Association for Information Systems
AIS Electronic Library (AISeL)

PACIS 2013 Proceedings

Pacific Asia Conference on Information Systems (PACIS)

6-18-2013

Development of the Risk Management Mechanism of an Enterprise Resource Planning System based on Work System Method

She-I Chang
National Chung Cheng University, actsic@ccu.edu.tw

Hsing-Jung Li
National Chung Cheng University, limo.preempt@gmail.com

Su-Han Cheng
National Chung Cheng University, u9631803@nkfust.edu.tw

Wan-Yun Lai
National Chung Cheng University, via2ashley@gmail.com

DEVELOPMENT OF THE RISK MANAGEMENT MECHANISM OF AN ENTERPRISE RESOURCE PLANNING SYSTEM BASED ON WORK SYSTEM METHOD

She-I Chang, Department of Accounting and Information Technology, National Chung Cheng University, Chiayi, Taiwan, actsic@ccu.edu.tw

Hsing-Jung Li, Department of Accounting and Information Technology, National Chung Cheng University, Chiayi, Taiwan, limo.preempt@gmail.com

Su-Han Cheng, Department of Accounting and Information Technology, National Chung Cheng University, Chiayi, Taiwan, u9631803@nkfust.edu.tw

Wan-Yun Lai, Department of Accounting and Information Technology, National Chung Cheng University, Chiayi, Taiwan, via2ashley@gmail.com

Abstract

This study collects 24 risk-management-relevant research papers published between 2000 and 2010 to elicit significant risk factors and thus develop the risk management mechanism of an enterprise resource planning (ERP) system. The study adopts the grounded theory and conducts an expert questionnaire in order to report its findings on 49 risk factors. Based on the work system method, the identified factors are classified into nine categories and a risk management mechanism is developed thereafter. Finally, to examine the feasibility of the mechanism, two case studies are further investigated. The developed mechanism is found to be a convenient, quick, and proper ERP system risk management tool that can assist enterprises in identifying, analyzing, assessing, and responding to potential risks.

Keywords: ERP system, risk management, work system method

1. INTRODUCTION

With the advances of technology, the ERP system has become an indispensable information integration tool for enterprises. According to Waigum (2009), irrespective of the global economic recession in 2008, two-thirds of the 400 policy makers in North America and Europe still invest actively in ERP systems. Enterprises believe that implementing an ERP system can increase their competitiveness, but they are likely to encounter challenges and problems imposed by the new system (Dezdar & Sulaiman, 2009). Meanwhile, failure becomes a high price to pay because implementing an ERP system is time- and resource-consuming (Siau & Messersmith, 2002, 2003).

In addition to the time and resources expended, the process of implementing an ERP system, from adoption to maintenance, inevitably affects an enterprise’s operating processes, internal structures, personnel performance-rewarding systems, job allocation, organizational culture, employee attitudes, and so on (Gibson, 2004). Sherer and Alter (2004) propose that enterprises should expand their scope of risk management by adopting the concept of work systems. The work system method (WSM) is a system analysis method that views information systems as part of the work system. WSM includes the static work system framework (WSF) and the changing work system life cycle (WSLC), which describes how work systems evolve and change over four phases, namely, operation and maintenance, initiation, development, and implementation (Alter 2002; Sherer & Alter, 2004; Alter, 2006, 2008, 2010). More importantly, an effective risk management mechanism helps enterprises identify and assess potential risks during operation, as well as properly respond to these risks.

Previous studies focus on the risk of IS/IT or on the identification of risks. Sherer and Alter (2004) also point out that hundreds of risk factors and countless risk factor components are difficult to assess and adopt. Nevertheless, the management of potential risks after the implementation of ERP systems is crucial. The present study strives to identify the risks of ERP systems based on the WSM, including WSF and the WSLC model. It aims to establish an ERP risk management assessment mechanism by employing WSM to assist enterprises in identifying, assessing, and prioritizing risks, as well as in utilizing appropriate measures to deal with such risks. Moreover, by adopting the grounded theory, the study identifies the potential risk factors of ERP systems based on WSF during different WSLC in order to prototype the risk management mechanism. Subsequently, an expert questionnaire is conducted to revise the prototype, and the feasibility of the risk management mechanism of ERP systems is examined through case studies.

