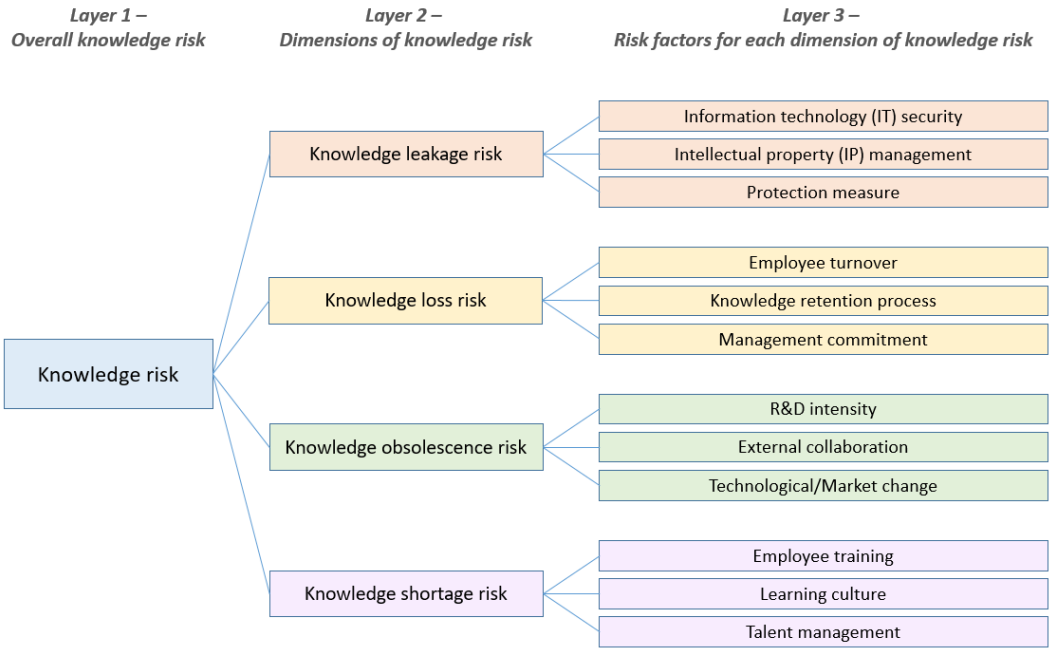

Figure 5.1 Four dimensions of knowledge risk and the associated risk factors

5.2 Construction of Survey Questions

At Level 1, an assessment checklist in the form of a survey is adopted. The survey consists of four sections, one for each of the four dimensions of knowledge risk: knowledge leakage risk, knowledge loss risk, knowledge obsolescence risk and knowledge shortage risk. Each section has questions for three risk factors involved in the particular knowledge risk dimension concerned.

5.2.1 Survey Design

The design of questions for assessing the risk factors of the four dimensions of knowledge risk was based on the outcomes of literature review (see details in

Section 2.4) and the semi-structured interview with knowledge management professionals (see details in Chapter 4). Table 5.1 shows the references which were especially used in the questionnaire design.

Table 5.1 References for assessment questions developed

Knowledge Risk Dimension	**Risk Factor**	**References**
Knowledge leakage risk	Information technology (IT) security	Ernest Chang and Lin (2007)
	Intellectual property (IP) management	Ahmad et al. (2014) and Manhart and Thalmann (2015)
	Protection measure	Parker (2012) and Norman (2002)
Knowledge loss risk	Employee turnover	Nil
	Knowledge retention process	DeLong (2004) and Hung et al. (2010)
	Management commitment	Levy (2011)
Knowledge obsolescence risk	R&D intensity	Chen, Lin, and Chang (2009)
	External collaboration	Zeng, Xie, and Tam (2010)

	Technological/Market change	García-Zamora et al. (2013)
Knowledge shortage risk	Employee training	Takeuchi et al. (2007) adpated from Lepak and Snell (2002)
	Learning culture	Hung et al. (2010)
	Talent management	Höglund (2012)

The assessment relied upon a multiple-item method and each item used a 6-point Likert scale to obtain participants' responses. A score of 1 indicates strongly disagreeing with the statement while a score of 6 indicates strongly agreeing with the statement. Past studies indicated that ordinal classification of perception is better than interval or ratio measures because it is more user-friendly or easily understood by the respondents who would then be more willing to reply, raising the general preciseness of the replies obtained (Geringer, 1991). A 6-point scale has the advantage of avoiding respondents opting for a mid-range position (Amabile, Conti, Coon, Lazenby, & Herron, 1996) to appear socially acceptable or 'help' the researcher, though still suffering from the common occurrence of respondents avoiding taking extreme positions (Albaum, 1997). The assessment questions in the survey are as follows.

Knowledge leakage risk

A. Information technology (IT) security

- A1: Our company has a team or department responsible for IT security issues.
- A2: Our company has a periodic check or update on the security of the IT system.
- A3: Our company has an IT system controlling the access right to sensitive or confidential knowledge.
- A4: Our company has a secure IT system to prevent unauthorized persons from intruding significant knowledge.

B. Intellectual property (IP) management

- B1: Our company recognizes the importance of applying for IP (e.g. patents, copyrights, trademarks) to protect our products or services.
- B2: Our company has measures for protecting important trade secrets to prevent leakage.
- B3: Our company has a term in the employment contract to decide the ownership of intellectual property rights.

C. Protection measure

- C1: Our company does not allow employees to view the company's essential knowledge outside the workplace (e.g. prohibiting copying data on

their USB drives for home usage).

- C2: Our company takes very seriously any data breach by employees.
- C3: Our company has control devices on the photocopier to prevent confidential documents from getting copied and circulated.

Knowledge loss risk

D. Employee turnover

- D1: In our company, the employee turnover rate of key employees is higher than the industry average.
- D2: In our company, the retirement rate of key employees is higher than the industry average.

E. Knowledge retention process

- E1: Our company transcribes significant (tacit) knowledge owned by the employees into archives or videos.
- E2: Our company makes past lessons learnt available to its employees.
- E3: Our company has a document version control to avoid obsolete documents being used.

F. Management commitment

- F1: In our company, the top management knows the critical knowledge to the business operation of the company.

- F2: In our company, the top management has a successor training programme for the critical tasks.
- F3: In our company, the top management allocates necessary resources (e.g. staff, teams, departments) to retain and elicit (tacit) knowledge of the employees.
- F4: In our company, the top management has a policy or plan to retain employees with specific skills and knowledge.
- F5: Our company encourages the sharing of important know-how and skills among employees.

Knowledge obsolescence risk

G. R&D intensity

- G1: Our company has an in-house R&D (Research & Development) team.
- G2: Our company regularly plans for new products or services.
- G3: Our company owns or has applied for patents or copyrights for its products.
- G4: Our company has a scheme to encourage employees to propose their new ideas.

H. External collaboration

- H1: Our company absorbs new knowledge from our suppliers.
- H2: Our company collects market and customer information regularly.
- H3: Our company searches for strategic partners (e.g. research institutions,

universities, experts) to collaborate with.

- H4: Our company will acquire companies with new knowledge or technology if there is a chance.

I. Technological/Market Change

- I1: In the market or industry where our company operates, consumer needs change very quickly.
- I2: In the market or industry where our company operates, product or service lifecycles are short.
- I3: In the market or industry where our company operates, competitors often adjust their price, product or service strategy.
- I4: In the market or industry where our company operates, competition is very fierce.

Knowledge shortage risk

J. Employee training

- J1: Our company offers opportunities for employees to grow continuously.
- J2: Our company has training programmes striving to develop firm-specific skills and knowledge.
- J3: Our company often invites external experts to deliver lectures or seminars to employees.

K. Learning culture

- K1: In our company, employees are willing to learn new knowledge or new

technology.

- K2: In our company, employees are willing to share their skills and know-how with their colleagues.
- K3: Our company has an information platform for employees to share knowledge with each other.
- K4: Our company has social sessions or activities for employees to release and absorb new knowledge.

L. Talent management

- L1: Our company offers career and promotion opportunities to suitable individuals.
- L2: Our company actively headhunts valuable candidates in the industry.
- L3: Our company maintains a sufficient number of employees in critical business areas or departments.
- L4: Our company has sufficient knowledge or expertise in various departments to develop its business.
- L5: Our company can recruit suitable candidates in the market to fill up vacancies.

Questions were reverse-coded except those in 'D. Employee turnover' and 'I. Technological/Market Change' such that a higher risk factor score implies an increased knowledge risk (Note that the risk factor score ranges from 1 to 6 with 1

representing low risk factor score and 6 representing high risk factor score, in line with the definition of risk factor in the literature. Refer to Table 5.2 below for details.

Table 5.2 Meanings of risk factor scores

Knowledge Risk Dimension	**Risk Factor**	**A Higher Risk Factor Score indicates**
Knowledge leakage risk	Information technology (IT) security	lower IT security
	Intellectual property (IP) management	poorer IP management
	Protection measure	a more insufficient protection measure
Knowledge loss risk	Employee turnover	higher employee turnover
	Retention process	a more insufficient retention process
	Managerial commitment	lower managerial commitment
Knowledge obsolescence risk	R&D intensity	lower R&D intensity
	External collaboration	lower external collaboration
	Technological/market change	a more rapid technological/market change
Knowledge shortage risk	Employee training	lower employee training
	Learning culture	a poorer learning culture
	Talent management	poorer talent management

5.2.2 Data Collection

Before the Level 1 assessment questions were used in the actual analysis (i.e. the case studies in Chapter 6), the questions in the list had to be checked for content, discriminant and convergent validity, and reliability. Therefore, the checklist questionnaires were distributed to a group of participants based on sample of convenience together with the key informant approach (see Section 3.4.1 for details) to provide sufficient data for subsequent validity and reliability checks by two statistical methods – Principal Component Analysis (PCA) and Cronbach's alpha test.

A group of 42 participants who are full-time employees were selected from among part-time master degree students and knowledge management workshop participants. In this pilot run, 52 assessment items were included in the checklist. Modifications to the checklist were then carried out according to the results from the initial factor analysis and reliability tests of the assessment items and feedback from the respondents. The checklist then had the number of assessment items reduced to 44.

The modified checklist was used in the formal survey of participants. The result was that a total of 69 completed or partially completed survey forms were returned with 63 being considered useable, representing a useable response rate of approximately 91.30%. In this round of formal survey, participants were asked to act as an assessor to evaluate the knowledge risk factors in his/her company as

shown in the checklist. Their companies' characteristics are summarised in Table 5.3. The classification of company size followed that of the Organization for Economic Co-operation and Development (OECD) (OECD, 2014) and that of industry followed the Global Industry Classification Standard (GICS) specified by Morgan Stanley Capital International (MSCI) (MSCI, 2017) with education, government and legal services added. As shown in Table 5.4 and Table 5.5, the respondents were from quite diverse backgrounds.

Table 5.3 Sample characteristic – firm size

Number of Employees	**Frequency**	**Percentage (%)**
0 – 249 (SMEs)	12	19
> 250 (Large enterprises)	51	81
Total	63	100

Table 5.4 Sample characteristic – firm industry

Industry	**Frequency**	**Percentage (%)**
Consumer discretionary	11	17.46
Consumer staples	2	3.17
Financials	7	11.11
Health-care industrials	1	1.59
Information technology	2	3.17
Materials	6	9.52

Telecommunication services	2	3.17
Utilities	19	30.16
Education	5	7.94
Government	4	6.35
Legal Services	1	1.59
Unclassified	3	4.76
Total	63	100

Table 5.5 Sample characteristic – position of respondents

Position Grade	**Frequency**	**Percentage (%)**
Managerial grade	22	34.92
Non-managerial grade	36	57.14
Unclassified	5	7.94
Total	63	100

5.2.3 Validity and Reliability Results of the Survey

Three types of validity of the checklist: content, discriminant and convergent validity, and reliability were required to be tested. Content validity refers to the degree of relevancy and representativeness of the elements involved in an assessment tool in relation to the construct set up for a specific assessment objective (Haynes, Richard, & Kubany, 1995). This validity check was done by an extensive, pertinent literature review and the results of the pilot testing of the questionnaire

design. Discriminant validity concerns whether the risk factors belonging to the same kind of risk differ from each other and this is done by factor analysis (Kerlinger, 1986). Principal Component Analysis (PCA) was performed to validate that the individual scores of assessment questions or items (which constitute the underlying construct) of the same risk factor could be averaged to obtain the risk factor score.

Before PCA testing, however, three assumption tests were required. First, the sample size had to fulfil the minimum which can be calculated based on the convention of a minimum of five responses per variable (E. Ngai & Cheng, 1997). The calculation results for each dimension of knowledge risk are shown in Table 5.6. Because there were 63 usable responses, the actual sample size of each risk dimension exceeded the minimum. Second, as the correlation matrix calculation showed a significant number of assessment items having at least one correlation coefficient greater than 0.3, PCA was suitable for this dataset (Hair, Anderson, Tatham, & Black, 1995). Third, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was performed on the whole data set. The KMO measures for each risk dimension are shown in Tables 5.7 to 5.10. They all exceeded the minimum value of 6 and were in or tended to be in the "Meritorious" class according to Kaiser (1974). Also, Bartlett's test of sphericity for each risk dimension was statistically significant ($p = 0.000 < 0.05$).

Table 5.6 Minimum sample size required for Principal Component Analysis

Knowledge Risk dimension	**Total number of assessment items**	**Minimum sample size required**
Knowledge leakage risk	10	50
Knowledge loss risk	10	50
Knowledge obsolescence risk	12	60
Knowledge shortage risk	12	60

Table 5.7 to 5.10 show the eigenvalues of each component for each risk dimension after running PCA. The varimax orthogonal rotation method (Kaiser, 1958) was then applied to make the final solution have a "simple structure" (Thurstone, 1947) for interpretation. For knowledge leakage risk, the eigenvalues of components 1, 2 and 3 were greater than 1, explaining 50.43%, 13.69% and 11.18% of the total variance respectively. For knowledge loss risk, the eigenvalues of components 1, 2 and 3 were greater than 1, explaining 40.83%, 15.08% and 13.70% of the total variance respectively. For knowledge obsolescence risk, the eigenvalues of components 1, 2 and 3 were greater than 1, explaining 43.21%, 18.74% and 11.19% of the total variance respectively. For knowledge shortage risk, the eigenvalues of components 1, 2 and 3 were greater than 1, explaining 51.79%, 13.40% and 10.06% of the total variance respectively.

