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Enterprise Risk Management in International Construction Operations

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ISBN 978-981-287-548-8 ISBN 978-981-287-549-5 (eBook)
DOI 10.1007/978-981-287-549-5

Library of Congress Control Number: 2015939663

Springer Singapore Heidelberg New York Dordrecht London

Printed on acid-free paper

Springer Science+Business Media Singapore Pte Ltd. is part of Springer Science+Business Media
(www.springer.com)

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Abbreviations

AHP	Analytic hierarchy process
AI	Artificial intelligence
AMA	American Management Association
ANN	Artificial neural network
ARM	Associate in risk management
AS/NZS	Standards Australia/Standards New Zealand
BCA	Building and Construction Authority
BOT	Build–operate–transfer
BSI	British Standard Institution
CAS	Casualty Actuarial Society
CCFs	Chinese construction firms
CEO	Chief executive officers
CFO	Chief financial officers
CoCo	Criteria of Control Board
COG	Center of gravity
COSO	Committee of Sponsoring Organizations of the Treadway Commission
CPC	Communist Party of China
CRO	Chief risk officer
DB	Design–build
DBB	Design–bid–build
DSE	Decision support engine
DSS	Decision support system
EIU	Economist intelligence unit
ENR	Engineering News Record
ERM	Enterprise risk management
ERMMI	Enterprise Risk Management Maturity Index
ES	Expert system
FST	Fuzzy set theory
GA	Genetic algorithm
GDP	Gross domestic product

GUI	Graphical user interface
HBRAS	Harvard Business Review Analytic Services
HK	Hong Kong
HSE	Health and Safety Executive
ICT	Information and communication technology
IDE	Integrated development environment
IMA	Institute of Management Accountants
IMPACT	Integrated Management of Productivity Activities
IRM	Institute of Risk Management
ISO	International Organization for Standardization
IT	Information technology
JIT	Just-in-time
KBDSS	Knowledge-based decision support system
KBS	Knowledge-based system
KPI	Key performance indicator
KRI	Key risk indicator
LILAC	Leadership, involvement, learning, accountability and communication
LPC	Least preferred co-worker
MD	Managing director
MO	Macao
MOHURD	Ministry of Housing and Urban-Rural Development
MOM	Ministry of Manpower
NBSC	National Bureau of Statistics of China
NYSE	New York Stock Exchange
OD	Organizational development
ODI	Overseas direct investments
PDCA	Plan–do–check–act
PDF	Portable document format
PMI	Project Management Institute
PPP	Public–private partnership
PRM	Project risk management
PROMETHEE	Preference Ranking Organization Method for Enrichment Evaluations
R&D	Research and development
RIMS	Risk and Insurance Management Society
RMB	Renminbi
RMIS	Risk management information system
S&P	Standard & Poor’s
SASAC	State-owned Assets Supervision and Administration Commission
SOA	Society of Actuaries
SOX	Sarbanes–Oxley Act
SPSS	Statistical Package for the Social Sciences
SWOT	Strengths, weaknesses, opportunities and threats
TFN	Triangular fuzzy number

TQM	Total quality management
TW	Taiwan
UC	University of California
WTO	World trade organization

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Abstract

In recent years, a paradigm shift has occurred in the way companies view risk management, and the trend has moved toward a holistic view of risk management. As the fundamental paradigm in this trend, enterprise risk management (ERM) has attracted much worldwide attention. Construction firms have been seen as prime candidates for ERM adoption because their businesses are risky ventures, plagued with complex and diverse risks. This research aims to provide an understanding of ERM implementation in Chinese construction firms (CCFs) based in Singapore, thereby contributing to the knowledge relating to ERM implementation in construction firms.

Specifically, this research proposes an ERM framework, which considers the project-based nature of construction firms and presents the functional steps toward ERM implementation. In addition, this research develops an ERM maturity model. This model adopts the fuzzy set theory (FST) to deal with the problems relating to ambiguous, subjective, and imprecise judgments that are inevitably involved in the ERM maturity assessment exercise. Through a literature review and a survey conducted with 89 professionals, a total of 16 important maturity criteria and 66 applicable ERM best practices as the subset of the criteria were identified and included in the model. Out of the 89 respondents, 64 were practitioners from CCFs in the global market and 25 were academics from universities located in Mainland China.

A further survey was performed to collect the data relating to the implementation levels of the 66 ERM best practices in CCFs based in Singapore. By inputting these data into the ERM maturity model, it was found that the overall ERM maturity level of these firms was low and that there was a significant association between the ERM maturity level and firm size.

ERM maturity can be influenced by the interactions between the drivers for and hindrances to ERM implementation. Thus, using the survey data, the research found that 13 drivers and 25 hindrances had significantly positive and negative influence on ERM implementation in CCFs based in Singapore, respectively. These significant drivers and hindrances were interpreted in tandem with the theories of organizational change, organizational learning, organizational culture, motivation, and leadership.

Case studies were also conducted to uncover how ERM was implemented in three Singapore-based CCFs. The cross-case comparison results substantiated the association between ERM maturity and firm size and implied that the ERM implementation in these firms was influenced by their respective parent companies.

Lastly, this research develops a knowledge-based decision support system (KBDSS) for ERM in CCFs, which can assess the ERM maturity, visualize the assessment results, provide action plans for improving ERM practices, and generate a printable ERM maturity assessment report. The KBDSS consists of a knowledge base, a graphical user interface, and a decision support engine.

As few studies have been focused on ERM implementation in construction firms, the proposed ERM framework, the development of the fuzzy ERM maturity model for CCFs, and the investigation of the ERM maturity and the factors influencing ERM implementation in Singapore-based CCFs significantly contribute to the current literature. In addition, the ERM KBDSS, which incorporates the ERM maturity model and a set of action plans, allows users to obtain a clear view of the status quo, strengths and weaknesses of their ERM implementation, and on how to improve their ERM practices, thus contributing to practices in the industry.

Future research would develop a set of metrics to measure ERM performance, examine the impact of ERM on project performance, set up an ERM benchmarking system, and identify the appropriate organizational learning styles, motivation measures, and leadership styles for ERM implementation in construction firms.

Chapter 1
Introduction

Keywords Research motivation · Research scope · Research objectives · Research hypotheses · Research significance

1.1 Research Motivation

There are numerous opportunities in the international construction market. According to the Engineering News Record (ENR), the top 250 international contractors as a group generated US$511.05 billion from overseas projects in 2012 (ENR 2013a). However, construction businesses, especially those conducted outside home countries, are risky ventures. Cost and time overruns were found to be frequent in international construction projects (Flyvbjerg et al. 2003). Contracting in overseas construction markets involves not only the typical risks at home, but also the complex and diverse risks peculiar to international transactions (Deng et al. 2014b; Han and Diekmann 2001). Inadequate overseas environmental information and construction experience contribute to a higher risk exposure and possibility of losses in the international market than that in the domestic market (Zhi 1995). Furthermore, contractors that fail to conduct effective risk management in the overseas market tend to bear the consequences such as poor cost and schedule performance, conflicts, and even business failures. Hence, risk management is critical for construction firms to survive and remain profitable in the international construction market.

The construction industry is a project-based industry. Hence, risks inherent in construction projects have been emphasized in the literature (Deng et al. 2014a; Hwang et al. 2014d; Lehtiranta 2013; Zhao et al. 2014; Zou et al. 2007b). However, construction firms are also exposed to the risks outside the projects, which tend to impact both project objectives and corporate objectives. Overemphasis on project risk management (PRM) tends to result in low efficiency in risk management, lack of transparency across multiple projects, inappropriate resource allocation among projects, and difficulties in achieving the corporate strategic objectives (Adibi 2007). Therefore, risk management in construction firms should cover not only the project risks, but also the risks encountered by being a business enterprise (Schaufelberger

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2009). Sometimes, the projects concurrently managed by a firm may fail at the same time, as the result of failure in risk management at the firm level (Liu et al. 2013).

For construction firms venturing into overseas markets, a global view to identify systemic risks was recommended to replace project-only risks (Zhi 1995). The recent trend is to take a holistic view of risk management (Gordon et al. 2009), recognizing risk management as an enterprise-wide process that collectively considers the risks that various projects face and links these risks to the corporate strategy (Adibi 2007). Thus, enterprise risk management (ERM), which is a holistic and integrated approach to risk management, has captured the attention of risk management professionals and researchers worldwide (McGeorge and Zou 2013) and was forecast to grow in the construction industry (Deloitte 2010). This approach agrees with the modern portfolio theory. This theory states that it is possible to build a portfolio that is reasonably safe even though it contains a number of uncorrelated or negatively correlated high-risk investments (Lam 2003).

ERM has been driven by a series of compulsory corporate governance requirements, such as the Sarbanes–Oxley Act (SOX) and New York Stock Exchange (NYSE) corporate governance rules in the USA, Corporate Governance Code in the UK, and KonTraG in Germany. The three main rating agencies, i.e., Standard & Poor's (S&P), Moody's, and Fitch, also regarded ERM implementation as an input to the analysis of credit ratings (Beasley et al. 2008). In addition, several ERM frameworks and standards have been issued for ERM implementation (CAS 2003; COSO 2004; ISO 2009b). Hence, ERM has been implemented in a variety of industries. A great number of studies on ERM have been conducted, with most of them focusing on the financial, insurance, manufacturing, energy, and chemical industries. Some surveys on ERM implementation have used the samples from construction firms (AON 2010; Beasley et al. 2010c; CFO/Crowe 2008; KPMG 2010), indicating that there were ERM practices in construction firms. However, few studies have been conducted to provide an understanding of ERM implementation in construction firms. Therefore, there exists a knowledge gap in ERM implementation in construction firms. This research fills the gap and provides an understanding of ERM implementation in construction firms.

1.2 Research Scope

According to the ENR, Chinese construction firms (CCFs) occupied the top three positions among the top 250 global contractors (ENR 2013c), and 55 CCFs were ranked within the top 250 international contractors based on their overseas contracting revenues in 2012 (ENR 2013a). Hence, CCFs are playing an important role in the international construction market. According to the National Bureau of Statistics of China (NBSC), by the end of 2012, CCFs had accumulated a turnover of US$652.75 billion from overseas projects (NBSC 2013).

As one of the four Asian Tigers, Singapore has become an important overseas market for CCFs because of its relatively stable political and economic environment, liberal rules, and attractive construction demand. According to the Building and Construction Authority of Singapore (BCA 2013), Singapore's construction demand reached S$28.1 billion (approximately US$22.3 billion) in 2012. CCFs have benefited greatly from this high demand. According to the NBSC (2013), the turnover of CCFs in Singapore had increased from US$0.51 billion in 2001 to US$2.88 billion in 2012, which made Singapore become the ninth largest overseas markets of CCFs.

This research focuses on ERM implementation in CCFs based in Singapore, which are actually the overseas subsidiaries of their parent companies located in mainland China. This research proposes an ERM framework to facilitate ERM implementation in construction firms and examines the ERM implementation level and the critical factors affecting the ERM implementation in Singapore-based CCFs. In addition, these critical factors are analyzed in tandem with five theories of organizational behavior, including organizational change, organizational learning, organizational culture, motivation, and leadership theories. Finally, to enhance the ERM implementation level toward the best practices in CCFs, a knowledge-based decision support system (KBDSS) for ERM is developed.

1.3 Research Objectives

As the research question is "*How is ERM implemented in CCFs based in Singapore*?", this research aims to provide an understanding of the ERM implementation in CCFs based in Singapore, thereby filling the knowledge gap in ERM implementation in construction firms. The specific objectives of this research are to:

1. Propose an ERM framework to facilitate the ERM implementation in construction firms;
2. Develop an ERM maturity model to assess the ERM maturity in CCFs;
3. Investigate the ERM maturity level in CCFs based in Singapore;
4. Examine the critical factors driving and hindering the implementation of ERM in CCFs based in Singapore and analyze them in tandem with theories of organizational behavior; and
5. Develop a KBDSS that can assess the ERM maturity level of CCFs and provide recommendations to improve ERM implementation along the maturity continuum.

1.4 Research Hypotheses

ERM implementation is an ongoing and iterative process (Bowling and Rieger 2005; Hallowell et al. 2013) and should proceed in incremental steps (IMA 2007). An effective ERM program requires several years to develop (Hallowell et al. 2013). Hence, the implementation level of ERM is often described by a maturity continuum. Several ERM maturity models have been developed to help organizations in various industries to assess their ERM maturity level (AON 2010; Ciorciari and Blattner 2008; RIMS 2008; Santori et al. 2007; UC 2009). These models help organizations to identify the status quo, strengths, and weaknesses of their ERM practices, from which they can derive measures to fill the existing gaps between the status quo and the best practices. The construction industry is project-based and has some typical characteristics, such as involvement of various parties, product uniqueness, on-site production, and ad hoc project teams with relatively high turnover rates (Burtonshaw-Gunn 2009; Tserng et al. 2009). These characteristics make the construction industry different from financial, insurance, and energy industries, where the existing ERM maturity models have been widely used. Also, the short-term perspective in the construction industry hinders innovation and technical development (Dubois and Gadde 2000, 2002), and the industry's specific uncertainties increase the difficulty in using a centralized approach to decision-making (Dubois and Gadde 2002). This research develops an ERM maturity model to assess the ERM maturity level in CCFs against several criteria. These criteria can reflect the key characteristics of advanced or successful ERM practices. The implementation levels of these criteria act as the independent variables in the model, while the ERM maturity level is the dependent variables. This model involves the formulation of the first hypothesis as follows.

Hypothesis 1 ERM maturity in CCFs depends on a set of critical criteria

Although the overall revenue of CCFs has been soaring in recent years, CCFs were still plagued with several weaknesses, one of which was identified as the lack of sufficient management capacities (Lu et al. 2009), including the risk management capacity. The low risk awareness caused by an unsupportive culture and the lack of expertise and experience was found to hinder the implementation of risk management in the Chinese construction industry (Liu et al. 2007). Although it is necessary for CCFs to properly analyze and understand the cultural, political, economic, institutional, and regulatory environment in their target overseas markets before they venture abroad (Zhao et al. 2009), a number of CCFs have rushed abroad without a proper market analysis (Orr and Scott 2008).

CCFs in Singapore also appeared to have a low level of risk awareness. External risks, which fall outside a firm's direct control (Fang et al. 2004; Frame 2003), tend to threaten construction firms in the overseas market. However, the lack of external risk management was found in most CCFs based in Singapore, where firms had low risk awareness and lacked capable people with the specific knowledge (Low et al. 2009). Moreover, CCFs that first ventured into Singapore would not spend resources in external risk management, but were eager to win a project, regardless of the potential risks (Low et al. 2008). In addition, some CCFs did not emphasize safety risks, with workers risking their lives to achieve early completion (Ling and Lim 2010). As ERM should cover all the risks that a firm faces, the lack of external risk management and low-level safety management may represent low-level ERM. Zou et al. (2010) compared the maturity measurement levels of various risk management maturity models and categorized maturity into four levels: initial and ad

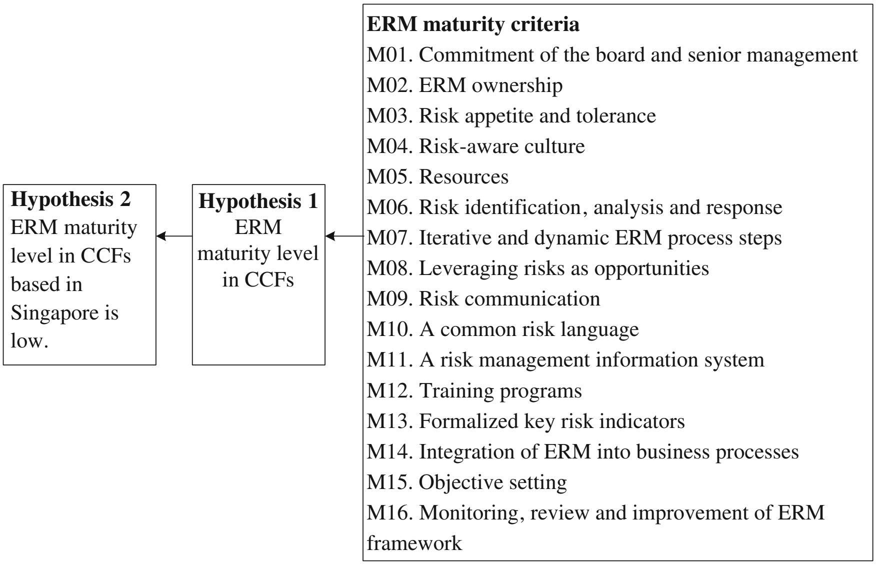


Fig. 1.1 Hypotheses 1 and 2. *Sources* Various sources

hoc, repeatable, managed, and optimized. Ciorciari and Blattner (2008) evaluated ERM maturity along a scale including the very weak, poor, middle, good, and optimized levels. The levels below the middle can be viewed as immature. Hence, the second research hypothesis can be drawn as follows.

Hypothesis 2 ERM maturity level in CCFs based in Singapore is low

The first two hypotheses are related to ERM maturity, and their relationship can be depicted as shown in Fig. 1.1. The sources of the 16 ERM maturity criteria are presented in Sect. 3.7.2. The weights of the criteria in the model were identified using the professional views collected from the first round of questionnaire survey. Professionals rated the importance of each criterion based on their experience and knowledge about risk management in CCFs. Through the one-sample t test, the criteria with significant importance were deemed as critical criteria and retained in the model. Thus, the ERM maturity level depends on these critical criteria and Hypothesis 1 can be tested (see Sect. 7.2.2). It should be noted that this ERM maturity model can be used to measure ERM maturity level of all the CCFs, including those based in Singapore. The data relating to the implementation level of each critical criterion were collected from the second round of questionnaire survey conducted with CCFs based in Singapore. The data were input into the model, and the overall maturity level of CCFs based in Singapore was identified. Thus, Hypothesis 2 can be tested (see Sect. 7.3.2).

The first two hypotheses are important because a review of current risk management practices is the foundation of improvements in risk management practices and such a review should be started by assessing its risk management maturity

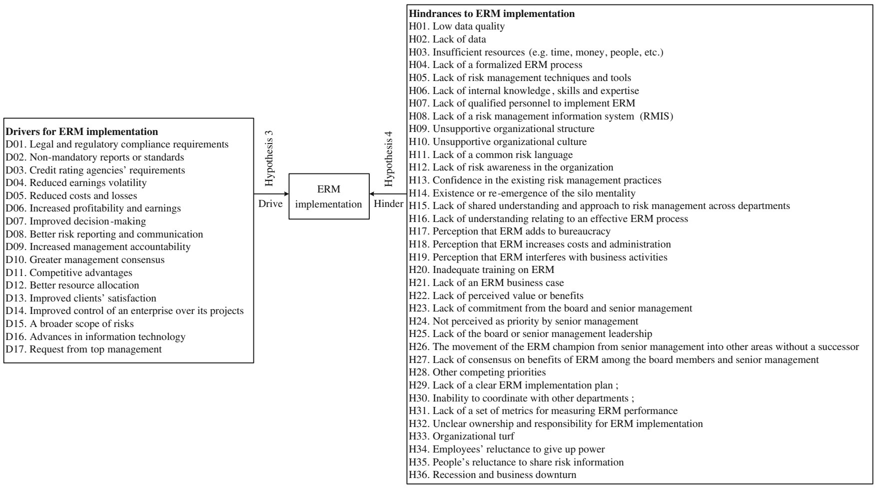


Fig. 1.2 Hypotheses 3 and 4. *Sources* Various sources

(Loosemore 2006). There has not been an ERM maturity model specifically for construction firms in the existing literature. The proposed ERM maturity model that helps CCFs assess their ERM maturity levels can expand the current literature.

ERM implementation is impacted by the interaction between drivers for and hindrances to ERM implementation. In this research, drivers for and hindrances to ERM implementation were collected from a literature review on ERM implementation in various industries (see Sects. 3.3.4 and 3.3.5). As these drivers and hindrances were hypothesized to drive and hinder the ERM implementation in CCFs based in Singapore, the following two research hypotheses can be formulated (see Fig. 1.2).

Hypothesis 3 ERM implementation in CCFs based in Singapore is affected by a set of critical drivers

Hypothesis 4 ERM implementation in CCFs based in Singapore is affected by a set of critical hindrances

A total of 17 drivers and 36 hindrances were identified and collated from the literature review and to test the Hypotheses 3 and 4. The data relating to the significance of drivers and hindrances were collected by the second survey conducted with the CCFs in Singapore. In addition, the one-sample t test was used to test the statistical significance of the drivers and hindrances (see Sects. 7.3.3 and 7.3.4).

Hypotheses 3 and 4 are important because the identification of the critical drivers and hindrances can help practitioners find the key points for ERM implementation. Hence, the management can take measures to strengthen the positive influence of drivers and diminish the negative influence of hindrances. The critical drivers and hindrances were analyzed in tandem with the organizational behavior theories, as

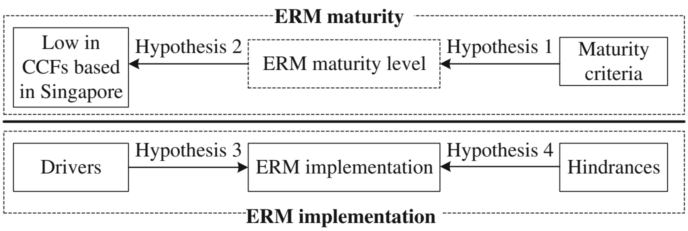
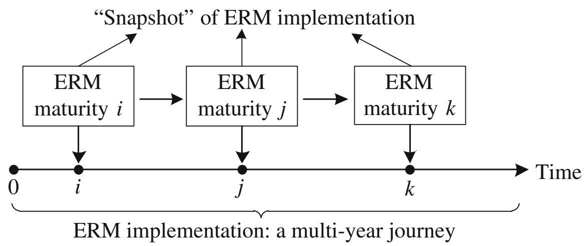


Fig. 1.3 The link of the four hypotheses

Fig. 1.4 The "snapshot" view of ERM implementation



well as it can extend the existing literatures relating to the linkages between ERM implementation and organizational behavior theories.

Figure 1.3 indicates how the four hypotheses are linked. The portion above, including Hypotheses 1 and 2, is for the study of ERM maturity, while the portion below, including Hypotheses 3 and 4, is for the study of ERM implementation.

It should be noted that ERM implementation is different from ERM maturity. ERM maturity is a static status, while ERM implementation is a dynamic status. ERM implementation is a multiyear journey and an ongoing process, during which there are different ERM maturity levels at different points in time for ERM implementation. Hence, ERM maturity can be considered as a "snapshot" of ERM implementation (see Fig. 1.4). ERM implementation level at a certain time point can be described by an ERM maturity continuum.

1.5 Research Significance

In recent years, a paradigm shift has occurred in the way companies view risk management, and the trend has moved toward a holistic view of risk management (Gordon et al. 2009). As the fundamental paradigm in this trend, ERM has attracted worldwide attention (McGeorge and Zou 2013). Compared with the traditional approach, ERM enables firms to shift the focus of the risk management function from primarily defensive to increasingly offensive and strategic (Liebenberg and Hoyt 2003) and provides a new way to improve PRM in construction firms (Liu et al. 2013). Given the complexity and diversity of the risks, construction firms have been seen as prime candidates for ERM adoption (Druml 2009). Thus, it is important to gain an understanding of ERM in construction firms.

ERM maturity reflects the sophistication of ERM implementation. To understand the ERM maturity of a company, a starting point can be the assessment of its current risk management practice (Loosemore 2006). It is necessary for a company to assess its ERM maturity because such assessment can help the company obtain a clear view of the status quo, strengths, and weaknesses of its ERM implementation. Based on the assessment results, the management staff of this company can take measures and prioritize resources to improve the weak areas of the ERM implementation. Thus, an ERM maturity model is developed and applied in the CCFs based in Singapore.

In addition, ERM implementation is impacted by the interaction between drivers for and hindrances to ERM implementation. Hence, it is important to identify the critical drivers and hindrances, which can help find the key points for ERM implementation, thus allowing the management to strengthen the positive influence of drivers and diminish the negative influence of hindrances. From the perspective of organizational behavior, ERM can be considered as a process of organizational change from the traditional, silo-based risk management approach to a holistic and integrated risk management approach. This organizational change also requires organizational learning as a medium (Alas and Sharifi 2002), change in the organizational culture (Senior and Fleming 2006), appropriate motivation measures, and the leadership of change agents. Thus, it is necessary to link ERM with the theories of organizational change, organizational learning, organizational culture, motivation, and leadership, thus providing the theoretical rationale behind ERM implementation in construction firms.

Furthermore, the ERM maturity assessment involves complicated mathematical calculations and the management needs to take measures to improve their ERM along the maturity continuum. Thus, it is necessary to develop an easy-to-use platform for the users to assess their ERM maturity and support their decision-making relating to ERM. The KBDSS developed in this research incorporates the ERM maturity model and thus enables the users to assess their maturity and obtain the action plans that help them to improve their ERM practices along the maturity continuum. This KBDSS can also serve as a learning tool for the users unfamiliar with ERM. When they use the KBDSS, they need to read the ERM best practices and think about the current practices in their firms. This thinking process contributes to their knowledge and practices relating to ERM.

1.6 Structure of the Book

This book consists of 10 chapters. Following this chapter, Chap. 2 provides an overview of the Chinese construction industry in terms of the domestic market, ownership of firms, workforce, safety, and profitability, and then focuses on the CCFs venturing into the international construction market.

Chapter 3 reviews the literature on risk management and ERM. In this chapter, the factors that drive and hinder ERM implementation are identified, an ERM framework for construction firms is proposed, and a fuzzy ERM maturity model for CCFs is developed.

ERM implementation also involves issues relating to organizational behaviors. Hence, five organizational behavior theories, including organizational change, organizational learning, organizational culture, motivation, and leadership theories, are reviewed in Chap. 4. Then, ERM implementation is linked to the five organizational behavior theories, respectively, and a conceptual model is generated in Chap. 5.

Chapter 6 describes the research process, data collection techniques, and data analysis methods. Two rounds of surveys and three case studies were performed, and the data were collected through past document analysis, questionnaires, and semi-structured interviews. Multiple statistical analysis methods were selected to analyze the data. The data analysis results of the two-round questionnaire surveys and relevant discussions are presented in Chap. 7, while the findings of the three case studies are described in Chap. 8.

Chapter 9 provides the background information of KBDSSs and presents the development of the KBDSS for ERM in CCFs. Also, a hypothetical example is used to demonstrate how the KBDSS works, and the KBDSS is validated using the case testing method with the views garnered from five industry experts.

Finally, Chap. 10 provides a summary of research findings and conclusions, a discussion of the contributions to the literature and practices, the research limitations, and recommendations for further research.

References

Adibi S (2007) Industry should embrace risk management tools. New York Construction News, New York. http://newyork.construction.com/opinions/bottomline/archive/2007/06.asp. Retrieved 12 Feb 2012

Alas R, Sharifi S (2002) Organizational learning and resistance to change in Estonian companies. Hum Resour Dev Int 5(3):313–331

AON (2010) Global risk management survey 2010. AON plc, Chicago

BCA (2013) Public sector projects to boost construction demand in 2013. Building and Construction Authority, Singapore. http://www.bca.gov.sg/newsroom/others/pr16012013_CP.pdf. Retrieved 4 March 2013

Beasley MS, Pagach DP, Warr RS (2008) Information conveyed in hiring announcements of senior executives overseeing enterprise-wide risk management processes. J Acc Auditing and Finan 23(3):311–332

Beasley MS, Branson BC, Hancock BV (2010) Report on the current state of enterprise risk oversight, 2nd edn. The ERM Initiative at North Carolina State University, Raleigh

Bowling DM, Rieger LA (2005) Success factors for implementing enterprise risk management. Bank Acc Finan 18(3):21–26

Burtonshaw-Gunn SA (2009) Risk and financial management in construction. Gower, Burlington

CAS (2003) Overview of enterprise risk management. Casualty Actuarial Society, Arlington

CFO/Crowe (2008) The changing landscape of risk management. CFO Research Services and Crowe, Boston

Ciorciari M, Blattner P (2008) Enterprise risk management maturity-level assessment tool. 2008 enterprise risk management symposium, Chicago, 14–16 April

COSO (2004) Enterprise risk management—integrated framework: executive summary & framework. Committee of Sponsoring Organizations of the Treadway Commission, Jersey City

Deloitte (2010) Enterprise risk management (ERM): success through intelligent risk taking. Deloitte Touche Tohmatsu Limited, Beirut, Lebanon. http://www.deloitte.com/assets/Dcom-Lebanon/Local%20Assets/Documents/ERS/me_ers_erm_09.pdf. Retrieved 3 March 2011

Deng X, Low SP, Zhao X (2014a) Project system vulnerability to political risks in international construction projects: the case of Chinese contractors. Project Manage J 45(2):20–33

Deng X, Low SP, Li Q, Zhao X (2014b) Developing competitive advantages in political risk management for international construction enterprises. J Constr Eng Manage 140(9):04014040

Druml D (2009) Contractors: are you adopting ERM or still stuck in the mud? Druml Group, Foster City, CA. http://www.druml.com/about/articles2009/04/contractors-enterprise-risk-management-adoption-construction-risk-management/. Retrieved 3 June 2011

Dubois A, Gadde L-E (2000) Supply strategy and network effects: purchasing behaviour in the construction industry. Eur J Purchasing Supply Manage 6(3):207–215

Dubois A, Gadde L-E (2002) The construction industry as a loosely coupled system: implications for productivity and innovation. Constr Manage Econ 20(7):621–631

ENR (2013a) The top 250 international contractors. Eng News-Record 271(8):9–13

ENR (2013b) The top 250 global contractors. Eng News-Rec 271(8):15–19

Fang D, Li M, Fong P, Shen L (2004) Risks in Chinese construction market-contractors' perspective. J Constr Eng Manage 130(6):853–861

Flyvbjerg B, Bruzelius N, Rothengatter W (2003) Megaprojects and risk: an anatomy of ambition. Cambridge University Press, Cambridge

Frame JD (2003) Managing risk in organizations: a guide for managers. Jossey-Bass, New York

Gordon LA, Loeb MP, Tseng CY (2009) Enterprise risk management and firm performance: a contingency perspective. J Acc Public Policy 28(4):301–327

Hallowell MR, Molenaar KR, Fortunato BR (2013) Enterprise risk management strategies for state departments of transportation. J Manage Eng 29(2):114–121

Han SH, Diekmann JE (2001) Approaches for making risk-based go/no-go decision for international projects. J Constr Eng Manage 127(4):300–308

Hwang BG, Zhao X, Toh LP (2014) Risk management in small construction projects in Singapore: status, barriers and impact. Int J Proj Manage 32(1):116–124

IMA (2007) Enterprise risk management: tools and techniques for effective implementation. Institute of Management Accountants, Montvale

ISO (2009) ISO 31000:2009 risk management—principles and guidelines. International Organization for Standardization, Geneva

KPMG (2010) Charting a safe and sustainable growth journey: Singapore enterprise risk management survey 2010. KPMG in Singapore, Singapore

Lam J (2003) Enterprise risk management: from incentives to controls. Wiley, Hoboken

Lehtiranta L (2013) Risk perceptions and approaches in multi-organizations: a research review 2000–2012. Int J Project Manage. doi:10.1016/j.ijproman.2013.09.002

Liebenberg AP, Hoyt RE (2003) The determinants of enterprise risk management: evidence from the appointment of chief risk officers. Risk Manage Insur Rev 6(1):37–52

Ling FYY, Lim SH (2010) Improving export performance of contractors from China. Eng Constr Architect Manage 17(6):581–597

Liu JY, Li BG, Lin BS, Nguyen V (2007) Key issues and challenges of risk management and insurance in China's construction industry-an empirical study. Ind Manage Data Syst 107 (3):382–396

Liu JY, Zou PXW, Gong W (2013) Managing project risk at enterprise level: exploratory case studies in China. J Constr Eng Manage 139(9):1268–1274

Loosemore M (2006) Risk management in projects, 2nd edn. Tayor & Francis, New York

Low SP, Liu JY, He SQ (2008) Management of external risks: case study of a Chinese construction firm at infancy stage in Singapore. Int J Constr Manage 8(2):1–15
Low SP, Liu JY, He SQ (2009) External risk management practices of Chinese construction firms in Singapore. KSCE J Civ Eng 13(2):85–95
Lu W, Li H, Shen L, Huang T (2009) Strengths, weaknesses, opportunities, and threats analysis of Chinese construction companies in the global market. J Manage Eng 25(4):166–176
McGeorge D, Zou PXW (2013) Construction management: new directions, 3rd edn. Willey-Blackwell, Chichester
NBSC (2013) China statistical yearbook 2013. China Statistics Press, Beijing
Orr RJ, Scott WR (2008) Institutional exceptions on global projects: a process model. J Int Bus Stud 39(4):562–588
RIMS (2008) RIMS State of ERM Report 2008. Risk and Insurance Management Society, New York
Santori L, Bevan K, Myers C (2007) Summary of standard & poor's enterprise risk management evaluation process for insurers. Standard & Poor's, New York
Schaufelberger J (2009) Construction business management. Pearson Prentice Hall, Upper Saddle River
Senior B, Fleming J (2006) Organizational change, 3rd edn. Financial Times Prentice Hall, Harlow
Tserng HP, Yin SYL, Dzeng R, Wou B, Tsai M, Chen W (2009) A study of ontology-based risk management framework of construction projects through project life cycle. Autom Constr 18 (7):994–1008
UC (2009) UC ERM maturity level framework. University of California, Oakland
Zhao ZY, Shen LY, Zuo J (2009) Performance and strategy of Chinese contractors in the international market. J Constr Eng Manage 135(2):108–118
Zhao X, Hwang BG, Phng W (2014) Construction project risk management in Singapore: resources, effectiveness, impact, and understanding. KSCE J Civ Eng 18(1):27–36
Zhi H (1995) Risk management for overseas construction projects. Int J Project Manage 13 (4):231–237
Zou PXW, Zhang G, Wang J (2007) Understanding the key risks in construction projects in China. Int J Proj Manage 25(6):601–614
Zou PXW, Chen Y, Chan TY (2010) Understanding and improving your risk management capability: assessment model for construction organizations. J Constr Eng Manage 136(8):854–863

Chapter 2
The Chinese Construction Industry and Firms

Keywords Chinese construction market · Chinese construction firms (CCFs) · Ownership forms · SWOT analysis · Risk management practices

2.1 Introduction

China, currently the second largest economy in the world, has experienced significant economic development in the past 30 years, benefiting from the "reform and opening-up" policy. China's Gross Domestic Product (GDP) has jumped from Renminbi (RMB) 364.52 billion (approximately US$60.36 billion) in 1978 to RMB51,894.2 billion (approximately US$8262.2 billion) in 2012 (NBSC 2013). As one of the oldest traditional industries, the construction industry has kept pace with infrastructural and urban development that formed the most essential ingredients of China's rapid economic development, and has been thus regarded as an important pillar supporting China's economy (Cheah et al. 2007; Low and Jiang 2003).