2. LITERATURE REVIEW

Failures in risk management are likely to result in considerable losses because ERP systems connect the functions of enterprises. Furthermore, the common cause of ERP failures is poor risk management or assessment (Wright & Wright, 2002; Sherer & Alter, 2004). For this reason, ERP risk management is an important key to successful business operations.

2.1 The Development of Risk Management

Risks are possible outcomes of an event leading to negative effects on an enterprise's goals (COSO, 2004). Managing risks means assigning a systemized process to evaluate the effect of risks, carry out a cost-benefit analysis, and employ skilled human resources to confirm and assess potential risks (Comptroller and Auditor General, 2000). When all the positive and negative factors are sorted out and controlled, the possibility of reaching an enterprise's goal may increase, and the possibility of failures and uncertainty decreases (IRM, AIRMIC, & ALARM, 2002). In the past years, several typical cyclical risk management mechanisms have been developed, such as PMI 2001, Standards Australia 1999, SAFE methodology, and Risk Diagnosing Methodology (Aloini, Dulmin, & Mininno, 2007).

Risk factors, critical success factors, and uncertainty factors are generally used to express similar meanings (Aloini et al., 2007). Risks can be described and categorized in different ways (Baccarini, Salm, & Love, 2004). Therefore, the identification of factors has been a challenge to the management level. The ERP system risk management should begin in the initial planning stage of the life cycle, and the information personnel, members, and departments associated with the business operation need to treat potential problems of the system with a broader perspective (Ojala, Vilpola, & Kouri, 2006). Organization-oriented operating processes can be influenced by the dynamics, interaction, cooperation, and abnormal communication inside the organization. Therefore, insufficient training, lack of internal experts, analysts without adequate operating and professional knowledge, poor coordination between internal and external experts, failures to meet ERP software standards, and inability to integrate the enterprise's systems are risk factors (Sumner, 2000; Wright & Wright, 2002).

Risk assessment includes identifying and analyzing external and internal factors, calculating the probability and considering the effect of these factors, and making decisions on how to manage these risks (COSO, 2004). Through risk assessment, the potential risks and weaknesses of enterprises are identified. Historical information and past records are also used to predict future risks. To assess and predict potential risks, both qualitative and quantitative methods should be applied (COSO, 2004). The quantitative method suggests that annual loss expectancy should be set to measure the risk. The qualitative method relies on analysts' expertise and judgment. Analysts measure the likelihood and impact loss degree of risk events by using descriptive variables. Analysis enables enterprises to prioritize the identified risks. In comparison, the qualitative method is more popular because enterprises only have to evaluate potential qualitative losses instead of calculating the financial losses caused by risks.

When risks are identified and evaluated, the management level should take cost into consideration and select an appropriate manner of response (COSO, 2004). More importantly, the chosen policy and relevant measurements should be performed in accordance with the enterprises' risk tolerance. After risks are responded to, it is necessary to monitor risks and modify response strategies to monitor whether the changing environment influences the priority. To ensure the execution of risk management, the Research, Development, and Evaluation Commission in Taiwan (2009) proposes the following four steps. First, the progress of risk management should be evaluated regularly. Second, the risk management framework, policies, and plans should be examined regularly to determine whether they are suitable for the external and internal environments. Third, risk reports have to record the progress of risk management plans and the extent that risk management policies are complied with. Lastly, to maintain the effectiveness of risk management examination, the adequacy of controlling and managing risks should be attended to.

2.2 Work System Method

Alter (2010) proposes the work system perspective as a core value in terms of organizational design engineering. Specifically, in adopting the WSM, the evolution and transformation of the work system can be analyzed by evaluating the dynamic WSLC and understanding the elements of the WSF (Alter, 2002; Sherer & Alter, 2004; Alter, 2006, 2008, 2010). Work systems refer to systems that are operated by humans and/or machines to provide products and/or services to internal organizations or external clients. These systems may overlap with IS while policy-making, communication, negotiation, and activities take place. Whatever role IT plays in an organization, WSM is one method to understand and analyze the system (Alter, 2002).

WSM has two parts. From a static view, the first part includes work practices, processes and activities, system participants, information, and technologies (Alter, 2010). The second part is composed of products and services, customers, environments, and infrastructure. WSF comprises a total of nine elements. Work systems can be evaluated and analyzed based on WSF. If WSF is adopted to identify the risk of a certain factor, then potential factors likely to affect other elements will be considered.