Following both the eigenvalue-one (Kaiser, 1960) and interpretability criteria, three components were retained for each risk dimension. Specifically, the three-

component solutions in each risk dimension explained 75.30%, 69.61%, 73.14% and 75.24% of the total variance of knowledge leakage risk, knowledge loss risk, knowledge obsolescence risk and knowledge shortage risk respectively. These findings are consistent with the three risk factors of each risk dimension that the checklist is designed to measure. For knowledge leakage risk, components 1, 2 and 3 had strong loadings of IT security items, IP management items and protection measure items respectively. For knowledge loss risk, components 1, 2 and 3 had strong loadings on management commitment items, knowledge retention process and employee turnover items respectively. For knowledge obsolescence risk, components 1, 2 and 3 had strong loadings of external collaboration items, technological/market change items and R&D intensity items respectively. For knowledge shortage risk, components 1, 2 and 3 had strong loadings of talent management, employee training items and learning culture items respectively.

Finally, for both the convergent validity and reliability, they were checked by the Cronbach's alpha test. The former was validated by the item-to-total correlation coefficient and the latter by the Cronbach's alpha value. The Cronbach's alpha values for each risk factor as shown in Tables 5.7 to 5.10 all exceed 0.7 which is the recommended value (DeVellis, 2003; Kline, 2005), except for employee turnover. The corrected item-total correlation for each risk factor exhibited a correlation with a Pearson coefficient over 0.3, except for employee turnover. For the two items in employee turnover, the Cronbach's alpha value does not meet the minimum requirement while the corrected item-total correlation has a correlation coefficient very close to 0.3. However, further inspection of the wordings of the

items shows that both items measured the intended construct and thus they were justifiable for subsequent analysis. To conclude, the Level 1 assessment was valid in terms of content, discriminant, convergent validity, and reliability. Thus, it could be used for evaluation of the risk factors concerned and subsequent analysis.

Table 5.7 Results of the Principal Component Analysis – knowledge leakage risk

Risk factor	**Variable**	**Loading**	**Eigenvalue**	**Accumulated variance (%)**	**Cronbach's alpha**
Information technology (IT) security (Component 1)	A4	0.905	5.403	50.433	0.921
	A3	0.867			
	A2	0.827			
	A1	0.805			
Intellectual property (IP) management (Component 2)	B1	0.847	1.368	64.118	0.817
	B3	0.837			
	B2	0.713			
Protection measure (Component 3)	C3	0.817	1.118	75.300	0.702
	C1	0.732			
	C2	0.659			
KMO = 0.806; Bartlett's test: 384.408; d.f. = 45; Sig. level: $p < 0.000$					

Table 5.8 Results of the principal component analysis – knowledge loss risk

Risk factor	**Variable**	**Loading**	**Eigenvalue**	**Accumulated variance (%)**	**Cronbach's alpha**
Management commitment (Component 1)	F2	0.895	4.803	40.831	0.871
	F3	0.874			
	F4	0.834			
	F1	0.716			
	F5	0.586			
Knowledge Retention process (Component 2)	E2	0.917	1.508	55.907	0.794
	E1	0.870			
	E3	0.613			
Employee turnover (Component 3)	D1	0.784	1.370	69.606	0.423
	D2	0.772			
KMO = 0.790; Bartlett's test: 267.769; d.f. = 45; Sig. level: $p < 0.000$					

Table 5.9 Results of the Principal Component Analysis – knowledge obsolescence risk

Risk factor	**Variable**	**Loading**	**Eigenvalue**	**Accumulated variance (%)**	**Cronbach's alpha**
	H2	0.890	5.185	43.212	0.866

External collaboration (Component 1)	H1	0.870			
	H3	0.824			
	H4	0.677			
Technological/ Market change (Component 2)	I3	0.838	2.249	61.951	0.855
	I2	0.838			
	I1	0.800			
	I4	0.754			
R&D intensity (Component 3)	G2	0.828	1.342	73.136	0.821
	G3	0.773			
	G1	0.762			
	G4	0.621			
KMO = 0.806; Bartlett's test: 435.976; d.f. = 66; Sig. level: $p < 0.000$					

Table 5.10 Results of the Principal Component Analysis – knowledge shortage risk

Risk factor	**Variable**	**Loading**	**Eigenvalue**	**Accumulated variance (%)**	**Cronbach's alpha**
Talent management (Component 1)	L5	0.872	6.214	51.787	0.883
	L3	0.864			
	L4	0.744			
	L1	0.697			
	L2	0.657			
Employee training	J2	0.867	1.607	65.183	0.885
	J3	0.814			

(Component 2)	J1	0.777			
Learning culture (Component 3)	K2	0.867	1.207	75.243	0.857
	K1	0.838			
	K4	0.655			
	K3	0.631			
KMO = 0.772; Bartlett's test: 558417; d.f. = 66; Sig. level: $p < 0.000$					

5.3 Construction of Evidence-based Questions

Level 1 can provide a quick feedback on the knowledge risk factors. However, the feedback is based on the personal understanding and subjective opinion of the respondent. The results of the survey may not be pervasive enough to draw a conclusion about the company's knowledge risk factor level. Thus, a Level 2 assessment was added. A list of questions was prepared to ask respondents to give more facts, examples or evidence to justify the rating they provided under each risk factor of knowledge risk in the Level 1 assessment. About half of these questions were adapted from the submission report for the Hong Kong Most Admired Knowledge Enterprise (MAKE) Award (SME) (MAKE, 2014) and the rest were developed specifically for this validation interview. Since 1998, MAKE has been a prestigious award recognising corporations with excellent knowledge management (MAKE, 2017) and the questions published in the submission report were found to be appropriate for the intended purpose. The reason for adaptation was to make the

MAKE questions closely related to the Level 1 assessment checklist and to achieve the objective of Level 2 assessment. The questions in the list are as follows.

Knowledge leakage risk

A. Information technology (IT) security:

1. Can you describe the features of the IT security system installed to prevent hacking or theft of knowledge in your company?

B. Intellectual property (IP) management:

2. In your company, are there any products, technologies or know-how in the form of patents, copyrights, registered designs, trademarks or equivalent? Please illustrate.
3. Why does your company think there is a need to apply for IP for the protection of products or services?

C. Protection measure

4. What are the kinds of valuable knowledge in your company that cannot be easily replicated by your competitors and/or are essential to the success of your company's business? Please illustrate.
5. How does your company protect trade secrets?

Knowledge loss risk

D. Employee turnover

6. Please put a '✓' in the appropriate box(es) to indicate the average percentage of employees who resigned from your company in the past year in the …

   (i) Front-line and clerical divisions

   □ 1% □ 5% □ >10%

   (ii) Technical and professional divisions (including marketing division)

   □ 1% □ 5% □ >10%

7. Please put a '✓' in the appropriate box(es) below to indicate the percentage of employees who will retire in the coming 5 years in the …

   (i) Front-line and clerical divisions

   □ 1% □ 5% □ >10%

   (ii) Technical and professional divisions (including marketing division)

   □ 1% □ 5% □ >10%

E. Knowledge retention process

8. Is the critical knowledge needed for the production of products or services known by only a small number of key staff in your company? Will they retire soon? Is there a high chance of them leaving the company and/or joining other companies (your company's competitors in particular)? Please describe the problems or impacts that may occur when critical staff resign

or retire with examples.

9. What are your company's measures to retain the knowledge or skills of employees? Please put a '✓' in the appropriate box(es) below.

   □ Conducting a knowledge audit

   □ Ensuring teamwork (more than two staff) in all important tasks

   □ Project review/Collection of lessons learnt/After-action review

   □ Staff transfer and retraining

   □ Incorporating retirees

   □ Internal coaching

   □ Conducting regular documentation

   □ Others, please specify: _____

10. What are the types of critical knowledge that need to be shared among staff to prevent loss? What are the measures taken to ensure that the skills and know-how are adequately shared in your company?

F. Management commitment

11. Has your company appointed a Chief Knowledge Officer (CKO)? If not, are there any management staff responsible for knowledge retention activities?
12. Are there any knowledge retention policies and/or regulations in your company? Please illustrate.

Knowledge obsolescence risk

G. R&D intensity

13. Please provide the Research and Development (R&D) spending as a percentage of sales revenue in the space below.

    _____ %

14. Please provide the percentage of employees engaging in R&D activities in the space below.

    _____ %

15. How do you compare the above two numbers with other companies in similar industries that your company is currently in? Is it higher, similar or lower than the industry average? Is it sufficient? Please illustrate.
16. What are the knowledge management practices and/or technologies being applied in your company especially for the purpose of R&D? Please put a '✓' in the appropriate box(es) below.

    □ Area of excellence □ Business intelligence

    □ Community of practice □ Data mining

    □ Enterprise system □ Intellectual property management

    □ Product development management □ Product lifecycle management

    □ Rapid prototyping (e.g. 3D printing) □ Service design thinking

    □ Others, please specify: _____

17. Please describe how the use of the above practices/technologies have enhanced the operation, products or services of your company.
18. Please describe briefly the new elements or improvements of the products or services offered by your company that differentiate the products or services from those of your competitors.

H. External collaboration

19. How often does your company acquire new knowledge from the following sources? Please put a '✓' in the appropriate space below.

Sources	Never	Seldom	Often	Very often
Competitors				
Commercial research institutes				
Customers or consumers				
External consultants				
Governmental research institutes				
Industry associations, trade associations				
Purchasing IPs, such as patents, etc.				
Internet				
Other business partners				

Sources	Never	Seldom	Often	Very often
Professional conferences, exhibitions or expositions				
Professional paid databases				
Suppliers of equipment, raw materials, and software				
Technical/industry journals				
Technology standards				
Universities				

20. Which of the above sources is the most effective one in your company? Please illustrate.
21. How does your company build up and maintain its reputation and relationship with external parties (e.g. clients, suppliers) for the purpose of collaboration? Please elaborate with examples.

I. Technological/Market Change

22. Can you describe the major threats to the products or services of your company?
23. What are the barriers to entry to the area of business that your company is currently in? Please illustrate.

Knowledge shortage risk

J. Employee training

24. What are the existing and new staff training programmes in your company? Please illustrate.

K. Learning culture

25. What are the knowledge management practices and/or technologies adopted in your company for the purpose of promoting and/or facilitating employees' learning? Please put a '✓' in the appropriate box(es) below.

□ Community of practices □ Document/Content management system

□ E-learning □ Enterprise blog/microblog

□ Group collaborative work systems □ Knowledge portal

□ Knowledge repository □ Project review/After-action review

□ Service design thinking □ Sharing of best practices

□ Storytelling/dialogue □ Use of social media

□ Video conferencing □ Others, please specify: _____

26. Please describe how the use of the above practices or technologies have enhanced the operation and products or services of your company.

L. Talent management

27. What measures does your company take to attract talents to join in it?
28. Are there any motivation or incentive schemes to reward employees who add value to the projects in your company? Please illustrate.

Chapter 6 Case Studies

6.1 Background of Cases Studies and Modelling Results

To determine whether the proposed Knowledge Risk Factor Assessment Model (KRFAM) is feasible, and specifically whether adding the Level 2 evidence-based validation interviews improves the assessment, a case study approach was adopted, which is especially appropriate for exploratory research like this one. A multiple case study was employed because it is more comprehensive than a single case study and offers higher-quality results and more convincing conclusions (Herriott & Firestone, 1983).

Three companies were chosen for the study, following the suggestions made by R. K. Yin (2009). In other words, the three cases would yield similar results or different results which are predictable beforehand with supporting reasons. In the current selection, the three companies were quite distinct from each other in terms of nature of business and maturity of knowledge management. Company A manufactures and sells toys and other consumer products, is not knowledge-intensive or highly dependent on tangible assets, and has nearly no knowledge management practice in place. Company B is a property developer company, which is heavily dependent on land and property for its major profits with little attention given to formal knowledge management processes. However, the last company,

Company C, is a public utility company in the knowledge-intensive industry, and demonstrates high-quality knowledge management know-how and culture. Because of such differences among them, it is expected that the adjusted overall knowledge risk factor level would be highest in Company A and lowest in Company C with Company B having a level between the two. It is also expected that there would be a difference between perceived ratings from Knowledge Risk Factor Assessment Model (KRFAM) version 1.0 which considers the Level 1 data only and adjusted ratings from KRFAM version 2.0 which incorporates both data from Level 1 and Level 2, for the three companies.

In each case study, a management-level representative participated in two assessment rounds – Level 1 and Level 2, in which he/she assessed the knowledge risk factors of the company. In the assessment session, the participant first completed the Level 1 assessment checklist in the first round. Then the participant was invited to attend the Level 2 evidence-based validation (in the form of a structured interview) which lasted between 60 and 90 minutes. In the interview, the interviewer asked the set of questions which were sent to him/her earlier (for him/her to collect objective data beforehand which would be helpful in the Level 2 assessment) as well as other pertinent questions arising during the interview to assist the interviewee to give a belief degree (Level 2 assessment data) to each of the 12 risk factor scores which are the average of scores of questions belonging to the same risk factor in the Level 1 checklist. The interviewee gave a belief degree based on facts or evidence about the company he/she answered. The belief degree

varies from 0 (no evidence or completely uncertain) to 1 (full evidence or completely certain).

Before the start of the validation interview, each interviewee was given an information sheet detailing the instructions, format and contents of the validation. Any confusion was clarified by the interviewer. The interviewee had the right to terminate the validation anytime without penalty, though no one exercised this right. The interviewee signed a consent form to indicate that he/she was willing to participate in the validation and understood that all information collected would remain confidential and would only be identified by codes. In this way, the interviewee would feel comfortable during the interview and could answer freely so that higher-quality answers could be obtained. Before the end of the interview, the interviewees were asked about their opinions especially about the Level 2 assessment, particularly about its usefulness and adequacy. They were also invited to make any suggestions.

6.1.1 Case 1: A Company in the Toys and Consumer Products Industry (Company A)

Background

Company A is a listed 20-year-old toys and consumer products company. Its large customer base includes not only children but adults as well. It offers a wide range of products, and the company has a strong workforce of designers, manufacturing professionals, engineers and marketing/sales personnel. It also licenses several

well-known global brands. From the manufacturing base in China, it sells products to companies around the world. In spite of its size and strength, a formal knowledge management system has not been implemented. Only small-scale informal knowledge management activities have been initiated in isolation so far.