The Chinese construction industry was relatively huge in size. Its annual output value had dramatically increased from RMB1,249.76 billion (approximately US $198.1 billion) in 2000 to RMB13,721.8 billion (approximately US$2251.9 billion) in 2012 (NBSC 2013). The construction industry has contributed to the employment scene in China. At the end of 2012, there were 42.6 million people employed by 75,280 construction firms (NBSC 2013). A majority of the workforce in the Chinese construction industry were peasant-workers with low level of knowledge.

This chapter provides an overview of the Chinese construction industry in terms of the domestic market, ownership of firms, workforce, safety, and profitability. Then, this chapter focuses on the CCFs venturing into the international construction market. The literature review covers their overseas market distributions and output values, SWOT (strengths, weaknesses, opportunities, and threats) analysis, and risk management practices. Finally, there appears to be a need for implementing ERM in the CCFs outside of China.

X. Zhao et al., *Enterprise Risk Management in International Construction Operations*, DOI 10.1007/978-981-287-549-5_2

2.2 Overview of the Chinese Construction Industry

2.2.1 The Chinese Construction Market

The massive output value of the Chinese construction industry was largely attributed to the booming domestic construction market. The boom in the domestic market was closely related to the national fixed assets investments. Specifically, more than 60 % of these investments had been in construction and installation projects between 2000 and 2012 (NBSC 2013) (see Fig. 2.1).

The national fixed assets investment decisions were made by the Central Committee of the Communist Party of China (CPC) and the State Council of China. Recent decisions for huge fixed assets investments relating to the construction industry included the following:

1. In November 2008, the State Council of China decided to complete a huge investment of about RMB4000 billion (approximately US$657.4 billion) before the end of 2010 (Xinhuanet 2008), which was aimed at stimulating the national economy, and thus alleviating the negative impacts of the global financial crisis. Most of the investments have been used for infrastructure construction, urban development, as well as the post-disaster reconstruction in the areas destroyed by the devastating Wenchuan earthquake in May 2008.
2. China's 12th Five-Year Plan indicated that about RMB7000 billion (approximately US$1150.6 billion) would be invested in urban infrastructure construction from 2011 to 2015 (Xiao 2010).
3. The No. 1 Document of the CPC Central Committee, which was issued in January 2011, proposed the development of rural water conservancy projects. Hence, the State Council plans to invest around RMB4000 billion (approximately US$657.4 billion) in rural water conservancy construction projects from 2011 to 2020 (Jin 2011).

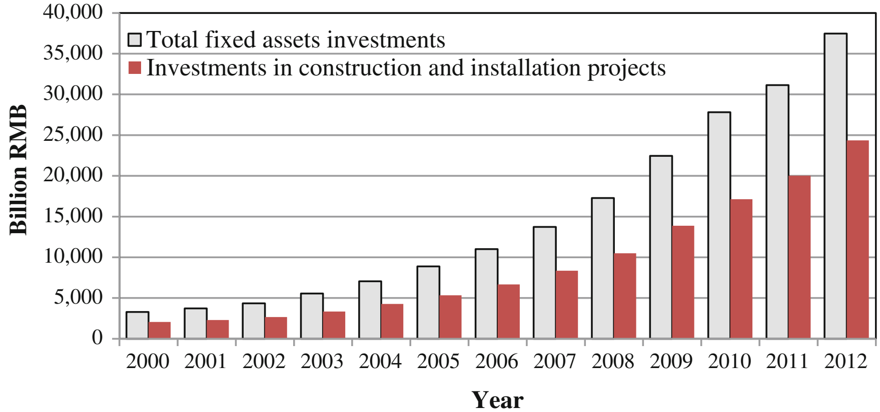


Fig. 2.1 Fixed assets investment in China in 2000–2012, *Statistical source* NBSC, various years

Besides the investments decided by the CPC Central Committee and the State Council, the provincial and municipal governments also invested massive sums of money into the infrastructure projects within their jurisdiction. This is because these investments could greatly contribute to the increase in local GDP, which was considered as one of the most important indicators to measure the performance of local officials. Furthermore, the investments in residential buildings by corporations (state-owned, private, or joint venture) also contributed to the development of the Chinese construction industry. The huge demand for housing among the Chinese urban people and the great benefits underlying the real estate development drove a number of corporations to invest in residential building development.

These huge investments have enabled the domestic construction market to experience continuous booms, thereby providing CCFs with many opportunities. Benefiting from the numerous opportunities, leading CCFs have got soaring revenues in recent years. ENR indicated that 46 CCFs were ranked within the top 250 global contractors based on their total contracting revenue in 2012 (ENR 2013c). Table 2.1 shows the 2012 total revenue of the leading Chinese contractors among the ENR top 250 global contractors. Chinese contractors occupied half of the top 10 global contractors. China Railway Construction Corp. Ltd. occupied the top position, with a total revenue of US$84642.0 million, followed by China Railway Group Ltd. with a total revenue of US$81,805.7 million, and China State Construction Engineering Corp. with US$81.366.8 million. Domestic revenue made up 97.5, 95.4 and 93.9 % of their total revenue in 2012, respectively. Domestic revenue also represented over 70 % of the total revenue in other CCFs.

Table 2.1 Leading Chinese global contractors in 2013 ENR ranking

Rank	Firm name	Total revenue (Million US$)	% of domestic revenue
1	China Railway Construction Corp. Ltd.	84,642.0	97.5
2	China Railway Group Ltd.	81,805.7	95.4
3	China State Construction Engineering Corp.	81,366.8	93.9
5	China Communications Construction Group Ltd.	47,327.3	76.4
9	China Metallurgical Group Corp.	31,522.6	92.7
13	Shanghai Construction Group	20,822.4	95.8
14	Sinohydro Group Ltd.	20,120.1	72.8
36	China National Chemical Engineering Group Corp.	8725.8	86.3
41	Shengli Petroleum Administration Bureau, Sinopec	7537.6	97.5
42	China Gezhouba Group Co. Ltd.	7507.3	73.2

Statistical source ENR (2013c)

It is worth noting that all the top 10 firms and a majority of the 46 CCFs in the 2012 ENR top 250 global contractors were state-owned enterprises. State-owned and collective-owned enterprises were two typical ownership forms of Chinese enterprises in China's planned economy system. There have been reforms in the ownership of enterprises since the adoption of "reform and opening-up" policy. The next section describes the ownership of the CCFs.

2.2.2 Ownership Forms of CCFs

Since adopting the "reform and opening-up" policy in late 1978, the traditional planned economy system has been challenged through reforms in a variety of industries. In 1992, the 14th CPC Congress identified the transformation to the socialist market economy as the goal of the reforms. Enterprise reforms, which stressed the establishment of a modern enterprise system, were critical for completing this transformation. As one of the enterprise reforms, ownership diversification had encouraged shareholding among entities with various ownership forms. Through ownership diversification, the authorities hoped to completely cut the direct ties between state-owned enterprises and their controlling authorities. Due to ownership diversification, the ownership of CCFs had evolved from traditional state and collective ownership toward a mixed economy (Wang et al. 2006).

According to ownership, the CCFs were categorized into state-owned firms, collective-owned firms, firms funded from Hong Kong (HK), Macao (MO), and Taiwan (TW), foreign funded firms, and other firms, most of which were private firms (NBSC 2013). Table 2.2 highlights the employees and number of each category of construction firms in 2000–2012. At the end of 2012, there were a total of 75,280 construction firms employing about 42.7 million people, creating a total output of about RMB13,721.8 billion. As Table 2.2 shows, in 2012, state-owned firms accounted for only approximately 6.1 % of all the firms, but employed 10.7 % of all the employees in construction firms and generated 16.7 % of the industry output value. Others represented about 86.8 % of all the firms, employed 83.7 % of all the employees, and contributed about 78.9 % to the whole output value of the Chinese construction industry. Construction firms funded from outside Mainland China represented around 0.9 % and employed only 0.5 % of all the employees.

In addition, the number of state-owned and collective-owned construction firms had decreased by 49.0 and 81.2 % from 2000 to 2012, respectively. Employees in state-owned firms had dropped by 28.0 %, but their output value had quadrupled during this period, which demonstrated the improvement in productivity of state-owned firms. By contrast, the number of firms in "others" category had jumped from 12,778 to 65,358 during this period, which was attributed to the privatization of some state-owned and collective-owned construction firms and the establishment of new private firms.

Table 2.2 Number, employees, and gross output value of CCFs in 2000–2012

Year	Total	State-owned		Collective-owned		Funded from HK/MO/TW		Foreign funded		Others	
		No.	%	No.	%	No.	%	No.	%	No.	%
Number of CCFs											
2000	47,518	9030	19.0	24,756	52.1	635	1.3	319	0.7	12,778	26.9
2001	45,893	8264	18.0	19,096	41.6	622	1.4	274	0.6	17,637	38.4
2002	47,820	7536	15.8	13,177	27.6	632	1.3	279	0.6	26,196	54.8
2003	48,688	6638	13.6	10,425	21.4	535	1.1	287	0.6	30,803	63.3
2004	59,018	6513	11.0	8959	15.2	511	0.9	386	0.7	42,649	72.3
2005	58,750	6007	10.2	8090	13.8	516	0.9	388	0.7	43,749	74.5
2006	60,166	5555	9.2	7051	11.7	479	0.8	370	0.6	46,711	77.6
2007	62,074	5319	8.6	6614	10.7	482	0.8	365	0.6	49,294	79.4
2008	71,095	5315	7.5	5843	8.2	474	0.7	363	0.5	59,100	83.1
2009	70,817	5009	7.1	5352	7.6	444	0.6	351	0.5	59,661	84.2
2010	71,863	4810	6.7	5026	7.0	416	0.6	331	0.5	61,280	85.3
2011	72,280	4642	6.4	4847	6.7	393	0.5	303	0.4	62,095	85.9
2012	75,280	4602	6.1	4640	6.2	385	0.5	295	0.4	65,358	86.8
Employees of CCFs (1,000)											
2000	19,943	6356	31.9	8875	44.5	82	0.4	44	0.2	4586	23.0
2001	21,107	5907	28.0	7399	35.1	77	0.4	43	0.2	7681	36.4
2002	22,452	5438	24.2	5792	25.8	74	0.3	45	0.2	11,104	49.5
2003	24,143	5243	21.7	5056	20.9	70	0.3	60	0.3	13,713	56.8
2004	25,003	4674	18.7	3864	15.5	68	0.3	81	0.3	16,316	65.3
2005	26,999	4800	17.8	3616	13.4	86	0.3	108	0.4	18,389	68.1
2006	28,782	4676	16.2	3320	11.5	89	0.3	81	0.3	20,616	71.6
2007	31,337	4701	15.0	3170	10.1	98	0.3	114	0.4	23,254	74.2
2008	33,150	4721	14.2	2668	8.0	105	0.3	92	0.3	25,564	77.1
2009	36,726	5189	14.1	2468	6.7	109	0.3	102	0.3	28,857	78.6
2010	41,604	5769	13.9	2465	5.9	122	0.3	98	0.2	33,151	79.7
2011	38,525	4449	11.5	2204	5.7	113	0.3	99	0.3	31,660	82.2
2012	42,672	4578	10.7	2162	5.1	130	0.3	103	0.2	35,700	83.7
Gross output value of CCFs (Billion RMB)											
2000	1249.8	505.4	40.4	403.6	32.3	9.9	0.8	6.7	0.5	324.1	25.9
2001	1536.2	536.3	34.9	377.6	24.6	10.3	0.7	7.3	0.5	604.7	39.4
2002	1852.7	558.3	30.1	333.9	18.0	11.4	0.6	9.1	0.5	940.1	50.7
2003	2308.4	606.0	26.3	327.1	14.2	12.4	0.5	12.9	0.6	1350.0	58.5
2004	2902.1	732.6	25.2	275.6	9.5	13.7	0.5	20.2	0.7	1860.0	64.1
2005	3455.2	843.2	24.4	281.5	8.1	17.3	0.5	24.9	0.7	2288.3	66.2
2006	4155.7	921.9	22.2	290.4	7.0	24.1	0.6	27.5	0.7	2891.9	69.6
2007	5104.4	1063.1	20.8	315.4	6.2	28.2	0.6	39.6	0.8	3658.1	71.7
2008	6203.7	1223.2	19.7	321.6	5.2	32.1	0.5	38.7	0.6	4588.1	74.0
2009	7680.8	1519.0	19.8	328.2	4.3	33.5	0.4	41.5	0.5	5758.6	75.0

(continued)

Table 2.2 (continued)

Year	Total	State-owned		Collective-owned		Funded from HK/MO/TW		Foreign funded		Others	
		No.	%	No.	%	No.	%	No.	%	No.	%
2010	9603.1	1814.9	18.9	365.5	3.8	44.4	0.5	43.9	0.5	7334.3	76.4
2011	11,646.3	2043.68	17.5	430.65	3.7	61.27	0.5	65.8	0.6	9044.9	77.7
2012	13,721.8	2293.02	16.7	491.90	3.6	64.97	0.5	47.7	0.3	10824.2	78.9

Statistical source NBSC, various years

Furthermore, the number of firms funded from HK/MO/TW had decreased by 39.3 %, while the number of foreign funded firms had reduced by 7.5 %. Despite the dramatic increase in the output value of both categories of construction firms, these firms still contributed less than 1 % to the construction industry output value.

2.2.2.1 Workforce of CCFs

The huge number of employees in the CCFs suggested that this industry was still a labor intensive industry, which was not likely to change drastically in the near future because of its potential impact on employment (Low and Jiang 2003) and social stability. A majority of the workforce in the construction industry were peasant-workers who used to be peasants living on farms in the countryside. Under the Residence Management and Registration Ordinance of China enacted in 1958, the migration of rural residents to cities or towns was strictly forbidden unless they could find a job in a city or town or obtain admission by a university or high school. The reforms in the agriculture had enabled agricultural productivity to increase dramatically, thereby freeing a number of rural workers from their tasks. Simultaneously, the "reform and opening-up" policy had accelerated the industrialization process in the coastal cities since 1979 and created huge demand for workers. Hence, the government allowed peasants to work in the cities or towns without changing their registered residence from peasants to workers (Yung 2009). Thus, the term peasant-worker appeared in the 1980s.

Peasants were usually gathered by a foreman to work on the construction site. Arrears in payment were thorny problems for peasant-workers. If paid on time, they would earn more money than farming in the countryside. If the foremen or contractors could not pay them on time, attributed to the clients' delay in payments or the dishonesty of the foremen or contractors, the peasant-workers would suffer heavy losses. With the increase in legal awareness, peasant-workers have been trying to protect their own rights. In addition, under the leadership of the State Council, provincial and municipal governments have also helped to clear arrears and to take measures to protect peasant-workers' rights since 2003. These measures also contributed to China's social stability.

These peasant-workers were usually industrious and eager to earn money to improve the living standards of their families in the countryside. However, they generally had a low-education level, and most of them did not receive any tertiary education. They obtained related knowledge and skills only through short-term training. Moreover, most of them lacked proper safety training and adequate safety awareness, which contributed to China's poor construction site safety record (Liu et al. 2007; Tam et al. 2004).

2.2.2.2 Safety

In terms of international standards, the safety record of the Chinese construction industry was poor (Tam et al. 2004). The Chinese construction industry was considered as the second most dangerous industry second to the coal mining industry (Zou et al. 2007a). To improve construction safety, a series of laws, regulations, and technical codes have been enacted. The Labor Law of China, which came into force on January 1, 1995, stipulated in the sixth chapter that employers should maintain safe and healthy working conditions. However, the clauses were not specific enough to ensure adequate inspection and enforcement. The Construction Law of China, enacted on March 1, 1998, was the basic law regulating the construction industry, and specifically set out in the fifth chapter the structure for safety administration in the construction industry. The Law of Working Safety of China, which became effective on November 1, 2002, set out requirements for the proper behavior of all forms of enterprises and employees. It was the foundation for the government administration in working safety. Moreover, the Ordinance for Construction Engineering Safety Management, enacted on February 1, 2004, stipulated the safety responsibilities of all stakeholders in construction activities and described the supervision and management system for construction safety. The Ordinance also set out the specific punishment for unacceptable behavior and emplaced criminal responsibilities on the owner, designer, construction, and supervision enterprises according to the Criminal Law of China (Zou et al. 2007a). In order to handle working safety accidents, the State Council enacted the Ordinance for Reporting and Investigating Work Safety Accidents on June 1, 2007, which developed the requirements for reporting accidents and classified safety accidents into four classes, as indicated in Table 2.3.

According to the Ministry of Housing and Urban-Rural Development of China (Mohurd 2013), construction safety in building and municipal works was still far

Table 2.3 Classification of safety accidents

Accident class	Accidents resulting in one of the following conditions		
	Fatalities	Serious injuries	Direct economic loss (Million RMB)
Extraordinarily serious	≥30	≥100	≥100
Serious	10–29	50–99	50–100
Relatively serious	3–10	10–49	10–50
Ordinary	≤2	≤9	<10

Table 2.4 Accidents in building and municipal works in 2010–2012

Year	Accidents		Relatively and more serious accidents	
	Total number	Fatalities	Number	Fatalities
2010	627	772	29	125
2011	589	738	25	110
2012	487	624	29	121

Statistical source MOHURD (2013)

from satisfactory. As Table 2.4 indicates, there were 487 safety accidents leading to 624 deaths in 2012, which was an improvement compared with that in 2011. The total number of safety accidents and fatalities had dropped gradually during these three years. However, in the terms of the number and fatalities of relatively and more serious accidents, there was still much room for improvement. It merits attention that the data provided by the MOHURD only presented the accidents in building and municipal works and did not indicate the safety status of the whole Chinese construction industry because other works were outside the jurisdiction of the MOHURD. Moreover, because some fatalities might be concealed deliberately, safety in building and municipal works might be worse than what is indicated in Table 2.4.

Poor safety in the Chinese construction industry could be attributed to a number of factors. Cheng et al. (2004) found that the safety knowledge level of project managers, safety officers, and foremen was very low, and proposed six root causes of accidents in China: lack of attention on safety protection by workers, lack of attention on safety management by main contractors and project managers, insufficient safety training, inadequate setting of minimum safety level, tiredness of workers, and poor quality of construction materials and equipment. In addition, Tam et al. (2004) claimed that poor safety awareness leaders in the firms, lack of training, poor safety awareness of project managers, reluctance to input resources for safety, and reckless operations were the top five causes for poor construction site safety in China.

Construction safety management is also a key element of PRM in construction firms because accidents can threaten project objectives (Zou et al. 2007b). From the perspective of the entire firm, safety risk could ruin the firm's reputation, erode its profitability, and even threaten its survival because accidents can involve criminal charges. Hence, safety risk should also be considered as a key element of ERM. A risk-aware culture tends to generate a safety culture on the site, thus lowering the accident occurrence rate.

2.2.2.3 Profitability of CCFs

The competitive bidding system was introduced into the Chinese construction industry in the early 1980s. In 1999, the National People's Congress of China

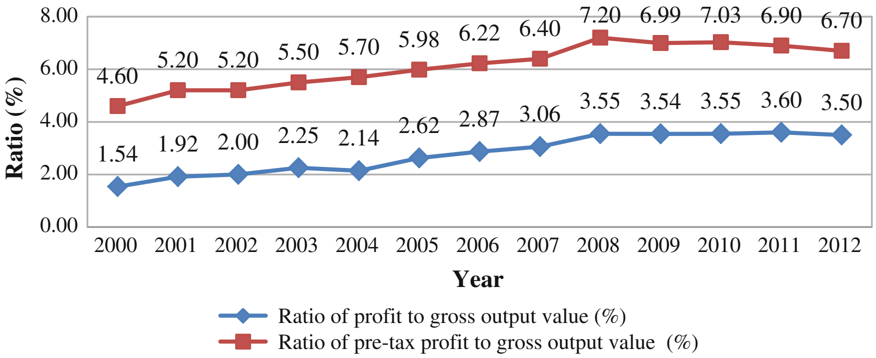


Fig. 2.2 Profitability of CCFs in 2000–2012, *Statistical source* NBSC, various years

passed the Tendering and Bidding Law, which stipulated that a project funded by the state or by international financial institutions was required to undergo a bidding process. Hence, most of the CCFs had to win contracts through competitive bidding. However, some large state-owned firms can still secure projects through government assignments.

Wang et al. (2006) found that maximizing profitability was considered as the most important objective by most construction firms. As Fig. 2.2 illustrates, the average profitability of CCFs had steadily increased from 2000 to 2012. The 2012 ratio of profit to output value was 3.50 %, which was more than double that of 2000 (1.54 %). The pretax profit to gross output value had increased by 45.7 % during this period.

Although the average profitability appeared satisfactory, a number of construction firms were still plagued with relatively low profitability (Cheah et al. 2007) or even deficits in contracting projects. There have been a number of plausible explanations for the low profitability of CCFs, including (Cheah et al. 2007; Wang et al. 2006):

1. Competitive bidding was a common practice for the CCFs to obtain contracts. The contractor's bid price was always very important in determining who would be awarded a contract. As a result, cutting price has been a common competing method for various categories of construction firms. This method might lead to low profitability.
2. Clients may force the contract price down through negotiations with the contractors. Most contractors would accept the lower price proposed by clients, especially so in a prevailing buyers' market.
3. Clients tended to ask contractors to finance the projects during construction, largely depleting the contractors' working capital. Without the advance and on-time payment, many contractors had no money to pay the subcontractors, and the subcontractors in turn had no money to pay the peasant-workers. Consequently, the main contractors' and subcontractors' profits were squeezed so that the profitability level might drop to nearly zero.

4. Losses in construction were always related to risks. Construction firms with poor risk management skills and low risk awareness would suffer losses during the construction process, leading to low profitability.

As poor risk management skills and low risk awareness contribute to low profitability of CCFs (Wang et al. 2006), a high level of risk management practice that indicates good risk management skills and appropriate risk awareness would improve the profitability.

2.3 CCFs in the Overseas Market

2.3.1 CCFs' Overseas Market

Despite the booming domestic construction market, an increasing number of CCFs have ventured overseas for market expansion, driven by the current globalization of construction markets. Encouraged by the Chinese government's "way out" strategy and support through loans, custom duties reliefs, improving the efficiency and administrative procedures for approving overseas construction works, etc., CCFs had built up their competencies to venture into the overseas markets and expanded their businesses in about 180 countries by the end of 2012 (NBSC 2013). In addition, joining the international competition has been thought of as a strategy that could strengthen the competitiveness of these firms, and afford them the opportunities to learn advanced management skills and technologies from their overseas competitors.

Construction projects awarded have been the main source of overseas turnover for the CCFs. As shown in Fig. 2.3, CCFs' annual overseas project turnover had been increasing gradually from 1989 to 2000. From 2000 to 2012, CCFs' overseas

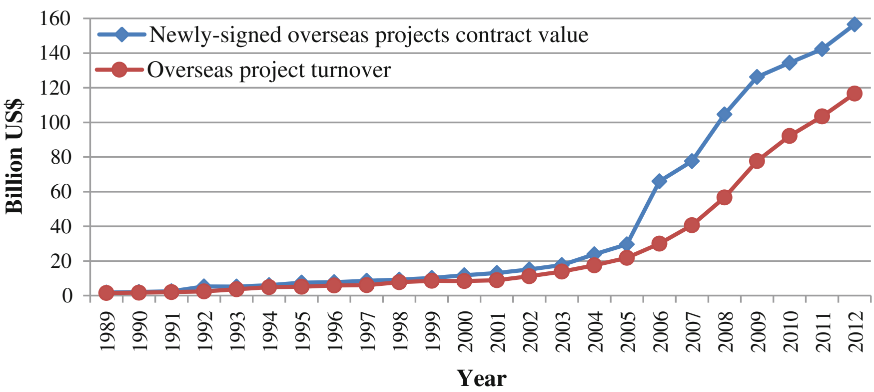


Fig. 2.3 Overseas project contract value and turnover of CCFs in 1989–2012, *Statistical source* NBSC, various years

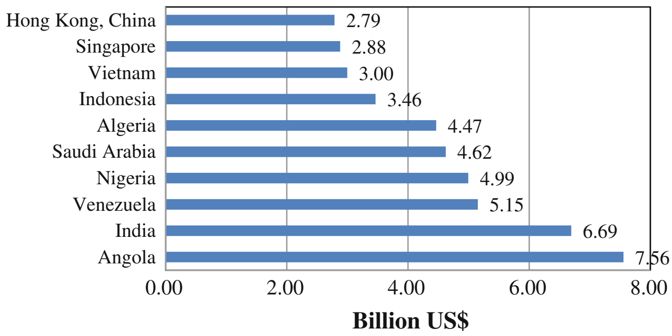


Fig. 2.4 Top 10 largest overseas markets of CCFs in 2012, *Statistical source* NBSC (2013)

project turnover had drastically increased by 14 times, from US$8.38 billion in 2000 to US$116.6 billion in 2012. In addition, after 17 years of gradual rise from 1989 to 2005, CCFs' overseas project contract value had rapidly increased since 2005, from US$29.6 billion in 2005 to US$156.5 billion in 2012 (NBSC 2013). Although CCFs had expanded their businesses in about 180 countries, over 99 % of CCFs' overseas turnover was based in the developing countries in 2012, and about 81.6 % came from Asia (46.56 %) and Africa (35.02 %). As Fig. 2.4 shows, Angola, India, Venezuela, Nigeria, and Saudi Arabia were the five largest overseas markets of CCFs (NBSC 2013).

As Fig. 2.5 indicates, the period of 2000–2012 witnessed a steady rise in CCFs' turnover in Asia and Africa, which could be attributed largely to the good relationship between China and Asian and African countries. However, CCFs' turnover in Europe and North America was still relatively low, which made CCFs weak in terms of the overall international market share.

The ENR top 250 international contractors generated US$511.05 billion from overseas projects in 2012 (ENR 2013b). A total of 55 CCFs were ranked within the

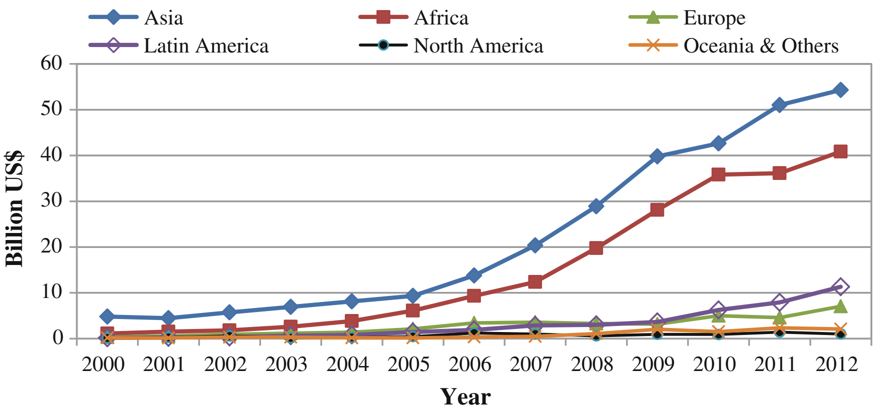


Fig. 2.5 Overseas project turnover of various markets of CCFs in 2000–2012, *Statistical source* NBSC, various years

top 250 international contractors, sharing about 13.3 % (US$67.17 billion) of the total overseas revenue (ENR 2013a). By contrast, 58 European firms shared 50.3 % (US$255.03 billion) and 34 American contractors shared 14.1 % (US$71.52 billion). This demonstrated that there were still weaknesses that rendered CCFs uncompetitive with respect to their European and American counterparts in the international market, despite a number of other strengths and increasing competitiveness. Hence, CCFs should understand their strengths and weaknesses, as well as the opportunities and threats while competing in the international market.

2.3.2 CCFs Based in Singapore

Despite being an island country with limited land resources, Singapore has a thriving and stable political and economic environment. Singapore's Building and Construction Authority (BCA) has made efforts to create a knowledgeable workforce and enables Singapore to be an ideal location for construction firms from various countries (Low et al. 2008). In addition, the Singapore construction industry has experienced a continuous increase in demand, driven by strong public housing demand and high construction demand for institutional developments and major infrastructure projects. In 2013, total construction demand reached a historical high of S$35.8 billion (approximately US$28.1 billion), increasing by 27.1 % from S$28.1 billion in 2012 (BCA 2014). The booming Singapore construction market also offers CCFs a number of opportunities. Ling and Lim (2010) indicated that CCFs in Singapore usually have strong financial capacity, received strong support from the Chinese government, offered low bids through low profit margins, low labor costs and satisfactory quality, and achieved satisfactory cost performance.

In 2012, CCFs in Singapore obtained a turnover of US$2880.1 million from contracted projects (see Fig. 2.6), which was more than triple of that in 2000 (US $654.2 million) (NBSC 2013). Thus, CCFs in Singapore occupied a share of about

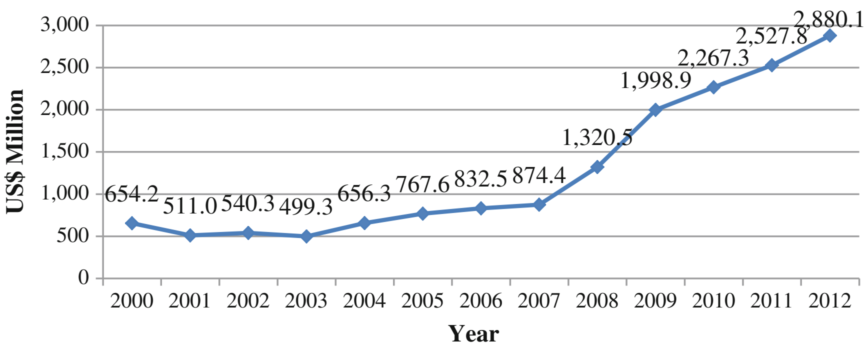


Fig. 2.6 Project turnover of CCFs in Singapore in 2000–2012, *Statistical source* NBSC, various years

10 % in this market. In addition, in terms of the annual turnover, Singapore has become the ninth largest overseas markets for CCFs. CCFs began to venture into the Singapore construction market in the early 1990s. At the time of this study, there were 46 CCFs based in Singapore, nine of which had the A1 grade under the BCA registry, indicating that they enjoyed unlimited tendering capability. Most of these CCFs were of medium-sized and small-sized entities. Also, a majority of these CCFs were registered under the general building category and engaged in building projects, while only a few were registered under the civil engineering category and served as main contractors in the mass rapid transit projects.