Alter (2002, 2004, 2010) elaborates that based on WSLC, WSF is suitable for an IS or a special project. WSLC outlines the evolution of a work system through the iterations of planned and unplanned changes. Planned changes in WSLC are represented by projects that include initiations, development, and implementation phases. Unplanned changes are ongoing adaptations and experimentations that transform aspects of the current work system or ongoing work system projects without separate allocations of significant resources. WSLC can provide risk factors with a life cycle view (Alter, 2004). Each phase can be regarded as a work system or a project.

3. RESEARCH METHODOLOGY

This study adopts Gowin’s Vee (Gowin, 1981) as the main research strategy (Novak, 1998, 2002; Novak & Gowin, 1984). On the theoretical end, the grounded theory is initially employed to derive the dimensions and items of the risk management mechanism. To compensate for the insufficiency of theories, expert questionnaires and a case study method are conducted to verify the usefulness/feasibility of the mechanism. Regarding the research process, the researchers first collect relevant data from past literature, and then the data are analyzed and sorted through the grounded theory. Subsequently, expert questionnaires are distributed, modified, and redistributed until a consensus is reached. Lastly, items suitable for the evaluation of risk factors of the ERP system life cycle are identified.

3.1 The Grounded Theory

Grounded theory suggests that research data should be collected and analyzed in a systematic manner to inductively generate patterns (Glaser & Strauss, 1967). Additionally, Strauss and Corbin (1990) note that no research hypotheses should be proposed beforehand to inductively generate concepts from the original data. As relevant concepts are not clarified in the initial stage, theories are established in a bottom-up fashion and concepts are derived based on the original data. Theories are established by connecting concepts. Basically, the grounded theory consists of three main steps. First, researchers gather and classify relevant literature in accordance with specific criteria. Next, literature gathered based on the search criteria undergo open coding. Open coding is the first process undergone by the collected data. In data collection, researchers should try to identify repeated themes and find original symbols or labels. Afterward, collected data are classified. Repeated themes are clearly revealed after the collected data undergo open coding. Third, axial coding elevates concepts to theories and facilitates the derivation of the mechanism. The purpose of axial coding is to cluster data that split in the process of open coding. During axial coding, more precise and complicated explanations of the phenomenon are elicited by interrelating categories with sub-categories. Axial coding encourages researchers to abandon existing themes and probe other themes.

3.1.1 Literature selection

Initially, research papers containing the keywords "ERP risk"' or "ERP threat" are chosen. The databases this study looks into are *EBSCOhost* and *Science Direct On Line (SDOL)*. This study also refers to the ranking of IT journals provided by the Association for Information Systems (http://www.aisnet.org) to include high-quality papers outside the two databases. Only academic papers longer than eight pages are gathered because the length affects the depth of research findings. The research target and focus of selected papers should be the life cycle of ERP systems. Selected papers should be published between 2000 and 2010, the period when information technology risk management was rapidly developing and became more mature. In total, 24[1] English academic papers are collected.

---

[1] Hakim and Hakim (2010), Peng and Nunes (2009), Warkentin, Moore, Bekkering, and Johnston (2009), Bannerman (2008), Aloini, et al. (2007), Han and Huang (2007), Abu-Musa (2006), Tiwana and Keil (2006), Uwadia, et al. (2006), Singla and Goyal (2005), Zafiropoulos, Metaxiotis, and Askounis (2005), Baccarini, et al. (2004), Huang, et al. (2004), Sherer and Alter (2004), Wallace, et al. (2004), Benaroch (2002), Maguire (2002), Wright and Wright (2002), Barki, et al. (2001), Grabski, et al. (2001), Jiang and Klein (2001), Schmidt, et al. (2001), Sumner (2000), Markus, Axline, Petrie, and Tanis (2000).

3.2 The Expert Questionnaire

Conducting the expert questionnaire is a method to collect expert opinions and suggestions based on research objectives. Validity is considered the most important indicator in terms of the expert questionnaire. Specifically, the validity of a questionnaire refers to whether a characteristic/feature can be correctly, reliably, and effectively measured through the test or rating scale. Apart from validity, content validity is used to measure the degree of validity of an expert's judgment. Expert validity, moreover, is an indicator measuring the adequacy of items in the designed questionnaire. Unlike content validity, expert validity can only indicate the consistency of experts' opinions, though it can be used as a reference to reveal the adequacy of items and research dimensions.