Modelling results

Table 6.1 and Table 6.2 show the modeling results of Company A – risk factor scores and risk factor levels respectively. The second column 'KRFAM version 1.0' has two sub-columns: 'original' and 'normalised'. The former shows the perceived ratings obtained in the Level 1 assessment (ranging from 1 to 6 with 1 representing low risk factor while 6 representing high risk factor) and the latter shows the normalised perceived ratings (ranging from 0 to 1 with 0 representing low risk factor while 1 representing high risk factor). The normalisation was performed using the equation below:

$$Normalised\ perceived\ rating = \frac{Perceived\ rating - 1}{6 - 1} \tag{33}$$

In the third column 'KRFAM version 2.0', the adjusted ratings are shown. They were modelled and estimated under both the evidential reasoning (ER) and utility-based approaches and therefore have a range from 0 to 1 (0 represents low risk factor while 1 represents high risk factor). To compare the two kinds of ratings in KRFAM version 1.0 and KRFAM version 2.0, the normalised ratings in the KRFAM 1.0 column were used, instead of the 'original' ratings.

In the last column ‘Percentage change (%)’, the difference between adjusted rating and normalised perceived rating are shown as a percentage of the normalised rating, calculated as below:

$$Percentage\ change\ (\%) = \frac{Adjusted\ rating - Normalised\ perceived\ rating}{Normalised\ perceived\ rating} \times 100\%$$

As for the last row ‘Average absolute percentage change of risk factor scores’ in Table 6.1, it is the average of the absolute values of percentage changes in the last column.

In addition to the above table, Figure 6.1 and Figure 6.2 show the deviations between the normalised perceived (from KRFAM version 1.0) and adjusted ratings (from KRFAM version 2.0) for risk factor scores and risk factor levels respectively. Similar tables and figures for Company B and C are shown below.

Table 6.1 Modelling results of Company A – risk factor scores

Risk factor score	**KRFAM version 1.0 (Perceived ratings)**		**KRFAM version 2.0 (Adjusted ratings)**	**Percentage change (%)**
	Original	**Normalised**		
Information technology (IT) security	2.500	0.300	0.300	0.000
Intellectual property (IP) management	1.333	0.067	0.067	-0.100
Protection measure	3.667	0.533	0.533	0.013
Employee turnover	1.500	0.100	0.100	0.000
Knowledge retention process	4.667	0.733	0.687	-6.359
Management commitment	4.200	0.640	0.612	-4.375
R&D intensity	2.250	0.250	0.250	0.000
External collaboration	3.250	0.450	0.450	0.000
Technological/Market change	5.500	0.900	0.900	0.000
Employee training	5.000	0.800	0.800	0.000
Learning culture	4.500	0.700	0.660	-5.714
Talent management	3.000	0.400	0.43	7.500
Average absolute percentage change of risk factor scores (%)				***2.005***

Table 6.2 Modelling results of Company A – risk factor levels

Risk factor level	**KRFAM version 1.0 (Perceived ratings)**		**KRFAM version 2.0 (Adjusted ratings)**	**Percentage change (%)**
	Original	**Normalised**		
Knowledge leakage risk factor level	2.500	0.300	0.300	0.000
Knowledge loss risk factor level	3.456	0.491	0.462	-5.948
Knowledge obsolescence risk factor level	3.667	0.533	0.529	-0.756
Knowledge shortage risk factor level	4.167	0.633	0.650	2.553
Overall knowledge risk factor level	***3.447***	***0.489***	***0.484***	***-1.031***

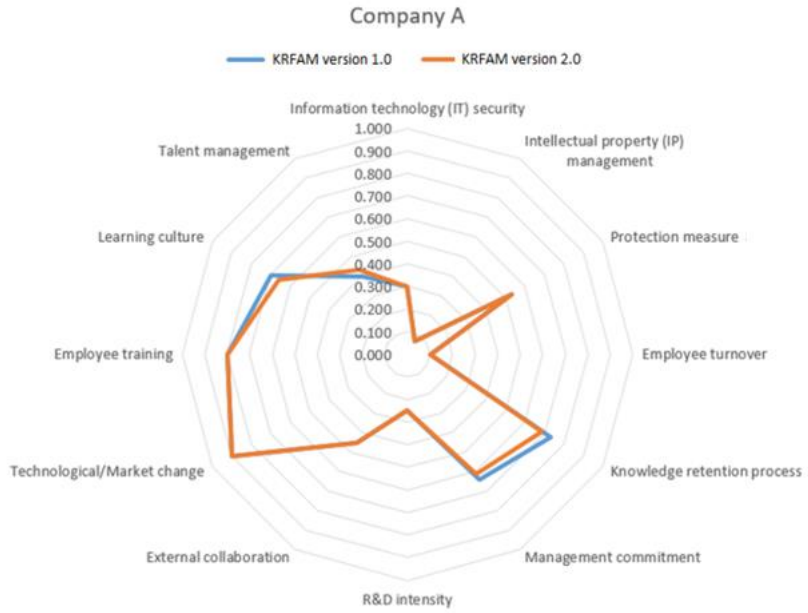

Figure 6.1 Deviations between KRFAM version 1.0 and KRFAM version 2.0 ratings of Company A – risk factor scores

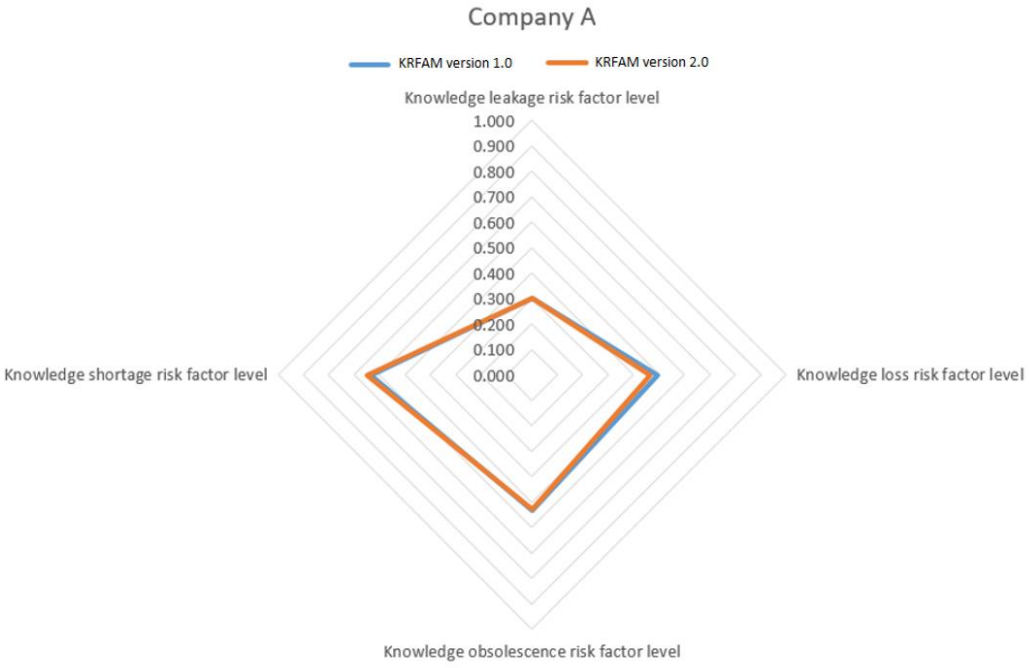

Figure 6.2 Deviations between KRFAM version 1.0 and KRFAM version 2.0 ratings of Company A – risk factor levels

6.1.2 Case 2: A Company in the Construction Industry (Company B)

Background

Company B is a well-known listed property development company established in Hong Kong more than 40 years ago and has its main business in Hong Kong and China. It runs the entire value chain from design, project management, construction and sales to property management of residential and commercial buildings. The company conducts business on a project basis where each project team is associated with the construction of a site and lasts till the construction is finished. The company outsources most jobs to contactors, sub-contractors and consultants, manages these external parties and coordinates various activities. By its nature, the assets of the company are land and property and its major revenue also come from sales or leasing of buildings. Thus, knowledge management does not seem so important to it strategically and operationally, resulting in insufficient awareness of knowledge management practices.

Modeling results

Table 6.3 and Table 6.4 show the modeling results of Company B – risk factor scores and risk factor levels respectively. On the other hand, Figure 6.3 and Figure 6.4 show the deviations between the normalised perceived and adjusted ratings for risk factor scores and risk factor levels respectively.

Table 6.3 Modelling results of Company B – risk factor scores

Risk factor score	**KRFAM version 1.0 (Perceived ratings)**		**KRFAM version 2.0 (Adjusted ratings)**	**Percentage change (%)**
	Original	**Normalised**		
Information technology (IT) security	1.250	0.050	0.140	180.000
Intellectual property (IP) management	3.000	0.400	0.420	5.000
Protection measure	4.333	0.667	0.667	-0.010
Employee turnover	3.500	0.500	0.500	0.000
Knowledge retention process	3.667	0.533	0.527	-1.244
Management commitment	4.200	0.640	0.640	0.000
R&D intensity	3.750	0.550	0.550	0.000
External collaboration	2.500	0.300	0.300	0.000
Technological/Market change	2.250	0.250	0.250	0.000
Employee training	5.000	0.800	0.800	0.000
Learning culture	3.250	0.450	0.475	5.556
Talent management	2.200	0.240	0.292	21.667
Average absolute percentage change of risk factor scores (%)				***17.790***

Table 6.4 Modelling results of Company B – risk factor levels

Risk factor level	**KRFAM version 1.0 (Perceived ratings)**		**KRFAM version 2.0 (Adjusted ratings)**	**Percentage change (%)**
	Original	**Normalised**		
Knowledge leakage risk factor level	2.861	0.372	0.417	12.191
Knowledge loss risk factor level	3.789	0.558	0.561	0.524
Knowledge obsolescence risk factor level	2.833	0.367	0.359	-2.091
Knowledge shortage risk factor level	3.483	0.497	0.533	7.295
Overall knowledge risk factor level	***3.242***	***0.448***	***0.468***	***4.297***

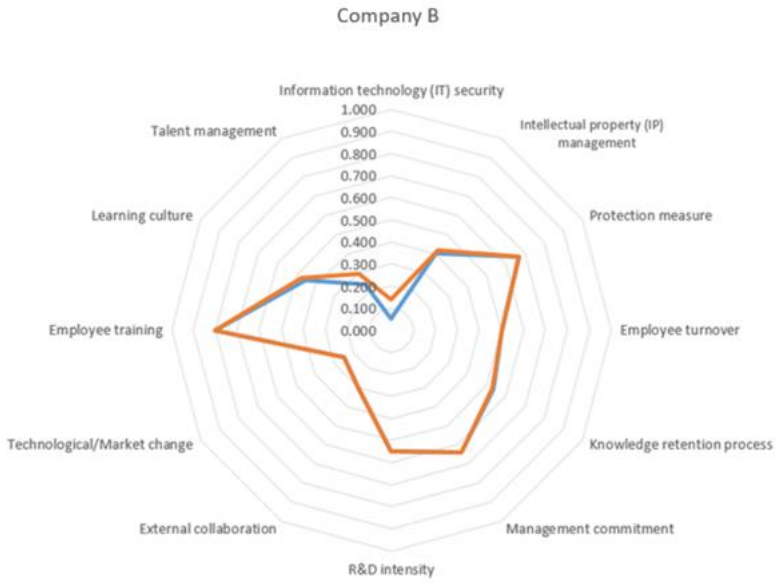

Figure 6.3 Deviations between KRFAM version 1.0 and KRFAM version 2.0 ratings of Company B – risk factor scores

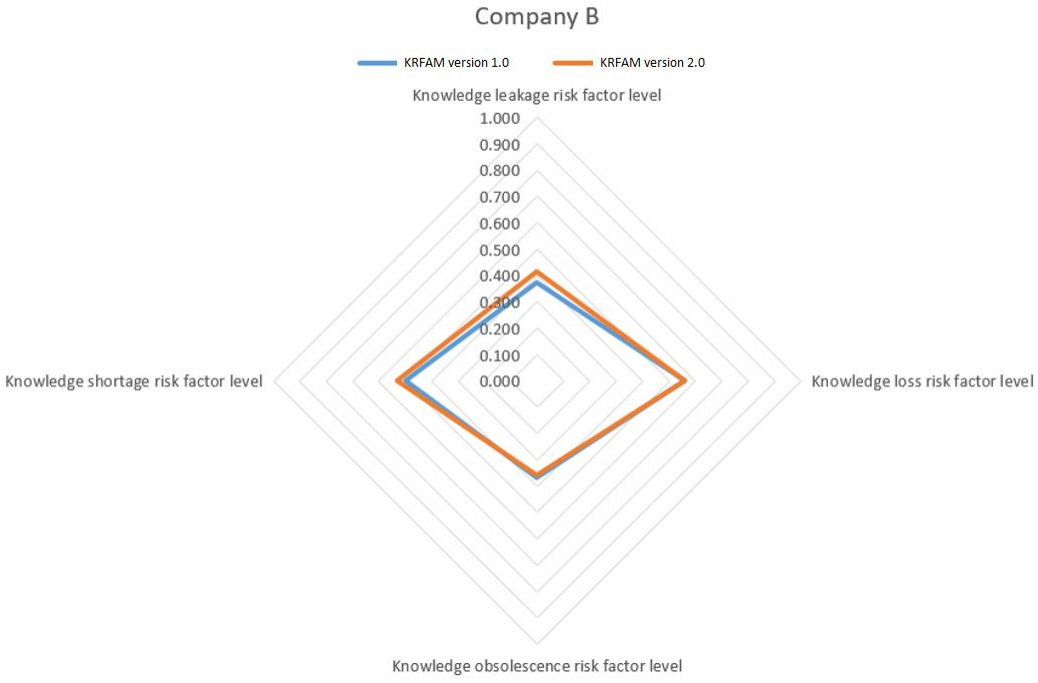

Figure 6.4 Deviations between KRFAM version 1.0 and KRFAM version 2.0 ratings of Company B – risk factor levels

6.1.3 Case 3: A MAKE-winner Company in the Energy Industry (Company C)

Background

Company C is a household name in Hong Kong and has over a century's history of providing highly reliable electricity to the local industry and population. It is one of the largest corporations listed on the Hong Kong Stock Exchange and at the same time the winner of the Most Admired Knowledge Enterprise (MAKE) award for its outstanding knowledge management performance. Through excellent knowledge management to maintain its leading position in advanced, professional knowledge, skills and expertise of its staff, it aspires to provide world-class products and services. It has made substantial investment in employee training and nurtured an encouraging learning culture among staff. In recent years, it has started a number of innovation initiatives and achieved significant success.