2.3.3 SWOT Analysis of CCFs in the Overseas Market

A construction firm's decision to venture overseas should be based on a good understanding of the opportunities and threats associated with the international business, as well as the development of company strengths relative to international activities (Gunhan and Arditi 2005). Previous studies (Lu et al. 2009; Zhao and Shen 2008; Zhao et al. 2009) conducted SWOT analysis of CCFs in the international market. The strengths and weaknesses tended to be internally controllable factors, while opportunities and threats were external factors that could not be directly controlled but could react to their advantages (Pearce 1992). Thus, Zhao and Shen (2008) and Zhao et al. (2009) identified CCFs' strengths and weaknesses in terms of management ability, financial ability, technological ability, resource differences, and cost differences. They also identified opportunities and threats in the light of the social and political environment, economic environment, as well as markets and competition.

The strengths of CCFs have enabled them to make significant progress in establishing their competitiveness and expanding into the overseas markets. Low cost of workforce, materials, and equipment were considered as traditional strengths of CCFs (Zhao and Shen 2008; Zhao et al. 2009). In addition, CCFs' employees usually worked hard due to the profound influence of Confucianism. Hard work has been accepted as a code of ethics by CCFs' employees that helped CCFs to expand even into markets with adverse conditions (Zhao et al. 2009). Moreover, huge investments in infrastructures and urban development in the domestic market involved constructing many large and complex projects, such as the Beijing Olympic venues, the Three Gorges Dam project, the South-to-North Water Transfer project, and the Qinghai-Tibet Railway project. These projects provided opportunities for CCFs to gain valuable experience and specialty expertise. Such experience and expertise allowed the CCFs to transfer these practices into the overseas market. Figure 2.7 (adapted from Zhao and Shen 2008; Lu et al. 2009; Zhao et al. 2009) lists the strengths, weaknesses, opportunities, and threats of CCFs in the overseas market.

Despite these strengths, CCFs were still plagued with several weaknesses, which hindered their market expansion in developed countries. The biggest problem of

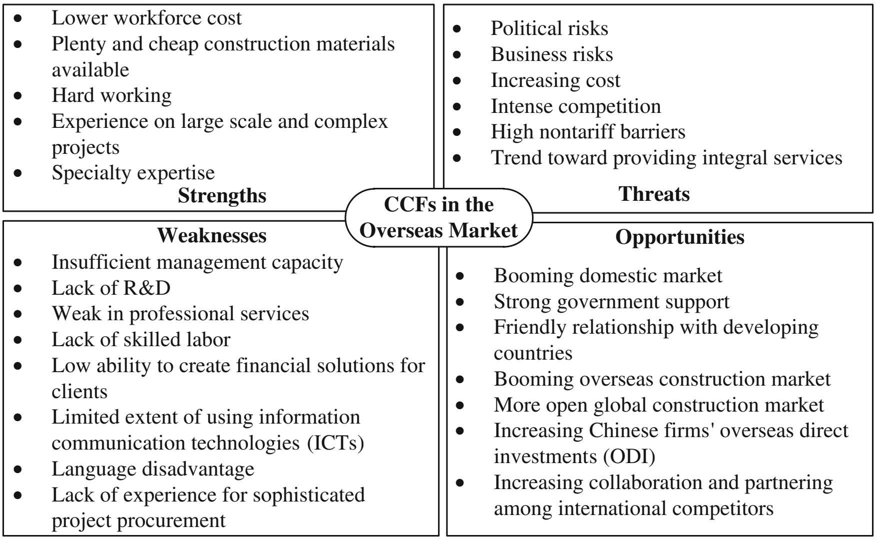


Fig. 2.7 SWOT analysis of CCFs in the overseas market

CCFs was the insufficient management capacity to integrate their strengths to penetrate the international market due to the lack of a strong base of international entrepreneurs and management professionals (Lu et al. 2009). Lack of research and development (R&D) was another weakness of CCFs. Few CCFs had R&D departments (Low and Jiang 2003), which made CCFs lagged behind their counterparts in scientific research and construction management skills. Lack of skilled labor also contributed to poor performance in many CCFs because most of the CCFs' workforce was made up of peasant-workers with inadequate knowledge and skills (Zhao et al. 2009). Lack of skilled employees also rendered CCFs weak in professional services in construction, such as design, engineering, consultancy, and information technology (IT) services. These professional services could reflect competitiveness in the international market and have seen as a necessary facilitator for business expansion (Lu et al. 2009). In particular, the lack of design capacity has been a common disadvantage of CCFs to bid for projects that adopt the Design–Build (DB) model.

In addition, despite strong financial capacities in some CCFs, they still lacked the experience to package financial solutions for clients, which hampered them from achieving a win-win situation both for their clients and themselves (Lu et al. 2009). Moreover, the use of information communication technologies (ICTs) in CCFs for construction management and decision-making was relatively slow compared with their overseas competitors, thus constraining them from improving performance in the overseas markets. Incompetence in English was also a common weakness of CCFs that affected effective communication between CCFs and their overseas clients, which might result in a reduction of overseas business opportunities (Zhao and Shen 2008). However, this language disadvantage did not seem to be significant for CCFs in Singapore, because many Singaporeans can communicate in Mandarin (Ling and Lim 2010). Furthermore, a majority of the CCFs were used to the traditional Design–Bid–Build (DBB) model, which hindered their bids for large and sophisticated projects that adopted new procurement models, such as the Public–Private Partnership (PPP) and Build–Operate–Transfer (BOT) projects (Lu et al. 2009).

There were also several opportunities in the domestic and overseas environments for the CCFs. As a result of huge investments in infrastructures and urban development, the booming domestic market provided a buffer for CCFs that enabled them to be more flexible when competing against their counterparts (Lu et al. 2009). Due to the "way out" strategy, the Chinese government has taken measures to help the CCFs compete in the overseas markets. These included loans, custom duties reliefs, providing overseas market information, and improving the efficiency of approving overseas construction work. China's long-standing and friendly relationships with a number of developing countries particularly in Africa and Asia also helped the CCFs to achieve high market shares in these countries (Zhao et al. 2009). Additionally, despite the negative influence of the 2008 global financial crisis, the Asian and African construction markets were still booming from infrastructural construction. Hence, opportunities were still available for the CCFs in their traditional markets. China's entry into the World Trade Organization (WTO) also enabled CCFs to embrace a more open global market. As the underlying principle of the WTO, global trade liberalization concerning open-market access and fair national treatment would provide tremendous opportunities for CCFs' expansion into new overseas markets (Lu et al. 2009). Moreover, the overseas direct investments (ODI) had spiraled drastically from US$5.5 billion in 2004 to US$87.8 billion in 2012 (NBSC 2013). Firms doing ODI tended to select familiar contractors to undertake their construction works, thus presenting good opportunities to CCFs in the overseas markets. Furthermore, CCFs' collaboration and partnering with their Japanese, American, or European counterparts has been a useful strategy when bidding for sophisticated projects. This also provided the opportunities to expanding into new markets. Partnering or joint ventures between CCFs, typically between civil engineering firms and mechanical and electrical supply/installation firms, were also very common (Lu et al. 2009).

Finally, the CCFs should not ignore the threats in the environment when venturing abroad. Overseas construction activities involve complex and diverse risks peculiar to these international transactions, over and above the typical risks at home (Han and Diekmann 2001). The uncertain political and economic environments in developing countries, which were the main overseas markets of CCFs (Deng and Low 2013), have significantly threatened their overseas business performance. The recent examples were the turmoil in the Middle East and North Africa arising from the Jasmine Revolution, which led to great losses for the CCFs. Increasing costs have been another thorny issue threatening CCFs' performance. The rapid increase in the costs of labor, materials, and equipment has weakened the CCFs' traditional advantage of low cost, which was worsened by currency fluctuation. The strong appreciation of Chinese RMB against the US dollar would reduce the CCFs' revenue in RMB because payments were usually made in US dollars in the international market (Zhao and Shen 2008). In addition, there was fierce competition in the international construction market due to globalization. Such competition would lead to a "low-bid-price war," which would lead to considerable decrease in profits for the CCFs (Zhao et al. 2009). Moreover, a number of new non-tariff barriers such as high technical standards or limiting visa permits for workforce have been set up by an increasing number of countries to protect their construction markets. Hence, the CCFs have been prevented from expanding their shares in the American and European markets. Furthermore, the increasing trend toward providing integral services would threaten the CCFs' business because most of them were used to the DBB model and lacked the experience of procurement in the PPP and BOT models. Other weaknesses such as low management capacity, low ability to create financial solutions for clients, and weak professional services would worsen this situation (Lu et al. 2009).

Opportunities and threats coexist in the international construction market. It is the task of risk management that seeks to maximize the positive impacts of opportunities as well as to minimize the negative impacts of threats.

2.3.4 Risk Management Practices of CCFs in the Overseas Market

Effective risk management is crucial to the survival, profitability, and success of the CCFs that have ventured into the international arena where the risk exposure is higher. Inadequate information pertaining to the overseas environment and construction experience also contributed to a higher risk exposure and possibility of losses in the international market than that in the domestic market (Zhi 1995). Hence, it is necessary for the CCFs to properly analyze and understand the cultural, political, economic, institutional, and regulatory environment in their target overseas markets before they venture abroad (Zhao et al. 2009). However, a number of CCFs went abroad without a proper market analysis (Orr and Scott 2008), which demonstrated their low risk awareness.

External risks, falling outside a firm's direct control (Fang et al. 2004; Frame 2003), can threaten construction firms in the overseas market. However, the Singapore-based CCFs lacked external risk management (Low et al. 2009) and those that first ventured into Singapore would not invest in external risk management but were eager to win a project regardless of the potential risks (Low et al. 2008). Evidently, not all overseas construction markets were as stable as Singapore's. Lack of effective risk management might lead to huge losses for the CCFs that contracted projects in the unstable markets due to the political risks. The war in Libya, which was CCFs' sixth largest overseas market in 2010 (NBSC 2011), has already resulted in tremendous losses for the CCFs. The latest conservative estimate of the state-owned CCFs' losses was approximately US$18.8 billion, but only 5.68 % of the losses could be covered by insurance contracts (Xinhuanet 2011). In addition, the devastating earthquake, tsunami, and nuclear meltdown in Japan would increase the uncertainty of some raw materials' prices and bring about some surprises to the international construction market. Furthermore, even if the environment is relatively stable, CCFs' ineffective risk management can engender huge losses.

Leading CCFs have already encountered their pitfalls in the overseas market. Two recent cases were related to the huge losses of China Railway Construction Corp. Ltd. in Saudi Arabia and China Overseas Engineering Group in Poland. These were the subsidiaries of the top and second ranked firms among the 2012 ENR top 250 global contractors, respectively (ENR 2013c). The former was estimated to have suffered a maximum loss of RMB4.15 billion (approximately US $681 million) (China 2011) while the latter was claimed about US$271.1 million (Cienski 2011). These huge losses were caused not only by project risks, but also by the risks from the strategic decisions. In other words, these were caused not only by low level of PRM, but also by low level of ERM.

However, cases of successful risk management in CCFs still abound. Wu (2008) illustrated the effective risk management practice of a subsidiary of China Communications Construction Group (Ltd.) through two construction projects in Indonesia and Singapore. Despite the complex risks, this firm achieved satisfactory performance in both projects.

2.4 Summary

The huge investments in infrastructures and urban development have contributed greatly to economic development and brought about a continually booming domestic construction market in China. In this market, state-owned construction firms still played a key role despite their reduced proportion due to ownership diversification brought about by the enterprise reforms. The "reform and opening-up" policy also contributed to the advent of peasant-workers, who made up a majority of the workforce in CCFs. Most of them and some managers lacked proper safety training or education, and adequate safety awareness, resulting in China's poor construction site safety records despite the presence of several enacted laws and regulations. This demonstrated the low level of risk management in CCFs, which also contributed to low profitability in some CCFs. Lack of effective risk management was also a thorny problem for CCFs based in Singapore, because the risks whose sources were perceptibly far away from Singapore might also threaten the profitability and even the survival of the firms in Singapore.

References

BCA (2014) Construction demand for 2014 to remain strong. Building and Construction Authority, Singapore, from http://www.bca.gov.sg/Newsroom/pr09012014_BCA.html. Retrieved 30 May 2014

Cheah CYJ, Kang J, Chew DAS (2007) Strategic analysis of large local construction firms in China. Constr Manage Econ 25(1):25–38

Cheng EWL, Li H, Fang D, Xie F (2004) Construction safety management: an exploratory study from China. Constr Innov Inf Process Manage 4(4):229–241

China (2011) Head office takes over CRCC's light rail project. Beijing, from http://www.china.org.cn/business/2011-01/22/content_21798050.htm.Retrieved 13 July 2011

Cienski J (2011) China group sees collapse of Poland ambitions. Financial Times, Warsaw, Poland, from http://www.ft.com/intl/cms/s/0/d17dda5a-96b7-11e0-baca-00144feab49a.html#axzz1Tgz4hTH5. Retrieved 31 July, 2011

Deng X, Low SP (2013) Understanding the critical variables affecting the level of political risks in international construction projects. KSCE J Civ Eng 17(5):895–907

ENR (2013a) The top 250 global contractors. Eng News-Rec 271(8):15–19

ENR (2013b) International market analysis. Eng News-Rec 271(8):2

ENR (2013c) The top 250 international contractors. Eng News-Rec 271(8):9–13

Fang D, Li M, Fong P, Shen L (2004) Risks in Chinese construction market-Contractors' perspective. J Constr Eng Manage 130(6):853–861

Frame JD (2003) Managing risk in organizations: a guide for managers. Jossey-Bass, New York

Gunhan S, Arditi D (2005) Factors affecting international construction. J Constr Eng Manage 131 (3):273–282

Han SH, Diekmann JE (2001) Approaches for making risk-based go/no-go decision for international projects. J Constr Eng Management 127(4):300–308

Jin Z (2011) Massive investment planned to ensure conservation of resource. China Daily, Beijing, from http://europe.chinadaily.com.cn/china/2011-01/31/content_11945533.htm. Retrieved 6 May 2011

Ling FYY, Lim SH (2010) Improving export performance of contractors from China. Eng Constr Archit Manage 17(6):581–597

Liu JY, Li BG, Lin BS, Nguyen V (2007) Key issues and challenges of risk management and insurance in China's construction industry—an empirical study. Ind Manage Data Syst 107 (3):382–396

Low SP, Jiang H (2003) Internationalization of Chinese construction enterprises. J Constr Eng Manage 129(6):589–598

Low SP, Liu JY, He SQ (2008) Management of external risks: case study of a Chinese construction firm at infancy stage in Singapore. Int J Constr Manage 8(2):1–15

Low SP, Liu JY, He SQ (2009) External risk management practices of Chinese construction firms in Singapore. KSCE J Civ Eng 13(2):85–95

Lu W, Li H, Shen L, Huang T (2009) Strengths, weaknesses, opportunities, and threats analysis of Chinese construction companies in the global market. J Manage Eng 25(4):166–176

Mohurd (2013) A bulletin of the safety accidents in building and municipal works in 2012. Ministry of Housing and Urban-Rural Development of China, Beijing, from http://www.mohurd.gov.cn/zxydt/201302/t20130205_212805.html. Retrieved 22 Oct 2013

NBSC (2011) China statistical yearbook 2011. China Statistics Press, Beijing

NBSC (2013) China statistical yearbook 2013. China Statistics Press, Beijing

Orr RJ, Scott WR (2008) Institutional exceptions on global projects: a process model. J Int Bus Stud 39(4):562–588

Pearce P (1992) Construction marketing: a professional approach. Thomas Telford, London

Tam CM, Zeng SX, Deng ZM (2004) Identifying elements of poor construction safety management in China. Safety Sci 42(7):569–586

Wang D, Hadavi A, Krizek RJ (2006) Chinese construction firms in reform. Constr Manage Econ 24(5):509–519

Wu Q (2008) Probe into risk management of overseas projects. China Harbour Engineering (4):77–79

Xiao M (2010) The investment into urban infrastructures will rise to RMB 7,000 billion in the twelfth five-year plan. 21st Century Business Herald, Beijing, from http://www.21cbh.com/HTML/2010-5-13/4NMDAwMDE3Njk4NA.html. Retrieved 6 Feb 2011

Xinhuanet (2008) Wen Jiabao held standing meeting of the state council, and proposed ten measures to expand domestic demand. Xinhuanet, Beijing, from http://news.xinhuanet.com/newscenter/2008-11/09/content_10331258_1.htm. Retrieved 6 Feb 2011

Xinhuanet (2011) Libyan crisis: how to deal with China's loss. Xinhuanet, Beijing, from http://news.xinhuanet.com/fortune/2011-05/24/c_121452193.htm. Retrieved 13 July 2011

Yung P (2009) Institutional arrangements and construction safety in China: an empirical examination. Constr Manage Econ 27(5):439–450

Zhao ZY, Shen LY (2008) Are Chinese contractors competitive in international markets? Constr Manage Econ 26(3):225–236

Zhao ZY, Shen LY, Zuo J (2009) Performance and strategy of Chinese contractors in the international market. J Constr Eng Manage 135(2):108–118

Zhi H (1995) Risk management for overseas construction projects. Int J Proj Manage 13(4):231–237

Zou PXW, Fang D, Wang SQ, Loosemore M (2007a) An overview of the Chinese construction market and construction management practice. J Technol Manage China 2(2):163–176

Zou PXW, Zhang G, Wang J (2007b) Understanding the key risks in construction projects in China. Int J Proj Manage 25(6):601–614

Chapter 3
Risk Management and Enterprise Risk Management

Keywords Risk management · Drivers for ERM · Hindrances for ERM · ERM frameworks · ERM maturity model · Fuzzy set theory

3.1 Introduction

All organizations, regardless of their size, industry, or customer base, have to face some degree of risks. Hence, risk management is seen as a management response to the volatile environment. Traditionally, risk management has been segmented and conducted in separate business units or departments (i.e., silos) within a company. However, the silo-based approach to risk management has been criticized because it overlooks risk interdependence, inefficient coordination, and duplication of expenditure. By contrast, ERM treats each risk as part of an enterprise's entire risk portfolio rather than a discrete one and is thus considered as a holistic and integrated risk management approach.

This chapter first provides an overview of risk management through an introduction to the definition of risk and risk management and the generic risk management process. Also, it discusses the fundamentals of ERM and the relationship between ERM and PRM, and proposes an ERM framework for construction firms. This framework can be customized by firms according to their stage reached in ERM implementation. Finally, to assess the ERM maturity level in construction firms, an assessment model is developed by adopting the fuzzy set theory (FST).

3.2 Overview of Risk Management

3.2.1 Definition of Risk and Risk Management

Risk has different meanings to different people, and the concept of risk varies according to viewpoints, attitudes, and experiences (Walewski et al. 2003). Some scholars emphasized the negative or harmful consequences of risk and considered

X. Zhao et al., *Enterprise Risk Management in International Construction Operations*, DOI 10.1007/978-981-287-549-5_3

the risk as synonymous with threat (Baloi and Price 2003; Rescher 1983; Rowe 1977), while some recognized risk as a double-edged sword, encompassing both downside risk (threat) and upside risk (opportunity) (Loosemore 2006; Segal 2011; Ward and Chapman 2003).

In addition, as risk arises from uncertainty (Hillson and Simon 2007), some definitions have linked risk with uncertainty. Knight (1921) argued that risk was calculable within reasonable precision, while uncertainty was not calculable. However, some scholars supported the interchangeable use of risk and uncertainty (Del Caño and De la Cruz 2002; Diekmann et al. 1988; Vernon 1981) because the likelihood of occurrence of uncertainty is usually estimated by subjective judgments and it is difficult to draw a clear line between a knowable and an unknowable belief (Tan 2007). This argument was challenged by Hillson (2006), who argued that uncertainty without impact on objectives should not be viewed as risk.

Also, some of the international and regional risk management standards admitted the double-edged nature of risk and linked risk with organization's objectives. For instance, the International Organization for Standardization (ISO) defined risk as "effect of uncertainty on objectives" (p. 1) in ISO 31000:2009, which has been adopted in the British Standards Institution (BSI), and Standards Australia/ Standards New Zealand (AS/NZS 4630:2004) defined risk as "the chance of something happening that will have an impact on objectives" (p. 4), which was withdrawn in 2009 in favor of ISO 31000. Given the double-edged nature of risk and its impact on objectives, this research adopts the risk definition provided by ISO 31000:2009 and puts aside the difference between risk and uncertainty in terms of availability of the likelihood of occurrence.

Definitions of risk management are also available in risk management standards. ISO 31000:2009 briefly defined risk management as "coordinated activities to direct and control an organization with regard to risk" (p. 2), while the Institute of Risk Management (IRM 2002) defined risk management as "the process whereby organizations methodically address the risks attaching to their activities with the goal of achieving sustained benefit within each activity and across the portfolio of all activities" (p. 2). In this research, risk management is recognized as the process supported by resources to deal with risk by monitoring and controlling the likelihood and/or impact of threats, or by seeking the realization of opportunities.

3.2.2 Risk Management Process

A systematic process of risk management is normally divided into risk identification, risk analysis, and risk response. Risk response can be further divided into four actions, i.e., retention, reduction, transfer, and avoidance (Zou et al. 2007). Recent risk management standards, such as BS 31100:2008 and ISO 31000:2009, have added some new elements, which render the risk management process more comprehensive. Such a risk management process, as shown in Fig. 3.1 (adapted from ISO 31000:2009), typically includes the following elements:

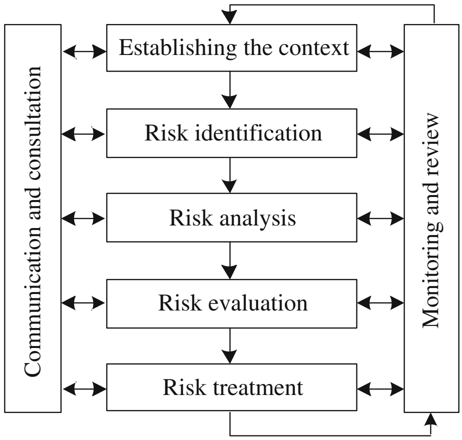


Fig. 3.1 A generic risk management process

1. Communication and consultation
   This is the continual and iterative processes that an organization conducts to provide, share, or obtain information, and to engage in dialogue with stakeholders regarding the management of risk. Communication and consultation with internal and external stakeholders should take place at each step of the risk management process.
2. Establishing the context
   The organization defines the external, internal, and risk management process context where the remaining process will take place. The external context is anything outside the organization that must be considered in risk management, while the internal context is anything within the organization that can influence risk management in the organization, such as the organizational structure and culture, objectives, strategies, resources and knowledge, and decision-making processes (both formal and informal). The risk management context is where the risk management process is applied and includes the responsibility for risk management, the scope of the risk management process, risk assessment methods to use, the way to evaluate the performance and effectiveness of the risk management, the relationships between a project and other projects in the organization, and the resources available for the risk management process.
3. Risk identification
   The organization should identify sources of risk, areas of impacts, events (including changes in circumstances), and their causes and potential consequences. The risks identified should be placed in a risk register or risk log before they can be treated. It should be assumed that not all risks will be identified, and hence, monitoring and review are necessary to add risks to the register. Review of historical document, brainstorming, Delphi technique, scenario analysis, checklist analysis, SWOT analysis, or other methods can help people identify risks, particularly infrequent risks, or "black swan" situations (Taleb 2007).

4. Risk analysis
   Risk analysis is to provide the decision maker with sufficient understanding of the risk. Risk analysis involves consideration of the causes and sources of risk, their positive and negative consequences, and the likelihood of the occurrence of consequences. Factors affecting consequences and likelihood should be identified. Risk is analyzed by determining consequences and their likelihood, and other attributes of the risk. Risk analysis methods can vary from quantitative mathematical models to qualitative methods.
5. Risk evaluation
   Risk evaluation assists in decision-making, based on the outcomes of risk analysis, about which risks need treatment and the priority for treatment. Risk evaluation involves comparing the level of risk found during the analysis process with the risk criteria. Based on this comparison, the need for treatment can be considered.
6. Risk treatment
   Risk treatment, which is synonymous with risk response, is the process to modify the risks. Selecting the most appropriate risk treatment option involves balancing the costs and efforts of implementation against the benefits derived, with regard to legal, regulatory, and other requirements such as social responsibility and the protection of the natural environment. Dealing with negative consequences, the risk treatment options include avoiding/eliminating risks, reducing risks, retaining/accepting risks, transferring risks, as well as sharing risks with others. In contrast, exploiting, sharing, accepting, or enhancing risks can be employed to treat risks with positive consequence, i.e., opportunities.
7. Monitoring and review
   Monitoring and review involve regular checking or surveillance, and encompass all aspects of a risk management process in order to ensure that controls are effective and efficient. Monitoring and review also obtain further information to improve risk identification, analysis, and evaluation, learn lessons from the risk management process, detect changes in the context, and identify emerging risks.

The risk management process should also be recorded to enable risk management activities to be traceable, thereby providing the foundation for continuous improvement in the overall process. Hence, all the risk management elements constitute a continuous cycle of review and improvement.

3.3 ERM Fundamentals

3.3.1 Definition of ERM

Although there have been various definitions of ERM (CAS 2003; Lam 2003; Miccolis and Shah 2000), ERM is most frequently defined with reference to the 2004 guidance document Enterprise Risk Management—Integrated Framework published by the Committee of Sponsoring Organizations of the Treadway Commission (COSO). The COSO (2004) defined ERM as “a process, effected by an entity’s board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives” (p. 4).

It is noteworthy that the events in this definition can have negative impact, positive impact, or both, which is consistent with the double-edged nature of risk. Additionally, ERM is a process, ongoing and flowing through an entity, and should be practiced by individuals at every level of an organization. This process is applied in strategy setting and the enterprise, including taking an entity-level portfolio view of risk. Identification of potential events and management of risk within corporation also falls within the scope of the ERM process. Moreover, this definition emphasizes reasonable assurance that is provided to the board of directors and management concerning the achievement of corporate objectives in one or more but overlapping categories, rather than complete enumeration and attempted eradication of the risks. Finally, ERM helps entities to understand the risks that they face and helps managers to tailor their goals to the firm’s risk appetite.

Enterprise or enterprise-wide risk management is currently the most widely used and generally accepted terminology for this approach to risk management (Hopkin 2010). Besides ERM, other terms have also been used to describe this approach, such as corporate risk management, holistic risk management, strategic risk management, and integrated risk management. The Casualty Actuarial Society (CAS 2003) considered these terms as similar to, even synonymous with, ERM, because they all emphasized a comprehensive view of risk and risk management, a movement away from the silo-based approach, and the view that risk management can be both a value-creating and a risk-mitigating process. Hence, these terms are used interchangeably in this research.

3.3.2 Differences Between ERM and Silo-Based Risk Management

Traditionally, risk management is segmented and conducted in separate business units or departments (i.e., silos) within a company. Under silo-based risk management, each silo deals with its own risks, and no single group or person in the organization has a grasp of the entire exposure that the company faces (IMA 2007). This practice is attributed to the way people think about solving problems, the existing organizational structure, the evolution of risk management practice (Chapman 2006), as well as the fact that each silo within a company possesses the best expertise to address the risks within its area of responsibility (Utter 2006).

However, silo-based risk management fails to consider the interdependence and interactions between risks (Cendrowski and Mair 2009; Chapman 2006; Collier

2009), creates inefficient coordination between various silos and duplication of risk management expenditure (Hoyt and Liebenberg 2011; Meulbroek 2002), pays little or no attention to strategic risks or financial risks (Narvaez 2011), and may overlook the most significant risks (Collier 2009) due to lack of a holistic view of the risks confronted by the company.

Risks are, by the very nature, dynamic, fluid, and highly interdependent (Cendrowski and Mair 2009; Chapman 2006; Lam 2003; Pennock and Haimes 2002) and thus cannot be segmented and managed independently. Hence, risk management should be integrated into the business process (Hilson 1998; Jutte 2010) and exist within all levels of an organization. Organizations that operate in the volatile environment need a holistic and integrated approach to managing their portfolio of risks (Lam 2003).

Since the mid-1990s, ERM has been recognized as a holistic and integrated approach to managing an enterprise's entire risk portfolio and widely used in the financial and energy industries. ERM treats each risk as part of a company's entire risk portfolio rather than a discrete one (Cumming and Hirtle 2001; Liebenberg and Hoyt 2003; Spicer 2006) and concerns understanding the interdependencies among risks and how risk response measures can address multiple risks across multiple business areas (Chapman 2006). It is the holistic management of the entire risk profile that distinguishes ERM from the silo-based approach to risk management (Pagach and Warr 2011).

Additionally, ERM attempts to consolidate the risk management process across all the levels within the organization (COSO 2004) and concerns not only an organization's view of the risks that it faces, but also the degree of coordination and consolidation with which the company manages the risks (Culp 2002).

Furthermore, since enterprise risks are considered as an integral part of corporate strategy, the selection of strategy can be one way to control these risks. Senior management can change a highly risky strategy to one with an acceptable risk profile. In addition, ERM implementation throughout an organization also needs the sponsorship of the board and senior management. Therefore, ERM can be viewed as a top-down approach to risk management (Dickinson 2001; Olson and Wu 2008).

3.3.3 Modern Portfolio Theory

Markowitz (1952, 1959) is the father of the modern portfolio theory who formulated the portfolio problem as a choice of the mean and variance of a portfolio of assets. Markowitz (1952, 1959) proved the fundamental theorems of the mean–variance portfolio theory. These theorems concern

1. Holding constant variance, maximizing expected return; and
2. Holding constant expected return, minimizing variance.

These two principles have guided investors to select their preferred portfolios, according to their risk return preferences. The theory conveyed an important message that assets could not be selected only on characteristics that were unique to the security. An investor had to consider how each security interacts with all other securities, which resulted in an ability to construct a portfolio that had the same expected return with less risks than a portfolio constructed by ignoring the interactions between securities (Elton and Gruber 1997). Portfolio risk depends not only on the risk of the individual investments on a stand-alone basis, but also how they interact with each other. In a sense, the risky investments lose their identity when combined into the portfolio. Hence, it is possible to construct a reasonably safe portfolio even if it contains a number of uncorrelated high-risk investments (SOA 2006).

The modern portfolio theory can be linked to ERM because ERM holds a portfolio view of risks and considers the interactions between risks. The concepts of the modern portfolio theory can be generalized beyond financial risks to include risks of all kinds, namely beyond a portfolio of investments to the entire collection of risks that an organization faces (CAS 2003). An enterprise can be thought of as a collection of risky activities. Each activity has risk and return expectation. Hence, "investments" in the modern portfolio theory are considered as equivalent with "risky activities" in an enterprise. Lam (2003) argued that enterprise risk managers should think and act like a "fund manager" and set portfolio targets and risk limits to ensure appropriate diversification and optimal portfolio returns. Thus, these managers can combine risky investments into a low-risk portfolio. Lam (2003) also regarded portfolio management as one of the seven components in the ERM framework. The portfolio management aggregates risk exposure, incorporates diversification effects, and monitors risk concentrations against risk limits.

Some benefits of ERM also derive from the portfolio approach to risk management. Improvements in business performance result from a portfolio view of all risks, managing the linkages among risk, capital, and profitability, and rationalizing the company's risk transfer strategies (Lam 2003). As holding a diverse portfolio of stocks reduces the return volatility, ERM can offset risks and result in a total risk level that is lower than the sum of the individual risks, which in turn can reduce risk management costs (Kleffner et al. 2003).