Following Lawshe's (1975) study of verification of expert validity, content validity ratio (CVR) is adopted in the current study. A panel of subject matter experts examines a set of items to decide whether the proposed items are essential, useful, or unnecessary, and thus determine content validity. CVR is calculated to indicate whether the items are pertinent to the content validity. CVR values range from +1 to -1. The closer to +1 the values are, the more the experts agree on the importance of the items.

Experts from relevant fields, such as IT/IS professionals responsible for implementing and maintaining ERP systems or ERP system users, are invited to participate in the evaluation of risk factors. Owing to time and space constraints, questionnaires are distributed via email. The designed questionnaire for the ERP system risk management mechanism can be divided into two parts. The first part specifies instructions and the second part includes the questions the present study intends to investigate. In the second part, the respondents have to confirm if the proposed factor is a risk factor. If yes, the respondents select which phase of the WSLC the proposed factor belongs to. After that, the respondents select from the five-point ordinal scale, including "strongly disagree," "disagree," "moderately agree," "agree," and "strongly agree," to determine whether the risk factor is appropriately categorized. At the end of the questionnaire, experts are allowed to write suggestions or comments in the blank area.

3.3 The Case Study Method

According to Eisenhardt (1989), the case study method allows researchers to observe and interview subjects, directly examine all files and literature to piece together the history, and focus on changes in the research context. Yin (1994) notes that case study is a form of empirical inquiry that focuses on phenomena and things taking place during the research. Researchers must also obtain sufficient data to reach conclusions. Case study method is not merely a data collection strategy. Instead, it is a method that emphasizes logic and specific techniques of data collection and analysis.

Single-case study and multi-case study are common case study techniques (Herriott & Firestine, 1983; Yin, 1994). Compared with the single-case study, the multi-case study method is more convincing and powerful. The purpose of employing the multi-case study method is to collect similar or different results and outcomes based on the researchers' prediction. In a multi-case study design, effectively carrying out six or ten cases is similar to conducting six or ten experimental studies. The number of cases can reflect the number of repetitive or similar findings. In this study, the multi-case study method is adopted to obtain high accuracy and in-depth results.

4. THE ERP SYSTEM RISK MANAGEMENT MECHANISM

This section first presents the analysis of ERP system literature and how the selected research papers are coded. After identifying the risk factors, the expert questionnaire is conducted accordingly. Lastly, results of the expert questionnaire are discussed.

4.1 Identifying Risk Factors

In Hakim and Hakim's study (2010), "Organizational Risks: sufficient resources, the degree of required changes, capabilities in process re-engineering, the degree of office automation, the stability of corporate objectives, the stability of project objectives and scopes" are discussed. Specifically, the 6 risks, including (1) insufficient resources, (2) lack of understanding of the required changes, (3) inability in process re-engineering, (4) low degree of office automation, (5) unstable corporate objectives, and (6) unstable project objectives and scopes negatively affect the ERP system or damage the organization. The remainders' classification proceeds similarly in open coding phase. The 24 articles listed a total of 511 risk items, which are analyzed and classified into 57 risk factors according to the initial definitions in Appendix A. For instance, the categories "insufficient resources," "insufficient resources" (Hakim & Hakim, 2010), "insufficient resources to support job tasks" (Sherer & Alter, 2004), and "the estimated resources are not enough" (Wallace, Keil, & Rai, 2004) are classified as one factor despite the different labels assigned to them by researchers. Through axial coding, 57 factors are analyzed, compared, and elevated to dimensions of higher levels in accordance with the WSM (Alter, 2006, 2008, 2010).

4.2 Analysis of the Expert Questionnaire

Owing to time and space constraints, 65 questionnaires are distributed via email, from which 22 valid questionnaires are obtained. The recovery rate is 34 %. The selected experts' backgrounds are presented in Table 1.

Type of industry	Number of experts	Tenure	Number of experts
Manufacturing	13	Over 10 years	5
High technology	3	6 to 10 years	10
Service	6	1 to 5 years	7

Table 1 Backgrounds of the selected experts

Among the 57 risk factors, 7 are removed because the CVR values must be bigger than 0.40 to reach content validity. Experts suggest that "key users' lack of required knowledge for the system" should be eliminated. Key users are expected to contribute to process re-engineering and to focus on the communication flow. Their professional knowledge and ability on the system are less important. The finalized ERP system risk assessment mechanism consists of 9 dimensions and 49 risk factors (See Appendix A).