Modelling results

Table 6.5 and Table 6.6 show the modeling results of Company C – risk factor scores and risk factor levels respectively. On the other hand, Figure 6.5 and Figure 6.6 show the deviations between the normalised perceived and adjusted ratings for risk factor scores and risk factor levels respectively

Table 6.5 Modelling results of Company C – risk factor scores

Risk factor score	**KRFAM version 1.0 (Perceived ratings)**		**KRFAM version 2.0 (Adjusted ratings)**	**Percentage change (%)**
	Original	**Normalised**		
Information technology (IT) security	1.000	0.000	0.000	0.000
Intellectual property (IP) management	2.333	0.267	0.337	26.225
Protection measure	3.000	0.400	0.410	2.500
Employee turnover	4.000	0.600	0.570	-5.000
Knowledge retention process	2.333	0.267	0.290	8.712
Management commitment	2.600	0.320	0.356	11.250
R&D intensity	1.750	0.150	0.220	46.667
External collaboration	2.500	0.300	0.320	6.667
Technological/Market change	4.000	0.600	0.580	-3.333
Employee training	5.000	0.800	0.770	-3.750
Learning culture	3.000	0.400	0.420	5.000
Talent management	1.800	0.160	0.194	21.250
Average absolute percentage of risk factor scores (%)				***11.696***

Table 6.6 Modelling results of Company C – risk factor levels

Risk factor level	**KRFAM version 1.0 (Perceived ratings)**		**KRFAM version 2.0 (Adjusted ratings)**	**Percentage change (%)**
	Original	**Normalised**		
Knowledge leakage risk factor level	2.111	0.222	0.246	10.565
Knowledge loss risk factor level	2.978	0.396	0.394	-0.494
Knowledge obsolescence risk factor level	2.750	0.350	0.364	4.000
Knowledge shortage risk factor level	***3.267***	***0.453***	***0.462***	***1.846***
Overall Knowledge risk factor level	***2.776***	***0.355***	***0.360***	***1.329***

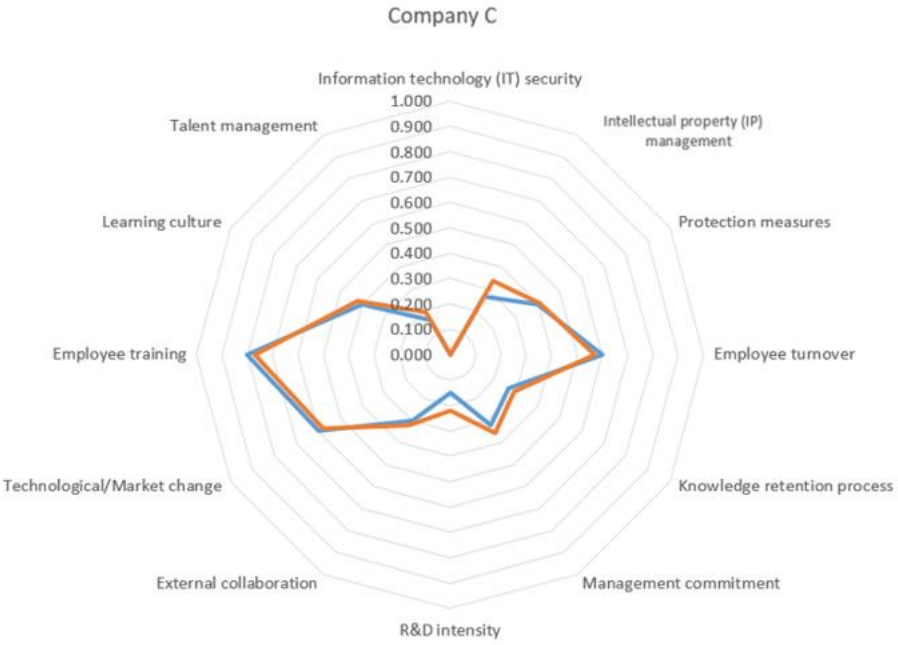

Figure 6.5 Deviations between KRFAM version 1.0 and KRFAM version 2.0 ratings of Company C – risk factor scores

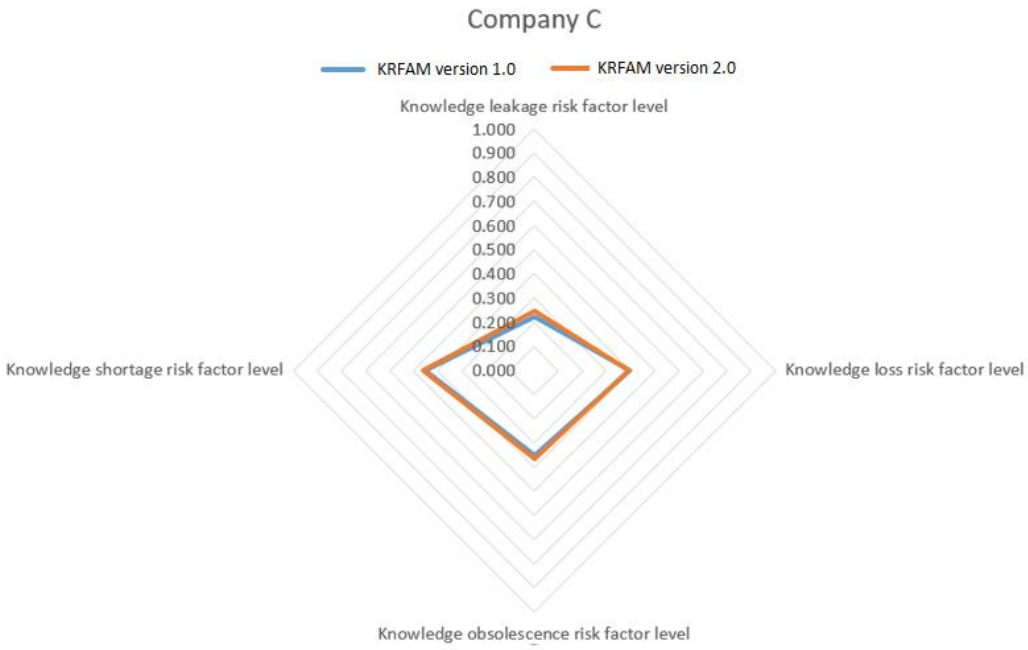

Figure 6.6 Deviations between KRFAM version 1.0 and KRFAM version 2.0 ratings of Company C – risk factor levels

6.2 Findings and Discussion

In this section, the findings and discussion of the overall knowledge risk factor levels between Company A, B and C, difference between perceived and adjusted ratings, participant feedback on validation interview, strengths of the KRFAM and proposed extended functionalities of the KRFAM are presented.

6.2.1 Adjusted Overall Knowledge Risk Factor Levels between Company A, B and C

The adjusted overall knowledge risk factor levels of the three companies in descending order are: 0.484 (Company A), 0.468 (Company B) and 0.360 (Company C). See Table 6.7 and Figure 6.7 for details. The order is consistent with their relative knowledge management capabilities and thus their relative knowledge risk factor levels. Company A is a traditional company manufacturing toys and consumer products and knowledge management activities are very few (if any), thus facing the greatest challenge in knowledge risk compared to the other two. Company B is a well-known property developer in Hong Kong and its main business is run on a per building project basis, without any formal knowledge management practice. On the other hand, Company C, a 100-year old large power utility corporation and a winner of the Most Admired Knowledge Enterprise (MAKE) award, has a strong knowledge management capability, making it achieve the lowest adjusted overall knowledge risk factor level among the three.

More detailed findings which can explain their rating differences are that as informed by the interviewee of Company A, activities that can be considered related to knowledge management are ad-hoc with no guidelines to follow. For example, when an employee leaves the company, knowledge transfer of the leaving employee to other colleagues and his/her knowledge retention take place non-systematically and ineffectively. There is no knowledge retention process in place to safeguard the company against possible knowledge loss. So far the company has not considered common knowledge management technologies like e-learning, a knowledge portal or community of practice.

Further, as for Company B, the interviewee said that it is not a knowledge-intensive company and it depends heavily on tangible assets like land and buildings as a property developer rather than intangible assets. Investment in knowledge management is far less likely than in building sites because the latter bring in nearly all the profits. There is no knowledge management system and no one is assigned knowledge management specific tasks. Employee turnover is not a serious problem as many of the company's business functions are outsourced. He further mentioned that there are no formal stringent processes set up to protect sensitive information like trade secrets.

On the other hand, Company C has deployed an effective knowledge management system throughout the corporation which is taken care of by a team of specialised knowledge management staff or professionals. This explains why the company has

the lowest adjusted overall knowledge risk factor level among the three companies studied. A capable document management system is in place for staff to access online or to search for relevant information which can assist their jobs. One effective knowledge retention programme is to hire 20% of retired former employees as temporary staff to facilitate knowledge retention or transfer. The company is active in sharing information with business partners or other related parties for mutual benefit. Knowledge leakage or loss is reduced because the staff are required to comply with information access, security and sharing policies and a corporate information classification system. It was no surprise to learn from the interviewee that their staff training programme is well above the average and the company has won the best employer award externally.

Table 6.7 Adjusted risk factor levels for Company A, B and C

Adjusted risk factor level	**Company**		
	A	**B**	**C**
Knowledge leakage risk factor level	0.300	0.417	0.246
Knowledge loss risk factor level	0.462	0.561	0.394
Knowledge obsolescence risk factor level	0.529	0.359	0.364
Knowledge shortage risk factor level	0.645	0.535	0.459
Overall knowledge risk factor level	0.484	0.468	0.360

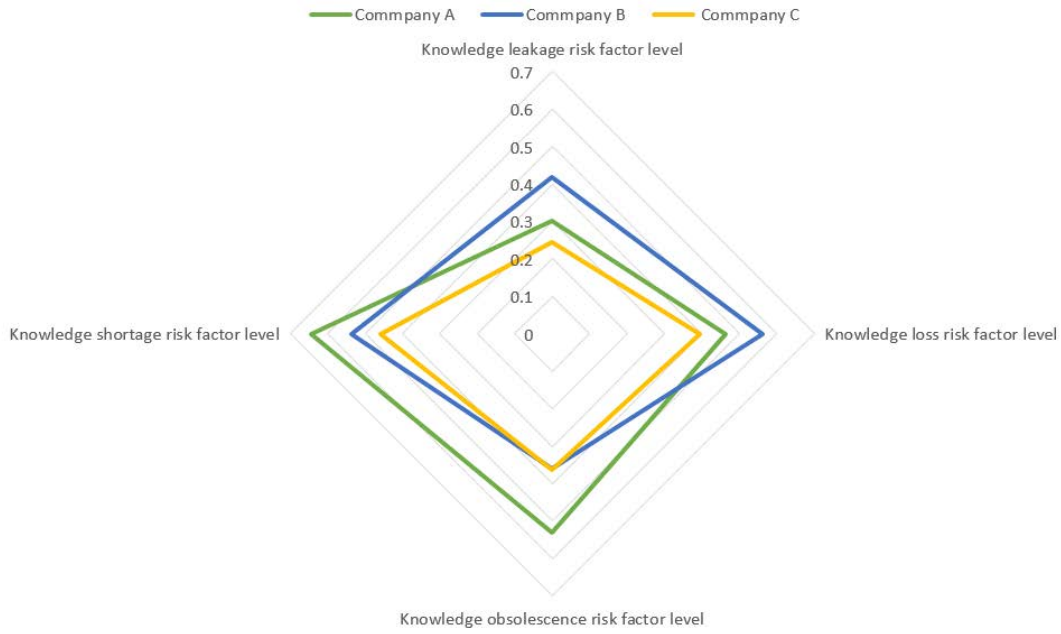

Figure 6.7 Adjusted risk factor levels between Company A, B and C

6.2.2 Difference between Perceived and Adjusted Ratings

As expected, there were differences between perceived ratings (obtained from KRFAM version 1.0) and adjusted ratings (obtained from KRFAM version 2.0) for the same risk factor. Such differences, large or small, are worthwhile to find out and investigate to a certain extent in order to understand knowledge risk factors in organizations better.

The mean of the average absolute percentage changes of risk factor scores of the three companies is 10.497% (see Table 6.8). This mean is not very high. To interpret the related data further, the two risk factors having the largest percentage change are 'Information technology (IT) security' and 'R&D intensity', being 180% (Company B) and 46.667% (Company C) respectively. For the IT security example,

it is possible that the assessor gave a low rating (0.05 out of 1 after normalisation) in the Level 1 survey because there are no high-profile or severe IT security problems which may cause large-scale knowledge risks occurred in the organization in recent times. However, when the same interviewee was asked questions about the details of the IT department, its operations and security measures in place, he was given the opportunity to go through what he knows about IT security more carefully and in greater depth. He then might come to realise that IT security is not what he first thought at the time of the Level 1 survey. It was observed that when he said that the corporate e-mail system is closely monitored by IT staff and contents in lost mobile devices can be remotely deleted to avoid information loss or leakage, he could not provide other more concrete details supporting his earlier claim. What might make him even more uncertain about the validity of his first response is that he might consider himself not so technically competent to answer a question which involves to a certain extent the technicalities of IT security and operation. Therefore, he gave a low belief degree to IT security. The final adjusted risk factor score is 0.14 out of 1, accounting for the large difference between the two ratings.

In the case of assessments given by the interviewee of Company C for the 'R&D intensity', the Level 1 risk factor score is low (0.15 out of 1). He might have the impression that the company has focused efforts, company-wide promotion and good culture in innovation and there are quite a lot of people dedicated to R&D. However, when he had the opportunity to review factual information like comparing the ratios of R&D expenses to total sales and ratio of number of R&D

staff to total number of staff with the industry average as he answered the related questions during the validation interview, he might have had certain doubt regarding his earlier response. He might think that such internal ratios cannot support the long-term growth of the company though the company is financially sound at the moment. He then considered that the company needs to have more innovative products for customers, and as quickly as possible change the present dependency on adapting new products or services already in the market. His adjusted rating is therefore 0.22.