3.3.4 Drivers for ERM Implementation

An argument gaining momentum in the literature is that ERM adoption has been compelled by a series of legal compliance and corporate governance requirements (Acharyya 2008; Conrad and Yau 2009; Gates 2006; Kleffner et al. 2003; Liebenberg and Hoyt 2003; Manab et al. 2010; Miccolis 2003; PwC 2008; SOA 2006; Perrin 2006; Utter 2006). Most of these requirements are the mandatory laws or regulations, and non-mandatory reports or standards that created public pressures and benchmarks for sound management practices. Table 3.1 illustrates several sources of compliance and corporate governance requirements. Adopting ERM has been viewed as one of the best strategies to comply with these new risk-based

Table 3.1 Regulatory compliance and corporate governance requirements

Initiatives	Description
Sarbanes–Oxley Act (SOX) in the USA	Enacted in 2002 as a reaction to major scandals including those affecting Enron and WorldCom, the SOX requires management and the external auditor to report on the adequacy of the company's internal control over financial reporting in Section 404
New York Stock Exchange (NYSE) corporate governance rules	In 2004, the NYSE adopted corporate governance rules that require the audit committees of its listed companies to discuss policies concerning risk assessment and risk management, including major financial risk exposures and the steps that management has taken to monitor and control such exposures
UK Corporate Governance Code	The UK Corporate Governance Code 2010 aims at the companies listed in the London Stock Exchange. The Listing Rules require public-listed companies to disclose how they have complied with the code and explain where they have not applied the code. The code consolidates and refines previous reports and codes concerning opinions on good corporate governance, such as the Cadbury Report, the Greenbury Report, the Hampel Report, and the Turnbull Committee Report
KonTraG in Germany	KonTraG is a law that requires the board to establish supervisory systems for risk management and internal revision, and calls for reporting on these systems to the supervisory board
Basel II	Basel II, initially published in 2004, is to create an international standard that banking regulators can use when creating regulations about how much capital banks need to put aside to guard against the types of financial and operational risks banks face
Dey Report in Canada	The Dey Report, commissioned by the Toronto Stock Exchange and released in December 1994, requires companies to report on the adequacy of internal controls
CoCo Report in Canada	The CoCo report, namely the "Guidance on Control" produced by the Criteria of Control Board (CoCo) of the Canadian Institute of Chartered Accountants in 1995, specifies reporting on risk assessment and risk management
AS/NZS 4360 in Australia/New Zealand	AS/NZS 4360:1995 called for a formalized system of risk management and for reporting to the organization's management on the performance of the risk management system. While not binding, the standard created a benchmark for sound management practices
Peters Report in the Netherlands	The Peters Report makes 40 non-mandatory recommendations on corporate governance, one of which concerns that the board should submit an annual report to the supervisory board on corporate objectives, strategy, related risks, and control systems
ISO 31000:2009	ISO 31000:2009 provides generic guidelines intended to promote the adoption of consistent processes so as to ensure the risk is managed effectively, efficiently, and coherently across organizations

governance requirements (Wu and Olson 2009). Moreover, because ERM can increase firm's value, the three main rating agencies, i.e., S&P, Moody's, and Fitch, have included a company's ERM system or its absence as a factor in their rating methodology for insurance, banking, and non-financial firms (Beasley et al. 2008). These requirements have significantly driven firms to embrace ERM. Accenture (2011) reported that 79 % of the global financial services firms and 56 % of the global resource and energy firms had ERM programs in place.

However, Duckert (2011) argued that the SOX undermined ERM and regarded the recent financial crisis as proof that the compliance efforts were not the panacea for all the problems of companies. Power (2009) also noted the danger of ERM turning out to be the "rule-based compliance" and failure to be integrated into decision-making and business processes. This was confirmed by the Harvard Business Review Analytic Services (HBRAS 2011), which found that the main barrier to embedding ERM was overemphasis on compliance rather than fundamental processes.

Although compliance and corporate governance requirements have driven firms to adopt ERM, firms carried out ERM for potential benefits (Pagach and Warr 2011) and such benefits should be convincing to the management of firms (Deloitte 2009). Also, the benefits of advanced ERM have been believed to exceed the significant costs associated with initiating an ERM program (Hallowell et al. 2013; Harner 2013).

A general viewpoint from the literature is that ERM implementation can improve firm performance (Barton et al. 2002; Gordon et al. 2009; Hoyt and Liebenberg 2011; Lam 2003; Nocco and Stulz 2006), which was found contingent on the match between ERM and the firm-specific factors, including environmental uncertainty, industry competition, firm size, firm complexity, and board of directors' monitoring (Gordon et al. 2009). Also, the fact that the more established firms are more receptive to ERM adoption (Yazid et al. 2011) underpins the view that ERM improves firm performance. With a more detailed view, benefits created by ERM include, but are not limited to:

1. Reduced earnings volatility (Gates 2006; Hoyt and Liebenberg 2011; Lam 2003; Liebenberg and Hoyt 2003; Manab et al. 2010; Miccolis 2003; Narvaez 2011; Walker et al. 2002);
2. Reduced costs and losses (Beasley and Frigo 2010; Cumming and Hirtle 2001; Gregory 2003; Harrington et al. 2002; Kleffner et al. 2003; KPMG 2010; Liu et al. 2011; Manab et al. 2010; Meulbroek 2002; Perrin 2006);
3. Increased profitability and earnings (Gates 2006; Manab et al. 2010; Miccolis 2003);
4. Improved decision-making (Bugalla et al. 2010; Deloitte 2010b; Gates 2006; HBRAS 2011; Kleffner et al. 2003; KPMG 2010; Lam 2003; Liu et al. 2011; Manab et al. 2010; Millage 2005; Narvaez 2011; Perrin 2006; Williams 2005);
5. Better risk reporting and communication (Chapman 2006; Gates 2006; Lam 2003; Manab et al. 2010; Narvaez 2011; Negus 2010; Utter 2006);
6. Increased management accountability (AON 2010; Gates 2006; HBRAS 2011; KPMG 2010; Muralidhar 2010; Narvaez 2011; Williams 2005);

7. Greater management consensus (Gates 2006; Millage 2005; Muralidhar 2010; Williams 2005);
8. Competitive advantages (Acharyya 2007; Gates 2006; Lam 2003; Nocco and Stulz 2006; Perrin 2006; Walker et al. 2002);
9. Better resource allocation (Liebenberg and Hoyt 2003; Liu et al. 2011; Meulbroek 2002);
10. Improved owners' satisfaction (Liu et al. 2011); and
11. Improved control of an enterprise on its projects (Liu et al. 2011).

Some of these potential benefits were found to drive ERM implementation in firms. Reduced earnings volatility, reduced costs and losses, and increased profitability and earnings, which also contribute to improved shareholder value, were found to be significant drivers for ERM implementation in previous studies (Accenture 2011; Manab et al. 2010; Rao 2007). In addition, Gates (2006), Miccolis (2003), and Muralidhar (2010) indicated that competitive advantages drove ERM implementation, while Manab et al. (2010), Rao (2007), and Liu et al. (2011) found that improvement in decision-making was a driver for ERM implementation. Moreover, Liu et al. (2011) indicated that improved control of an enterprise on its projects, improved owners' satisfaction, and better resource allocation motivated construction firms to implement ERM. Although better risk reporting and communication, increased management accountability, and greater management consensus have not been considered as significant drivers for ERM in the existing literature, these are hypothesized to drive ERM implementation in CCFs in this research.

In addition, a broader scope of risks from globalization and market as well as greater risk interdependence drove firms to embrace an integrated approach to risk management (Lam and Kawamoto 1997; Liebenberg and Hoyt 2003). Perrin (2006) claimed that natural disasters like hurricanes, global pandemics such as avian flu, and increased liability risks were the key factors that raise the emphasis on ERM. The Economist Intelligence Unit (EIU 2007) found that macroeconomic volatility, cost of capital, and political uncertainty were the key external drivers for ERM. Deloitte (2010a) indicated that catastrophic events such as stock market crashes and the current credit crisis were likely to trigger ERM implementation. Pagach and Warr (2011) found that firms with more volatile operating cash flows and riskier stock returns were more likely to embrace ERM.

Moreover, technological advancement was also considered as a major external driver (Liebenberg and Hoyt 2003) as ERM needs a lot of computing power (Segal 2011). Advances in IT have enabled firms to gather better data for certain risks, model complex risks, measure risks more precisely, and better understand risk interdependence across a firm (Davenport and Bradley 2000; Green 2001; Jablonowski 2001). There are currently a variety of ERM software packages, which make ERM implementation more efficient. However, Manab et al. (2010) found that the technology was considered as a driver for ERM implementation by few firms in Malaysia.

The above forces that drive ERM would compel the board and senior management to request for ERM implementation. Kleffner et al. (2003) found that 51 % of Canadian firms viewed the encouragement from the board as key factors underlying their ERM adoption. Gates (2006) indicated that the board request was a primary driver for ERM implementation. Request and encouragement from top management is an internal force that drives ERM implementation in a firm. In addition, Narvaez (2011) believed that board and senior executives should drive ERM implementation because ERM involves the commitment of the entire enterprise.

3.3.5 Hindrances to ERM Implementation

It is not easy to implement ERM because ERM implementation faces some hindrances. As a survey conducted in North America discovered, 70 % of the respondents (audit committee members) identified ERM as their most challenging issue in the next 12 months (CFO/Crowe 2008). There are a number of factors hindering ERM implementation available in the literatures relating to ERM. These hindrances include (where "H" represents "hindrance") the following:

H01 Low data quality (Muralidhar 2010; RMA 2006; Schlottmann et al. 2005);
H02 Lack of data (RMA 2006; Ross 2005; Schlottmann et al. 2005; Tang et al. 2007);
H03 Insufficient resources (e.g., time, money, people) (AON 2010; Beasley et al. 2010c; Blades 2010; Bowling and Rieger 2005; CFO/Crowe 2008; Gates 2006; KPMG 2010; Miccolis 2003; Miccolis et al. 2000; Rao 2007; RMA 2006; Roth 2006);
H04 Lack of a formalized ERM process (Miccolis 2003; Miccolis et al. 2000; Rao 2007);
H05 Lack of risk management techniques and tools (CFO/Crowe 2008; Miccolis 2003; Miccolis et al. 2000; Muralidhar 2010; Rao 2007; Segal 2007; Shaw 2005; Tang et al. 2007);
H06 Lack of internal knowledge, skills, and expertise (AON 2010; CFO/Crowe 2008; KPMG 2010; Miccolis 2003; Miccolis et al. 2000; Rao 2007; Tang et al. 2007);
H07 Lack of qualified personnel to implement ERM (Kleffner et al. 2003; RMA 2006);
H08 Lack of a risk management information system (RMIS) (CFO/Crowe 2008; Muralidhar 2010; Ross 2005; Tang et al. 2007);
H09 Unsupportive organizational structure (Blades 2010; CFO/Crowe 2008; EIU 2001; Kleffner et al. 2003; Rao 2007; Ross 2005);

H10 Unsupportive organizational culture (Blades 2010; De la Rosa 2006; Kimbrough and Componation 2009; Kleffner et al. 2003; Merkley 2001; Miccolis 2003; Miccolis et al. 2000; Muralidhar 2010; Rao 2007; Shimpi 2010);
H11 Lack of a common risk language (Muralidhar 2010; Nielson et al. 2005);
H12 Lack of risk awareness in the organization (De la Rosa 2006; Muralidhar 2010);
H13 Confidence in the existing risk management practices (Beasley et al. 2010c; Roth 2006);
H14 Existence or re-emergence of the silo mentality (Kleffner et al. 2003);
H15 Lack of shared understanding and approach to risk management across departments (CFO/Crowe 2008);
H16 Lack of understanding relating to an effective ERM process (EIU 2001);
H17 Perception that ERM adds to bureaucracy (Beasley et al. 2010c; RIMS and Marsh, 2006);
H18 Perception that ERM increases costs and administration (KPMG 2010);
H19 Perception that ERM interferes with business activities (CFO/Crowe 2008);
H20 Inadequate training on ERM (Gupta 2011);
H21 Lack of an ERM business case (Aabo et al. 2005; AON 2010; KPMG 2010);
H22 Lack of perceived value or benefits (AON 2010; Beasley et al. 2010c; Blades 2010; KPMG 2010; Roth 2006);
H23 Lack of commitment from the board and senior management (AON 2010; Bowling and Rieger 2005; CFO/Crowe 2008; KPMG 2010; Ross 2005; Roth 2006; Spicer 2006);
H24 Not perceived as priority by senior management (Merkley 2001; Miccolis 2003; Muralidhar 2010);
H25 Lack of the board or senior management leadership (Beasley et al. 2010c);
H26 The movement of the ERM champion from senior management into other areas without a successor (Simkins 2008);
H27 Lack of consensus on benefits of ERM among board members and senior management (Gates 2006);
H28 Other competing priorities (Beasley et al. 2010c; Gates 2006; KPMG 2010);
H29 Lack of a clear ERM implementation plan (AON 2010);
H30 Inability to coordinate with other departments (Gupta 2011);
H31 Lack of a set of metrics for measuring ERM performance (RIMS and Marsh 2006);
H32 Unclear ownership and responsibility for ERM implementation (AON 2010);
H33 Organizational turf (Miccolis 2003; Miccolis et al. 2000);
H34 Employees' reluctance to give up power (EIU 2001);
H35 People's reluctance to share risk information (Simkins 2008); and
H36 Recession and business downturn (Kleffner et al. 2003)

Hence, 36 factors hindering ERM implementation were summarized from a total of 30 literatures on ERM. Because of these hindrances, the percentage of companies adopting or implementing ERM was not high. According to Beasley et al. (2010a, c), 46 % of the global respondents had a formal ERM process that regularly provides a robust, systematic report of aggregate top risk exposures to the board and senior management. In contrast, only 11 % of the US respondents possessed a complete formal ERM process. The status was better in Singapore as another survey indicated that 81 % of the 203 firms in Singapore had ERM programs in place and that approximately 53 % had implemented ERM for more than three years (KPMG 2010).

3.4 Existing ERM Frameworks

A framework serves as a guide, an outline, or overview of interlinked items (activities) to facilitate an approach toward achieving a specific goal. An ERM framework is described as a specific set of functional activities and the associated definitions that define the ERM system in an organization and its relationship with the organizational system (Dafikpaku 2011). According to the Corporate Governance Council of Singapore (CGC 2012), the design and pace of implementation of ERM frameworks vary greatly among firms. Some firms wish to be best in class, some simply to be in the pack, while for others, the barest minimum of formality suffices (CGC 2012).

3.4.1 CAS ERM Framework

The CAS (2003) conceptualized ERM as cutting across the two dimensions of risk type and risk management process. As shown in Fig. 3.2 (adapted from CAS 2003), some risk management process steps apply to each risk type individually, while others apply to all the risk types in the aggregate.

<table>
<tr><td rowspan="2">Risk management process</td><td colspan="4">Types of risk</td></tr>
<tr><td>Hazard</td><td>Financial</td><td>Operational</td><td>Strategic</td></tr>
<tr><td>Establish Context</td><td colspan="4"></td></tr>
<tr><td>Identify Risks</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Analyze/Quantify Risks</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Integrate Risks</td><td colspan="4"></td></tr>
<tr><td>Assess/Prioritize Risks</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Treat/Exploit Risks</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Monitor and Review</td><td colspan="4"></td></tr>
</table>

Fig. 3.2 CAS ERM framework

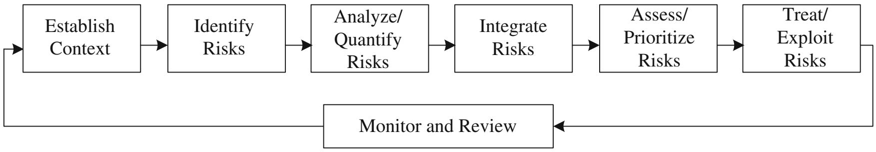


Fig. 3.3 CAS risk management process

Enterprises are generally exposed to four types of risks (CAS 2003): (1) hazard risks, which include risks from fire and other property damage, natural perils, theft and other crime, personal injury, business interruption, disease and disability, and liability claims; (2) financial risks, which consist of risks stemming from asset value, interest rate, foreign exchange, commodity, cash flow, credit, inflation/purchasing power, and hedging/basis risk; (3) operational risks, which include risks from business operations, empowerment, IT, and information/business reporting; and (4) strategic risks, which include risks from reputational damage, competition, customer needs, social and cultural trends, technological innovation, capital availability, and regulatory and political trends. It is worth noting that the precise slotting of individual risk factors under each of these four categories is less important than the recognition that ERM covers all categories and all material risk factors that can influence the organization's value. The risk management process dimension includes seven iterative elements, as illustrated in Fig. 3.3. The CAS risk management process is similar to the one shown in Fig. 3.1, except with the absence of communication and consultation with internal and external stakeholders at each step of the process. Although "establish context" involves communication policy with the identified shareholders, it fails to emphasize that this policy should be performed at each stage of the risk management process.

3.4.2 COSO ERM Framework

The COSO (2004) has developed an ERM conceptual framework. This framework builds on and extends the integrated framework for internal control issued in 1994 and is applicable to all industries. As shown in Fig. 3.4 (adapted from COSO 2004), this framework has three dimensions, specifying how the people from each level of an enterprise implement the eight ERM components in order to achieve the four categories of corporate objectives.

In this framework, ERM implementation covers eight interrelated components: internal environment, objective setting, event identification, risk assessment, risk response, control activities, information and communication, and monitoring. These components comprise the "component dimension." Meanwhile, the four categories of objectives (i.e., strategic, operations, reporting, and compliance) share a depiction at the top of the cube, representing the "objective dimension." In addition, ERM should be implemented across an enterprise, at the four levels including

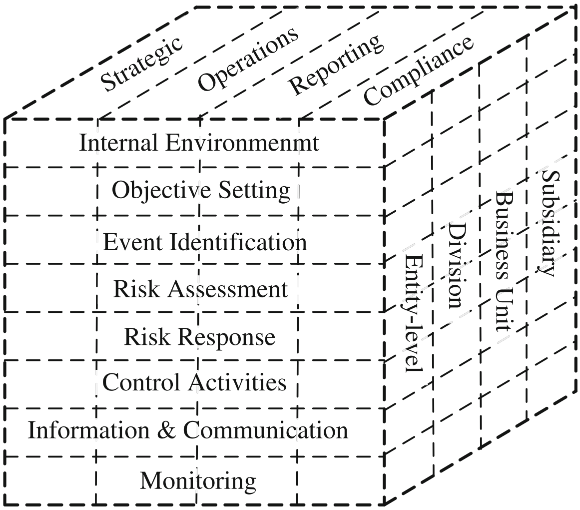


Fig. 3.4 COSO ERM framework

subsidiary, business units, division, and entity level. This is the "hierarchy dimension" of the ERM cube. This dimension varies by the size and type of the entity that adopts this framework (Cendrowski and Mair 2009).

This framework intends to provide a model to facilitate the organizations in considering and understanding their risk-related activities at all levels of the organization as well as their impacts on one another (Moeller 2007). ERM is not strictly a serial process, where one component affects only the next. Instead, it is a multidirectional, iterative process in which almost any component can and does influence another. The effectiveness of ERM could be judged in terms of whether these eight components are present and functioning effectively (COSO 2004).

In terms of the objectives, the strategic category involves overarching activities such as corporate governance, strategic objectives, and business models; the operations level relates to business processes, value chains, financial flows, and related issues; reporting objectives refer to reports produced for both internal and external purposes, and is concerned with how to communicate corporate performance on multiple dimensions; and compliance considers organizational reporting on legal, contractual, and other regulatory requirements (Wu and Olson 2008: p. 32). According to the COSO (2004), ERM can provide reasonable assurance of achieving objectives relating to reliability of reporting and compliance with laws and regulations because these two categories are within the realms of corporate control. As for the strategic and operational objectives, whose achievement may be out of corporate control, ERM can provide reasonable assurance that the management and the board are made aware of the extent to which the enterprise is moving toward achievement of these objectives.

Furthermore, this framework can also be accomplished within a specific subsidiary, unit, or division, representing a form of "partial adoption" while still retaining an enterprise-wide focus. Protiviti (2006) suggested that some strategic operating units should have distinctly different risk profiles because of distinctively different objectives and strategies, manage distinctive product groups, serve heterogeneous markets, and act as stand-alone profit centers. Additionally, considering a competitive environment among different strategic units, the risk profiles for these units may differ so that it may be appropriate to manage them separately. Under such circumstances, a decentralized approach may make more sense with ERM applied in the selected operating units. However, Fraser and Simkins (2007) considered this as a misconception and argued that in such cases, managers would only care about the risks within their silos, without an understanding of their effects on the firm's overall risk.

3.4.3 ISO 31000:2009 Risk Management Framework

The ISO published a common risk management framework in ISO 31000:2009, which incorporates the best practices from the COSO, Project Management Institute (PMI), AS/NZS 4360:2004, as well as other leading international risk management standards. Hence, the ISO framework is current best practice for risk management frameworks (Shortreed 2010).

As Fig. 3.5 illustrates, the ISO 31000:2009 risk management framework consists of five components: mandate and commitment, design of framework for managing risk, implementing risk management, monitoring and reviewing, as well as continual improvement of the framework. The underlying concept of this framework is

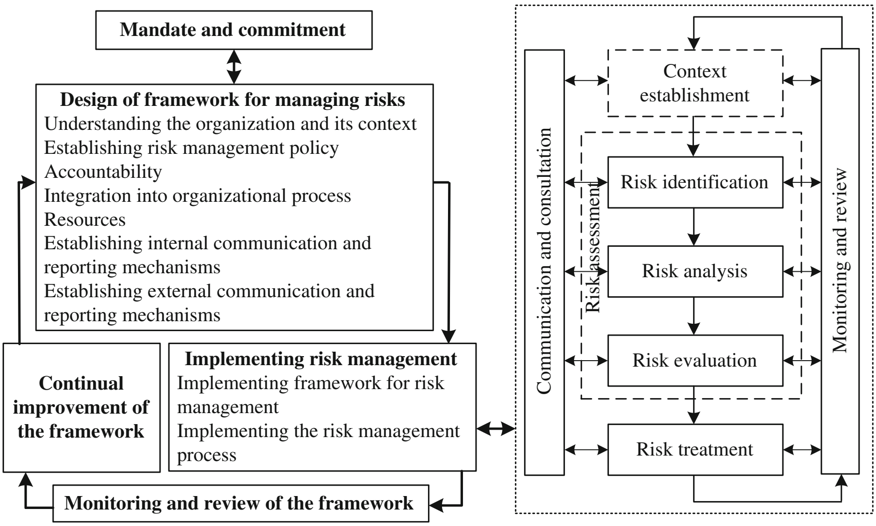


Fig. 3.5 ISO 31000:2009 risk management framework

a quality management approach using the Deming paradigm of plan-do-check-act (PDCA) (Deming 1986), which indicates that the framework is designed, implemented, monitored, and continuously improved. With the continual improvement of the framework, the quality of decision-making is also improved.

ISO 31000:2009 provides an internationally recognized benchmark for the design and implementation of the ERM framework. Although this approach for developing and implementing ERM is similar to and compatible with other approaches, it is the first standard to provide a complete and practical solution (Shortreed 2010). It also merits attention that ISO 31000:2009 is a guideline standard rather than a standard requiring accreditation. Thus, a risk manager is able to flexibly implement the risk management process in a manner suitable for his or her organization.

3.4.4 SASAC ERM Framework

In 2006, the State-owned Assets Supervision and Administration Commission (SASAC) of the State Council of China issued the Guidance to Enterprise Risk Management for Central Enterprises to drive ERM implementation in central enterprises following the massive losses by China Aviation Oil (Singapore) in future investments (Ockenden 2004). The term “central enterprise” is defined as state-owned enterprises whose investor is the SASAC with the authority vested by China’s State Council, namely the enterprises owned by China’s central government. Some of the leading CCFs are central enterprises, such as China Railway Construction Corp. Ltd., China Railway Group Ltd., China Communications Construction Group (Ltd.), China State Construction Engineering Corp., and China Metallurgical Group Corp.

Similar to ISO 31000: 2009, the SASAC defines risk as “effects of uncertainty on enterprise business objectives” (SASAC 2006). In this guidance, risk management process encompasses the following:

1. Collection of initial risk management information
   Initial information involving strategic risks, financial risks, market risks, operational risks, and legal risks should be collected by functional departments and business units. This information includes cases of the enterprises suffering losses due to ineffective risk management, historical data, and forecast for the future and will be employed in risk assessment.
2. Risk assessment
   Risk assessment consists of risk identification, risk analysis, and risk evaluation. Risk assessment can be conducted by functional departments and business units, or intermediaries with qualifications, good reputation, and experienced professionals. Both qualitative and quantitative methods can be employed in risk identification, analysis, and evaluation.

3. Development of risk management tactics
   Risk management tactics include identifying risk appetite, selecting risk response measures and tools, as well as defining the principles of human and financial resource allocation, based on the enterprise's internal and external context and strategy.
4. Formulation and implementation of risk management solutions
   Based on the risk management tactics, an enterprise can formulate and implement risk management solutions, which include the specific objectives of solutions, necessary organizational leadership, relevant business processes, necessary resources, risk response measures, as well as risk management tools. The risk management solutions can be handled through outsourcing or internal control.
5. Monitoring and improvement of risk management
   Each unit and department should periodically review its own risk management practices and find the defects. A risk communication channel across the enterprise should be established and thus sets a foundation for monitoring and improving ERM.

In addition, the SASAC (2006) identifies five objectives for ERM implementation of central enterprises:

1. Ensure risks controlled within the risk appetite that fits the corporate objectives;
2. Ensure true and reliable internal and external information communication, especially the communication between enterprises and shareholders;
3. Ensure compliance with laws and regulations;
4. Ensure the implementation of the corporate institutions and key measures for achieving business objectives, as well as the effectiveness of business management; improve efficiency and effectiveness of business activities; and lower the uncertainty of business objective achievement; and
5. Ensure the establishment of crisis management plans against major risk occurrence, in order to avoid suffering heavy losses caused by human errors or disasters.

This guidance emphasizes the organizational structure for ERM. If possible, an enterprise can establish triple lines of defense to manage risks. Functional departments and business units act as the first line of defense, and the risk management department and the board-level risk management committee comprise the second line of defense, followed by the last line of defense: the internal audit department and the audit committee of the board. The guidance also advocates the application of IT in risk management and suggests establishing a RMIS that covers the risk management process and internal control activities, including risk information collection, storage, analysis, testing, dissemination, reporting, and disclosure. This system should also facilitate integration and sharing of the information from various departments and units. In addition, this guidance emphasizes the creation of a risk management culture at all levels of an enterprise and the incorporation of the risk management culture into the corporate culture. Furthermore, this guidance suggests linking the creation of the risk management culture with the salary and manpower institutions, which can strengthen risk awareness of management at all levels, especially the senior level.

3.5 ERM in Construction Firms

The construction industry is a project-based industry. Product uniqueness, on-site production, and ad hoc project teams with relatively high turnover rates are typical characteristics of the industry (Tserng et al. 2009). Additionally, the construction industry is usually blamed for its inefficient operations (Cox and Thompson 1997), and the short-term perspective hinders innovation and technical development (Dubois and Gadde 2000, 2002). Moreover, a construction project typically involves a variety of parties, such as the client, main contractor, subcontractors, designers, and suppliers. These parties work in a diversity of disciplines and technologies (Burtonshaw-Gunn 2009), thus leading to the fragmentation of the construction industry (Ang and Ofori 2001). Furthermore, complexity in construction, which results from the industry-specific uncertainties and interdependences among tasks (Gidado 1996), is another characteristic. The uncertainties stem from the unfamiliarity of management with local resources and the local environment, lack of complete specifications for the activities at the construction site, lack of uniformity of materials, work, and teams with regard to place and time, and unpredictability of the environment (Dubois and Gadde 2002). These characteristics increase the difficulty in using a centralized approach to decision-making (Dubois and Gadde 2002).

Construction activities are risky, because risks are inherent in all construction projects (Rahman and Kumaraswamy 2002), which are one-off endeavors with unique features such as long period, complicated processes, abominable environment, financial intensity, and dynamic organization structures (Zou et al. 2007b). A construction firm depends on construction projects to generate revenues and profits to sustain the business. Project managers deal with risks based on their own professional disciplines and experiences, and tend to care only about the projects they are participating in. Hence, a construction firm usually emphasizes PRM, but tends to fail to deal with risks at the firm level. Similarly, there have been many studies on PRM in the construction industry, but few focus on ERM in construction firms.

Risk management should cover not only project risks, but also the risks encountered by being a business enterprise (Schaufelberger 2009). Overemphasis on PRM will lead to lack of coordination between different projects, increase difficulties in achieving the strategic objectives, result in inadequate transparency across multiple projects, and thus bring about low efficiency in risk management, inappropriate resource distribution among various projects, and little access to company-wide information (Adibi 2007). For construction firms venturing into the international arena, a global view to identify risks has been recommended to replace the consideration of only project risks (Zhi 1995). Therefore, construction firms need ERM which provides a holistic view of the risks that their projects face and link these factors with the corporate strategy (Adibi 2007). The construction industry was expected to experience a growth in ERM implementation (Deloitte 2010a).

Both ERM and PRM are approaches to dealing with risks that a firm faces, but at different levels (Liu et al. 2011, 2013). Hence, ERM and PRM do not contradict each other. They share a similar management process, in which risk identification, analysis, and response are critical steps.

However, ERM and PRM have different goals due to their different levels. ERM deals with risks at the enterprise level, focuses on the strategic, operations, reporting, and compliance objectives of a firm, and deals with risks that could negatively and positively affect these objectives (COSO 2004). Compared with ERM, PRM addresses risks at the project level and focuses on project objectives, such as time, cost, quality, and safety objectives. PRM aims to increase the probability and impact of positive events and decrease the probability and impact of events that can negatively affect project objectives (PMI 2008). It merits attention that project objectives are the main elements of operational objectives of a construction firm because the operation of a construction firm mainly depends on the construction projects that it is engaged in.

PRM is still necessary and should not be considered as a hindrance to implementing ERM in a construction firm. PRM has been considered as one of the nine project management knowledge areas (PMI 2008) and is critical to the success of projects and the survival of construction firms. Thus, ERM cannot replace the role that PRM plays in the construction industry. In fact, PRM can be regarded as an integral part of ERM because project risks are within the entire risk profile of a construction firm and ERM should be implemented at all levels of a firm, including the project level. Effective PRM practices, which properly deal with project risks, can contribute to ERM effectiveness throughout a firm. In turn, ERM provides a new way to improve PRM in construction firms (Liu et al. 2013) because ERM implementation involves better communication of project risk information, thus helping the management to make better informed decisions and deal with project risks more effectively and efficiently.

However, ERM implementation in CCFs was still at the infancy stage. The recent survey conducted by Liu et al. (2011) with 34 leading CCFs in the international market indicated that 52.9 % of the respondents had established a full-time risk management department in their respective organizations. In addition, only 14.7 % had fully implemented ERM, and 17.6 % had established their ERM strategies and routines, but had not fully implemented them yet.

Implementing ERM in a construction firm is actually an organization change because the staff has been accustomed to PRM. Thus, ERM in construction firms should be implemented steadily and gradually (Adibi 2007). An ERM framework should be developed in order to guide ERM implementation in construction firms and help them to overcome the negative influence that hinders ERM implementation.

3.6 A Proposed ERM Framework for Construction Firms

Based on the existing ERM frameworks and the project-based nature of the construction industry, an ERM framework is proposed for construction firms, thus fulfilling the first research objective, "propose an ERM framework to facilitate the ERM implementation in construction firms." As Fig. 3.6 indicates, this framework consists of the following components: (1) an ERM process; (2) commitment of the board and senior management; (3) training programs; (4) resources; (5) ERM ownership; (6) risk-aware culture; (7) objectives; (8) a common risk language; (9) PRM; (10) RMIS; (11) risk communication; and (12) monitoring, review, and continuous improvement of the ERM framework.