Dimension	Risk factor	Number of experts	CVR
System participants	B5. Lack of experience or ability	15	0.36
	B7. Lack of adequate employees	13	0.18
Technologies	D1. Inability to obtain required software	14	0.27
Products and services	E2. Products or services do not meet customers' requirements	13	0.18
Customer	F2. Customers' prediction do not correspond to the project goals	14	0.27
Environment	G3. Adopting standards incompatible with the ERP system	14	0.27
	G6. Not suitable for enterprise culture	14	0.27

Table 2 Risk factors with low CVR values

5. EMPIRICAL STUDY OF THE ERP SYSTEM RISK MANAGEMENT MECHANISM

To examine the feasibility of the derived ERP system risk management mechanism, two companies are selected for the case study. In the following sections, the backgrounds of the companies and how the chosen companies manage their ERP systems are addressed.

5.1 Backgrounds of the Companies

Founded in 2002, Company A is the chief TFT-LCD manufacturer in Taiwan. Its production bases and plants are located in Taiwan, China, and Europe. Its product lines include LCD panels, TV panels, monitor panels, notebook panels, and so on. To expand its market, Company A intends to assemble LCD panels. Company B, established in 1985, is a well-known manufacturer of automobile components such as automatic transmissions, clutches, and auto air-condition compressors, 93% of which are exported worldwide. Its main market is Northern America's after sales and maintenance market. Company A and B mainly sells its products to the top five dealers of US automobile components.

5.2 ERP Systems of the Companies

Company A's Oracle ERP system was implemented upon its establishment. Company A's implementation process consists of six phases: defining, analyzing the company operation situation, planning solutions, constructing solutions, preparing for online operation, and operating. Owing to the compliance on IFRS and the merging of businesses, the company's ERP system faces many risks. Oracle ERP R11i was implemented by Company B in 2006. Company B followed the Method Blue of IBM by dividing its implementation process into four phases: preparing, designing, setting the system, and operating the system. Its ERP system includes two stages, implementing and maintaining. The maintaining process can be further divided into basic system maintenance and special project improvement.

5.3 ERP System Risk Analysis in the Companies

The risk factors, countermeasures, and possible solutions for the two case companies are analyzed based on WSF.

(A) Processes and activities: Company A may have internal control flaws, but unauthorized alteration rarely occurs. Although its system users may input incorrect data, this mistake can be solved through the Accounting Department's auditing. Additionally, when the users are unable to clearly articulate their needs, they are highly likely to cause errors. Therefore, the importance of effective communication between IT staff and system users cannot be overlooked. Company B, on the other hand, experiences problems in its system operation because of the replacement of employees and miscommunication among departments sometimes happens. Consequently, its system cannot be adequately operated, which is a big risk to Company B.

(B) System participants: Company A has undergone system conversion, and therefore its employees need new training sessions. However, its employees may not support the change because of the inappropriate transformation. Other than that, following the regulations of IFRS is reinforced by the government. Therefore, Company A's system users may not actively support the change of regulations. In Company B, the lack of cooperation among its users from different departments is a problem. Even so, Company B regards this lack of cooperation as a predictable situation for most companies.

(C) Information: As Company A has undergone system conversion, some data may not be completely converted. Manual check and conversion are still required. Although the data stored in the previous system are compatible with those in the new one, further examination is necessary. In Company B, there are problems of compatibility between its system and database. Thus, complementary programs are implemented to solve the problems.

(D) Technologies: Company A's ERP system functions may not be capable of dealing with system conversion. When the ERP system is upgraded, the enterprise employees have to strengthen their abilities; otherwise, it is impossible to maintain the upgraded system. In Company B, the latest technologies are rarely selected as solutions when the functions of its ERP system are insufficient. Instead, the company tends to adjust its current system by adopting an ERP improvement project.

(E) Products and services: Company A's employees state that when the system performance is poor, risks may exist in the input and output of data. If the hardware storage is insufficient, data transmission will be interrupted and, as a result, data may be lost. For Company B, the system performance can be improved through adjusting parameters and updating hardware. However, as data accumulate, the hardware should be maintained and updated. Too much data will affect the performance of the system.

(F) Customer: From Company A's perspective, the change in customers' needs have no direct impact on the system. To be more specific, the organization tends to deal with external issues first, rather than adjust the system without careful planning. Company B agrees that the change in customers' needs is related to deadlines or product designs. Thus, it only affects production lines. Moreover, the ERP system assists the company in noticing possible costs or detecting inventory problems when customers' needs change.