Table 6.8 Percentage change of risk factor scores for Company A, B and C

Risk factor score	**Percentage change (%)**			**Average absolute percentage change (%)**
	Company			
	A	**B**	**C**	
Information technology (IT) security	0.000	180.000	0.000	60.000
Intellectual property (IP) management	-0.100	5.000	26.225	10.442
Protection measure	0.013	-0.010	2.500	0.840
Employee turnover	0.000	0.000	-5.000	1.667
Knowledge retention process	-6.359	-1.244	8.712	5.438

Management commitment	-4.375	0.000	11.250	5.208
R&D intensity	0.000	0.000	46.667	15.556
External collaboration	0.000	0.000	6.667	2.222
Technological/Market change	0.000	0.000	-3.333	1.111
Employee training	0.000	0.000	-3.750	1.250
Learning culture	-5.714	5.556	5.000	5.423
Talent management	7.500	21.667	21.250	16.806
Average absolute percentage of risk factor scores (%)	***2.000***	***17.790***	***11.691***	***10.497***

6.2.3 Participant Feedback on Evidence-based Validation

In general, with regard to the relevance of questions asked in the Level 2 evidence-based validation interview which helped or encouraged them to think more deeply about the risk factors, the feedback from the interviewees was that the questions were sufficient and successful in making them give more objective and higher quality responses. Though the interviewee from Company B said that the belief degree was not required for those questions in relation to which he was fully confident in the replies at Level 1, they all welcomed the simple and direct use of an appropriate belief degree (as Level 2 rating) to be applied to the first-time response (Level 1 rating) to reflect how much confidence or certainty they had in

their answers, which made the combined effect of the replies at both levels closer to the real situation. Should there be no belief degree available, they were not able to express other pertinent information about their replies which are equally important.

6.2.4 Strengths of the Proposed KRFAM

The Knowledge Risk Factor Assessment Model (KRFAM) proposed in this research has a number of strengths. Structurally, the KRFAM consists of three layers: knowledge risk of an organization (topmost), the four dimensions of knowledge risk, and risk factors of each dimension of knowledge risk (bottommost). As the three layers assume a hierarchical structure, this facilitates the assessment of knowledge risk factors in an organization to be done rationally (J. B. Yang et al., 2001). The three-layer hierarchy instead of a two-layer one with only the two topmost layers is deemed necessary to arrive at more reliable and more consistent assessments in the context of organizational knowledge risk. As pointed out by J. B. Yang et al. (2001), usually the more levels in a hierarchy, the more robust and reliable the assessment framework.

In the assessment process, a survey by means of questionnaire was adopted for the assessment of the individual items for risk factors in layer 3 – Level 1 assessment checklist. This procedure is considered efficient and quite effective. The survey participants' responses became the results of KFRAM version 1.0 through simple averaging as the aggregation method, which, however, may suffer from reliability

problems introduced by the bias of the assessor (Paulhus, 2002) or psychological, social or environmental factors which may affect his/her judgment. For example, a respondent may choose the reply he/she prefers subjectively rather than objectively (Slater, 1999) or does not select extreme responses to appear friendly to the investigator (Portsmouth, 2012; Steenkamp, de Jong, & Baumgartner, 2009). On the other hand, the participant may likely select the response which does not reflect the actual situation he/she knows in order not to reveal something bad.

To overcome the problems potentially occurring in the Level 1 assessment, a further Level 2 assessment taking the form of an interview could be helpful to arrive at assessment results with improved quality and reliability. To do this, the Level 2 assessment should make use of more objective methods to overcome the shortcoming of subjectivity at Level 1, an approach suggested by IJsselsteijn, de Ridder, Freeman, and Avons (2000). During the interview, the researcher asks the interviewee a set of questions related to the response he/she gave at Level 1. When the interviewee answers these questions, his/her replies help the interviewee to recollect from evidences (or memory facts) related to the earlier response (in Level 1) to find grounds to support that particular response. In so doing, the belief degree expressed by the interviewee which reflects his/her new thinking or opinion should have the effect of making the combination of the first-time response and belief degree better than the first-time response alone in terms of objectiveness, scope, applicability, reliability, appropriateness, and quality. The net result is that the researcher can obtain data that more truly or genuinely represent the real situation.

The evidential reasoning approach adopted, a general form of the Bayesian theory (Deng et al., 2011), was then applied in the model to aggregate the response values (from Level 1 assessment) and their corresponding belief degree values (from Level 2 assessment) to produce the adjusted ratings in KFRAM version 2.0 (J. B. Yang & Sen, 1994; J. B. Yang & Singh, 1994), which reduces the subjectivity bias and unreliability inherent in KFRAM version 1.0 ratings. It can be said that the strengths of KRFAM version 2.0, which is a refinement of KRFAM version 1.0 lies in its conceptual and theoretical soundness, effective and direct structure, process clarity, ease of application and finally appropriateness and applicability as far as knowledge risk exploratory study and assessment is concerned.

From another perspective, the Evidence reasoning (ER) approach offers other advantages compared to the traditional survey approach adopted in Level 1 assessment. Traditional surveys treat all responses as complete assessments (i.e. belief degree is always 1) and cannot handle incomplete assessments (i.e. belief degree is 0 or less than 1). This is less than desirable for practical purposes (Y. M. Wang et al., 2006; J. B. Yang, 2001). In other words, the straight-forward additive and averaging mechanisms (in KFRAM version 1.0) in handling responses will not be possible. However, ER (in KRFAM version 2.0) has no such assumption on linear additive independence (Y. M. Wang et al., 2006), which may introduce inflexibility or limitations in model construction or aggregation. Further, even when probability theory or fuzzy set theory is used instead of the simple additive and

averaging method, their incomplete assessment handling is not as efficient as ER (Deng et al., 2011).

From a practical point of view, the traditional survey approach adopted in Level 1 assessment and the aggregation method – simple averaging in KRFAM version 1.0 still has its own merits. First, it is simple, fast to perform and easily understood in regard to procedure and analysis, making it the choice for quick, initial assessment. It can be done for a very large number of respondents which may run into hundreds (Milne, 1999) (something considered not practical for ER), for example, in benchmarking surveys in the business sector. The time, cost and other resources are much less demanding than ER (Portsmouth, 2012). Because of these reasons, KRFAM version 2.0, or in particular, ER is a good option to address the inadequacy of traditional surveys by using a smaller, more focused sample to generate finer, more reliable and higher quality analysis for better interpretation of the corresponding traditional survey results.

6.2.5 Proposed Extended Functionalities of the KRFAM

The functionalities of the KRFAM offer a template of basic but varied features ready for extension when the scope of research becomes greater and more involved as the research is stepped up.

(1) The KFRAM model is flexible in allowing other researchers or practitioners to change (according to the needs) the assessment items in a risk factor, the kinds of risk factors in a risk dimension or even the dimensions of risk in the hierarchy of risk assessment without changing other parts of the model. For example, there may be other types of knowledge risk in the era of big data for KM that can be added. The present version should be applicable to many organizations at least at the early stage of adopting the model because the model addresses common dimensions of knowledge risk and risk factors. This flexibility should take advantage of for future study of companies in different industries, of different sizes or in different locations.

(2) By comparing the assessment scores for items at the same level of the knowledge risk factor assessment hierarchy as calculated by the model, prioritisation of resources for risk mitigation actions is facilitated, as suggested in the present research. However, future efforts should be spent on finding out how to make use of the same set of scores and the additional new, pertinent data collected in various occasions of contacting the staff to formulate risk mitigation strategies which necessitate more reflection on research results. For example, if the model shows that a company has a much higher knowledge loss risk than knowledge obsolescence risk as revealed by the model's assessment mechanism, human resources management personnel may need to find out whether the causes of high loss is due to employee turnover and propose strategies to mitigate the loss risk. Risk mitigation is an action against a risk and is as important as the assessment of the same risk. Getting involved in a typical risk response is one direction the research in the future may take beyond the exploratory stage.

(3) If the KRFAM is adopted in a company, the model can be applied to different business units (e.g. team, department, division, subsidiary, area, city, country and others) to compare the risk ratings among them. The same model can be applied to the same unit at different times to enable comparison of risk ratings in different periods. Such comparisons all help the identification of differences of knowledge risk management in different units or trends of risk performance against time in the same unit, which should be interpreted for follow up actions to address issues or to improve risk management. For example, a department's ratings are better than another because the former adopts a more effective risk mitigation practice or on the opposite, because the former misunderstands some of the questions asked while the latter does not. The exact cause of difference needs to be found out. The use of this functionality in future research will increase the acceptance of the model in business with the end-result that more research and practice data are available for the study to progress further.

Chapter 7 Conclusion

7.1 Summary and Significance

No financial investment by an enterprise would be prudent if only investment returns are considered without taking into account the potential investment risk, which is one of the enterprise risks. The same would apply to knowledge if knowledge acquisition and application for value creation in an enterprise is performed without proper handling of potential knowledge risk. It is against this background that the need to study knowledge risk and its effective management for an enterprise to be both competitive and sustainable in the long run arises. However, as compared with other business risks such as financial risk, the general awareness of knowledge risk among business professionals is low. This study fills an important gap in enterprise risk management and knowledge management. Given this, knowledge risk as an enterprise risk (though it is quite different compared to other typical enterprise risks) would naturally benefit at least from current risk theory, know-how, and experience gained in research and practice. However, current ERM literature is not adequate in regard to handling such an intangible risk as far as knowledge risk management is concerned. The common ERM frameworks in the field do not deal with knowledge risk specifically (CAS, 2003; COSO, 2012). In view of its importance and uniqueness, this study is a good attempt to come up with a systematic assessment of knowledge risk factors.

In the existing KM literature, knowledge risk is still under-researched (Ahmad et al., 2014; Daghfous et al., 2013; Durst et al., 2016; Frishammar et al., 2015; Lepak and Snell, 2002; Mohamed et al., 2007; Perrott, 2007; Trkman and Desouza, 2012). Research and practice are focused on acquisition, creation, organization and application of knowledge in an enterprise using an information technology and system approach. There are not too many firms and organizations putting KM efforts as a high priority in their business agenda as the benefits or payback brought to an enterprise are difficult to quantify financially (e.g. improvement in operational efficiency or effectiveness is difficult to be given a dollar value), are not as apparent or impressive as investment in plant and machinery, and take much longer time to realise in real terms in business. The present research study reveals (with general agreement to the revelation from participants in the interviews) that if knowledge is not managed well, knowledge can bring problems, inefficiencies or even serious threats to an enterprise. In fact, the participants realised that knowledge risk can potentially decrease the value created by knowledge and in some cases wipe out the benefits altogether. As the feedback of the participants in the semi-structured interviews and evidential reasoning interviews demonstrated, this increased awareness of knowledge risk has come at a time when awareness of or concerns over business risk have been raised in the workforce as a result of the global financial crisis in 2008 and other serious incidents related to risk handling in enterprises. Therefore, employees at different levels, including top management, will better appreciate the advantages of KM when knowledge risk management is included. This will make KM more acceptable to enterprises. Knowledge risk will

make the launching of KM become a business necessity instead of extra activities that are nice to have.

As revealed in the semi-structured interview conducted with the KM professionals, some understanding of knowledge risk exists in the staff of enterprises in general. Most of them mentioned that knowledge risks had not received proper attention by their top management. They agreed that enterprise employees pay disproportionate more attention to the values created by knowledge than the problems or risks associated with the leakage, loss, deterioration or lack of knowledge.

In this study, four dimensions of knowledge risk were identified through a comprehensive literature review and the semi-structured interview conducted. A knowledge risk factor assessment model (KRFAM) is proposed to assess four common types of knowledge risk occurring in most organizations, namely knowledge leakage risk, knowledge loss risk, knowledge obsolescence risk and knowledge shortage risk. It consists of two levels of connected assessments which are carried out sequentially. Level 1 assessment makes use of the standard survey approach which is quicker and simpler to perform, and Level 2 assessment makes use of an Evidential Reasoning (ER) approach. The ER assessment takes longer and has more complicated steps to refine the ratings provided at Level 1 in order to obtain a less subjective and more reliable assessment. The development of this assessment model contributes to the knowledge risk research field by taking a much larger scope encompassing the four major dimensions of knowledge risk compared

to the past assessment studies which mostly focus on specific aspects of knowledge leakage and loss risk only.

As shown by the three case studies, differences between the perceived and adjusted ratings exist and the greater differences can be explained with some assumptions. This shows that the ER approach can be said to improve the reliability of ratings obtained from the survey approach. In the case studies, the participants provided further assessment to the same item based on the related, relevant factual information collected by themselves or obtained in the interview sessions with the researcher, and the flexibility of the ER approach allowed them to provide information about the earlier assessment as long as the further information could refine their answers given earlier. For example, though the original selected item was still the most appropriate to reflect their opinions from the list of options, they could provide the interviewer or the researcher more pertinent information about the reason for and background of their earlier selection like the extent to which the selected option was close to the real situation. It is this or other advantages as well that make the ER approach provide more trusted analysis outcomes compared to having subjective responses alone by filling in a questionnaire.

As for the risk factors and four risk dimensions dealt with in the KRFAM itself, the risk factor scores, risk factor levels and overall knowledge risk factor levels obtained by the ER approach for an enterprise have significance in research and practical use. In the literature, it is usually found that only one type of knowledge

risk is measured for an enterprise. However, the KRFAM measures the four most common knowledge risks at the same time for an enterprise. The resulting set of statistical results can provide a richer picture of the status of knowledge risk in an enterprise or how well an enterprise performs in managing them. In practice, when such knowledge risk performance data have been obtained for a number of enterprises, they can be compared by enterprise, industry, business sector or others for benchmarking and performance monitoring. Within the same enterprise, the comparison can be by year or a longer/shorter period than year, department, region, or the time before or after an event has taken place in business.

This exploratory research has made valuable findings about the status of knowledge risk in enterprises and proposed an effective model to assess the risk factors of four important types of knowledge risk. At the same time, it has contributed to further develop the current enterprise risk management to include knowledge risk which is as important as other common conventional risks and adds the risk dimension to KM discipline to increase the adoption rate in enterprises. This exploratory study has also provided useful empirical information about the current research and practice in knowledge risk management and a practical base to build on for future work. To conclude, the main achievements and significance of this study are as follows:

i. The filling up of the gap in enterprise risk management which has not included the risks associated with the valuable intangible asset – knowledge in an enterprise

ii. The development of an assessment model for the knowledge risk factors

iii. The incorporation of an evidential reasoning approach for the validation of the standard survey to enhance its reliability

Apart from the successful trial runs in the three reference sites, the knowledge risk factor model is well-accepted by industry as evidenced by the good response from the workshops and seminars delivered to the industry. The study also aroused interests from prominent researchers. Invitations from parties overseas (Australia and Germany) and in mainland China to launch joint benchmarking projects in regard to knowledge risk were received. A video interview on knowledge risk was recorded and posted on various channels as well.