The project-based nature of the construction industry requires that the ERM framework specifically for construction firms should be different from the existing ones for other industries, where the project-based nature is not a dominant characteristic. Thus, it is the component "PRM" that makes the proposed ERM framework different from the existing frameworks. In addition, the component "objectives" includes project objectives, representing the project-based nature. Except for these two components, the other components, which are common ERM fundamentals, were adopted from the existing frameworks.

The ERM process is the key component of this framework. In this framework, the ERM process adopts the process described in ISO 31000:2009. Construction firms tend to have PRM in place. According to the PMI (2008), project risks can be

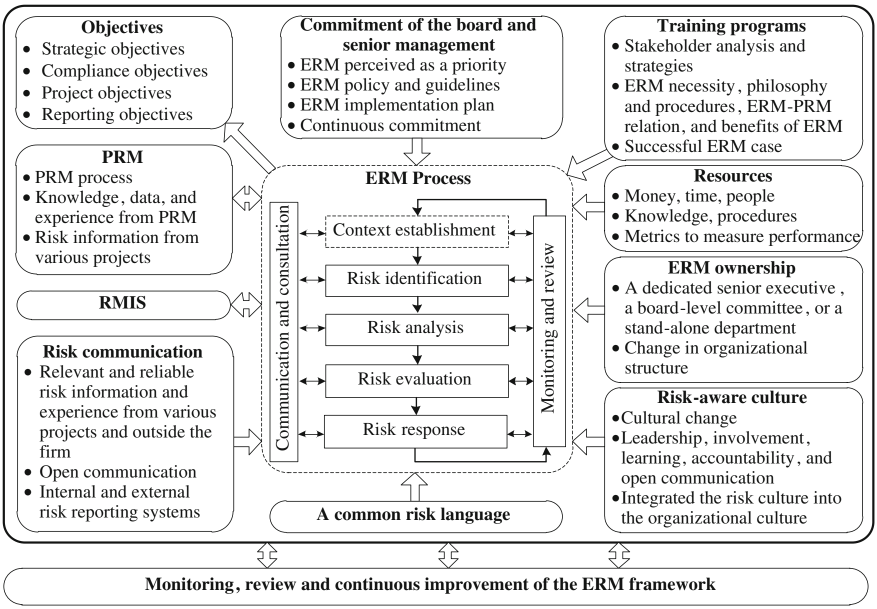


Fig. 3.6 A proposed ERM framework for construction firms

managed through six phases, i.e., plan risk management, identify risks, perform qualitative analysis, perform quantitative analysis, plan risk responses, as well as monitor and control risks. Besides this process, there are other PRM processes in the literature (APM 2004; Fairley 2002; Hillson and Simon 2007; Kliem and Ludin 1997; Perry and Hayes 1985). Irrespective of the number of phases, risk identification, risk analysis, and risk response are the generally recognized phases (Low et al. 2009; Uher and Toakley 1999). These three phases can be corresponded to the risk identification, analysis, evaluation, and response in the ERM framework. The context establishment in the ERM process could seldom be found in the PRM process because the context typically concerns things at the enterprise level rather than the project level. The internal context establishment is crucial for ERM implementation in a construction firm because their existing internal context tends to fit only PRM. It is necessary for construction firms to change the internal context to make it fit ERM. Some of the remaining components of the ERM framework, such as commitment of the board and senior management, resources, training programs, ERM ownership, culture, as well as risk communication and reporting mechanisms, concern change in the internal context of construction firms.

The commitment of the board and senior management is critical to implementing ERM across an enterprise (Abrams et al. 2007) and was considered as a prerequisite for implementing ERM (Barton et al. 2002). Without such commitment, the corporate culture or mind-set at all levels within a firm would not be changed to be receptive to ERM. Such commitment can also signify the priority in implementing ERM to the personnel in a firm and ensure that resources (including funds, people, time, expertise, procedures, and tools) are allocated for ERM implementation. Hence, ERM policies, guidelines, and an implementation plan should be developed and made known to all the staff of a firm. The commitment of the board and senior management should be continuous and ensures that the change in the ERM champion does not interrupt ERM implementation.

Resources are necessary for ERM implementation in construction firms because the ERM program that changes the accustomed way to manage risks concerns the need for funds, people, and time input. Besides these inputs, resources should also include intellectual resources, such as knowledge, skills, and expertise. In order to make people perceive the benefits or value of an ERM program, a set of metrics should be created to measure ERM performance. Such a set of performance indicators also contributes to the continuous improvement of ERM practices.

ERM should be implemented at all levels of firms, not just at the senior management level. However, during the initial stage of ERM implementation, management at the middle or lower middle level may view the impact of ERM as negative, such as an extra burden to their existing responsibilities, thus resisting the ERM programs. Hence, resources should also be allocated for training programs. These programs are necessary to help the personnel at all levels throughout a firm to clearly understand the necessity of ERM implementation, the ERM philosophy, the ERM procedure, the relationship between ERM and PRM, as well as the potential benefits of ERM. In order to make such programs effective, stakeholders' needs should be analyzed and training strategies should be developed. Successful business cases for ERM can be used to illustrate the values and benefits of ERM. Thus, misunderstanding of ERM will be reduced or even eliminated, and the commitment at all levels within the organization will form. It merits attention that the effectiveness of such training programs depends on the employee–manager relationships and mutual trust.

Similar to the ERM implementation in other industries (such as the financial or energy industry), implementing ERM in the construction industry also requires an owner. A senior executive may be appointed to be responsible for enterprise-wide risk oversight. Alternatively, a stand-alone risk management department or a board-level risk management committee may be set up to take charge of ERM. These methods all concern changes in the existing organizational structure.

In addition, because ERM implementation is viewed as an organizational change, change in the organizational culture is also necessary. Cultural elements unsupportive of ERM implementation should be changed. Cultural changes may involve discarding the "blame culture," a shift from "do not report bad news" to "report as early as possible," and from "how do risks affect my project" to "how do risks affect the entire firm" (IMA 2007). Thus, a risk-aware culture can be created. A risk-aware culture requires clear commitment of the board and senior management, involvement of all the stakeholders, learning, accountability, and open communication on all risk management issues and the lessons learned (Hopkin 2010). Instituting clear accountability for risks has been identified as a successful approach to creating a risk culture (AON 2010). The risk-aware culture should be embedded into the organizational culture, which can encourage management at all levels to be aware of the potential project and enterprise risks. Hence, due to the pervasiveness of risk awareness throughout the firm, risk management becomes a critical part of the corporate culture (Barton et al. 2002; Kimbrough and Componation 2009).

Moreover, risk information is critical to manage risks at both project and enterprise levels. Thus, mechanisms need to be set up to motivate individuals to embrace ERM and share risk information across projects. Open risk communication across different projects enables each project team to obtain adequate risk information. The relevant risk information and experience in previous projects should also be collected for risk identification, analysis, and evaluation. Risk information or historical data from outside the firm should also be collected, as long as the information or data are relevant and reliable. Risk communication also concerns risk reporting, which should be customized to gather and deliver the right information to the right people at various levels of the business, internally and externally. Benefiting from risk reporting, the board and senior management can have a clear perspective of the firm's entire risk profile to make better informed decisions.

In order to improve the effectiveness and efficiency of risk communication and reporting, a RMIS needs to be set up and placed on the intranet of the construction firm with sufficient resources. A RMIS improves risk communication through providing an information platform, which facilitates risk information distribution from one project to another. In addition, a RMIS can facilitate data-based risk reporting, which leads to rapid and accurate evaluation of risk and timeliness of reporting (Duckert 2011). A RMIS can also record risk management activities and provide traceability of decisions and continuous improvement in risk management. Hence, it contributes to organizational learning through storing the valuable project data, experience, and knowledge after the project completion. Besides these functions, some RMIS software packages can undertake risk identification and analysis, and provide response plans. Although the cost of a RMIS is relatively high, large firms can still gain enough marginal benefits from RMIS to offset the costs (Hopkin 2010).

Successful risk communication can also be attributed to the development of a common risk language. The risk language clearly explains terminologies and methods to be used universally in the organization and contributes to a common understanding of risks. The risk language should be communicated to all risk management practitioners at all levels of the firm. To facilitate the acceptance of the risk language, a glossary that is a collection of key terms can be created and disseminated across the firm. The risk language also underpins the risk culture of the organization because it facilitates open communication, which is a component of a risk-aware culture (Hopkin 2010).

In construction firms, PRM is still necessary and can be considered as an integral part of ERM. Better PRM can assure the achievement of the objectives of the projects that the firms are engaged in and thus further contributes to the achievement of the objectives at the enterprise level.

The ERM framework is also evolving continuously for improvement, so it also needs monitoring, review, and improving. This is consistent with the ISO 31000:2009 risk management framework.

To embrace ERM, construction firms can customize the framework by selecting the components according to their stage in ERM implementation. ERM should be implemented step by step. In the initial stage of ERM implementation, the commitment of the board and senior management as well as training is essential. The ERM responsibility can be included in the CEO's function, because creating a stand-alone department or a board-level committee for ERM involves changes in the organizational structure, which is time-consuming. Change in the organizational culture unsupportive of ERM can be another thorny issue for the firm. Staff in construction firms tends to be accustomed to PRM practices and only care about the project they are engaged in, even though they possess risk awareness. To create a risk-aware culture throughout the firm and to embed it into the corporate culture, accountability at all levels needs to be instituted. Additionally, motivation mechanisms are necessary for staff to care about not only the project objectives but also the enterprise objectives. Thus, individuals would share risk information in their projects with their counterparts in other projects, which ensures risk communication. A common risk language should be developed to ensure the success of risk communication and to improve the risk culture. If possible, the construction firm can develop or purchase a RMIS and embed it in the intranet.

3.7 An ERM Maturity Model for Construction Firms

3.7.1 Existing ERM Maturity Models

ERM maturity reflects the sophistication of ERM implementation. To understand the ERM maturity of a firm, a starting point can be the assessment of its current ERM practice. It is necessary for a firm to assess its ERM maturity because such assessment can help the management staff to obtain a clear view of the status quo, strengths, and weaknesses of its ERM implementation. Based on the assessment results, the management staff can take appropriate actions and prioritize resources to improve the weak areas of the ERM implementation.

An ERM maturity model reviews the ERM performance throughout the organization, tracks various criteria, and assesses the implementation level of each criterion. Thus, an ERM maturity model takes a snapshot of where the ERM program stands and measures the progress of ERM implementation (Narvaez 2011). Several ERM maturity models have been developed to help organizations in various industries to assess their ERM maturity and to identify the strengths and weaknesses of their ERM practices. Thus, they can derive measures to fill the existing gaps between the status quo and the best practices.

S&P evaluated an insurer's ERM practices by five criteria: the risk management culture, risk controls, emerging risk management, risk and capital models, and strategic risk management (Santori et al. 2007). Each criterion was assigned a weight according to the specific situation faced by each insurer, and the assessment led to an ERM score of a weak, adequate, strong, or excellent level.

In addition, the University of California (UC 2009) applied an ERM maturity-level framework, which consisted of 29 criteria based on the eight components of the COSO ERM framework and categorized ERM maturity into five levels: ad hoc, initial, repeatable, manageable, and leadership.

The Washington State Office of Financial Management (WSOFM 2010) also developed a model for the state agencies to score their ERM efforts. The ERM maturity was measured in five areas, and the overall ERM maturity ranges from level 1 (beginning) to 6 (advanced).

Moreover, Ciorciari and Blattner (2008) developed a complex ERM maturity model for banks. They detailed the eight components of the COSO ERM framework into 26 topics, which were further detailed into 123 elements. These elements were evaluated along a maturity-level scale including the very weak, poor, mid, good, and optimized levels.

AON (2010) also proposed an ERM maturity self-assessment model for organizations in a wide range of industries. In this model, ERM implementation was assessed against nine criteria, which were also considered as hallmarks of advanced ERM. ERM implementation was categorized into initial/lacking, basic, defined, operational, and advanced levels.

Furthermore, the Risk and Insurance Management Society (RIMS 2008) collaborated with LogicManager Inc. to develop a risk maturity model for ERM. This model had seven core attributes that described the fundamental characteristics of an effective ERM program: adoption of the ERM-based approach, ERM process management, risk appetite management, root cause discipline, uncovering risks, performance management, and business resiliency and sustainability. These attributes contained 25 competency drivers, and the competency drivers contained 68 best practices (key readiness indicators), against which organizations scored the effectiveness, proactivity, and coverage of each competency driver implementation.

Therefore, it can be seen that the keys of the above ERM maturity models are the criteria or attributes that describe an effective or successful ERM program and relate to the components of the existing ERM frameworks. Although AON's (2010) model can be used to assess ERM maturity level in various industries, there has not been an ERM maturity model specifically for construction firms. Hence, this research proposes such a model to assess ERM maturity in construction firms.

3.7.2 The Criteria in the ERM Maturity Model

To develop an ERM maturity model, maturity criteria need to be established. These criteria should reflect the characteristics of an advanced or successful ERM practice. These criteria were established based on the components of the proposed ERM framework for construction firms (see Fig. 3.6) and the criteria mentioned in the literature relating to the best practices and key characteristics in ERM (see Table 3.2). If a firm has practiced these criteria thoroughly, its ERM implementation can be deemed as highly mature. These criteria are as follows:

M01 Commitment of the board and senior management

Commitment of the board and senior management is not only regarded as a driver for ERM, but also as a critical success factor (Stroh 2005). It was also among the criteria in some ERM maturity models (AON 2010; RIMS 2008). Visible commitment makes people perceive ERM as a priority for the leadership. Garvey (2008) argued that risk management must be a priority for the leadership. More importantly, the commitment should be continual and should not be interrupted by changes in the ERM champion because ERM practice is an ongoing process (Bowling and Rieger 2005; Simkins 2008). Consultants, if employed, should supplement, not replace, the involvement of upper management in the ERM implementation (Barton et al. 2002).

M02 ERM ownership

Due to the centralized nature of ERM, ERM needs a risk owner to oversee an enterprise's entire risk profile at a high level rather than different overseers managing specific risks (Banham 2004). A chief risk officer (CRO) position can be created to take responsibility for risk oversight and thus signals the firm's emphasis on risk management to its employees and investors (Cendrowski and Mair 2009; Lam 2003). Alternatively, firms may include the ERM responsibility in the C-level executives, such as chief executive

Table 3.2 ERM maturity criteria

Code	ERM maturity criteria	Literature																		Sum
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
M01	Commitment of the board and senior management		✓	✓				✓	✓	✓	✓		✓		✓			✓	✓	10
M02	ERM ownership	✓	✓	✓	✓					✓	✓	✓	✓		✓					9
M03	Risk appetite and tolerance	✓		✓				✓	✓	✓			✓				✓			7
M04	Risk-aware culture		✓	✓	✓		✓		✓	✓		✓	✓		✓		✓	✓	✓	12
M05	Sufficient resources	✓				✓	✓		✓				✓							5
M06	Risk identification, analysis, and response	✓	✓	✓		✓				✓			✓	✓		✓	✓	✓	✓	11
M07	Iterative and dynamic ERM process steps	✓	✓	✓		✓	✓			✓	✓		✓		✓	✓	✓	✓		12
M08	Leveraging risks as opportunities	✓	✓			✓				✓				✓				✓		6
M09	Risk communication		✓				✓		✓	✓			✓			✓		✓	✓	8
M10	A common risk language							✓									✓			2
M11	A risk management information system			✓	✓		✓	✓			✓					✓				6
M12	Training programs						✓		✓	✓	✓					✓	✓		✓	7
M13	Formalized key risk indicators							✓					✓			✓				3
M14	Integration of ERM into business processes		✓	✓	✓					✓				✓					✓	6
M15	Objective setting					✓				✓										2
M16	Monitoring, review, and improvement of ERM framework				✓					✓							✓			3

Literature: *1* Aabo et al. (2005); *2* AON (2010); *3* Barton et al. (2002); *4* Cendrowski and Mair (2009); *5* Ciorciari and Blattner (2008); *6* Dafikpaku (2011); *7* Duckert (2011); *8* EIU (2007); *9* Narvaez (2011); *10* Garvey (2008); *11* Muralidhar (2010); *12* RIMS (2008); *13* Segal (2011); *14* Stroh (2005); *15* UC (2009); *16* Ward (2006); *17* Hallowell et al. (2013); *18* WSOFM (2010) officers (CEOs) and the chief financial officers (CFOs), or create a stand-alone department or a board-level risk management committee. Who the ERM owner is should be openly communicated to all the staff. In addition, each risk should have a risk owner. Risk owners should have sufficient authority to oversee any risk-related action and should be responsible for managing the risks that fall within the limit of their accountability. The authority and responsibility of risk owners should be clearly defined, made known company-wide (AON 2011), and woven into all processes (RIMS 2008).

M03 Risk appetite and tolerance

Risk appetite is the "amount and type of risk that an organization is willing to pursue and retain," while risk tolerance is an "organization's or stakeholder's readiness to bear the risk after risk response in order to achieve its objectives" (ISO 2009: p. 9). Risk appetite, which is established by management with oversight of the board of directors, relates primarily to the business model and is a guidepost in strategy setting, while risk tolerance relates primarily to the organization's objectives and is tactical (COSO 2004; Protiviti 2006). Risk tolerance can be measured and is measured in the same units as the related objectives in most cases. In setting risk tolerance, management should consider the relative importance of the related objectives and aligns risk tolerance with risk appetite. Operating within risk tolerance provides management with greater assurance that the company is within the risk appetite, which, in turn, produces a higher degree of comfort that the company will achieve its objectives (COSO 2004). Risk appetite and tolerance should be clearly defined and made known to all the staff within a firm.

M04 Risk-aware culture

Nothing is more crucial to the success of ERM efforts in an organization than a supportive culture (Brooks 2010; Cendrowski and Mair 2009). Without such a culture, the organization cannot ensure that good risk-adjusted decisions were consistently made (Brooks 2010), and thus, their ERM systems and procedures would fail (De la Rosa 2006). Such a culture is called a risk-aware culture (Brooks 2010; Protiviti 2006), risk management culture (Santori et al. 2007), or risk culture (Collier 2009; Sanchez et al. 2009; Zou et al. 2010) in the existing literature relating to ERM. It enables decision makers to recognize and understand the importance of risk identification, risk assessment, and risk communication, and requires the explicit expression and deliberation about the expected behaviors (Brooks 2010). A strong risk-aware culture is necessary for ERM success (Brooks 2010; Sanchez et al. 2009), and such a culture requires buy-in of organizational individuals at all levels (Hopkin 2010) and embedment into the corporate culture (AON 2010). In addition, risk awareness should be integrated into the decision-making process (AON 2010; Santori et al. 2007), especially in the strategic decision-making process. Advanced ERM practices typically embed the management system into their culture (Derr 2009; Stroh 2005).

M05 Sufficient resources
Sufficient resources, such as funds, qualified staff, time, knowledge, and expertise, are necessary for ERM implementation in construction firms. Resources should also be consistently allocated for improving the risk management process, tools, techniques, personnel skills, etc. Hence, ERM implementation can be maintained at a high level. Additionally, resources should be distributed for risk response based on the results of risk analysis and risk priority (Aabo et al. 2005; RIMS 2008).

M06 Risk identification, analysis, and response
Management needs to identify all categories of potential risks from internal and external sources that the enterprise faces. Risk analysis techniques help management prioritize the risks identified and identify the key ones. Thus, a corporate risk profile, which is "a periodic documentation of key risks to an organization to achieving its stated objectives over a specific future time" (Fraser 2010: p. 171), can be formed. It can be a list of top risks or a risk map that has been used in the successful ERM practice (Aabo et al. 2005). The appropriate risk response measures are then identified, considering their significance in terms of likelihood and impact. Residual risks, which remain after the response measures are fully implemented, should be assessed.

M07 Iterative and dynamic ERM process steps
An ERM process encompasses monitoring and review, risk identification, risk analysis, risk evaluation, and risk response. The iterative and repetitive steps comprise a continuous improvement cycle. Such an ERM process also involves monitoring, identifying, and assessing new risks that may emerge following changes in the environment (AON 2010; Dafikpaku 2011; Garvey 2008; Santori et al. 2007; UC 2009), thus enabling an enterprise to deal with risks in a proactive way and to update its risk profile.

M08 Leveraging risks as opportunities
Risks encompass both threats and opportunities (Ward and Chapman 2003). In addition to focusing on dealing with downside risks (threats), ERM also involves leveraging and exploiting the upside risks (opportunities) for competitive advantages (Banham 2004; COSO 2004; Dafikpaku 2011; Miccolis and Shah 2000; Pagach and Warr 2010; Stroh 2005). Opportunities exist where a risk is more dangerous to competitors, or where an enterprise has a greater ability to manage the risk than its competitors (Berry and Phillips 1998). The more an enterprise understands its risk landscape, the more it can leverage opportunities (AON 2010). The RIMS (2008) suggested that enterprises should routinely identify and explore strategic opportunities during planning for adverse events.

M09 Risk communication

Risk information should flow up, down, and across an organization (Narvaez 2011). Relevant and reliable risk information obtained from various sources should be communicated transparently across multiple projects and departments of a construction firm in order to be shared by everyone in the firm. In addition, frontline employees who deal with critical operating issues are in the best position to recognize problems as they arise (COSO 2004). Transparent risk communication allows and encourages individual comments and expert views during the development of cross-functional understanding of risks and risk management strategies (AON 2010). Moreover, there should be a mechanism in place to ensure that critical risk information is reported to the board and senior management in a periodic or timely manner (Dafikpaku 2011). Furthermore, there should be clear communication lines established to ensure that line managers, project managers, and staff are promptly notified of critical information and decisions (Barton et al. 2002).

M10 A common risk language

A common risk language, which explains the terminologies and methodologies and contributes to a common understanding of their meanings and context throughout the enterprise, is viewed as a key quality of an effective ERM program (Duckert 2011). This is because such a risk language would underpin risk culture, facilitate risk communication, cut through the layers, and break down the silos (Espersen 2007). This risk language should be communicated to all risk management practitioners and then used consistently in all communications, thus contributing to a common understanding of its meaning and contents across the company (Duckert 2011). In contrast, without such a language, the risk management team will have to spend much time resolving communication issues at the expense of their primary responsibilities. A glossary of risk terms, which provides risk management practitioners with a common reference resource for risk terminologies, could be created and distributed within the organization (Espersen 2007) and facilitates the acceptance of the risk language.

M11 A risk management information system (RMIS)

ICT plays a key role in enabling the flow of information and knowledge across an enterprise (Dafikpaku 2011). Thus, a firm should consider potential technological solutions to support the ongoing activities that facilitate risk awareness and risk response in a timely manner (Arnold et al. 2011). A RMIS serves as a platform for risk communication and reporting, records risk management activities, or even undertakes risk identification and analysis and provides response plans. All the relevant staff should know how to apply this RMIS in ERM, to ensure that the functions are fully used.

M12 Training programs

To succeed in implementing ERM, it is critical that individuals at all levels throughout an enterprise accept ERM (Nocco and Stulz 2006). Hence, training programs can be used to reduce misunderstanding and anxiety about ERM, and help personnel clearly understand the ERM philosophy and policy, the ERM process, and the value of ERM. Such programs can also instill risk awareness into the minds of the employees and contribute to the application of ERM tools and techniques within the firm. As the ERM implementation matures, such programs can serve as an organizational learning mechanism which enables employees to learn about ERM techniques and lessons from past projects.

M13 Formalized key risk indicators (KRIs)
A KRI is "a measure to indicate the potential, presence, level, or trend of a risk" (Hwang 2010: p. 126). In other words, it is a measure used to indicate how risky an activity is (Narvaez 2011). KRIs help monitor risks and involve predetermined thresholds for each KRI that will trigger actions by management to adjust its strategies proactively to manage the risks accordingly (Beasley et al. 2010b). Duckert (2011) argued that well-defined KRIs were critical to successful ERM implementation and that a data-centric approach to ERM with well-defined KRIs would be the only sensible way to establish it in the twenty-first century. KRIs should be identified for all the risks that a firm faces and need to be periodically analyzed and revisited by risk owners (RIMS 2008).

M14 Integration of ERM into business processes
ERM should be fully integrated into the management and business processes of an enterprise (COSO 2004). These include decision-making and strategic planning. An ERM program is only effective if it is used to inform decision-making (Narvaez 2011). In all decision-making processes, especially in strategic decision-making, the risks identified should be consistently considered, and emerging risks should also be anticipated. Integration of ERM into decision-making is an important indication that risk management is being embedded into the corporate culture (AON 2010).

M15 Objective setting
An enterprise should consider how risks affect its ability to achieve the objectives (Narvaez 2011) because risk is defined as "effect of uncertainty on objectives" in ISO 31000:2009 (p. 1). Objective setting is one of the eight components of the COSO ERM framework and is seen as a precondition to risk identification, risk assessment, and risk response (COSO 2004). Hence, corporate objectives should be clearly identified and understood by staff at all levels. All objectives should have performance measures, and all performance measures should be linked with objectives. Thus, deviations from plans or expectations should be assessed against the corporate objectives and project objectives (Hopkinson 2011).

M16 Monitoring, review, and improvement of ERM framework
Ongoing monitoring and review of the ERM framework are also necessary (Ward 2006) to ensure that risk management is effective and continuously supports organizational performance. According to ISO 31000:2009,

management should periodically measure progress against the risk management plan and review whether the risk management framework, policy, and plan are still appropriate. Considering the results of monitoring and reviews, decisions should be made on how the ERM framework, policy, and plan can be improved.

Based on the literature review, this research identifies 71 ERM best practices, which are related to the 16 criteria and serve as the subcriteria. These practices enable assessors to easily understand the criteria and assess their ERM maturity according to their current ERM practices. The detailed descriptions of these best practices are presented in Sect. 7.2.3.

The importance of these criteria varies from one to another; hence, weights should be assigned to them. The maturity level of construction firms therefore depends on the weights of the criteria and the implementation levels of the criteria. The assessment of the implementation levels involves the subjective and imprecise judgments of individuals. The imprecision results from several sources, such as unquantifiable information, incomplete information, or unavailable information (Chen et al. 1992).

3.7.3 A Fuzzy ERM Maturity Model

Since ERM maturity assessment involves multiple criteria, five multicriteria analysis methods, including the FST, artificial neural network (ANN), preference ranking organization method for enrichment evaluations (PROMETHEE), analytic hierarchy process (AHP), and genetic algorithm (GA), were reviewed. Their advantages and disadvantages are summarized in Table 3.3.

In the context of this research, multiple criteria have various weighs. As the PROMETHEE has no specific guidelines to determine the weights, this method is not applicable in this research. Although the AHP method can determine the weights of criteria, the number of pairwise comparisons to be made is potentially very large. As the ERM maturity model has 16 criteria, a total of 120 (i.e., $16 \times (16 - 1)/2 = 120$) pairwise comparisons need to be made. Such a lengthy task would lead to a low response rate for the survey. In addition, respondents may find it difficult to distinguish among the nine-point scale using the AHP. Hence, the AHP method is not applicable in this research. Moreover, the ERM maturity model needs to be embedded into the proposed KBDSS. The GA is likely to have a long computational time, and the selection and implementation of encoding and fitness function can be difficult. These drawbacks of the GA may make the KBDSS not user-friendly. Hence, the GA is also not applicable in this research.

The ERM maturity model, which serves as a tool for self-assessment by practitioners, should make users feel that it is user-friendly. The most important

Table 3.3 Advantages and disadvantages of different multicriteria analysis methods

Methods	Advantages	Disadvantages
Fuzzy set theory (FST) (Hudec and Vujosevic 2004; Shapiro 2002; Sii et al. 2001)	• It is possible to implement human knowledge and experience using natural language and linguistic terms • It is unnecessary to have precise mathematical models • It can deal with uncertain and imprecise data and ambiguous information • It gives a more flexible structure for combining qualitative and quantitative information	• It is difficult to define accurate membership functions • There is no standard and systematic method for the transformation of the human knowledge or experience into the rule base of a fuzzy inference system, no general procedure for choosing the optimal number of rules, since a large number of factors are involved in the decisions • Fuzzy system software products are complex from the perspective of end users
Artificial neural network (ANN) (Godjevac 1995; Tu 1996; Wang and Elhag 2007)	• It can implicitly detect complex nonlinear relationships between independent and dependent variables • When an element of the ANN fails, it can continue without any problem by their parallel nature • It is capable of modeling the data of multiple inputs and multiple outputs • It is unnecessary to know the concrete functional relationship between outputs and inputs	• It needs training to operate • High processing time is required for large neural networks • It has limited ability to explicitly identify possible causal relationships • It has slow convergence speed • It uses "black box" data processing structure • It requires greater computational resources • It is prone to overfitting • There is subjectivity in designing an ANN and determining its parameters • It adopts networks without any constraint conditions. If there are any constraints on inputs and/or outputs, it will be difficult for an ANN to be trained to meet such constraints

(continued)

Table 3.3 (continued)

Methods	Advantages	Disadvantages
Preference ranking organization method for enrichment evaluations (PROMETHEE) (Anand and Kodali 2008; Athawale and Chakraborty 2010; Brans and Mareschal 2005; Macharis et al. 2004)	• It can classify the alternatives which are difficult to be compared because of a trade-off relation of evaluation standards as non-comparable alternatives • Only the evaluations have to be performed of each alternative on each criterion • It is based on the importance of a performance difference between two solutions, which is best describing whether a solution should be preferred to another one	• It does not build hierarchies of criteria, so it may become very difficult for the decision maker to obtain a clear view of the problem and to evaluate the results in the case of many criteria • It has no specific guidelines to determine the weights • It is rather uncommunicative and tends to act as a black box to the non-professional users • Rank reversal problems are likely to occur • It cannot always be applied to non-convex problems • Since it relies upon value functions, it proves to be a less objective method than the alternative models available • Because of the outranking principles, no independent ratings, but rankings, are only produced by PROMETHEE
Analytic hierarchy process (AHP) (Belton and Stewart 2002; Macharis et al. 2004; Millet and Wedley 2002; Ramanathan 2001)	• It is able to check inconsistencies and accept limited inconsistencies • It decomposes a decision problem into its constituent parts and builds hierarchies of criteria • It helps to capture both subjective and objective evaluation measures • It is uniquely positioned to help model situations of uncertainty and risk since it is capable of deriving scales where measures ordinarily do not exist	• Ranking irregularities can occur when the AHP or some of its variants are used. This rank reversal is likely to occur, e.g., when a copy or a near copy of an existing option is added to the set of alternatives that are being evaluated • It can be considered as a complete aggregation method of the additive type. The problem with such aggregation is that compensation between good scores on some criteria and bad scores on other criteria can occur • The decision problem is decomposed into a number of subsystems, within which and between which a substantial number of pairwise comparisons need to be completed • It is sometimes difficult to distinguish among the nine-point scale, and there is the artificial limitation of the use of such a scale

(continued)

Table 3.3 (continued)

Methods	Advantages	Disadvantages
Genetic algorithm (GA) (Lahoz and Mateo 2008; Morimoto 2006; Shapiro 2002)	• It solves problems with multiple solutions • It can solve multidimensional, non-differential, non-continuous, and even non-parametrical problems • It can be easily transferred to existing simulations and models	• Choosing and implementation of encoding and fitness function can be difficult • Certain optimization problems (such as variant problems) cannot be solved by means of the GA • The computational time is long • In many problems, the GA may have a tendency to converge toward local optima or even arbitrary points rather than the global optimum of the problem • Operating on dynamic data sets is difficult, as genomes begin to converge early on toward solutions which may no longer be valid for later data

advantage of the FST over the ANN is that the FST can deal with vague, imprecise, and ambiguous information and uses natural language and linguistic terms (Godjevac 1995; Higgins and Goodman 1993). Specifically, in the real world, human factors are likely to noticeably influence the decision-making process. The manner of human thinking, including the perception of preferences, is ambiguity, subjective, and imprecise (Zimmermann 2001). The problems relating to the ambiguity and imprecision in human judgments cannot be handled by the classical set theory. However, the FST, first proposed by Zadeh (1965), can deal with such problems and quantify the linguistic facet of available data and preferences for individual or group decision-making (Pedrycz et al. 2011; Zimmermann 2001). Therefore, the FST is adopted to develop the ERM maturity model.