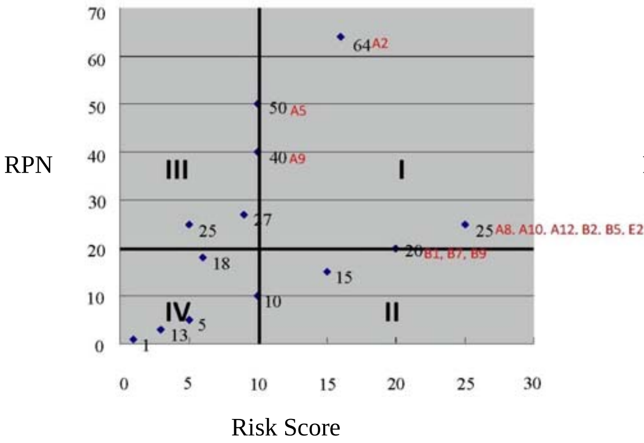
(G) Environment: The problem Company A encounters is whether to replace or integrate its system. The enforcement of IFRS pushed Company A to evaluate whether to adopt a new system in compliance with IFRS or to continue using the current system. Company B follows ROC GAAP to prepare its tax declaration. However, two forms of financial reports, namely, tax record and financial record, have to be produced during the IFRS promotion period. Company B's ERP system cannot support both reports. Therefore, a new system is required.

(H) Infrastructure: Company A seems to have no technology infrastructure problems. Even so, when personnel changes occur, the new employees may need training to enhance their ability. In Company B, the unfamiliarity of users on computer operation or the ERP system allows training education to improve their computer skills and expand their knowledge systems. Note that the lack of training or understanding of the application software is a huge problem for large-scale enterprises in terms of system implementation. Hence, conducting training sessions may solve the problem (Aloini et al., 2007).

(I) Strategy: After merging, Company A must decide whether to replace or integrate its system in response to IFRS. A complete plan and countermeasures are needed. Company B regularly adjusts its organizational strategies, and so its system may need frequent modifications. To fulfill the company's needs, the system needs extra time to run smoothly. In other words, the enterprise's goals, strategies, and needs are key factors of ERP implementation.

5.4 Applying the ERP Risk Management Mechanism

Company A's risk score and RPN are 10 and 20, respectively. The risk assessment results are presented in Figure 1. Specifically, nine factors in quadrant I deserve the most attention because both their risk scores and RPN values are high. Therefore, factors in quadrant I should be top priority. Company B's risk score and RPN are 12 and 20 respectively. As shown in Figure 2, 25 factors are located in quadrant I.



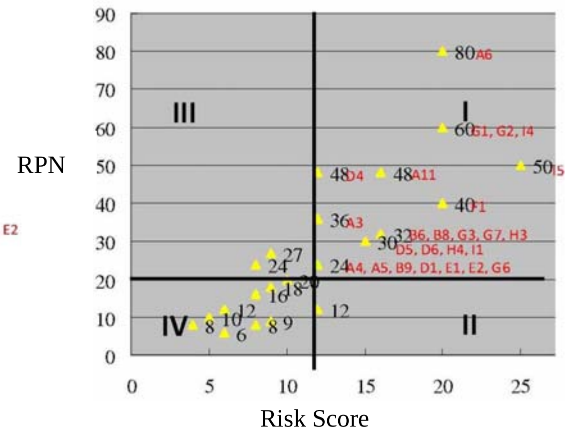


Figure 1 Risk Assessment Results (Company A)

Figure 2 Risk Assessment Results (Company B)

Factors in quadrant II have high risk scores and may jeopardize the organizations. Therefore, if the management level can identify such risks, they will have sufficient time to react. Factors in quadrants III and IV are acceptable risks for enterprises. Compared with risks in quadrant IV, risks in quadrant III have a higher degree of danger because they are not easily detected.

Through interviewing employees from the two companies, the risks of ERP systems in Company A and Company B are included in the 49 factors proposed in this study. As each organization has its unique environment, the level of risk acceptance varies as well. The two companies should manage their system risks through internal control. When ignorance of internal control or violation occurs within their organizations, their entire systems will not function normally.