7.2 Limitations and Future Work

Despite the success of this pilot launch and the development of the methodology to assess knowledge risk factors, this study can be the beginning of a wider scope of research to be carried out to overcome the limitations in this attempt. These are related to the number of companies which took part in the assessment. In this study, only three companies took part in the Level 1 and 2 assessment. A systematic study in different industry types may throw more light on the knowledge risk characteristics to enable statistical analysis of the factors affecting risk to be made. Also, all weighting factors used in the assessment data were assumed the same

because of the anticipated resource needed to determine the weighting factors in this exploratory stage.

On the basis of two fields of ERM and KM, future work will cover a number of areas to deepen this research. The future work proposed is divided into two categories: additional data collection and advanced statistical work as below.

Additional data collection

Essentially, the data collected for both levels of assessment enable the KRFAM to achieve the intended mission to demonstrate the applicability of the assessment mechanism in research and practice. Other forms of data are to enrich and expand the model in the future:

(1) In the interview with participants in the Level 2 validation process, the researcher went through a list of pre-determined questions and invited answers from the participants. These questions were related to the earlier responses provided at Level 1 and mostly dealt with relevant facts, figures or information. When the interviewee replied, he/she would mentally go through an evidence-based process to validate his/her earlier response and gave a belief degree (from 0 to 1) to reflect how close the earlier responses were to the real situation. The researcher would also mention other related information to help the respondent to exercise his/her judgement in the validation. During such question and answer session, not only was

the validation facilitated but also the researcher collected additional information which was useful in obtaining more insights into the research topic about the company. In the future, a formal walk-through visit of the company will be more valuable. If the interviewing location is at the site of the company, the researcher can obtain more useful information by observation or contacting staff other than the interviewees in the same visit. If there is logistical difficulty, another site visit for the same purpose should be arranged. Narratives which describe all forms of information collected from different sources inside the company can be made and then later analysed to interpret or verify/support the level 2 validation provided by the interviewee as well as to scrutinize other company information related to the research topic provided on earlier occasions (Lissack & Ross, 1999).

(2) Though the number of companies involved in the current evidential reasoning research was only three, the information collected was sufficiently varied at the exploratory stage because they were from three diverse industries with varying degrees of awareness or success in KM or risk management, enabling quite valuable analysis outcomes. Nevertheless, more case studies in the same industry for vertical exploration or more case studies of companies of similar size across a wider spectrum of industries for horizontal exploration are worthwhile to be conducted in future study. In this way, the research results have a greater chance of being generalised based on more evidence to produce conceptual principles for theoretical studies.

Advanced statistical work

The statistical work conducted which has covered the needs of exploratory research should be enhanced to meet the additional demands when research steps out of the exploratory environment as below:

(1) In the Level 1 assessment, the weightings of items involved for the question, risk factor and risk dimensions are all equal. The same applies to the Level 2 assessment even when the ER approach is adopted. Depending on the situation in research or practice, should the need to have unequal weightings later arise, the model should still incorporate weighting factors with ease for both levels. As a matter of fact, for example, knowledge obsolescence risk is usually of more concern than knowledge leakage risk in a highly secured research and development department of a high-tech enterprise, making the knowledge obsolescence risk have a higher weighting factor in the overall knowledge risk assessment. To help determine the weightings, the Delphi method (Sun, Srivastava, & Mock, 2006) and AHP (Analytical Hierarchy Process) (Saaty, 2008) are the two common methods which can be used. In both, a group of experts are invited to participate in the determination process.

(2) The sample size in the current research for the survey meets the validity and reliability tests (PCA and Cronbach's Alpha test). However, surveys of even bigger sample sizes in different industries or countries should be chosen for future research to increase the validity and reliability of data.

(3) Correlation between business performance and a subset of ratings can be performed to determine whether risk factor level is negatively correlated to business performance. Correlation results can then be analysed and interpreted for follow-up actions. If such correlation exists, top management may be more willing to allocate resources to knowledge risk management.

(4) Further advanced study can be carried out in principle to quantify the impact of different knowledge risk categories. This would require detailed econometric analysis of the company and its environment.

Appendix I

Sample Screenshots from Intelligent Decision System (IDS)

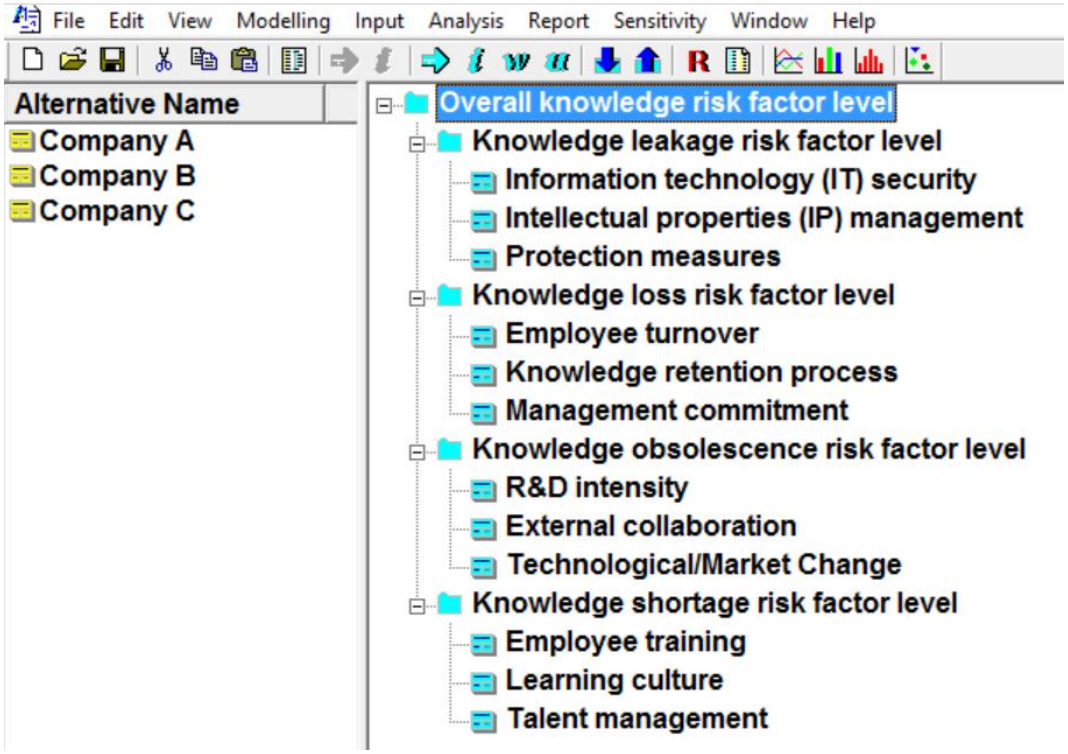

Figure I.1 Construction of the KRFAM hierarchy in IDS

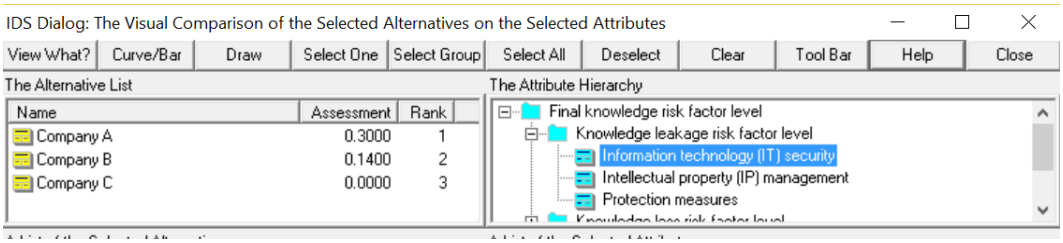

Figure I.2 Results of 'information technology (IT) security' risk factor score from IDS

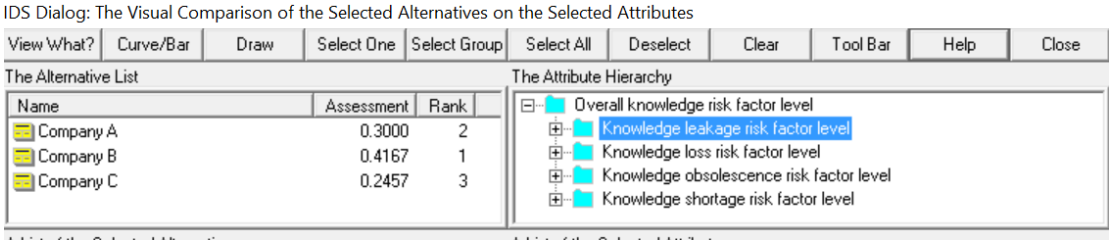

Figure I.3 Results of 'knowledge leakage' risk factor level from IDS

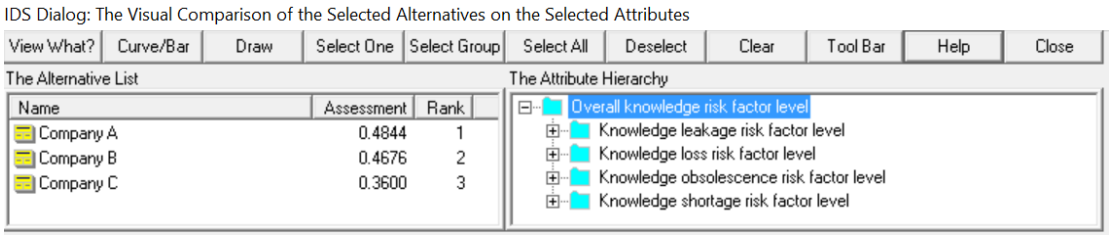

Figure I.4 Results of 'overall knowledge risk factor level' from IDS

References

Ackoff, R. L. (1989). From data to wisdom. *Journal of Applied Systems Analysis, 16*(1), 3-9.

Aebi, V., Sabto, G. & Schmid, M. (2012). Risk management, corporate governance, and bank performance in the financial crisis. *Journal of Banking & Finance*, *36*(12), 3213-3226.

Aggestam, L. (2016). Knowledge leakage when SMEs participate in supply chains: what is it about and how can it occur? *International Journal of Knowledge and Systems Science (IJKSS), 7*(3), 30-45.

Ahmad, A., Bosua, R., & Scheepers, R. (2014). Protecting organizational competitive advantage: a knowledge leakage perspective. *Computers & Security, 42*, 27-39.

Akindele, A., Chang, P., Jung, W. H., Lawrence, J., Nyame, C., Susanto, M., & Wun, A. N. (2004). *Systemic risk management*. Pittsburgh, PA: Carnegie Mellon University.

Albaum, G. (1997). The Likert scale revisited: an alternate version. *Journal of the Market Research Society, 39*(2), 331-348.

Alcacer, J., Khanna, T., & Snively, C. (2014). *The rise and fall of Nokia*. Boston, Massachusetts.: Harvard Business School Publishing.

Alexander, J. A., Bloom, J. R., & Nuchols, B. A. (1994). Nursing turnover and hospital efficiency: an organization-level analysis. *Industrial Relations: a*

Journal of Economy and Society, 33(4), 505-520.

Aloini, D., Dulmin, R., & Mininno, V. (2007). Risk management in ERP project introduction: Review of the literature. *Information & Management, 44*(6), 547-567.

Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M. (1996). Assessing the work environment for creativity. *Academy of Management Journal, 39*(5), 1154-1184.

Andersen, T. J. (2008). The performance relationship of effective risk management: Exploring the firm-specific investment rationale. *Long Range Planning, 41*(2), 155-176.

Annansingh, F. (2012). Exploring the risks of knowledge leakage: an information systems case study approach. In H. T. Hou (Ed.), *New research on knowledge management models and methods*. Croatia: InTech Open Science, Open Minds.

Arena, M., Arnaboldi, M. & Azzone, G. (2010). The organizational dynamics of enterprise risk management. Accounting, *Organizations and Society*, *35*(7), 659-675.

Bellinger, G., Castro, D., & Mills, A. (2004). *Data, information, knowledge, and wisdom.* Retrieved from http://geoffreyanderson.net/capstone/export/37/trunk/research/ackoffDiscussion.pdf

Benbya, H., Passiante, G., & Belbaly, N. A. (2004). Corporate portal: a tool for knowledge management synchronization. *International Journal of Information Management, 24*(3), 201-220.

Bernard, R. (2000). *Social research methods: Qualitative and quantitative approaches*. Thousands Oaks: Sage Publications.

Bhatt, G. D. (2001). Knowledge management in organizations: examining the interaction between technologies, techniques, and people. *Journal of Knowledge Management, 5*(1), 68-75.

Boisot, M. (1987). *Information and organizations: the manager as anthropologist*. London: Fontana

Bollinger, A. S., & Smith, R. D. (2001). Managing organizational knowledge as a strategic asset. *Journal of Knowledge Management, 5*(1), 8-18.

Boyce, C., & Neale, P. (2006). *Conducting in-depth interviews: a guide for designing and conducting in-depth interviews for evaluation input*: Pathfinder International Watertown, MA.

Brunold, J., & Durst, S. (2012). Intellectual capital risks and job rotation. *Journal of Intellectual Capital, 13*(2), 178-195.

Bryman, A. (2003). *Quantity and quality in social research*. London: Routledge.

Burrows, P. (2011). Stephen Elop's Nokia adventure. Retrieved from https://www.bloomberg.com/news/articles/2011-06-02/stephen-elops-nokia-adventure

Cambridge Dictionary. (2017). Cambridge Dictionary. Retrieved from http://dictionary.cambridge.org/dictionary/english/

Campbell, D. T. (1955). The informant in quantitative research. *American Journal of Sociology*, 339-342.

Caroline Martins, E., & Meyer, H. W. (2012). Organizational and behavioral factors that influence knowledge retention. *Journal of Knowledge*

Management, 16(1), 77-96.

CAS. (2003). Overview of Enterprise Risk Management. Retrieved from https://www.casact.org/area/erm/overview.pdf

CAS. (2017). Casualty Actuarial Society. Retrieved from http://www.casact.org/about/

Chen, Y. S., Lin, M. J. J., & Chang, C.H. (2009). The positive effects of relationship learning and absorptive capacity on innovation performance and competitive advantage in industrial markets. *Industrial Marketing Management, 38*(2), 152-158.

Chin, K. S., Wang, Y.M., Poon, G. K. K., & Yang, J. B. (2009). Failure mode and effects analysis using a group-based evidential reasoning approach. *Computers & Operations Research, 36*(6), 1768-1779.