A fuzzy set $\tilde{A}$ in X allows partial membership, and the membership value can range from 0 to 1. A fuzzy set $\tilde{A}$ in X can be annotated as a set of ordered pairs:

$$\tilde{A} = \left\{ \left(x, \mu_{\tilde{A}}(x) \right) | x \in X \right\} \tag{3.1}$$

where $\mu_{\tilde{A}}(x)$ is the membership function. $\mu_{\tilde{A}}(x)$ specifies the grade or degree to which any element x in X belongs to the fuzzy set $\tilde{A}$ and ranges in the interval [0,1].

Five types of membership functions have been widely used in practical applications: (1) triangular; (2) trapezoidal; (3) S function; (4) Gaussian; and (5) Z function (Imriyas 2007), as shown in Table 3.4.

Among these membership functions, the triangular membership function has been most commonly adopted (Hsu and Yang 1997; Nieto-Morote and Ruz-Vila 2012; Tah and Carr 2000; Xu et al. 2010b). The triangular membership number (TFN) is easy to use and appropriate for promoting representation and information processing in a fuzzy environment (Chou and Chang 2008; Lam et al. 2010; Xu et al. 2010b). Moreover, the precision in the shape of the membership functions is unimportant due to the quantitative nature of the problems with vague predicates, and fuzzy numbers with simpler membership function shapes tend to have more intuitive and more natural interpretation (Nieto-Morote and Ruz-Vila 2011, 2012). Hence, the TFN is used in this model to quantify the qualitative information.

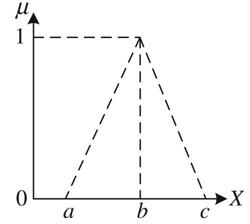
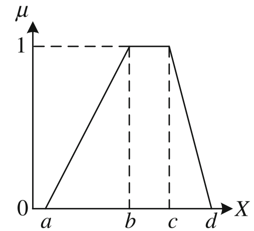
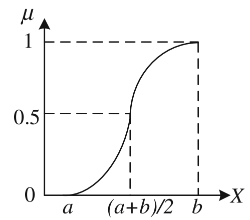
A TFN, denoted as $\tilde{A} = (a, b, c)$, can be defined by the following membership function:

$$\mu_{\tilde{A}}(x) = \begin{cases} 0, & x < a \ \text{ or } \ x > c \\ (x-a)/(b-a), & a \le x \le b \\ (c-x)/(c-b), & b \le x \le c \end{cases} \tag{3.2}$$

where a is the lower bound of variable x; b represents the strongest grade of membership; and c is the upper bound of variable x, as indicated in Fig. 3.7.

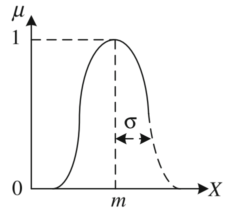
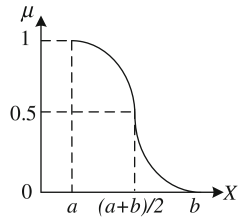
The fuzzy arithmetic operations of any two TFNs, $\tilde{A}_1 = (a_1, b_1, c_1)$ and $\tilde{A}_2 = (a_2, b_2, c_2)$, follow these operational rules:

Table 3.4 Five types of membership functions

Name	Equation	Diagram
Triangular membership function	$\text{triangle}(x : a, b, c) = \begin{cases} 0, & x < a \text{ or } x > c \\ (x-a)/(b-a), & a \leq x \leq b \\ (c-x)/(c-b), & b \leq x \leq c \end{cases}$	
Trapezoidal membership function	$\text{trapezoid}(x : a, b, c, d) = \begin{cases} 0, & x < a \text{ or } x > d \\ (x-a)/(b-a), & a \leq x \leq b \\ 1, & b \leq x \leq c \\ (d-x)/(d-c), & c \leq x \leq d \end{cases}$	
S membership function	$s(x : a, b) = \begin{cases} 0, & x < a \\ 2[(x-a)/(b-a)]^2, & a \leq x \leq (a+b)/2 \\ 1 - 2[(x-a)/(b-a)]^2, & (a+b)/2 \leq x \leq b \\ 1, & x > b \end{cases}$	

(continued)

Table 3.4 (continued)

Name	Equation	Diagram
Gaussian membership function	$\text{gaussian}(x : m, \sigma) = \exp[-(x-m)^2/\sigma^2]$	
Z membership function	$z(x : a, b) = \begin{cases} 1, & x < a \\ 1 - 2[(x-a)/(b-a)]^2, & a \le x \le (a+b)/2 \\ 2[b - x/(b-a)]^2, & (a+b)/2 \le x \le b \\ 0, & x > b \end{cases}$	

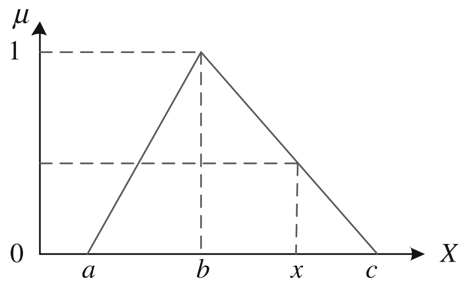


Fig. 3.7 Triangular fuzzy number

$$\text{Addition:} \tilde{A}_1 + \tilde{A}_2 = (a_1 + a_2, b_1 + b_2, c_1 + c_2) \quad (3.3)$$

$$\text{Subtraction:} \tilde{A}_1 - \tilde{A}_2 = (a_1 - c_2, b_1 - b_2, c_1 - a_2) \quad (3.4)$$

$$\text{Multiplication:} \tilde{A}_1 \times \tilde{A}_2 = (a_1 \times a_2, b_1 \times b_2, c_1 \times c_2) \quad (3.5)$$

$$\text{Division:} \tilde{A}_1 / \tilde{A}_2 = (a_1/c_2, b_1/b_2, c_1/a_2) \quad (3.6)$$

$$\text{Scalar multiplication:} k \times \tilde{A} = (k \times a, k \times b, k \times c) \quad \text{if } k > 0 \quad (3.7)$$

$$k \times \tilde{A} = (k \times c, k \times b, k \times a) \quad \text{if } k < 0 \quad (3.8)$$

The concept of linguistic variables lies at the root of the FST. Compared to numerical variables whose values are numbers, linguistic variables are considered as variables whose values are linguistic terms, i.e., words or sentences in a natural or artificial language (Nieto-Morote and Ruz-Vila 2012; Zadeh 1973). This concept plays a fundamental role in the decision-making problems where decision makers face the difficulty in assigning exact numerical values to some variables due to the availability and uncertainty of information (Nieto-Morote and Ruz-Vila 2012). Thus, the decision maker tends to prefer the use of linguistic variables. Each linguistic term needs to be transformed to a fuzzy number, which enables these terms to be mathematically operable. In this research, a linguistic variable, i.e., the implementation level of each best practice under each criterion, is defined. According to the "seven plus or minus two" principle (Miller 1956), the model adopts the scale of five, which makes it convenient for users to judge. The linguistic values of this variable are defined as follows: very low, low, medium, high, and very high. These fuzzy terms are transformed into TFNs, respectively.

Each fuzzy set has to overlap its neighboring sets to some degree. In most cases, the overlap for triangle-to-triangle fuzzy regions averages between 25 and 50 % of the fuzzy set base (Cox 1998). Driankov et al. (1996) argued that the crossing point for two overlapping membership functions must be 50 % for control applications and a little lower for classifiers and others. Hence, this research adopts 50 % as the degree to which each triangular fuzzy region overlaps its neighboring region, as shown in Fig. 3.8.

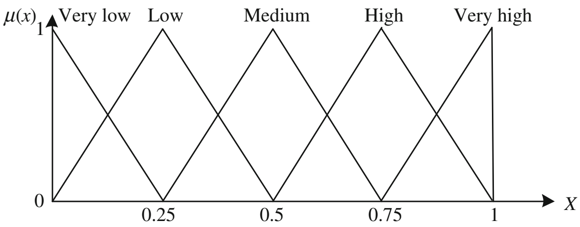


Fig. 3.8 Membership functions of linguistic values

Table 3.5 Fuzzy numbers of the linguistic values

Linguistic value	Range of % of likelihood	Fuzzy number
Very low	0–25	(0, 0, 0.25)
Low	0–50	(0, 0.25, 0.5)
Medium	25–75	(0.25, 0.5, 0.75)
High	50–100	(0.5, 0.75, 1)
Very high	75–100	(0.75, 1, 1)

The Likert scale provides unambiguous results that are easy to interpret (Ekanayake and Ofori 2004). As Table 3.5 shows, a five-point Likert scale (1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high) is used to measure the importance of the criteria in a survey with the experts who have professional knowledge or practical experience about risk management in construction firms.

The criteria without significant importance in the one-sample t test are excluded. Thus, the weights (W) can be assigned to the criteria retained by the mean scoring method. This method was adopted to establish the relative importance of causes of delay in building construction projects in Hong Kong (Chan and Kumaraswamy 1996) and to determine the weights of risk allocation criteria and critical risk factors in PPP projects in China (Xu et al. 2010a, b). The mean score (MS_i) for each ERM maturity criterion can be calculated by the following equation:

$$\mathrm{MS}_i = \sum_{i=1}^{n} (f_i s_i)/n \tag{3.9}$$

where s_i is the score given to significantly important criterion i by the respondents, ranging from 1 to 5; f_i is the frequency of each rating; and n is the total number of responses concerning a particular criterion. Thus, the weight for the criterion i can be computed by the following equation:

$$W_i = \mathrm{MS}_i / \sum_{i=1}^{n} \mathrm{MS}_i \tag{3.10}$$

where W_i represents the weight for the criterion i and $\sum_{i=1}^{n} W_i = 1$; MS_i is the mean score of the criterion i; and n is the number of the criteria retained.

The input data of the model are the implementation levels of all the best practices, which are rated by the participants in the ERM maturity assessment. Thus, the implementation level of a best practice can be computed as follows:

$$\tilde{L}_{ip} = \left(l_{ip1}, l_{ip2}, l_{ip3}\right) = 1/k \times \sum_{j=1}^{k} \tilde{L}_{ipj} \tag{3.11}$$

where $\tilde{L}_{ip}$ is the TFN of the implementation level of the best practice p under criterion i; k is the number of the individuals who participate in assessing the implementation level; $\tilde{L}_{ipj}$ is the TFN of the implementation level of the best practice p under criterion i assessed by individual j; and l_{ip1}, l_{ip2}, and l_{ip3} represent the lower bound, the strongest membership degree, and the upper bound of $\tilde{L}_{ip}$, respectively.

The implementation level of each maturity criterion is measured by the average implementation level of all the best practices under this criterion:

$$\tilde{L}_i = (l_{i1}, l_{i2}, l_{i3}) = 1/u \times \sum_{p=1}^{u} \tilde{L}_{ip} \tag{3.12}$$

where $\tilde{L}_i$ is the TFN of the implementation level of criterion i; u is the number of the best practices under criterion i; l_{i1}, l_{i2}, and l_{i3} denote the lower bound, the strongest membership degree, and the upper bound of $\tilde{L}_i$, respectively.

Thus, $\tilde{M}$ can be calculated as follows:

$$\tilde{M} = (m_1, m_2, m_3) = \sum_{i=1}^{n} (W_i \times \tilde{L}_i) = \sum_{i=1}^{n} \left(W_i/u \times \sum_{p=1}^{u} \tilde{L}_{ip} \right) \tag{3.13}$$

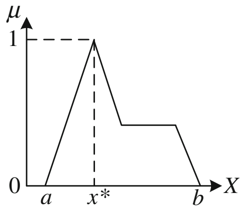
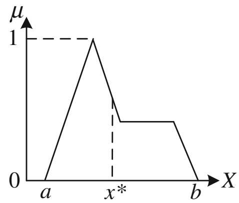
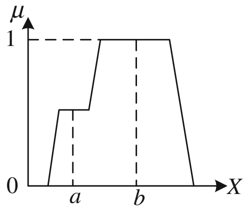
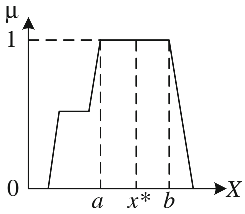
$$m_t = \sum_{i=1}^{16} (W_i \times l_{it}) \ (t = 1, 2, 3) \tag{3.14}$$

where m_1, m_2, and m_3 represent the lower bound, the strongest membership degree, and the upper bound $\tilde{M}$, respectively, and l_{it} can be calculated using Eq. 3.12.

Defuzzification is the operation of producing a crisp number that adequately represents the fuzzy number. There are several defuzzification methods available, such as the max-membership principle, centroid method, weighted average method, and mean-max membership (Chou and Chang 2008; Negnevitsky 2006; Ross 2010). Four popular defuzzification methods are presented in Table 3.6.

The centroid method is adopted in this research to transform the fuzzy number of the maturity level into a crisp value because it is one of the most popular methods

Table 3.6 Four defuzzification methods

Name	Equation	Diagram
Max-membership principle	$\mu_{\tilde{A}}(x^*) \geq \mu_{\tilde{A}}(x), x \in X$	
Centroid method	$x^* = \int_a^b \mu_{\tilde{A}}(x) x \mathrm{d}x / \int_a^b \mu_{\tilde{A}}(x) \mathrm{d}x$	
Weighted average method	$x^* = \sum \mu_{\tilde{A}}(\bar{x})\bar{x} / \sum \mu_{\tilde{A}}(\bar{x})$	
Mean-max membership	$x^* = (a+b)/2$	

(Negnevitsky 2006) and has several desirable properties: (1) The defuzzified values tend to move smoothly around the output fuzzy region; (2) it is relatively easy to calculate; and (3) it can be applied to both fuzzy and singleton output set geometries (Cox 1998). This method finds the point where a vertical line would slice the aggregated fuzzy set into two equal masses. This point represents the center of gravity (COG) of the fuzzy set (Negnevitsky 2006):

$$\mathrm{COG} = \int_a^b \mu_{\tilde{A}}(x) x \mathrm{d}x \Big/ \int_a^b \mu_{\tilde{A}}(x) \mathrm{d}x \tag{3.15}$$

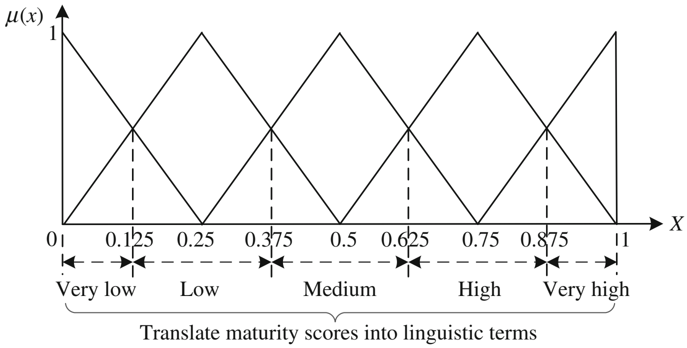


Fig. 3.9 Translation of maturity scores into linguistic terms

In this research, the fuzzy set is a triangle, whose COG is easy to calculate. Therefore, the crisp number of ERM maturity level, i.e., the ERM maturity index (ERMMI), can be calculated by the following equation:

$$\mathrm{ERMMI} = 1/3 \times (m_1 + m_2 + m_3) \tag{3.16}$$

Alternatively, ERMMI can be calculated in another way:

$$\mathrm{ERMMI} = \sum_{i=1}^{n} (W_i \times L_i) = \sum_{i=1}^{n} \left(W_i/u \times \sum_{p=1}^{u} L_{ip} \right) \tag{3.17}$$

$$L_{ip} = 1/3 \times (l_{ip1} + l_{ip2} + l_{ip3}) \tag{3.18}$$

$$L_i = 1/u \times \sum_{p=1}^{u} L_{ip} \tag{3.19}$$

where L_{ip} is the crisp number of the implementation level of the best practice p under criterion i and L_i is the crisp number of the implementation level (i.e., maturity score) of criterion i.

The ERMMI is in the interval of [0, 1] and tends to fall into the regions of two adjacent linguistic terms, namely L^m and L^n (m, n = 1, 2, 3, 4, 5) of $\tilde{L}$. Therefore, the ERMMI can be translated to the linguistic term whose membership value is higher (see Fig. 3.9):

$$\mu_{L^{\mathrm{ERMMI}}}(\mathrm{ERMMI}) = \max\{\mu_{L^m}(\mathrm{ERMMI}), \mu_{L^n}(\mathrm{ERMMI})\} \tag{3.20}$$

Therefore, the fuzzy ERM maturity model provides a method to allow the management staff to understand the extent to which their construction firm implements ERM.

The assessment result can be either a crisp number or a linguistic term to demonstrate the maturity level. An example is presented in Appendix 5 to illustrate the calculation process of the fuzzy ERM maturity model.

3.8 Summary

This chapter reviews the literature on risk management as well as ERM fundamentals and frameworks. Drivers for and hindrances to ERM implementation in the literature are identified. This chapter also discusses ERM implementation in construction firms and its relationship with the existing PRM practices. Implementing ERM in construction firms can be viewed as a gradual organizational change because it concerns shaking the accustomed approach to managing risks, i.e., PRM. This chapter proposes a customizable ERM framework for construction firms at different stages of implementing ERM. Furthermore, this chapter develops a fuzzy model for construction firms to assess their ERM maturity levels.

References

Aabo T, Fraser JRS, Simkins BJ (2005) The rise and evolution of the chief risk officer: enterprise risk management at Hydro One. J Appl Corp Finan 17(3):62–75

Abrams C, von Kanel J, Muller S, Pfitzmann B, Ruschka-Taylor S (2007) Optimized enterprise risk management. IBM Syst J 46(2):219–234

Accenture (2011) Report on the Accenture 2011 global risk management study. Accenture, New York

Acharyya M (2007) Proposing a conceptual framework to measure the performance of enterprise risk management from an empirical study of four major European insurers. The 34th seminar of the European group of risk and insurance economists, 17–19 September. Cologne

Acharyya M (2008) An empirical study on enterprise risk management in insurance. In: Olson DL, Wu D (eds) New frontiers in enterprise risk management. Springer, Heidelberg, pp 39–55

Adibi S (2007) Industry should embrace risk management tools. New York Construction News, New York. Retrieved 12 February, 2012, from: http://newyork.construction.com/opinions/bottomline/archive/2007/06.asp

Anand G, Kodali R (2008) Selection of lean manufacturing systems using the PROMETHEE. J Model Manage 3(1):40–70

Ang YK, Ofori G (2001) Chinese culture and successful implementation of partnering in Singapore's construction industry. Constr Manage Econ 19(6):619–632

AON (2010) Global risk management survey 2010. AON plc, Chicago

AON (2011) Global risk management survey 2011. AON plc, Chicago

APM (2004) Project risk analysis and management (PRAM) guide, 2nd edn. Association for Project Management, High Wycombe

Arnold V, Benford T, Sutton SG (2011) The role of strategic enterprise risk management and organizational flexibility in easing new regulatory compliance. Int J Account Inf Syst 12 (3):171–188

Athawale VM, Chakraborty S (2010) Facility location selection using PROMETHEE II method. Proceedings of the 2010 international conference on industrial engineering and operations management, 9–10 January, Dhaka, pp 59-64

Baloi D, Price ADF (2003) Modelling global risk factors affecting construction cost performance. Int J Proj Manage 21(4):261–269

Banham R (2004) Enterprising views of risk management. J Accountancy 197(6):65–71

Barton TL, Shenkir WG, Walker PL (2002) Making enterprise risk management pay off. Financial Times Prentice Hall, Upper Saddle River

Beasley MS, Frigo ML (2010) ERM and its role in strategic planning and strategy execution. In: Fraser J, Simkins BJ (eds) Enterprise risk management. Wiley, Hoboken, pp 31–50

Beasley MS, Pagach DP, Warr RS (2008) Information conveyed in hiring announcements of senior executives overseeing enterprise-wide risk management processes. J Acc Auditing Finan 23(3):311–332

Beasley MS, Branson BC, Hancock BV (2010a) Enterprise risk oversight: a global analysis. Chartered Institute of Management Accountants, American Institute of Certified Public Accountants and the ERM Initiative at North Carolina State University, Raleigh

Beasley MS, Branson BC, Hancock BV (2010b) Developing key risk indicators to strengthen enterprise risk management. ERM Initiative at North Carolina State University and the Committee of Sponsoring Organizations of the Treadway Commission, Raleigh

Beasley MS, Branson BC, Hancock BV (2010c) Report on the current state of enterprise risk oversight (2nd ed). The ERM Initiative at North Carolina State University, Raleigh

Belton V, Stewart TJ (2002) Multiple criteria decision analysis: an integrated approach. Kluwer Academic Publishers, Norwell

Berry A, Phillips J (1998) Enterprise risk management: pulling it together. Risk Manage 45(9):53–55

Blades M (2010) Is ERM leaving security behind? SecurityinfoWatch, Retrieved 11 February, 2011, from: http://www.securityinfowatch.com/is-erm-leaving-security-behind

Bowling DM, Rieger LA (2005) Success factors for implementing enterprise risk management. Bank Account Finan 18(3):21–26

Brans J-P, Mareschal B (2005) Promethee methods. In: Figueira J, Greco S, Ehrgott M (eds) Multiple criteria decision analysis: state of the art surveys. Springer, New York

Brooks DW (2010) Creating a risk-aware culture. In: Fraser J, Simkins BJ (eds) Enterprise risk management. Wiley, Hoboken, pp 87–96

Bugalla J, Franklin B, Gooch C (2010) Climbing the ERM tree. Risk Manage 57(4):40–43

Burtonshaw-Gunn SA (2009) Risk and financial management in construction. Gower, Burlington

CAS (2003) Overview of enterprise risk management. Casualty Actuarial Society, Arlington

Cendrowski H, Mair WC (2009) Enterprise risk management and COSO: a guide for directors, executives, and practitioners. Wiley, Hoboken

CGC (2012) Risk governance guidance for listed boards. Corporate Governance Council, Singapore

Chan DWM, Kumaraswamy MM (1996) An evaluation of construction time performance in the building industry. Build Environ 31(6):569–578

Chapman R (2006) Simple tools and techniques for enterprise risk management. Wiley, Chichester

Chen SJ, Hwang CL, Hwang FP (1992) Fuzzy multiple attribute decision making: methods and applications. Springer-Verlag, New York

Chou SY, Chang YH (2008) A decision support system for supplier selection based on a strategy-aligned fuzzy SMART approach. Expert Syst Appl 34(4):2241–2253

Ciorciari M, Blattner P (2008) Enterprise risk management maturity-level assessment tool. 2008 Enterprise Risk Management Symposium, 14–16 April, Chicago

Collier PM (2009) Fundamentals of risk management for accountants and managers. Butterworth-Heinemann, Oxford

Conrad L, Yau C (2009) Enterprise risk management: a critical tool for strategic decision making. Zurich Services Corporation and SGS, Schaumburg, IL. Retrieved 26 October, 2011, from: http://hpd.zurichna.com/Whitepaper/ERMexecutivesummary.pdf

COSO (2004) Enterprise risk management—integrated framework: executive summary and framework. Committee of Sponsoring Organizations of the Treadway Commission, Jersey City

Cox A, Thompson I (1997) 'Fit for purpose'contractual relations: determining a theoretical framework for construction projects. Eur J Purchasing Supply Manage 3(3):127–135

Cox E (1998) The fuzzy systems handbook, 2nd edn. AP Professional, Boston, MA
Crowe CFO (2008) The changing landscape of risk management. CFO Research Services and Crowe, Boston
Culp CL (2002) The revolution in corporate risk management: a decade in innovations in process and products. J Appl Corp Finan 14(4):8–26
Cumming C, Hirtle B (2001) The challenges of risk management in diversified financial companies. FRBNY Econ Policy Rev 7(1):1–17
Dafikpaku E (2011) The strategic implications of enterprise risk management: a framework. 2011 enterprise risk management symposium, 14–16 March. Chicago
Davenport EW, Bradley LM (2000) Enterprise risk management: a consultative perspective, 2000 discussion paper program on insurance in the next century. Casualty Actuarial Society, Arlington, pp 23–42
De la Rosa S (2006) Cultivating the best board. Intern Auditor 63(4):69–75
Del Caño A, De la Cruz MP (2002) Integrated methodology for project risk management. J Constr Eng Manage 128(6):473–485
Deloitte (2009) Perspectives on ERM in Hong Kong: a benchmarking survey. Deloitte Touche Tohmatsu Limited, Hong Kong
Deloitte (2010a) Enterprise risk management (ERM): success through intelligent risk taking. Deloitte Touche Tohmatsu Limited, Beirut. Retrieved 3 March, 2011, from: http://www.deloitte.com/assets/Dcom-Lebanon/Local%20Assets/Documents/ERS/me_ers_erm_09.pdf
Deloitte (2010b) Risk intelligence in the energy and resources industry: enterprise risk management benchmark survey. Deloitte Touche Tohmatsu Limited, New York
Deming WE (1986) Out of the crisis. MIT Press, Cambridge
Derr T (2009) Implementing enterprise-wide risk reduction across operational and financial process. Syntex Management Systems Inc, Houston
Dickinson G (2001) Enterprise risk management: its origins and conceptual foundation. Geneva Papers Risk Insur Issues Pract 26(3):360–366
Diekmann J, Sewester EF, Taher K (1988) Risk management in capital projects. Construction Industry Institute, Austin
Driankov D, Hellendoorn H, Reinfrank M (1996) An introduction to fuzzy control. Springer, New York
Dubois A, Gadde L-E (2000) Supply strategy and network effects: purchasing behaviour in the construction industry. Eur J Purchasing Supply Manage 6(3):207–215
Dubois A, Gadde L-E (2002) The construction industry as a loosely coupled system: implications for productivity and innovation. Constr Manage Econ 20(7):621–631
Duckert GH (2011) Practical enterprise risk management: a business process approach. Wiley, Hoboken
EIU (2001) Enterprise risk management: implementing new solutions. Economist Intelligence Unit, London
EIU (2007) Best practice in risk management. Economist Intelligence Unit, London
Ekanayake LL, Ofori G (2004) Building waste assessment score: design-based tool. Build Environ 39(7):851–861
Elton EJ, Gruber MJ (1997) Modern portfolio theory, 1950 to date. J Bank Finan 21(11): 1743–1759
Espersen D (2007) The language of risk: organizations can improve risk management and audit processes by communicating risks in terms that everyone understands. Intern Auditor 64 (3):69–73
Fairley R (2002) Risk management for software projects. Soft IEEE 11(3):57–67
Fraser JRS (2010) How to prepare a risk profile. In: Fraser JRS, Simkins BJ (eds) Enterprise risk management. Wiley, Hoboken, pp 171–188
Fraser JRS, Simkins BJ (2007) Ten common misconceptions about enterprise risk management. J Appl Corp Finan 19(4):75–81
Garvey PR (2008) Analytical methods for risk management. CRC Press, Boca Raton

Gates S (2006) Incorporating strategic risk into enterprise risk management: a survey of current corporate practice. J Appl Corp Finan 18(4):81–90
Gidado KI (1996) Project complexity: the focal point of construction production planning. Constr Manage Econ 14(3):213–225
Godjevac J (1995) Comparative study of fuzzy control, neural network control and nero-fuzzy control. École Polytechnique Fédérale de Lausanne, Lausanne
Gordon LA, Loeb MP, Tseng CY (2009) Enterprise risk management and firm performance: a contingency perspective. J Account Public Policy 28(4):301–327
Green PL (2001) Risk managers cover enterprise exposure. Global Finan 15(1):72–74
Gregory CA (2003) Minimizing enterprise risk. Financial Times Prentice Hall, London
Gupta PK (2011) Risk management in Indian companies: EWRM concerns and issues. J Risk Finan 12(2):121–139
Hallowell MR, Molenaar KR, Fortunato BR (2013) Enterprise risk management strategies for state departments of transportation. J Manage Eng 29(2):114–121
Harner M (2013) The potential cost and value of ERM. The Conference Board, Ottawa
Harrington SE, Niehaus G, Risko KJ (2002) Enterprise risk management: the case of United Grain Growers. J Appl Corp Finan 14(4):71–81
HBRAS (2011) Risk management in a time of global uncertainty. Harvard Business Review Analytic Services, Cambridge
Higgins CM, Goodman RM (1993) Learning fuzzy rule-based neural networks for control. Advances in neural information processing systems. Morgan Kaufmann Publishers, San Francisco, pp 350–357
Hilson D (1998) Project risk management: future developments. Int J Proj Bus Risk Manage 2(2): 1–11
Hillson D (2006) Integrated risk management as a framework for organisational success. PMI Global Congress, Seattle
Hillson D, Simon P (2007) Practical project risk management: the ATOM methodology. Management Concepts, Vienna
Hopkin P (2010) Fundamentals of risk management. Kogan Page, London
Hopkinson M (2011) The project risk maturity model: measuring and improving risk management capability. Gower, Burlington
Hoyt RE, Liebenberg AP (2011) The value of enterprise risk management. J Risk Insur 78(4): 795–822
Hsu TH, Yang TS (1997) The application of fuzzy synthetic decision to the human resource management. Fu Jen Manage Rev 4(2):85–100
Hudec M, Vujosevic M (2004) A fuzzy system for municipalities classification. Proceddings of the 7th seminar on neural network applications in electrical engineering, 23–25 September, Belgrade, Serbia and Montenegro, pp 231–236
Hwang S (2010) Identifying and communicating key risk indicators. In: Fraser JRS, Simkins BJ (eds) Enterprise risk management. Wiley, Hoboken, pp 125–140
IMA (2007) Enterprise risk management: tools and techniques for effective implementation. Institute of Management Accountants, Montvale
Imriyas K (2007) A fuzzy knowledge-based system for premium-rating of workers' compensation insurance for construction projects. Unpublished PhD Thesis, National University of Singapore, Singapore
IRM (2002) A risk management standard. Institute of Risk Management, London
ISO (2009) Guide 73:2009 risk management—vocabulary. International Organization for Standardization, Geneva
Jablonowski M (2001) Thinking in numbers. Risk Manage 48(2):30–35
Jutte B (2010) 10 golden rules of project risk management. Concilio, Delft, Netherlands. Retrieved 21 March, 2011, from: http://www.projectsmart.co.uk/10-golden-rules-of-project-risk-management.html
Kimbrough RL, Componation PJ (2009) The relationship between organizational culture and enterprise risk management. Eng Manage J 21(2):18–26