6. CONCLUSIONS AND IMPLICATIONS

6.1 Conclusions

The present study identifies 49 risk factors through the grounded theory from the perspective of WSM. An expert questionnaire is conducted to enhance the mechanism, and two companies are invited for the multi-case study. The finalized mechanism consists of four procedures, namely, risk identification, risk assessment, risk response, and risk monitoring and modification. In the risk identification phase, past literature is coded and classified. Through the expert questionnaire, the 49 risk factors are identified and modified. In the three later phases, the 49 factors and sizes of the risks are evaluated by allowing evaluators to estimate the frequency of occurrence, impact, and delectability of each risk. By computing risk scores and RPN values, the risk factors are prioritized, which provides the investigated companies a guide to cope with risk factors. The actual risk factors of the two companies are found to correspond with those generated from the current study.

6.2 Implications

This study uses the WSM to construct the ERP risk management mechanism. Apart from helping enterprise supervisors understand the risks of their systems and eliminating communication barriers with the IT staff, the mechanism can recognize risk factors and analyze the impact of these factors. Through adopting this list of risk factor evaluation, the management level can detect potential risks within systems in a shorter period, thus enabling them to seek appropriate methods to respond. In previous studies on IT risk management, the focus is more on risk factor identification and risk management. Thus, the elicited ERP risk management mechanism can be used as a guide for companies from the perspective of WSM. Only when enterprises emphasize risk management can they quickly respond to risks and effectively manage their companies.

References

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

Alter, S. (2002) The work system method for understanding information systems and information system research. *Communications of the Association for Information Systems*, 9, 90–104.

Alter, S. (2006). The Work System Method: Connecting People, Processes, and IT for Business Results. Larkspur, CA: Work System Press

Alter, S. (2008). Defining information systems as work systems: Implications for the IS field. *European Journal of Information Systems*, 17(5), 448–469.

Alter, S. (2010). Work systems as the core of the design space for organizational design and engineering. *International Journal of organizational Design and Engineering*, 1(1/2), 5–28

Babbie, E. (1989). The Practice of Social Research. Belmont, CA: Wadsworth Publishing Company.

Baccarini, D., Salm, G. S., and Love, P. E. D. (2004). Management of risk in information technology projects. *Industrial Management & Data Systems*, 104(4), 286–295.

Comptroller and Auditor General. (2000). Supporting innovation: Managing risk in government departments, HC 864 Session, 1999–2000.

COSO. (2004). Enterprise Risk Management- Integrated Framework. Retrieved February 6, 2013, from http://www.coso.org/documents/COSO_ERM_ExecutiveSummary_Chinese_Unsimplified.pdf

COSO. (2004). The committee of sponsoring organizations of the Treadway Commission. Retrieved February 9, 2013, from http://www.coso.org/.

Dezdar, S., and Sulaiman, A. (2009) Successful enterprise resource planning implementation: taxonomy of critical factors. *Industrial Management & Data Systems*, 109(8), 1035–1052.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review*, 14(4), 532–550.

Gibson, C. F. (2003). IT-enabled business change: An approach to understanding and managing risk. *MIS Quarterly Executive*, 2(2), 104–115.

Glaser, B. and Strauss, A. (1967). The discovery of grounded theory: Strategies for qualitative research. Chicago: Aldine.

Herriott, R.E. and Firestine, W.A. (1983). Multisite qualitative policy research: Optimizing description and generalizability. Educational Researcher, 12, 14–19.

Hakim, A. and Hakim, H.(2010). A practical model on controlling the ERP implementation risks. *Information systems*, 35(2), 204–214.

IRM, AIRMIC, and ALARM. (2002). IRM risk management standard.

Lawshe, C. H. (1975). A quantitative approach to content validity. *Personnel Psychology*, 28(4), 563–575.

Ojala, M, Vilpola, I. and Kouri, I. (2006). Risks in ERP project – A case study of IS/ICT management capability maturity level and risk assessment. In Frontiers of e-Business Research 2006, Maula, M., Hannula, M., Seppä, M, and Tommila, J. (eds.), Tampere University of Technology (TUT) and University of Tampere (UTA).

Research, Development and Evaluation Commission, Executive Yuan (2009). Risk management and crisis management operations manual. Retrieved February 7, 2013, from http://www.rdec.gov.tw/ct.asp?xItem=3854955&CtNode=12944&mp=100

Sherer, S. A., and Alter, S. (2004) Information system risks and risk factors: Are they mostly about information systems? *Communications of Association for Information Systems*, 14, 29–64.