Chin, K. S., Yang, J. B., Guo, M., & Lam, J. P. K. (2009). An evidential-reasoning-interval-based method for new product design assessment. *IEEE Transactions on Engineering Management, 56*(1), 142-156.

Clark, J. A., & Soliman, F. (1999). A graphical method for assessing knowledge-based systems investments. *Logistics Information Management, 12*(1/2), 63-77.

Cody, W. F., Kreulen, J. T., Krishna, V., & Spangler, W. S. (2002). The integration of business intelligence and knowledge management. *IBM systems journal, 41*(4), 697-713.

COSO. (2012). *Risk assessment in practice*. Retrieved from http://www.coso.org/documents/COSOAnncsOnlineSurvy2GainInpt4Updt2IntrnlCntrlIntgratdFrmwrk%20-%20for%20merge_files/COSO-

ERM%20Risk%20Assessment%20inPractice%20Thought%20Paper%20OCtober%202012.pdf

Daghfous, A., Belkhodja, O., & C. Angell, L. (2013). Understanding and managing knowledge loss. *Journal of Knowledge Management, 17*(5), 639-660.

Das, T., & Teng, B. S. (2004). The risk-based view of trust: A conceptual framework. *journal of Business and Psychology, 19*(1), 85-116.

Davenport, T. H., De Long, D. W., & Beers, M. C. (1998). Successful knowledge management projects. *Sloan Management Review, 39*(2), 43.

Davenport, T. H., & Prusak, L. (1998). *Working knowledge: How organizations manage what they know*. Boston: Harvard Business School Press.

Deloitte & Touche LLP, (2013). The risk intelligent enterprise: ERM done right. In *Risk intelligence*, Deloitte Development LLC.

DeLong, D. W. (2004). *Lost knowledge: Confronting the threat of an aging workforce*. New York: Oxford University Press.

Deng, Y., Sadiq, R., Jiang, W., & Tesfamariam, S. (2011). Risk analysis in a linguistic environment: a fuzzy evidential reasoning-based approach. *Expert Systems with Applications, 38*(12), 15438-15446.

Dess, G. G., & Shaw, J. D. (2001). Voluntary turnover, social capital, and organizational performance. *Academy of Management Review, 26*(3), 446-456.

DeVellis, R. F. (2003). *Scale development: theory and applications* (2 ed.). Thousand Oaks, CA: Sage Publications.

Dhanaraj, C., Lyles, M. A., Steensma, H. K., & Tihanyi, L. (2004). Managing tacit

and explicit knowledge transfer in IJVs: the role of relational embeddedness and the impact on performance. *Journal of International Business Studies, 35*(5), 428-442.

Dickinson, G. (2001). Enterprise risk management: its origins and conceptual foundation. *Geneva Papers on Risk and Insurance. Issues and Practice*, 360-366.

Diefenbach, T. (2009). Are case studies more than sophisticated storytelling?: Methodological problems of qualitative empirical research mainly based on semi-structured interviews. *Quality & Quantity, 43*(6), 875-894.

Du Plessis, M. (2005). Drivers of knowledge management in the corporate environment. *International Journal of Information Management, 25*(3), 193-202.

Duffy, J. (2001). The tools and technologies needed for knowledge management. *Information Management, 35*(1), 64.

Durst, S., Bruns, G., & Henschel, T. (2016). The management of knowledge risks: what do we really know? *International Journal of Knowledge and Systems Science (IJKSS), 7*(3), 19-29.

Durst, S., & Wilhelm, S. (2013). Do you know your knowledge at risk? *Measuring Business Excellence, 17*(3), 28-39.

Edvinsson, L., & Sullivan, P. (1996). Developing a model for managing intellectual capital. *European Management Journal, 14*(4), 356-364.

EKCYP. (2017). The EKCYP expert database. Retrieved from http://pjp-eu.coe.int/en/web/youth-partnership/expert-database?inheritRedirect=true

Ernest Chang, S., & Lin, C.S. (2007). Exploring organizational culture for

information security management. *Industrial Management & Data Systems, 107*(3), 438-458.

Fischer, G., & Otswald, J. (2001). Knowledge management: problems, promises, realities, and challenges. *IEEE Intelligent Systems, 16*(1), 60-72.

Franco, M., & Haase, H. (2015). Interfirm alliances: a taxonomy for SMEs. *Long range planning, 48*(3), 168-181.

Frishammar, J., Ericsson, K., & Patel, P. C. (2015). The dark side of knowledge transfer: exploring knowledge leakage in joint R&D projects. *Technovation, 41*, 75-88.

Fu, C., & Yang, S.L. (2010). The group consensus based evidential reasoning approach for multiple attributive group decision analysis. *European Journal of Operational Research, 206*(3), 601-608.

Fu, C., & Yang, S. (2012). The combination of dependence-based interval-valued evidential reasoning approach with balanced scorecard for performance assessment. *Expert Systems with Applications, 39*(3), 3717-3730.

García-Zamora, E., González-Benito, Ó., & Muñoz-Gallego, P. A. (2013). Organizational and environmental factors as moderators of the relationship between multidimensional innovation and performance. *Innovation, 15*(2), 224-244.

Geringer, J. M. (1991). Strategic determinants of partner selection criteria in international joint ventures. *Journal of International Business Studies, 22*(1), 41-62.

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*(S2), 109-122.

Grant, R. M. (2002). The knowledge-based view of the firm. *The Strategic Management of Intellectual Capital and Organizational Knowledge*, 133-148.

Groth, R. E., & Bergner, J. A. (2006). Preservice elementary teachers' conceptual and procedural knowledge of mean, median, and mode. *Mathematical Thinking and Learning, 8*(1), 37-63.

Grover, V., & Davenport, T. H. (2001). General perspectives on knowledge management: Fostering a research agenda. *Journal of Management Information Systems, 18*(1), 5-21.

Hagedoorn, J. (2002). Inter-firm R&D partnerships: an overview of major trends and patterns since 1960. *Research Policy, 31*(4), 477-492.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1995). *Multivariate Data Analysis with Reading* (4 ed.). Englewood Cliffs: Prentice-Hall

Halawi, L., Aronson, J., & McCarthy, R. (2005). Resource-based view of knowledge management for competitive advantage. *The Electronic Journal of Knowledge Management, 3*(2), 75-86.

Hallikas, J., Karvonen, I., Pulkkinen, U., Virolainen, V.-M., & Tuominen, M. (2004). Risk management processes in supplier networks. *International Journal of Production Economics, 90*(1), 47-58.

Haynes, S. N., Richard, D., & Kubany, E. S. (1995). Content validity in psychological assessment: A functional approach to concepts and methods. *Psychological Assessment, 7*(3), 238.

Herriott, R. E., & Firestone, W. A. (1983). Multisite qualitative policy research: optimizing description and generalizability. *Educational Researcher,*

12(2), 14-19.

Herschel, R. T., & Jones, N. E. (2005). Knowledge management and business intelligence: the importance of integration. *Journal of Knowledge Management, 9*(4), 45-55.

Hiebert, J., & Lefevre, P. (1986). Conceptual and procedural knowledge in mathematics: An introductory analysis. In J. Hiebert (Ed.), *Conceptual and procedural knowledge: the case of mathematics,* (pp. 1–27). Hillsdale, NJ,: Lawrence Erlbaum Associates.

Hlava, M. (2012). What is a Taxonomy? Retrieved from http://www.kmworld.com/Articles/Editorial/What-Is-.../What-is-a-Taxonomy-81159.aspx

Höglund, M. (2012). Quid pro quo? Examining talent management through the lens of psychological contracts. *Personnel Review, 41*(2), 126-142.

Holbrook, M. B., & Schindler, R. M. (1989). Some exploratory findings on the development of musical tastes. *Journal of Consumer Research, 16*(1), 119-124.

Huang, K.T. (1998). Capitalizing on intellectual assets. *IBM Systems Journal, 37*(4), 570-583.

Hung, R. Y. Y., Yang, B., Lien, B. Y.-H., McLean, G. N., & Kuo, Y.-M. (2010). Dynamic capability: Impact of process alignment and organizational learning culture on performance. *Journal of World Business, 45*(3), 285-294.

IDS. (2007). IDS Multicriteria Assessor Manual. England.

IJsselsteijn, W. A., de Ridder, H., Freeman, J., & Avons, S. E. (2000). *Presence:*

concept, determinants, and measurement. Paper presented at the Electronic Imaging.

Interantional Bureau. (2017). Expert Database - Interantional Bureau. Retrieved from http://www.internationales-buero.de/en/expert_database

Jennex, M. E. (2014). A proposed method for assessing knowledge loss risk with departing personnel. *VINE: The Journal of Information and Knowledge Management Systems, 44*(2), 185-209.

Jiang, B., Baker, R. C., & Frazier, G. V. (2009). An analysis of job dissatisfaction and turnover to reduce global supply chain risk: Evidence from China. *Journal of Operations Management, 27*(2), 169-184.

Jiang, X., Li, M., Gao, S., Bao, Y., & Jiang, F. (2013). Managing knowledge leakage in strategic alliances: The effects of trust and formal contracts. *Industrial Marketing Management, 42*(6), 983-991.

Johannessen, J. A., & Olsen, B. (2003). Knowledge management and sustainable competitive advantages: The impact of dynamic contextual training. *International Journal of Information Management, 23*(4), 277-289.

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research, 1*(2), 112-133.

Kaiser, H. F. (1958). The varimax criterion for analytic rotation in factor analysis. *Psychometrika, 23*(3), 187-200.

Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educational and Psychology Measurement, 20*, 141-151.

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika, 39*(1), 31-

36.

Kamph, B. (2007). A bottom-line approach to knowledge retention. *Power Engineering, 111*(4), 92-93.

Keane, S., Smith, T., Lincoln, M., Wagner, S., & Lowe, S. (2008). The rural allied health workforce study (RAHWS): background, rationale and questionnaire development. *Rural and Remote Health, 8*(4), 1132.

Kerlinger, F. N. (1986). *Foundation of behavioral research* (3 ed.). Holt, Rinehart and Winston: Fort Worth, TX.

Khan, R. A. (2014). Sustainable competitive advantage through knowledge management. *International Journal of Advanced Research in Computer & Technology, 3*(4).

Khokhar, R. H., Bell, D. A., Guan, J., & Wu, Q. (2006). Risk assessment of e-commerce projects using evidential reasoning *Fuzzy Systems and Knowledge Discovery* (pp. 621-630): Springer.

Kimble, C., & Hildreth, P. (2005). Dualities, distributed communities of practice and knowledge management. *Journal of Knowledge Management, 9*(4), 102-113.

King, N., Cassell, C., & Symon, G. (1994). Qualitative methods in organizational research: A practical guide. *The qualitative research interview, 17*.

Kirkpatrick, G. (2009). The corporate governance lessons from the financial crisis. *OECD Journal: Financial Market Trends*, *2009*(1), 61-87.

Klenke, K. (2016). *Qualitative research in the study of leadership*: Emerald Group Publishing Limited.

Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2

ed.). New York: Guildford.

Kshetri, N. (2005). Pattern of global cyber war and crime: A conceptual framework. *Journal of International Management*, *11*(4), 541-562.

Lee, S., Suh, E., & Lee, M. (2014). Measuring the risk of knowledge drain in communities of practice. *Journal of Knowledge Management, 18*(2), 382-395.

Lepak, D. P., & Snell, S. A. (2002). Examining the human resource architecture: The relationships among human capital, employment, and human resource configurations. *Journal of Management, 28*(4), 517-543.

Levy, M. (2011). Knowledge retention: minimizing organizational business loss. *Journal of Knowledge Management, 15*(4), 582-600.

Liao, R., Zheng, H., Grzybowski, S., Yang, L., Zhang, Y., & Liao, Y. (2011). An integrated decision-making model for condition assessment of power transformers using fuzzy approach and evidential reasoning. *IEEE Transactions on Power Delivery, 26*(2), 1111-1118.

Liebenderg, A. P. & Hoyt, R. E. (2003). The determinants of enterprise risk management: Evidence from the appointment of chief risk officers. *Risk Management and Insurance Review*, *6*(1), 37-52.

Lissack, M., & Ross, J. (1999). *The next common sense: Mastering corporate complexity through coherence*. London: Nicholas Brealey Publishing Limited.

Liu, X. B., Zhou, M., Yang, J. B., & Yang, S. L. (2008). Assessment of strategic R&D projects for car manufacturers based on the evidential reasoning approach. *International Journal of Computational Intelligence Systems,*

1(1), 24-49.

Lucas, H. C., & Goh, J. M. (2009). Disruptive technology: how Kodak missed the digital photography revolution. *The Journal of Strategic Information Systems, 18*(1), 46-55.

MAKE. (2014). *Submission report for 2014 Most Admired Knowledge Enterprise (MAKE) Award (SME)*. 2014 Hong Kong Most Admired Knowledge Enterprise (MAKE) Award (SME). Hong Kong.

Manhart, M., & Thalmann, S. (2015). Protecting organizational knowledge: a structured literature review. *Journal of Knowledge Management, 19*(2), 190-211.

Marquardt, M. J. (2002). *Building the Learning Organization: Master the Five Elements for Corporate Learning* Palo Alto, CA: Davies-Black.

Massingham, P. (2008). Measuring the impact of knowledge loss: more than ripples on a pond? *Management Learning, 39*(5), 541-560.

Massingham, P. (2010). Knowledge risk management: a framework. *Journal of Knowledge Management, 14*(3), 464-485.

McCormick, R. (1997). Conceptual and procedural knowledge. *International Journal of Technology and Design Education, 7*, 141-159.

Merriam-Webster Dictionary. (2017). Merriam-Webster Dictionary. Retrieved from https://www.merriam-webster.com/dictionary/risk%20factor

Meso, P., & Smith, R. (2000). A resource-based view of organizational knowledge management systems. *Journal of Knowledge Management, 4*(3), 224-234.

Miles, M. B. & Huberman, A. M. (1984). *Qualitative data analysis: A sourcebook of new methods.* Sage Publications.

Millwood, J., & Heath, M. R. (2000). Food choice by older people: the use of semi-structured interviews with open and closed questions. *Gerodontology, 17*(1), 25-32.

Milne, J. (1999). Questionnaires: advantages and disadvantages. Retrieved from http://www.icbl.hw.ac.uk/ltdi/cookbook/info_questionnaires/

Mingers, J., & Brocklesby, J. (1997). Multimethodology: towards a framework for mixing methodologies. *Omega, 25*(5), 489-509.