Kleffner AE, Lee RB, McGannon B (2003) The effect of corporate governance on the use of enterprise risk management: evidence from Canada. Risk Manage Insur Rev 6(1):53–73
Kliem RL, Ludin IS (1997) Reducing project risk. Gower, Brookfield
Knight FH (1921) Risk, uncertainty, and profit. Houghton Mifflin, Boston
KPMG (2010) Charting a safe and sustainable growth journey: Singapore enterprise risk management survey 2010. KPMG in Singapore, Singapore
Lahoz D, Mateo P (2008) Neural network ensembles for classification problems using multiobjective genetic algorithms. In: Kurková V, Neruda R, Koutník J (eds) Artificial neural networks–ICANN 2008. Springer, Berlin, pp 443–451
Lam J (2003) Enterprise risk management: from incentives to controls. Wiley, Hoboken
Lam JC, Kawamoto BM (1997) Emergence of the chief risk officer. Risk Manage 44(9):30–35
Lam KC, Tao R, Lam MCK (2010) A material supplier selection model for property developers using fuzzy principal component analysis. Autom Constr 19(5):608–618
Liebenberg AP, Hoyt RE (2003) The determinants of enterprise risk management: evidence from the appointment of chief risk officers. Risk Manage Insur Rev 6(1):37–52
Liu JY, Low SP, He X (2011) Current practices and challenges of implementing enterprise risk management (ERM) in Chinese construction enterprises. Int J Constr Manage 11(4):49–63
Liu JY, Zou PXW, Gong W (2013) Managing project risk at enterprise level: exploratory case studies in China. J Constr Eng Manage 139(9):1268–1274
Loosemore M (2006) Risk management in projects, 2nd edn. Tayor & Francis, New York
Low SP, Liu JY, He SQ (2009) External risk management practices of Chinese construction firms in Singapore. KSCE J Civil Eng 13(2):85–95
Macharis C, Springael J, De Brucker K, Verbeke A (2004) PROMETHEE and AHP: the design of operational synergies in multicriteria analysis. Strengthening PROMETHEE with ideas of AHP. Eur J Oper Res 153(2):307–317
Manab NA, Kassim I, Hussin MR (2010) Enterprise-wide risk management (EWRM) practices: between corporate governance compliance and value creation. Int Rev Bus Res Papers 6 (2):239–252
Markowitz HM (1952) Portfolio selection. J Finan 7(1):77–91
Markowitz HM (1959) Portfolio selection: efficient diversification of investments. Wiley, New York
Marsh RIMS (2006) The changing face of risk management-excellence in risk management iii-an annual survey of risk. Risk and Insurance Management Society and Marsh Inc, New York
Merkley BW (2001) Does enterprise risk management count? Risk Manage 48(4):25–28
Meulbroek L (2002) A senior manager's guide to integrated risk management. J Appl Corp Finan 14(4):56–70
Miccolis J (2003) ERM lessons across industries. International Risk Management Institute, Dallas. Retrieved 3 March, 2011, from: http://www.irmi.com/expert/articles/2003/miccolis03.aspx
Miccolis J, Shah S (2000) Enterprise risk management: an analytic approach. Tillinghast-Towers Perrin, Parsippany
Miccolis J, Mueller H, Gruhl R (2000) Enterprise risk management in the insurance industry: 2000 benchmarking survey report. Tillinghast-Towers Perrin, Parsippany. Retrieved 21 April, 2011, from: http://www.towersperrin.com/tp/getwebcachedoc?webc=till/usa/2000/200001/2000060107.pdf
Millage A (2005) ERM is still in its infancy. Intern Auditor 62(5):16–17
Miller GA (1956) The magical number seven, plus or minus two: some limits on our capacity for processing information. Psychol Rev 63(2):81–97
Millet I, Wedley WC (2002) Modelling risk and uncertainty with the analytic hierarchy process. J Multi-Criteria Decis Anal 11(2):97–107
Moeller RR (2007) COSO enterprise risk management. Understanding the new integrated ERM framework. Wiley, Hoboken
Morimoto T (2006) Genetic algorithm. In: Sablani SS, Datta AK, Rehman MS, Mujumdar AS (eds) Handbook of food and bioprocess modeling techniques. CRC Press, Boca Raton, pp 405–434

Muralidhar K (2010) Enterprise risk management in the Middle East oil industry: an empirical investigation across GCC countries. Int J Energy Sect Manage 4(1):59–86

Narvaez K (2011) Success stories: public entities adopt ERM best practices. Public Entity Risk Institute, Fairfax

Negnevitsky M (2006) Artificial intelligence: a guide to intelligent systems, 2nd edn. Pearson Education Limited, New York

Negus J (2010) 10 common ERM challenges. Risk Manage 57(2):28–34

Nielson NL, Kleffner AE, Lee RB (2005) The evolution of the role of risk communication in effective risk management. Risk Manage Insur Rev 8(2):279–289

Nieto-Morote A, Ruz-Vila F (2011) A fuzzy approach to construction project risk assessment. Int J Project Manage 29(2):220–231

Nieto-Morote A, Ruz-Vila F (2012) A fuzzy multi-criteria decision-making model for construction contractor prequalification. Autom Constr 25:8–19

Nocco BW, Stulz RM (2006) Enterprise risk management: theory and practice. J Appl Corp Finan 18(4):8–20

Ockenden J (2004) China aviation oil hid US$390 m derivative loss in struggle to survive. Retrieved 1 December, 2012, from: http://www.risk.net/energy-risk/news/1511116/china-aviation-oil-hid-ususd390m-derivative-loss-struggle-survive

Olson DL, Wu D (2008) Enterprise risk management. World Scientific Publishing, Singapore

Pagach DP, Warr RS (2010) The effects of enterprise risk management on firm performance. North Carolina State University, Raleigh

Pagach DP, Warr RS (2011) The characteristics of firms that hire chief risk officers. J Risk Insur 78 (1):185–211

Pedrycz W, Ekel P, Parreiras R (2011) Fuzzy multicriteria decision-making: models, methods and applications. Wiley, Chichester

Pennock M, Haimes Y (2002) Principles and guidelines for project risk management. Syst Eng 5 (2):89–108

Perrin T (2006) A changing landscape: a study of corporate ERM in the US. Towers Perrin, Stamford

Perry JG, Hayes RW (1985) Risk and its management in construction projects. Proc Inst Civil Eng Part 1:499–521

PMI (2008) A guide to the project management body of knowledge. Project Management Institute, Newtown Square

Power M (2009) The risk management of nothing. Acc Organ Soc 34:849–855

Protiviti (2006) Guide to enterprise risk management. Protiviti Inc, Menlo Park

PwC (2008) Enterprise risk management (ERM) benchmarking survey 2008. PricewaterhouseCoopers Oy, Helsinki

Rahman MM, Kumaraswamy MM (2002) Risk management trends in the construction industry: moving towards joint risk management. Eng Constr Architectural Manage 9(2):131–151

Ramanathan R (2001) A note on the use of the analytic hierarchy process for environmental impact assessment. J Environ Manage 63(1):27–35

Rao A (2007) Evaluation of enterprise risk management (ERM) in Dubai: an emerging economy. Risk Manage 9(3):167–187

Rescher N (1983) Risk: a philosophical introduction to the theory of risk evaluation and management. University Press of America, Lanham

RIMS (2008) RIMS state of ERM report 2008. Risk and Insurance Management Society, New York

RMA (2006) Enterprise risk management survey 2006. Risk Management Association, Philadelphia

Ross A (2005) The evolving role of the CRO. Economist Intelligence Unit, London

Ross TJ (2010) Fuzzy logic with engineering applications (3rd ed). Wiley, New York

Roth J (2006) An enterprise risk catalyst. Intern Auditor 63(2):81–87

Rowe WD (1977) An anatomy of risk. Wiely, New York

Sanchez H, Robert B, Bourgault M, Pellerin R (2009) Risk management applied to projects, programs, and portfolios. Int J Managing Projects Bus 2(1):14–35
Santori L, Bevan K, Myers C (2007) Summary of standard and poor's enterprise risk management evaluation process for insurers. Standard & Poor's, New York
SASAC (2006) Guidance to enterprise risk management for central enterprises. State-owned Assets Supervision and Administration Commission of the State Council of China, Beijing
Schaufelberger J (2009) Construction business management. Pearson Prentice Hall, Upper Saddle River
Schlottmann F, Mitschele A, Seese D (2005) A multi-objective model framework for the integrated management of financial risks. Retrieved 21 April, 2011, from: http://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=QMF2005&paper_id=89
Segal S (2007) Value-based enterprise risk management: the key to unlocking ERM potential. Corp Finan Rev 10(4):16–26
Segal S (2011) Corporate value of enterprise risk management. Wiley, Hoboken
Shapiro AF (2002) The merging of neural networks, fuzzy logic, and genetic algorithms. Insur Math Econ 31(1):115–131
Shaw J (2005) Managing all of your enterprise's risks. Risk Manage 52(9):22–30
Shimpi P (2010) Financial crisis exposes need for all to adopt enterprise risk management. National Underwriter Property Casualty 114(3):22–23
Shortreed J (2010) ERM framework. In: Fraser J, Simkins BJ (eds) Enterprise risk management. Wiley, Hoboken, pp 97–123
Sii HS, Ruxton T, Wang J (2001) A fuzzy-logic-based approach to qualitative safety modelling for marine systems. Reliab Eng Syst Safety 73(1):19–34
Simkins B (2008) Enterprise risk management: current initiatives and issues journal of applied finance roundtable. J Appl Finan 18(1):115–132
SOA (2006) Enterprise risk management specialty guide. Society of Actuaries, Schaumburg
Spicer RL (2006) Enterprise risk management and Sarbanes-Oxley Compliance: a model of convergence in accounting audit practice. Unpublished PhD Thesis, Capella University, Minneapolis
Stroh PJ (2005) Enterprise risk management at united healthcare. Strateg Finan 87(1):26–35
Tah JHM, Carr V (2000) A proposal for construction project risk assessment using fuzzy logic. Constr Manage Econ 18(4):491–500
Taleb NN (2007) The black swan: the impact of the highly improbable. Penguin Group, New York
Tan W (2007) Principles of project and infrastructure finance. Taylor & Francis, London
Tang WZ, Qiang MS, Duffield CF, Young DM, Lu YM (2007) Risk management in the Chinese construction industry. J Constr Eng Manage 133(12):944–956
Tserng HP, Yin SYL, Dzeng R, Wou B, Tsai M, Chen W (2009) A study of ontology-based risk management framework of construction projects through project life cycle. Autom Constr 18 (7):994–1008
Tu JV (1996) Advantages and disadvantages of using artificial neural networks versus logistic regression for predicting medical outcomes. J Clin Epidemiol 49(11):1225–1231
UC (2009) UC ERM maturity level framework. University of California, Oakland
Uher TE, Toakley AR (1999) Risk management in the conceptual phase of a project. Int J Project Manage 17(3):161–169
Utter JS (2006) Enterprise risk management in 2005—moving beyond market and credit risk. In: Karyl BL, David LB, Marilyn LT (eds) Managing enterprise risk. Elsevier, Oxford, pp 107–115
Vernon JD (1981) An introduction to risk management in property management. Urban Land Institue, Washington
Walewski J, Gibson GE, Dudley G (2003) Development of the international project risk assessment (IPRA) tool. Construction Industry Institute, Austin
Walker PL, Shenkir WG, Barton TL (2002) Enterprise risk management: pulling it all together. Institute of Internal Auditors Research Foundation, Altamonte Springs
Wang YM, Elhag T (2007) A comparison of neural network, evidential reasoning and multiple regression analysis in modelling bridge risks. Expert Syst Appl 32(2):336–348

Ward J (2006) ERM: evolving, resonating, and maturing down under. Standard & Poor's, New York

Ward S, Chapman C (2003) Transforming project risk management into project uncertainty management. Int J Proj Manage 21(2):97–105

Williams K (2005) How is your company managing risk? Strateg Finan 87(3):21–22

WSOFM 2010. Enterprise risk management maturity model. Washington State Office of Financial Management, Olympia. Retrieved 8 November, 2012, from: http://www.ofm.wa.gov/rmd/erm/ermmm_form.xlsx

Wu D, Olson DL (2008) Enterprise risk management: financial and accounting perspectives. In: Olson DL, Wu D (eds) New frontiers in enterprise risk management. Springer, Heidelberg, pp 25–38

Wu D, Olson DL (2009) Enterprise risk management: small business scorecard analysis. Prod Plann Control 20(4):362–369

Xu Y, Yeung JFY, Chan APC, Chan DWM, Wang SQ, Ke Y (2010a) Developing a risk assessment model for PPP projects in China–a fuzzy synthetic evaluation approach. Autom Constr 19(7):929–943

Xu Y, Chan APC, Yeung JFY (2010b) Developing a fuzzy risk allocation model for PPP projects in China. J Constr Eng Manage 136(8):894–903

Yazid AS, Hussin MR, Wan-Daud WN (2011) An examination of enterprise risk management (ERM) practices among the government-linked companies (GLCs) in Malaysia. Int Bus Res 4 (4):94–103

Zadeh LA (1965) Fuzzy sets. Inf Control 8(3):338–353

Zadeh LA (1973) Outline of a new approach to the analysis of complex systems and decision processes. IEEE Trans Syst Man Cybern SMC 3(1):28–44

Zhi H (1995) Risk management for overseas construction projects. Int J Proj Manage 13(4):231–237

Zimmermann HJ (2001) Fuzzy set theory and its applications, 4th edn. Kluwer Academic Publishers, Boston

Zou PXW, Zhang G, Wang J (2007) Understanding the key risks in construction projects in China. Int J Proj Manage 25(6):601–614

Zou PXW, Chen Y, Chan TY (2010) Understanding and improving your risk management capability: assessment model for construction organizations. J Constr Eng Manage 136(8):854–863

Chapter 4
Theories of Organizational Behavior

Keywords Organizational behavior · Organizational change · Organizational learning · Organizational culture · Motivation theories · Leadership theories

4.1 Introduction

Organizational behavior is "a field of study that investigates the impact that individuals, groups, and structure have on behavior within an organization, and then it applies that knowledge to make organizations work more effectively" (Robbins and Judge 2007: p. 34). The behavior is collectively influenced by the individual, the group, the organization, and the environment (Mullins 2007).

From the perspective of organizational behavior, ERM can be considered as a process of organizational change from the traditional, silo-based risk management approach to a holistic and integrated risk management approach. This change should be led by an individual or a team (a change agent), which is supported by the board and senior management, through motivation, organizational learning, and creation of a risk-aware culture. This chapter reviews the literature on theories of organizational change, organizational learning, organizational culture, motivation, and leadership, under the umbrella of organizational behavior theories. In addition, factors that drive and resist organizational change are identified. Some sources of resistance to organizational change can be directly or indirectly linked to organizational learning, organizational culture, motivation, and leadership. Moreover, the relationships among these theories of organizational behavior are elaborated in this chapter.

X. Zhao et al., *Enterprise Risk Management in International Construction Operations*, DOI 10.1007/978-981-287-549-5_4

4.2 Organizational Change

4.2.1 Two Perspectives on Organizational Change

An organization consists of formal organizational management and operations, as well as informal aspects of organizational life. Senior and Fleming (2006) indicated that the organization systems operated in internal, external, and temporal environments whose elements interacted with each other to form the triggers of change.

According to Choi and Ruona (2011), organizational change can be defined from two perspectives: strategic management and organizational development (OD). From the strategic management perspective, organizational change can be viewed as a process of implementing corporate strategy (Child 1972; Dunphy 2000), based on power-coercive and rational–empirical strategies. The change process is driven by a small group of people with leadership roles, and they must apply directive and coercive actions to force change recipients to comply with the proposed change goals (Choi and Ruona 2011). In comparison, OD encompasses a collection of planned change interventions, built on humanistic–democratic values, that seeks to improve organizational effectiveness and employees' well-being (Robbins 2003). From the OD perspective, organizational change can be thought of as intentional efforts to make differences in the organizational work context to improve individual development and organizational performance (Porras and Robertson 1992).

4.2.2 Paradigms and Typologies of Organizational Change

Hayes (2007) provided a good review of the literature on paradigms of organizational change. There are two paradigms of organizational change: (1) the punctuated equilibrium paradigm; and (2) the gradualist paradigm. The punctuated equilibrium paradigm involves "relatively long periods of stability (equilibrium), punctuated by compact periods of qualitative, metamorphic change (revolutionary)" (Gersick 1991: p. 12). This paradigm involves the change of deep structures, which determines the basic patterns that maintain its existence. The essence of the punctuated equilibrium paradigm lies in the organizations' evolution through periods of equilibrium with limited change to the persistent deep structures and periods of revolution with fundamental transformation of the deep structures. Weick and Quinn (1999) and Gersick (1991) referred to the change during the period of disequilibrium in this paradigm as revolutionary change, while Tichy and Devanna (1986) and Kotter (1996) used the term transformational change.

In comparison, the gradualist paradigm posits that fundamental change (organizational transformation) can occur through a process of continuous adjustment and does not require some major discontinuous jolt to the system in order to trigger a short episode of revolutionary change, which therefore means the change is evolutionary and cumulative (Hayes 2007). Some scholars referred to this type of change as continuous change (Weick and Quinn 1999) or incremental change (Hayes 2007).

In the punctuated equilibrium paradigm, evolutionary change also occurs during the period of equilibrium but cannot fundamentally transform the deep structures. While the punctuated equilibrium paradigm focuses on the interdependence of organizational subunits and a web of interdependent relationships, the gradualist paradigm stresses the relative independence of subunits (Hayes 2007). Weick and Quinn (1999) suggested that the loose interdependence could confine the continuous adjustments within subunits, thereby hindering the adjustments from cumulating and creating fundamental change.

In addition, Lewin (1951) differentiated between the planned and unplanned change. Planned change involves a deliberate, purposeful, and explicit decision to engage in a program of change (Levy 1986). In unplanned change, the response is adaptive, spontaneous, and accidental (Porras and Robertson 1992).

Another classification of organizational change is between first-order and second-order change. First-order change "may involve adjustments in systems, processes, or structures, but it does not involve fundamental change in strategy, core values, or corporate identity" (Newman 2000: p. 604). First-order change maintains and develops the organization (Bate 1998). It is incremental and evolutionary change. By contrast, second-order change "transformational, radical, and fundamentally alters the organization at its core" (Newman 2000: p. 604). It is akin to discontinuous and revolutionary change (Levy 1986).

4.2.3 Models of Planned Organizational Change

Lewin (1947) found groups were consistently in a "quasi-stationary equilibrium" state, and that change could occur only by changing the driving and restraining forces. In addition, Lewin (1947) found that a change toward a higher level of group performance was frequently short-lived and groups returned to their previous performance level, and suggested that the permanency of the new state should be included in the objective of a planned change. Therefore, Lewin (1947) proposed a three-step model of planned change consisting of unfreezing, moving, and refreezing:

1. Unfreezing is to shake people's habitual modes of thinking and behavior to enhance their awareness of the need for change. This involves weakening the forces that maintain the status quo, strengthening the forces that push for change, and introducing discrepancies between desirable goals and the current situation.
2. Moving is the process of making the actual changes that moves the current situation to the desired state. This step involves the new types of individual behavior and the establishment of new strategies and structure, with associated systems to help secure the new ways of working.

3. Refreezing is to stabilize or institutionalize the changes by helping employees to integrate the changed behavior or attitude into their normal way of working. The continuous involvement and support of top management is crucial to this step.

Although the refreezing step is laudable to prevent organizations from backsliding to the previous state, it would ignore the increasingly volatile environment where modern organizations operate and the need for continuous change. Hence, this step seems to be suitable for only small-scale change projects because of its assumption that organizations operate in a stable state (Burnes 2004).

Based on Lewin's (1947) model, other organizational change models were proposed. Lippittet et al. (1958) expanded the three steps to five phases: development of a need for change (unfreezing), establishment of a change relationship between the change agent and the client organization, working toward change (moving), generalization and stabilization of change (refreezing), and achieving a termination in the relationships. In addition, Egan (1988) developed a model which focused more on the moving phase and argued that this phase should include the assessment to the current scenario (diagnosis), the creation of a preferred scenario (visioning), and the design of plans that moves the system from the current to the preferred scenario (planning for change).

4.2.4 Theory E and Theory O

Beer and Nohria (2000a, c) suggested that organizational change could be achieved through two significantly different approaches called Theory E and Theory O. Theory E is change based on economic value while Theory O is change based on organizational capability. In Theory E, shareholder value is the only legitimate measure of corporate success. This "hard" change strategy involves the use of economic incentives, drastic layoffs, downsizing, and restructuring and focuses on the strategy, structure, and systems of organizations. It is driven by the top management with the help from financial incentives and consultants. In comparison, Theory O is to develop organizational culture and capability through individual and organizational learning. This "soft" approach is geared to cultivating a high-commitment organizational culture, has high-level involvement and collaboration, and has been viewed as an organizational development strategy (Hayes 2007; Mullins 2007). However, it is too indirect and takes too long, especially when the need for change is urgent (Hayes 2007). Thus, far fewer senior executives hold true to Theory O (Beer 2001).

Although these two approaches are distinct, Beer and Nohria (2000a, c) argued that combining the two theories enabled an organization to adapt, survive, and prosper in the long run and suggested embracing the two approaches along the key dimensions of change, such as goals, leadership, focus, process, reward system, and the use of consultants, as shown in Table 4.1 (adapted from Beer and Nohria 2000a).

Table 4.1 Theory E and Theory O

Theory	Dimensions of change					
	Goals	Leadership	Focus	Process	Reward system	Use of consultants
Theory E	Maximize economic value	Manage change from the top down	Emphasize structure and systems	Plan and establish programs	Motivate through financial incentives	Consultants analyze problems and develop solutions
Theory O	Develop organizational capabilities	Encourage participation from the bottom up	Build up corporate culture: employees' behavior and attitudes	Experiment and evolve	Motivate through commitment-use pay as fair exchange	Consultants support management in shaping their own solutions
Theories E and O combined	Embrace the paradox between economic value and organizational capability	Set direction from the top and engage the people below	Focus on both the hard (structures and systems) and the soft (corporate culture)	Plan for spontaneity	Use incentives to reinforce change but not to drive it	Consultants are expert resources who empower employees

4.2.5 Drivers for Organizational Change

An organization can be viewed as an open system of interrelated components that transacts with a larger environment. Many scholars have suggested that the drivers for organizational change came from the external and internal environment (e.g., Holbeche 2006; Lunenburg 2010; Senior and Fleming 2006). The external and internal driving forces of organizational change are listed in Table 4.2.

As for the external forces, Tichy (1983) proposed a framework for identifying and understanding drivers for organizational change, including broad categories such as technical, political, and cultural forces. Kaestle (1990) recognized that marketplace dynamics and IT were the two basic drivers for organizational change. Jick (1995) identified competitive pressures and the pursuit of competitive advantages as accelerators of change while Pascale et al. (1996) suggested that the rapid pace of change and competitive pressures were key forces for organizational change. In addition, Holbeche (2006) believed that globalization, emerging e-economy, and factors underlying in the social context could drive organizations to reinvent themselves in order to survive and thrive. Brimley and Garfield (2009) indicated that laws and regulations and economic factors (such as recession or inflation) were among the forces driving organizational change.

While external forces can be strong drivers for organizational change, change can also be triggered by the internal factors (Holbeche 2006). Janjua and Sobia (2010) found that the internal needs for restructuring, growth, and new products provided opportunities for organizations to change. Moreover, Robbins (2003), Senior and Fleming (2006), and Mullins (2007) identified the need for reorganization and higher profitability, conflict between organizational components, and the changing nature and composition of the workforce as the internal forces for organizational change.

4.2.6 Resistance to Organizational Change

Despite the potentially positive outcomes, change is often resisted by individuals. Resistance to change is a natural human response to imposed and significant change, based on the assumption that individuals get used to particular ways of behaving that

Table 4.2 Driving forces of organizational change

External forces	Internal forces
Technical advancements	Need for reorganization
Globalization	Need for higher profitability
Competition pressures	Conflict between organizational components
Social and cultural factors	The changing nature and composition of the workforce
Economic factors	
Political and legal pressures	
Market changes	

have worked for them in the past (Holbeche 2006). However, some studies argued that individuals just resisted the way change was imposed on them, rather than the change itself (Dent and Goldberg 1999; Fuegen and Brehm 2004; Senge 1990).

Thomas and Hardy (2011) identified two dominant approaches to conceptualizing resistance to change: (1) demonizing it and (2) celebrating it. Demonizing resistance to change considers resistance as a problem that hinders the attempts to change organizations. This was a long-established assumption in the literature on organizational change, and was a dominant view in both management practices and theories (Coch and French 1948; Dent and Goldberg 1999; Giangreco and Peccei 2005; McCarthy et al. 2008). Different from this approach, celebrating resistance to change has recently emerged and views resistance as part of successful change. Resistance to change may stem from positive intention (Piderit 2000) and contributes to organizational change through challenging change agents (Ford and Ford 2009; Lüscher and Lewis 2008).

This research adopts the demonizing approach to viewing the resistance to change because it concerns the hindrances to implementing ERM in construction firms, and these hindrances have only negative impacts on ERM implementation. Previous studies that have adopted the demonizing approach involved individual and organizational sources of resistance to organizational change. In this research, a total of 21 sources of resistance to organizational change (i.e., C01–C21) were identified from previous studies (George et al. 2008; Hayes 2007; Low 1998; Mullins 2007; Recardo 1995; Robbins 2003). Out of these sources, 15 are at the individual level while six are at the organizational level:

Category I: Individual sources of resistance

C01 Habits

Individuals tend to respond to situations in an established and accustomed way (Low 1998), which serves as a means of comfort and security. Proposed change to habits would be resisted, especially if the habits are well established.

C02 Fear of the unknown

Changes with the uncertainty or ambiguity tend to cause anxiety or fear, and threaten the psychological safety of individuals. Hence, these people are likely to resist the change (Robbins 2003).

C03 Parochial self-interest

Individuals resist the change that is perceived as causing them to lose something of value because it is common for people to focus on their own best interests rather than those of the total organization (Kotter and Schlesinger 1979). Hence, individuals will assess the impact of change in terms of how it affects their ways of working (convenience or freedom), job security, economic value (income or other rewards), job satisfaction, career prospects, and so on, and in terms of how it undermines or improves their power and status, and the prestige of the groups which they belong to (Recardo 1995).

C04 Social factors

Individuals who may believe that change will hurt their images, result in ostracism from peers, or simply make them feel “different” (Low 1998), tend to resist the change.

C05 Lack of individual capability to change
Individuals tend to consider their own skills and competencies and determine the likelihood of their success in new roles. They are likely to resist the change if they feel they lack the personal capabilities for success (Mullins 2007).

C06 Misunderstandings
Individuals do not understand the reason for change and its impact on them are reluctant to embrace change. Misunderstandings cause individuals to perceive that the change will cost them more than they will gain (Hayes 2007). Such misunderstandings are likely to be a result of poor communication and lack of trust.

C07 Insufficient resources
One of the key variables used by individuals to judge management commitment is the sufficiency of resources allocated for change (Recardo 1995). Without timely and sufficient resources to complete the task, individuals who are asked to embrace a change will feel frustrated and thus resist the change. The resources may include people, budget, time, expertise, and other necessary inputs.

C08 Inadequate rewards and punishments
If a change agent neither rewards the desired behavior or output measures nor punishes non-compliance, then employees will have little incentive for embracing the change (Low 1998). Employees who try to embrace the change tend to have feelings of being inequitably treated because they spend much in the change but get only a little in return compared to others who ignore the change (Mullins 2007).

C09 Poor internal communication
Poor communication within an organization renders individuals unable to understand the vision of change and the impact of change on them. In addition, change agents cannot understand people's concerns (Hayes 2007; Recardo 1995). Hence, people are likely to resist the change. Simply providing information does not reduce resistance because decisions of whether or not to resist are based upon whether or not people agree with the change proposed.

C10 Lack of the board and senior management commitment
Commitment of the board and senior management represents the support from the top management. A transformational change within an organization requires such commitment, which can ensure the resources for the change and the authority of change agents. Lack of such commitment implies that the change is not perceived as a priority among board and senior management, and thus results in skepticism and cynicism across the organization (Hayes 2007).

C11 Lack of trust in management
Trust in management involves individuals' perceived confidence levels in management's ability to lead effective change, and their feelings that they can depend on management to do what is in the best interest of the organization and its members. Lack of trust in management is strongly related to

individuals' anger, frustration, and anxiety, as well as resistance to change (Oreg 2006). Skepticism and cynicism are two concepts related to trust and are also predictors of resistance to change (Stanley et al. 2005).

C12 Inconsistency
Inconsistency in change messages delivered by change agents is related to resistance (Larson and Tompkins 2005). This inconsistency reflects management's ambivalence about the change initiative and thus provides individuals with justifications for resistance.

C13 Low-level employee–manager relation
The effectiveness of management tactics in reducing resistance to change depends on the level of employee–manager relationship (Furst and Cable 2008). Low-level employee–manager relation tends to make employees experience less trust in management. Hence, the management tactics in reducing resistance would be less effective.

C14 Ineffective management styles
Different management styles can affect the strength of resistance to change. Szabla (2007) found that collaborative change leaders were the most effective in reducing resistance to change, that those perceived as focusing only on facts and logic were less effective, and that those using power and coercion were the least effective.

C15 Selective information processing
Individuals shape their world through their perceptions. This can lead to a biased view of a particular situation, which fits most comfortably into a person's own perception of the reality (Low 1998; Mullins 2007; Robbins 2003). Thus, they ignore the information that challenges the world they have created.

Category II: Organizational sources of resistance

C16 Threats to power or influence
Change will be resisted by the groups whose power or influence such as the control over decisions, resources, or information is threatened. These groups perceive such power or influence as their "territorial rights."

C17 Threats to resource allocations
The groups that benefit from the current resource allocations tend to feel threatened by the change that affects the future allocations, and resist it.

C18 Limited focus of change
Organizations are composed of several interdependent subsystems. Hence, limited change in one subsystem without simultaneously modifying the organizational structure to match is likely to be resisted (Robbins 2003).

C19 Organizational culture
The pervasive nature of organizational culture significantly influences organizational processes and individuals' behavior. Ineffective or unsupportive culture is likely to result in a lack of flexibility for, or acceptance of change (George et al. 2008).

C20 Group inertia
Group norms specify appropriate and inappropriate behavior and govern the interaction between group members. The change that alters task and role relationship in a group disrupts group norms and the informal expectations that members have of one another and thus is likely to be resisted by group members. Even if individuals would like to change their behavior, the group norms may act as a constraint and make them resist the change (Hayes 2007).

C21 Structural inertia
The structure of an organization provides a strong element of stability. Adaptive, flexible organizations are likely to enjoy competitive advantages over rigid, static organizations (Weick and Sutcliffe 2001). The more mechanistic or bureaucratic the structure is, the less likely the organization responds to change.

4.2.7 Approaches to Overcoming Resistance to Change

Several approaches to breaking the resistance to change are available. Kotter and Schlesinger (1979) proposed six approaches for change agents to deal with the resistance to organizational change. These approaches are situational, and thus the selection of approaches should depend on contextual factors.

A01 Education and communication
Communication of ideas helps people see the need for and the logic of a change. The education process can involve one-on-one discussions, presentations to groups, or memos and reports. This tactic assumes that resistance is based on inadequate or inaccurate information and analysis, and requires good relationships between change initiators and resistors. Such relationships are characterized by mutual trust and credibility. However, this approach is time-consuming if many people are involved.

A02 Participation and involvement
Coch and French (1948) demonstrated that workers showed much more acceptance to a change in work practice when they were allowed to participate in the design and development of the change. With a participative change effort, the change agents listen to the people involved in the change and use their advice. When change agents believe they do not have all the information they need to design and implement the change, or when they need the commitment of others to do so, people's involvement can reduce resistance to change, obtain commitment, and increase the quality of the change decision. However, this approach is likely to lead to a poor solution and great time-consumption if not carefully managed.

A03 Facilitation and support
Facilitation and support are most helpful when fear and anxiety lie at the heart of resistance. Change agents can provide new-skills training, a short paid leave of absence, or simply listening and providing emotional support.

The basic drawback of this approach is that it can be time-consuming and expensive and still fail. If time, money, and patience are not available, then using supportive methods is not very practical.

A04 Negotiation

People can be motivated to change by rewarding the behavior that will facilitate the change. This approach is to exchange something of value for a lessening of the resistance. It is particularly appropriate when it is clear that someone is going to lose out as a result of a change and yet his or her power to resist is significant. Negotiated agreements can be a relatively easy way to avoid major resistance, despite high costs. In addition, once a change agent negotiates with one party to avoid major resistance, he or she is open to the possibility of blackmail.

A05 Manipulation and co-optation

Manipulation is the covert attempt to influence others to change. This approach is used when other tactics do not work or are too expensive. Manipulation normally involves the deliberate biasing of information and the conscious structuring of events. Examples of manipulation are twisting and distorting facts to make them more attractive, withholding undesirable information, and creating rumors to get employees to accept a change. Co-optation is a common form of manipulation. Co-opting an individual involves giving him or her a desirable role in the change decision. Co-opting a resistance group involves providing the leaders of it key roles in the change decision. However, this is not a form of participation because the advice of the co-opted merely gets the endorsement rather than a better decision. Both manipulation and co-optation are relatively inexpensive and easy ways to gain the support of an individual or a group, but this approach can backfire if people become aware that they are being tricked into not resisting, are not being treated equally, or are being lied to. Once a reputation as a manipulator is developed, the change agent may lose credibility.

A06 Coercion

Change agents essentially force people to accept a change by explicitly or implicitly threatening them. Examples of coercion are threats of transfer, loss of promotion possibilities, and negative performance evaluations. Using coercion is as risky as manipulation because people strongly resent forced change. However, in situations where speed is essential and where the changes will be unpopular, coercion may be the only option.

In addition, Recardo (1995) proposed ways to effectively reduce resistance to organizational change, which can supplement Kotter and Schlesinger's (1979) approaches:

A07 Communicating a clear vision of the change

The senior management team is typically in the best position to develop a clear vision of the desired state. Such a vision will communicate the fact that something is broken, while creating a sense of urgency in employees to act.