Siau K. and Messersmith J. (2002). Enabling technologies for E-Commerce and ERP integration. *Quarterly Journal of Electronic Commerce*, 3(1), 43–52.

Siau K. and Messersmith J. (2003). Analyzing ERP implementation at a public university using the innovation strategy model. *International Journal of Human Computer Interaction*, 16(1), 57–80.

Strauss, P. A. and Corbin, J. (1990). Basics of qualitative research: Grounded theory procedures and techniques. Thousand Oaks, CA: Sage.

Sumner, M. (2000). Risk factors in enterprise wide information management systems projects. *Journal of Information Technology*, 180–187.

Wailgum, T. (2009). ERP investments still top the list for corporate IT spending, Forrester research. Retrieved February 6, 2013, fromhttp://www.cio.com/article/507663/ERP_Investments_Still_Top_the_List_for_Corporate_IT_Spending

Wallace, L., Keil, M. and Rai, A. (2004). Understanding software project risk: A cluster analysis. *Information & Management*, 42, 115–125.

Wright, S., and Wright, A. M. (2002).Information system assure for enterprise resource planning: unique risk considerations. *Journal of Information Systems*, 16

Yin, R. K. (1994). Case Study Research: Design and Methods, Sage, London, CA, 2nd Ed.

Appendix A: The finalized ERP system risk management mechanism

WSF (Dimension)	Risk factor	Work System Life Cycle			
		Initiation	Development	Implementation	Operation and maintenance
Processes and activities	A1. Inability to re-engineer business process	◎	◎		
	A2. Mismatch between the business process and system requirements	◎	◎		
	A3. Lack of adequate special project management		◎	◎	
	A4. Poor special project control		◎	◎	◎
	A5. Inability to operate the system properly		◎	◎	◎
	A6. Insufficient system planning	◎	◎		
	A7. Insufficient system budget and financial support	◎	◎		
	A8. Schedule is delayed or interrupted	◎	◎	◎	
	A9. Lack of understanding of enterprise transformation requirements	◎	◎		
	A10. Change of enterprise transformation requirements		◎	◎	◎
	A11. Inability to prepare for enterprise transformation	◎	◎		
	A12. Poor communication		◎	◎	
	A 13. Lack of documentation		◎	◎	◎
System participants	B1. Problems of suppliers and partners	◎	◎		
	B2. Lack of cooperation between users' departments		◎	◎	
	B3. Lack of users' participation	◎	◎	◎	
	B4. Lack of users' support and commitment	◎	◎	◎	
	B5. Users' resistance to system transformation	◎	◎	◎	
	B6. Lack of experienced or adequate experts	◎	◎		
	B7. Unstable team or lack of adequate members	◎	◎	◎	
	B8. Team members lack experiences or proficiency	◎	◎	◎	

	B9. Conflicts between team members	◎	◎	◎	
Information	C1. Problems of system information		◎	◎	◎
Technologies	D1. Developing inaccurate functions or functions are insufficient		◎	◎	◎
	D2. The use of new technologies		◎		◎
	D3. Poorly established system		◎	◎	
	D4. Complicated technologies		◎	◎	
	D5. Incompatibility with the existing system	◎	◎		
	D6. Insufficient integration of internal and external systems	◎	◎		
Products and services	E1. The system produces poor products	◎	◎		◎
	E2. Poor performance	◎	◎		◎
Customers	F1. Customers' needs change constantly		◎	◎	◎
Environment	G1. Change of organizational policies	◎	◎		
	G2. Change of organizational environment	◎	◎		
	G3. Natural or man-made disasters		◎		◎
	G4. Lack of support from executives	◎	◎		
	G5. Insufficient resources	◎	◎		
	G6. Poor performance management	◎	◎		◎
	G7. Inadequate data storage and authorization		◎	◎	◎
Infrastructure	H1. Inadequate human infrastructure to support the work system	◎	◎	◎	
	H2. Inadequate technical infrastructure to support the work system	◎	◎		
	H3. Lack of team member training		◎	◎	◎
	H4. Lack of user educational training		◎	◎	◎
Strategy	I1. Mismatch between the work system and the organization's strategy	◎	◎		
	I2. Poor leadership and management	◎	◎	◎	
	I3. Vague project goals or scopes	◎	◎		

	I4. Unstable project goals or scopes	◎	◎		
	I5. Inconsistent project goals	◎	◎		
	I6. Lack of analysis of the organization’s overall operations	◎	◎		