Mock, T. J., Sun, L., Srivastava, R. P., & Vasarhelyi, M. (2009). An evidential reasoning approach to Sarbanes-Oxley mandated internal control risk assessment. *International Journal of Accounting Information Systems, 10*(2), 65-78.

Mohamed, S., Mynors, D., Grantham, A., Chan, P., Coles, R., & Walsh, K. (2007). Unearthing key drivers of knowledge leakage. *International Journal of Knowledge Management Studies, 1*(3-4), 456-470.

Mohamed, S., Mynors, D., Grantham, A., Walsh, K., & Chan, P. (2006). *Understanding one aspect of the knowledge leakage concept: people*. Paper presented at the Proceedings of the European and Mediterranean Conference on Information Systems (EMCIS).

Mohammad, A., & Sykes, R. (2012). Sharpening strategic risk management: PricewaterhouseCoopers International Limited.

Mokhtari, K., Ren, J., Roberts, C., & Wang, J. (2012). Decision support framework for risk management on sea ports and terminals using fuzzy set theory and evidential reasoning approach. *Expert Systems with Applications, 39*(5), 5087-5103.

Morehouse, R. E. (1994). *Beginning qualitative research: A philosophic and practical guide* (Vol. 6): Psychology Press.

MSCI. (2017). Global Industry Classification Standard (GICS). Retrieved from https://www.msci.com/gics

Ngai, E., & Cheng, T. (1997). Identifying potential barriers to total quality management using principal component analysis and correspondence analysis. *International Journal of Quality & Reliability Management, 14*(4), 391-408.

Ngai, E. W., & Chan, E. (2005). Evaluation of knowledge management tools using AHP. *Expert Systems with Applications, 29*(4), 889-899.

Ngan, S.C. (2015). Evidential Reasoning approach for multiple-criteria decision making: A simulation-based formulation. *Expert Systems with Applications, 42*(9), 4381-4396.

Nonaka, I., & Takeuchi, H. (1995). *The Knowledge-creating Company: jow Japanese companies create the dynamics of innovation*. New York: Oxford University Press.

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

Nordstrom, L. (2008). Assessment of information security levels in power communication systems using evidential reasoning. *IEEE Transactions on Power Delivery, 23*(3), 1384-1391.

Norman, P. M. (2002). Protecting knowledge in strategic alliances: Resource and relational characteristics. *The Journal of High Technology Management Research, 13*(2), 177-202.

Norman, P. M. (2004). Knowledge acquisition, knowledge loss, and satisfaction in high technology alliances. *Journal of Business Research, 57*(6), 610-619.

Nunnally, J. C. (1978). Psychometric theory. *NY: McGraw-Hill*.

OECD. (2014). Enterprises by business size. Retrieved from https://data.oecd.org/entrepreneur/enterprises-by-business-size.htm

Onwuegbuzie, A. J., & Leech, N. L. (2005). On becoming a pragmatic researcher: The importance of combining quantitative and qualitative research methodologies. *International Journal of Social Research Methodology, 8*(5), 375-387.

OPM. (2008). *Structured interviews: a practical gudie* (U. S. O. o. P. Management Ed.). Washington, DC.

Oxford Dictionary. (2017). Oxford Dictionary. Retrieved from https://en.oxforddictionaries.com/

Pan, Y., Wang, T. Y., & Weisbach, M. S. (2015). Management risk and the cost of borrowing. *The Ohio State University Fisher College of Business Working Paper Series.*

Parise, S., Cross, R., & Davenport, T. H. (2006). Strategies for preventing a knowledge-loss crisis. *MIT Sloan Management Review, 47*(4), 31.

Parker, H. (2012). Knowledge acquisition and leakage in inter-firm relationships involving new technology-based firms. *Management Decision, 50*(9), 1618-1633.

Paulhus, D. L. (2002). Socially desirable responding: The evolution of a construct. Retrieved from http://neuron4.psych.ubc.ca/~dpaulhus/research/SDR/downloads/CHAPT

ERS/ETS%20chapter.pdf

Pemberton, J. D., & Stonehouse, G. H. (2000). Organizational learning and knowledge assets-an essential partnership. *The Learning Organization, 7*(4), 184-193.

Pennings, J. M., Lee, K., & Van Witteloostuijn, A. (1998). Human capital, social capital, and firm dissolution. *Academy of Management Journal, 41*(4), 425-440.

PennState. (2017). Expert Database. Retrieved from http://sustainability.psu.edu/expert-database

Perrott, B. E. (2007). A strategic risk approach to knowledge management. *Business Horizons, 50*(6), 523-533.

Polanyi, M. (1966). *The tacit dimension*. Garden City, NY: Doubleday and Co.

Portsmouth, U. o. (2012). Advantages and disadvantages of using questionnaires.

Prencipe, A., & Tell, F. (2001). Inter-project learning: processes and outcomes of knowledge codification in project-based firms. *Research Policy, 30*(9), 1373-1394.

Prosser, S. (2007). *Philosophy higher: problems of knowledge*. Retrieved from Scotland: https://www.st-andrews.ac.uk/~www_spa/pops/docs/knowledge.pdf

Quintas, P., Lefere, P., & Jones, G. (1997). Knowledge management: a strategic agenda. *Long Range Planning, 30*(3), 322385-322391.

Roth, W. D., & Mehta, J. D. (2002). The Rashomon effect combining positivist and interpretivist approaches in the analysis of contested events. *Sociological Methods & Research, 31*(2), 131-173.

Saaty, T. L. (2008). Decision making with the analytic hierarchy process. *International journal of services sciences, 1*(1), 83-98.

Schindler, M., & Eppler, M. J. (2003). Harvesting project knowledge: a review of project learning methods and success factors. *International Journal of Project Management, 21*(3), 219-228.

Senge, P. M. (1990). *The fifth discipline: the art and practice of the learning Organization*. New York: Doubleday.

Senge, P. M. (2014). *The fifth discipline fieldbook: Strategies and tools for building a learning organization*: Crown Business.

Shafer, G. A. (1976). *Mathematical theory of evidence*. Princeton: Princeton University Press.

Sharma, A. (1997). Professional as agent: Knowledge asymmetry in agency exchange. *Academy of Management Review, 22*(3), 758-798.

Shaw, W. S., & Huang, Y. H. (2005). Concerns and expectations about returning to work with low back pain: Identifying themes from focus groups and semi-structured interviews. *Disability and Rehabilitation, 27*(21), 1269-1281. doi:10.1080/09638280500076269

Skemp, R. R. (1976). Relational understanding and instrumental understanding. *Mathematics Teaching in Higher Education, 77*, 20=26.

Slater, M. (1999). Measuring presence: A response to the Witmer and Singer presence questionnaire. *Presence: Teleoperators and Virtual Environments, 8*(5), 560-565.

Smith, C. W., & Stulz, R. M. (1985). The determinants of firms' hedging policies. *Journal of Financial and Quantitative Analysis, 20*(04), 391-405.

Smith, E. A. (2001). The role of tacit and explicit knowledge in the workplace. *Journal of Knowledge Management, 5*(4), 311-321.

Song, M., Bij, H., & Weggeman, M. (2006). Factors for improving the level of knowledge generation in new product development. *R&D Management, 36*(2), 173-187.

Spurgeon, K., Tang, W., Wu, Q., Richardson, Z., & Moss, G. (2005). Dissolved gas analysis using evidential reasoning. *IEE Proceedings-Science, Measurement and Technology, 152*(3), 110-117.

Steenkamp, J. E. M., de Jong, M. G., & Baumgartner, H. (2009). Socially Desirable Respones Tendencies in Survey Research. *Journal of Marketing Research, 46*.

Sun, L., Srivastava, R. P., & Mock, T. J. (2006). An information systems security risk assessment model under the Dempster-Shafer theory of belief functions. *Journal of Management Information Systems, 22*(4), 109-142.

Takeuchi, R., Lepak, D. P., Wang, H., & Takeuchi, K. (2007). An empirical examination of the mechanisms mediating between high-performance work systems and the performance of Japanese organizations. *Journal of Applied Psychology, 92*(4), 1069.

Tang, W., Spurgeon, K., Wu, Q., & Richardson, Z. (2004). An evidential reasoning approach to transformer condition assessments. *IEEE Transactions on Power Delivery, 19*(4), 1696-1703.

Tantau, D. A., & Paicu, E. A. (2013). Managing knowledge risks in an intrapreneurial environment. *The International Journal of Management Science and Information Technology, 2*, 4-9.

Teddlie, C., & Yu, F. (2007). Mixed methods sampling a typology with examples. *Journal of Mixed Methods Research, 1*(1), 77-100.

Thibaut, J. W., & Kelley, H. H. (1959). *The social psychology of groups*. New York: John Wiley.

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation, 27*(2), 237-246.

Thurstone, L. L. (1947). *Multiple factor analysis*. Chicago, IL: University of Chicago Press.

Trkman, P., & Desouza, K. C. (2012). Knowledge risks in organizational networks: an exploratory framework. *The Journal of Strategic Information Systems, 21*(1), 1-17.

Tsang, H. W. C., Lee, W. B., & Tsui, E. (2016). AHP-driven knowledge leakage risk assessment model: a construct-apply-control cycle approach. *International Journal of Knowledge and Systems Science (IJKSS), 7*(3), 1-18.

Tutton, J. (2010). Incident response and compliance: A case study of the recent attacks. *Information Ssecurity Technical Report*, *15*(4), 145-149.

Van Heijst, G., Van Der Spek, R., & Kruizinga, E. (1997). Corporate memories as a tool for knowledge management. *Expert Systems with Applications, 13*(1), 41-54.

Veliyath, R., George, R., Ye, Z. S., Hermanson, D. R., & Tompkins, J. G. (2015). What do compensation committees on the boards of public companies do? comparisons of Indian and US process differences juxtaposing complementary theoretical lenses. *Long Range Planning, 49*(4), 519-539.

Walker, D. H., & Christenson, D. (2005). Knowledge wisdom and networks: a project management centre of excellence example. *The Learning Organization, 12*(3), 275-291.

Wallace, D. P. (2007). *Knowledge management: historical and cross-disciplinary themes*: Libraries unlimited.

Wang, J., Yang, J., & Sen, P. (1995). Safety analysis and synthesis using fuzzy sets and evidential reasoning. *Reliability Engineering & System Safety, 47*(2), 103-118.

Wang, X., Yang, B., & McLean, G. N. (2007). Influence of demographic factors and ownership type upon organizational learning culture in Chinese enterprises. *International Journal of Training and Development, 11*(3), 154-165.

Wang, Y.M., & Elhag, T. M. (2008). Evidential reasoning approach for bridge condition assessment. *Expert Systems with Applications, 34*(1), 689-699.

Wang, Y. M., Yang, J. B., & Xu, D. L. (2006). Environmental impact assessment using the evidential reasoning approach. *European Journal of Operational Research, 174*(3), 1885-1913.

Warner, M., & Witzel, M. (2004). *Managing in virtual organizations*. London: Thomson Learning.

Weber, R. (2004). Editor's comments: the rhetoric of positivism versus interpretivism: a personal view. *MIS quarterly*, iii-xii.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal, 5*(2), 171-180.

WHO. (2017). Risk Factors. Retrieved from

http://www.who.int/topics/risk_factors/en/

Wiig, K. M. (1997). Knowledge management: where did it come from and where will it go? *Expert Systems with Applications, 13*(1), 1-14.

Wiig, K. M. (1999). Comprehensive knowledge management. *Knowledge Research Institute, Inc. Working Paper KRI, 4*.

Williams, T. (1993). Risk-management infrastructures. *International Journal of Project Management, 11*(1), 5-10.

Xu, D. L., & Yang, J. B. (2005). Intelligent decision system based on the evidential reasoning approach and its applications. *Journal of Telecommunications and Information Technology*, 73-80.

Yang, J. B. (2001). Rule and utility based evidential reasoning approach for multiattribute decision analysis under uncertainties. *European Journal of Operational Research, 131*(1), 31-61.

Yang, J. B., Dale, B., & Siow, C. (2001). Self-assessment of excellence: an application of the evidential reasoning approach. *International Journal of Production Research, 39*(16), 3789-3812.

Yang, J. B., & Sen, P. (1994). A general multi-level evaluation process for hybrid MADM with uncertainty. *IEEE Transactions on Systems, Man, and Cybernetics, 24*(10), 1458-1473.

Yang, J. B., & Singh, M. G. (1994). An evidential reasoning approach for multiple-attribute decision making with uncertainty. *Systems, Man and Cybernetics, IEEE Transactions on, 24*(1), 1-18.

Yang, J. B., & Xu, D. L. (2002). On the evidential reasoning algorithm for multiple attribute decision analysis under uncertainty. *Systems, Man and*

Cybernetics, Part A: Systems and Humans, IEEE Transactions on, 32(3), 289-304.

Yang, Z., Wang, J., Bonsall, S., & Fang, Q. (2009). Use of fuzzy evidential reasoning in maritime security assessment. *Risk Analysis, 29*(1), 95-120.

Yao, R., Yang, Y., & Li, B. (2012). A holistic method to assess building energy efficiency combining DS theory and the evidential reasoning approach. *Energy Policy, 45*, 277-285.

Yew Wong, K. (2005). Critical success factors for implementing knowledge management in small and medium enterprises. *Industrial Management & Data Systems, 105*(3), 261-279.

Yin, J. & Jamali, D. (2016). Strategic corporate social responsibility of multinational companies subsidiaries in emerging markets: Evidence from China. *Long Range Planning*, *49*(5), 541-558.

Yin, R. K. (2004). *The case study anthology*. Thousand Oaks: Sage.

Yin, R. K. (2009). *Case study research: design and methods* (4 ed. Vol. 5). USA: SAGE Publications.

Yip, Y. T. (2015). *Design research on anecdote-based knowledge elicitation for organization development.* (Ph.D.), The Hong Kong Polytechnic University, Hong Kong.

Zeng, S. X., Xie, X., & Tam, C. M. (2010). Relationship between cooperation networks and innovation performance of SMEs. *Technovation, 30*(3), 181-194.

Zhang, Y., Deng, X., Wei, D., & Deng, Y. (2012). Assessment of E-Commerce security using AHP and evidential reasoning. *Expert Systems with*

Applications, 39(3), 3611-3623.

Zhi, H. (1995). Risk management for overseas construction projects. *International Journal of Project Management, 13*(4), 231-237.