A08 Leadership of senior management
Successful large-scale organizational change needs the leadership of senior management. Senior management should act as role models and openly demonstrate their commitment. Also, they must clearly communicate their expectations and hold people accountable for success.

A09 Modification of the organization's architecture
Depending on the type of change, one or more elements of the organization's architecture may need to be modified to support the change. For instance, the organizational structure, business systems (e.g., performance management and administrative policies), and infrastructure (e.g., the physical layout of offices) may need modification.

A10 Modification of performance measures and rewards
The desired behavior in the status quo and desired state tend to be significantly different. Recardo (1995) illustrated the necessity to modify the performance measures and rewards through comparing behavior and performance measures rewarded in a traditional manufacturing environment with those in a just-in-time (JIT) or total quality management (TQM) environment.

A11 Supply of adequate resources
Resources can take the form of money, facilities, equipment, or access to key people. A change initiative with adequate resources tends to signal the support from the top management and competent management.

The above 11 approaches could be adopted to overcome the 21 sources of resistance to organizational change, as shown in Table 4.3. Taking a different perspective on the attitude toward change, Choi and Ruona (2011) focused on the readiness for organizational change rather than resistance. They pointed out that individuals in an environment with strong emphasis on a learning culture were more likely to be ready for organizational change than those who have not. Furthermore, Rowden (2001) proposed that the learning organization approach enabled organizations to be attuned to the changing environment and thus created constant readiness for change. The following part of this chapter focuses on organizational learning.

4.3 Organizational Learning

4.3.1 Definition of Organizational Learning

Organizational learning has numerous definitions. Senge (1990) defined organizational learning as "a continuous testing of experience and its transformation into knowledge available to whole organization and relevant to their mission" (p. 6). Huber (1991) viewed it as a combination of four processes: knowledge acquisition, information distribution, information interpretation, and organizational memory. Argyris and Schön (1996) provided a less restrictive definition that organizational

Table 4.3 Approaches to overcoming resistance to organizational change

Source of resistance	Approaches to overcoming resistance to organizational change										
	A01	A02	A03	A04	A05	A06	A07	A08	A09	A10	A11
C01		✓				✓					
C02			✓			✓					
C03				✓		✓					
C04	✓	✓				✓					
C05	✓		✓								
C06	✓	✓				✓	✓				
C07											✓
C08						✓				✓	
C09	✓						✓				
C10								✓			
C11		✓				✓					
C12						✓		✓			
C13	✓	✓	✓								
C14						✓					
C15	✓	✓				✓					
C16				✓	✓						
C17				✓	✓						
C18							✓				
C19	✓	✓									
C20	✓			✓	✓	✓					
C21									✓		

learning emerged when organizations acquired information (knowledge, understandings, know-how, techniques, and procedures) of any kind by any means. Moreover, Dimovski et al. (2008) defined it as a process of information acquisition and information interpretation that resulted in behavioral and cognitive changes, which should exert impact on organizational performance.

Organizational learning stems from the knowledge acquisition of the individuals within the organization and progresses with the exchange and integration of this knowledge until collective knowledge is created (Hedberg 1981; Jerez-Gómez et al. 2005). Organizational learning has its roots in individual learning (Senge 1990; Shrivastava 1983), but it is distinct from adding together the individual learning of the organization's different members (Alas and Sharifi 2002; Argyris and Schön 1978; Hedberg 1981). Individual learning alone does not necessarily result in organizational learning (Kim 1993).

4.3.2 Types of Organizational Learning

Argyris and Schön (1978) distinguished between single-loop and double-loop learning. Single-loop learning involves the production of matches, or the detection and correction of the mismatches that inhibits learning, without change in the underlying governing policies or value. Single-loop learning was considered as the lower level learning and partially contributes to short-term improvements (Fiol and Lyles 1985). This type of organizational learning works when a firm operates in a relatively unchanging market environment (McGill and Slocum 1993). By contrast, double-loop learning involves re-examining and challenging the governing values and policies in order to facilitate the learning process and enables organizational members to understand the environment, develop appropriate responses to new requirements, and manage change effectively (Garratt 1995). This type of change was viewed as a higher level change (Fiol and Lyles 1985). It is characterized by considering problems as the challenges that the firm faces and dealing with the root causes (Kululanga 1999). In addition, Senge (1994) distinguished between adaptive learning and generative learning, comparable to single-loop and double-loop learning. The adaptive learning enables the organization to improve what it is doing, while generative learning challenges and redefines the basic requirements of the tasks and how they should be undertaken (Bennett 1998).

Argyris (1977) proposed the idea of deutero-learning, which involved learning how to learn and helped organizations to improve the performance of single-loop and double-loop learning (Morgan 1997). Deutero-learning is conceptualized as behavioral adaptions of conditioning in relationships in an organizational context (Visser 2007). Thus, deutero-learning is continuous, behavioral-communicative, and largely subconscious (Rowe and Boyce 2009).

4.3.3 Approaches to Organizational Learning

Sfard (1998) proposed two metaphors of learning: the acquisition and participation metaphors, which are also called the cognitive-behavioral approach and the sociocultural (or situated) approach, respectively (Ellström 2010).

From the perspective of the acquisition metaphor, the mind is a container of knowledge, and learning is a process of filling the container and implanting knowledge there. Knowledge is viewed as a property or capacity of an individual mind (Paavola et al. 2004). Sense (2011) distinguished between cognitive and behavioral perspectives in this metaphor. The cognitive perspective involves knowledge, understanding, and insights, i.e., the organization gaining knowledge regardless of whether that knowledge is converted into actions, while the behavioral perspective concerns either an actual change or a potential behavioral change (Tsang 1997). Hence, learning is a process of knowledge acquisition through experienced-based changes in behavior or cognition. This approach is aligned with Huber's (1991) four-stage approach to organizational learning, which consisted of knowledge acquisition, information distribution, information interpretation, and organizational memory.

By contrast, the participation metaphor regards learning as a process of participation in cultural practices and shared learning activities. From this perspective, learning cannot be separated from working and other social practices where it is used (Brown and Duguid 1991). In this view, learning and process activities (knowing) rather than outcomes or products (knowledge) are emphasized. Learning is "situated" in these relations and networks of activities of participation (Paavola et al. 2004). Situated learning evolves through the processes of observation, dialogue, storytelling, and conversations between people as they participate and interact within a practice (Sense 2011).

Sfard (1998) argued that both approaches were needed, which was consistent with the conclusion of Anderson et al. (2000). They are not simply rivals but complement each other. There is also a third approach to organizational learning: the knowledge-creation approach. It is based on the view that the production, transformation, and utilization of knowledge are fundamental for understanding organizational learning (Ellström, 2010). There are three influential models of this approach:

1. Nonaka's knowledge-creation model
   Nonaka (1991) distinguished between different types of knowledge: explicit and tacit knowledge. Explicit knowledge is described as knowledge that can be documented and stored in formats such as papers or drawings, while tacit knowledge is based on experience, mental models, and perspectives which are so deeply embedded in a person that the knowledge becomes the second nature to an individual. The dynamic of Nonaka's model arises from the interactions between explicit and tacit knowledge. Nonaka (1991) proposed four basic patterns for creating knowledge in any organizations: socialization (conversion from tacit to tacit), combination (conversion from explicit to explicit), externalization (conversion from tacit to explicit), and internalization (conversion from explicit to tacit).
2. Engeström's expansive learning model
   Engeström's model viewed learning as an expansive cycle, which consisted of seven stages: questioning and criticizing certain existing practices, analyzing the situation, modeling a new solution to the problematic situation, examining the new model, implementing the new model, evaluating the process, and consolidating the new practice (Engeström 1999). This model has also been used as an intervention method for facilitating innovative learning in organizations.
3. Bereiter's knowledge-building model
   Bereiter (2002) considered knowledge as a thing that can be systematically produced and shared among members of a community. Bereiter's theory made a conceptual distinction between learning and knowledge building. In modern enterprises, knowledge consists of objects or conceptual artifacts that can be systematically produced and developed. The primary goal of members of an innovative expert community is not to learn something but to create new knowledge and add the value of conceptual artifacts.

4.3.4 Impediments to Organizational Learning

Similar to the presence of resistance to change, there are impediments to organizational learning (Alas and Sharifi 2002; Ellström 2010; Hayes 2007; Salaman and Butler 1994), because individuals have been trained to think and act in conflicting ways (DiBella and Nevis 1998). Hence, when involving change in behavior and mindset of organizational members, the learning process would be resisted within the organization. Due to the interaction between change and learning, there may be overlap between the resistance to change and learning. Several impediments to organizational learning are listed below:

L01 Lack of leadership commitment and support
Leadership plays a special role in learning because it is "where the exchange of information is launched, becomes systematic, and then is monitored and rewarded" (Goeser and Davenport 1996: p. 28). Leaders need to make organizational learning a central element in the organization's strategy, create organizational learning mechanisms to turn individual learning into organizational learning, produce cultural and psychological conditions conducive to learning (Popper and Lipshitz 2000), allocate resources for learning, and facilitate learning on the part of organizational members (Ellström 2010). Hence, lack of leadership support will impede organizational learning and make employees perceive organizational learning as not being emphasized.

L02 Lack of internal knowledge
Because organizational learning stems from knowledge acquisition (Senge 1990; Shrivastava 1983), lack of knowledge within the organization tends to inhibit the learning process, even though organizations can also acquire knowledge from external sources. Lack of internal knowledge can partly be attributed to the lack of qualified personnel with tacit knowledge.

L03 Lack of organizational commitment
Organizational commitment is "the extent to which organizational members identify with an organization's goals and values and make no distinction between promoting its interests and their own personal ones" (Lipshitz et al. 2002: p. 87). Organizational commitment allows diffusion of individual learning into the organization (Lewitt and March 1988) and is viewed as an inducement for people's willingness to share their knowledge (Davenport and Prusak 1998), on which organizational learning crucially depends. The people who feel more commitment toward the organization will share their information more with the organization and other employees (Atak and Erturgut 2010). Hence, lack of organizational commitment tends to interrupt knowledge transfer and impedes organizational learning.

L04 Lack of psychological safety
Psychological safety is a state in which people feel safe to make errors and honestly discuss what they think and how they feel. Without psychological safety, individuals are reluctant to take risks for learning. Edmondson (1999) found that high-level and low-level learning teams differ in the extent to

which their members feel psychologically safe. Tolerance for errors that is inevitably generated from organizational learning is a policy that contributes positively to employees' psychological safety. In addition, commitment to the workforce also improves psychological safety through employment security and is essential for organizational commitment to the goals and values. Organizational learning expected to bring about layoffs will be resisted by employees regardless of its improvement (Lipshitz et al. 2002).

L05 Lack of motivation

Positive and negative rewards are common to motivate individual learning. Lack of motivation for organizational learning results in passivity, hidden sabotage, or outright rejection of accepting new knowledge and sharing crucial knowledge with others (Szulanski 1996). A reward system is also necessary to stimulate innovative behavior, because innovation is much riskier, more difficult, and time-consuming. Lack of such reward system may discourage the people engaged in innovation and thus impede organizational learning.

L06 Reluctance to share knowledge

Organizational members may be reluctant to spend time sharing knowledge, because they are overwhelmed with work or believe their time can be spent more profitably elsewhere (Husted and Michailova 2002). Their reluctance to share knowledge may also derive from the fear of losing a position of privilege and superiority and the lack of motivation for sharing as well as the perception that the knowledge source is unreliable (Szulanski 1996). Hence, knowledge transfer is interrupted, and individual learning does not contribute to organizational learning. This is fragmented organizational learning (Kim 1993).

L07 Reluctance to accept knowledge

People may be reluctant to accept knowledge even if others are willing to share knowledge with them. People may reject the knowledge of others due to the unreliability of the source or idleness. The reluctance of potential knowledge recipients can increase the internal stickiness of knowledge and lower knowledge distribution, which ultimately impedes learning within an organization.

L08 Lack of knowledge absorptive or retentive capacity

Absorptive capacity is indicated in the knowledge recipients' ability to value, assimilate, and apply new knowledge. Lack of this capacity may make people incapable of exploiting the outside sources of knowledge (Cohen and Levinthal 1990). Additionally, retentive capacity is reflected by the ability of a recipient to institutionalize the use of new knowledge. A transfer of knowledge is effective only when the knowledge transferred is retained. Hence, lack of such capacity allows people to regard initial difficulties during the integration of received knowledge as an excuse for discontinuing its use (Szulanski 1996).

L09 Lack of channels for dialogue and sharing meaning
The essence of organizational learning is the joint construction of meaning, which occurs through sharing and dialogue (Hayes 2007). Sharing meaning is constructed in the dialogue between organizational members (Dixon 1997). Thus, lack of accessible channels for dialogue and sharing meaning is a barrier to organizational learning.

L10 Arduous relationships
Individual exchanges are required during a transfer of knowledge, especially when the knowledge transferred has tacit elements that is deeply embedded in people (Nonaka 1994). To some extent, the success of such exchanges depends on the ease of communication and the intimacy of the relationship between the knowledge source and recipient. An arduous relationship tends to create additional difficulties in the knowledge transfer (Szulanski 1996).

L11 Downsizing or layoff strategies
Downsizing, a form of restructuring, involves departure of people with valuable experience and knowledge. Their departure disrupts the networks of interpersonal relationships among employees where organizational learning is generated (Fisher and White 2000). In addition, large-scale layoffs cause voluntary turnover, particularly among the better qualified employees who possess valuable knowledge and who can best contribute to future learning (Pfeffer 1998). In particular in the case of fragmented organizational learning, loss of individuals means loss of learning as well. This is because individuals' learning has not contributed to organizational learning when they leave the firm.

L12 Unsupportive organizational culture
Salaman and Butler (1994) claimed that the resistance to learning may derive from unsupportive organizational culture, which would engender behavior and attitudes detrimental to learning and thus hinders the learning process. One example is blame culture, which is related to the passive attitudes toward errors and failures within an organization. Blame culture exerts fear on people that they will be blamed for their errors or failures, raises the possibility of the same mistake being made repeatedly, and limits the sharing of information. Thus, individuals are motivated to play safe and avoid experimentation, which stifles creativity and learning (Hayes 2007). Another example is organizational defensive routines, which are action, policy, or practice that prevents organizational participants from experiencing embarrassment or threat and, at the same time, prevents them from discovering the causes of the embarrassment or threat (Argyris 1995). The defensive routines that are incorporated into the organizational culture can affect new arrivals, despite the movement of organization members (García-Morales et al. 2006). These routines inhibit double-loop learning, overprotect the individuals and the organization (Argyris 1990), and make organizational members become "skillfully incompetent (Argyris 1986)."

4.3.5 Organizational Learning, Learning Organization, and Organizational Change

The accelerating pace of change in the environment has heighten organizational learning in the West, even though it is not a new concept (Burnes et al. 2003). To deal with an increasingly complex environment, organizations recognize the need to acquire and utilize the knowledge in order to remain competitive. Learning implies a different state which is likely to lead to new knowledge and skills, as well as new attitudes and behavior (Mullins 2007).

Learning is fundamentally about change (Spector and Davidsen 2006). Organizational learning has not actually occurred if no behavioral or cognitive changes occur (Dimovski et al. 2008). Sanchez (2005) suggested that “learning leads to change in an individual’s beliefs about causal relationships in the world and within an organization,” and that “organizational learning can be said to occur when there is a change in the content, conditionality, or degree of belief of the beliefs shared by individuals who jointly act on those beliefs within an organization” (p. 16). However, change is not necessarily the result of learning processes. Some changes in behavior may be triggered by situational factors and have little or nothing to do with organizational learning (Ellström 2010).

Learning is a medium for change (Alas and Sharifi 2002) and improves the ability to adapt to change, both at the individual and organizational levels (Garvin 1993; Senge 1990). Pettigrew and Whipp (1993) argued that collective learning was one of the preconditions for sustainable change. Clarke (1994) and Nadler (1993) suggested that individual and organizational learning encouraged the commitment to, and shared ownership of, the organization’s vision, actions, and decisions that were necessary to respond to the external environment. Benjamin and Mabey (1993) regarded questioning the status quo as the essence of bottom-up change and suggested that the openness and knowledge of staff from employee’s learning pressed managers to question the purpose and direction of the organization. Learning and change were not only parallel and simultaneous, but are also interactive processes, as learning has a mediating role in the change process (Lähteenmäki et al. 2001). In the tumultuous environment, learning also helps to reduce uncertainty and thus inevitably reduce resistance to change (Lähteenmäki et al. 2001). Hence, these should not be isolated from each other.

The inextricable link between change and learning is also considered as a supporting rationale for learning organizations (Senge et al. 1994). A learning organization is “where people continually expand their capacity to create desirable results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together” (Senge 1990: p. 3). A learning organization is viewed as an ideal type of organization, which has the capacity not only to facilitate the learning of its members, but also to transform this learning into continuous organizational renewal (Ellström 2010). The terms organizational learning and learning organization are actually different. Organizational learning is a process of activities, whereas the learning organization is a form of organization (Tsang 1997). Organizational learning and the learning organization can and should co-exist (Gorelick 2005).

Learning organizations are designed to anticipate and react to changing external and competitive environments in a positive and proactive manner, and help to establish internal organizational structures that are more capable of responding to the turbulence of change (Watkins and Marsick 1993). Characteristics of learning organizations help to overcome resistance to change and facilitate learning (Alas and Sharifi 2002). Kontoghiorghes et al. (2005) found that open communications and information sharing, risk taking, and new idea promotion, as well as resource availability are the characteristics that strongly predict rapid organizational change adaption. Moreover, Rowden (2001) claimed that four characteristics of learning organizations contributed to their response to change. These are given as follows:

1. Constant readiness
   Learning organizations exist in a constant state of readiness for change, attuned to the environment and willing to question its fundamental ways of doing business.
2. Continuous planning
   Learning organizations develop flexible, open plans that are fully shared and embraced by the entire organization.
3. Improvised implementation
   Rather than implementing plans regularly, learning organizations improvise change, encouraging experimentation, rewards small wins, and institutionalizing success throughout the organization.
4. Action learning
   Rather than waiting for the problems to arise to compel reevaluation, learning organizations take action, reflect, and adjust courses as they go, seeking to improve the speed and effectiveness by which they learn how to change.

4.4 Organizational Culture

4.4.1 Definition of Organizational Culture

There has been no consensus on the definition of organizational culture. Robbins (2003) believed that organizational culture refers to a system of shared meaning held by members that distinguishes the organization from other organizations. Cummings and Worley (2005: p. 509) defined organizational culture as "the pattern of assumptions, values, and norms that are shared by an organization's members." As a long-time researcher of organizational culture, Schein (1990: p. 111) defined organizational culture as "a pattern of basic assumptions, invented, discovered, or developed by a given group, as it learns to cope with its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore is to be taught to new members as the correct way to perceive, think, and feel in relation to those problems."

4.4.2 Model of Organizational Culture

Models of organizational culture enable different cultural characteristics to be linked with one another (Senior and Fleming 2006). Schein (1990, 1992) distinguished three levels of organizational culture: observable artifacts, espoused values, and basic underlying assumptions. At the surface, there are visible artifacts of the organization, i.e., the organizational structure, rules of conduct, dress codes, policies, procedures, symbols, stories, heroes, ceremonies and rituals, and other overt behavior of organizational members. Beneath this dimension are espoused values, which reflect the work of the organization in the form of articulated strategies, ideologies, attitudes, and philosophies. Finally, the deepest level is the taken-for-granted and underlying assumptions that are deeper manifestations of values and that determine perceptions, thoughts, feelings, and behavior. These assumptions are reflected in and give meaning to the expressed values and observable artifacts and patterns of behavior at the surface (Ashkanasy et al. 2000). Schein (2004) also emphasized the effects of situational contingencies arising from the external environment on the values and artifacts and argued that overt behaviors are the joint product of cultural predilection and environmental stimuli.

4.4.3 Functions of Organizational Culture

Culture performs a host of functions within an organization. According to Brown (1995), organizational culture helps avoid conflict and thus facilitates the processes of coordination and control. It also reduces the complexity and uncertainty of the organizational context so that any actions taken are in tandem with organizational rationalities as seen by most organizational members. In addition, the functions of organizational culture include responding to both external adaption and internal integration issues (Schein 1990). External adaption issues develop consensus on the core mission, functions, and primary tasks of the organization, the specific goals to be pursued, the basic means to be used to achieve the goals, and the criteria to be used for measuring results, as well as the methods of coping with success and failure. Internal integration deals with the creation of a collective identity and with ways of working and living together (Schermerhorn et al. 2011). Moreover, organizational culture conveys a sense of identity for organization members and facilitates the generation of organizational commitment (Peters and Waterman 1982). Furthermore, Robbins (2003) indicated that organizational culture could distinguish one organization from others, convey a sense of identity for organization members, and facilitate the commitment to something larger than individual interests. Organizational culture also serves as the social glue that helps hold the organization together and guides and shapes the individual behavior and attitudes in the organization.

4.4.4 Typologies of Organizational Culture

In an organization, culture can be categorized into dominant culture, subculture, and counterculture. A dominant culture expresses the core values that are shared by a majority of the organization's members and is referred to as the organization's culture (Robbins 2003). Organizations also comprise subcultures throughout its occupational groups, various divisions, and geographic regions. Some subcultures enhance the dominant culture by espousing parallel values and assumptions; other subcultures emphasize different but not competing values; still others are countercultures which directly oppose the dominant values of the organization (McShane and Von Glinow 2007). Strong subcultures are often found in task forces, special project groups and teams in the organizations, and bind individuals intensely together to complete a task (Schermerhorn et al. 2011). They retained the core values of the dominant culture, but are modified to reflect the unique situation or values to the members of a unit or department of the organization (Robbins 2003). In addition, subcultures maintain the standard of performance and ethical behavior, to prevent individuals from blindly following one set of values (McShane and Von Glinow 2007; Sinclair 1993). Moreover, they enable organizations to be more in tune with the changing environment (Boisnier and Chatman 2003).

Organizational cultures differed significantly in terms of their relative strengths (Brown 1995) and can be differentiated between strong and weak cultures (Robbins 2003). Gordon and DiTomaso (1992) provided a comprehensive literature review on the definition of the strength of an organization's culture. It had been defined as coherence (Deal and Kennedy 1982; Weick 1985), homogeneity (Ouchi and Price 1978), congruence (Schall 1983), thickness (Sathe 1983), and penetration (Louis 1985), as well as internalized control (DiTomaso 1987). Strong organizational cultures, defined as "a set of norms and values that are widely shared and strongly held throughout the organization" (O'Reilly and Chatman 1996: p. 166), can increase behavioral consistency across individuals in an organization (Sørensen 2002). Conversely, a weak culture implies the absence of a dominant pervasive culture but an organization made up of various cultures, some of which conflict with each other (Senior and Fleming 2006). Individuals in a weak culture would waste much time trying to understand what they should do and how they should do it (Deal and Kennedy 1982).

4.4.5 Organizational Culture and Change

Strong cultures exert a stabilizing force on organizations by encouraging cohesion, organizational commitment, and desirable work behavior among members (Deal and Kennedy 1982; Nemeth and Staw 1989; O'Reilly and Chatman 1996). This stability brings about cultural clarity and consistency among members, which is an asset to an organization in a stable environment (Kotter and Heskett 1992; O'Reilly 1989).

However, the stability can also be a liability and burden for the organization to be competitive and responsive to the dynamic environment (Boisnier and Chatman 2003; Brown and Harvey 2005; Tushman and Smith 2002). Organizational performance in changing environments depends on the ability of a firm to modify its routines in response to changes in conditions. Nemeth (1997) argued that the uniformity, loyalty, commitment, and potentially "cult-like" behavior brought about by strong cultures could stifle an organization's ability to respond to change. Sørensen (2002) found that in relatively stable environments, firms with strong cultures had more reliable performance but this was not the case in volatile environments. Jaskyte and Dressler (2005) found that the higher the cultural consensus on values such as stability, security, low level of conflict, predictability, rule orientation, team orientation, and collaboration, the less innovative the organization may be.

Therefore, the contents of strong cultures should be change-oriented. Schein (1992) suggested that the culture of modern organizations should be strong but limited to differentiate basic assumptions that were vital to organizational survival and success from everything else that was desirable but not mandatory. In fact, making organizations responsive to change does not necessarily need to weaken the strong culture. Boisnier and Chatman (2003) found that various subcultures enabled organizations to become agile and generate responses to the environment without necessarily losing its internal coherence.

According to the level model of Schein (1990, 1992), the organizational structure is at the artifacts level of organizational culture. The organizational structure is also an element of the cultural web (Johnson et al. 2008) and was also considered as particularly relevant to the ease with which change occurs (Senior and Fleming 2006). By examining the relationship between the internal structure of 20 British firms and the operating environment, Burns and Stalker (1961) identified the mechanistic and organic management systems. These two contrasted forms of management systems have been employed to depict organizational structures (Hayes 2007; Senior and Fleming 2006) and cultures (Kimbrough and Componation 2009; Reigle 2003). The mechanistic management system is suited to stable environments, while the organic one is appropriate to unpredictable and dynamic environments and tends to have a decentralized and adaptive internal organization. Hence, the organic type appears more capable of responding to change than the mechanistic one. Senior and Fleming (2006) claimed that the mechanistic organizational structure and the role culture (Handy 1993) were unsupportive of some types of change due to their structural characteristics and the attitudes, beliefs, and values held by the individuals working in them.

In addition, Kanter (1983) provided two extreme organizational cultures: the segmentalist culture and the integrative culture. These are not only distinct in structural characteristics but also differ in the attitudes, beliefs, and values of the organizational members. The segmentalist culture compartmentalizes events, actions, and problems, has segmented structures and weak coordination mechanisms, divides resources among departments, and avoids conflict and confrontation, as well as stresses precedents and procedures. Conversely, the integrative culture combines the ideas from unconnected sources, views problems as wholes, challenges established practices, and encourages exchange of information and ideas, as well as looks for novel solutions to problems. It is evident that the segmentalist culture stifles organizational change, while the integrative culture is supportive of change. Thus, an integrative culture linked to an organic structure is suitable for organizations to change.

Due to the pervasive nature of organizational culture, organizational change takes place within the context of an organization's culture and needs a change in the culture (Austin and Ciaassen 2008). However, changing the culture is not an easy task for an organization. The greater degree of change and the greater impact on the existing culture, the greater resistance to change and lower chance of success (Brown and Harvey 2005). Despite the difficulty in changing organizational culture, two approaches were found in previous studies. Austin and Ciaassen (2008) argued that sustainable changes in organizational culture involved changing the basic assumptions, then addressing the values level, and, finally, dealing with the cultural artifacts. However, Beer et al. (1994) advocated first changing the organizational context (such as individuals' responsibilities, roles, and the interpersonal relationship), which would result in changed behavior and associated attitudes. This was consistent with the view of Peters (1992) who advocated rapid and complete destruction of existing hierarchical organization structures as a precursor to behavioral change.

Carrying out organizational change and the sequential change in organizational culture involves motivating organizational members. The next section discusses motivation theories.

4.5 Motivation

4.5.1 Definition of Motivation

Motivation was defined as the processes that account for an individual's intensity, direction, and persistence of effort toward attaining a goal (Robbins 2003). There are various motivation theories, which predict behavior (Mitchell 1982) and describe why and how human behavior is activated and directed (Seiler et al. 2012).

These can be divided into two broad categories: content theories and process theories (Mullins 2007; Seiler et al. 2012). Content theories of motivation are concerned with identifying individuals' needs and their relative strengths, and the goals that they pursue in order to satisfy their needs. They emphasize the nature of needs and what motivates. By contrast, process theories are concerned with how behavior is initiated, directed, and sustained. They focus on the actual process of motivation (Mullins 2007). A number of authors on organizational behavior (McShane and Von Glinow 2007; Mullins 2007; Robbins 2003; Schermerhorn et al. 2011) have also provided good reviews of the literature on theories of motivation.

4.5.2 Content Theories of Motivation

Major content theories of motivation include Maslow's hierarchy of needs theory, Alderfer's ERG theory, and Herzberg's two-factor theory.

4.5.2.1 Maslow's Hierarchy of Needs Theory

Maslow (1943) identified five levels of individual needs, which range from the self-actualization and esteem needs at the top to social, safety, and physiological needs at the bottom of a pyramid, as shown in Fig. 4.1 (adapted from Maslow 1943). This theory assumes that peoples pursue these needs in a specific hierarchical order, which means that individuals turn their attention to higher order needs only after lower order ones have been met. For instance, physiological needs, which are the most basic needs, must be satisfied before safety needs are activated; safety needs must be satisfied before social needs are activated; and so on.

Despite the intuitive appeal of Maslow's theory, critics argued that his work did not have a great deal of scientific support (Heylighen 1992; Rauschenberger et al. 1980;

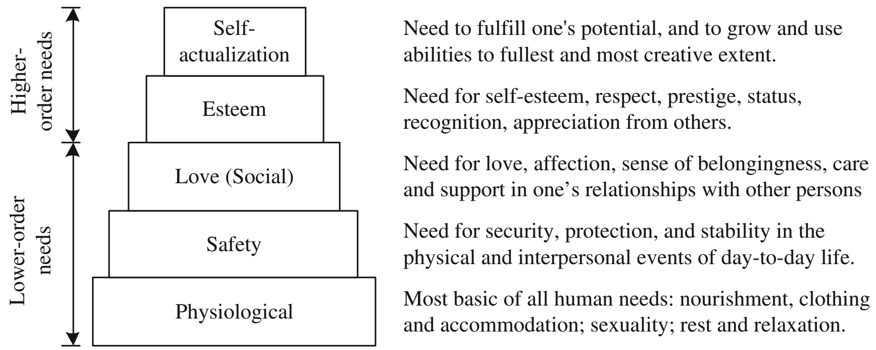


Fig. 4.1 Maslow's hierarchy of needs

Schott 1992; Wahba and Bridwell 1976). However, Maslow's theory has encouraged organizations to begin thinking broadly about what motivates their employees and laid the foundation for subsequent research on noneconomic sources of employee motivation (Stroh et al. 2002).

4.5.2.2 Alderfer's ERG Theory

The ERG theory, which was proposed by Alderfer (1969), collapses Maslow's five-need categories into three: existence needs (E), which are the basic physiological needs and protection from physical danger; relatedness needs (R), which desire for satisfying interpersonal relationships; and growth needs (G), which desire for continued personal growth and development and thus fulfill one's potential. Different from Maslow's theory, the ERG theory emphasizes a frustration–regression component. When circumstances prevent a higher level need from being fulfilled, a person shifts his or her attention to fulfillment of needs lower down the hierarchy. Thus, continual frustration in individual attempts to fulfill growth needs enables relatedness needs to be motivators. In addition, Alderfer et al. (1974) claimed that more than one need may be activated at the same time. The ERG theory provides a more flexible approach to understanding human needs than does Maslow's theory and has garnered encouraging support (Rauschenberger et al. 1980; Tracy 1984).

4.5.2.3 Herzberg's Two-Factor Theory

Herzberg (1966) argued that two categories of factors were primary sources of job satisfaction and job dissatisfaction (see Fig. 4.2). These two categories of factors are hygiene factors and motivator factors. Hygiene factors are related to a broad category of working conditions, including salary, job security, status, quality of supervision, organizational polices, and administration, as well as interpersonal relationships. Failure to fulfill employee's hygiene factors causes their job dissatisfaction. However, fulfillment of these factors does not satisfy workers. For example, low salary makes people dissatisfied but higher salary does not necessarily motivate or satisfy them. Motivator factors are sources of job satisfaction. These

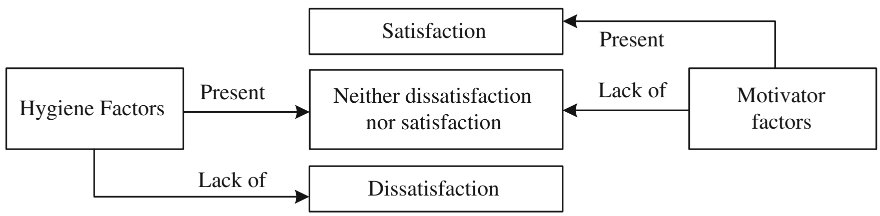


Fig. 4.2 Herzberg's two-factor theory

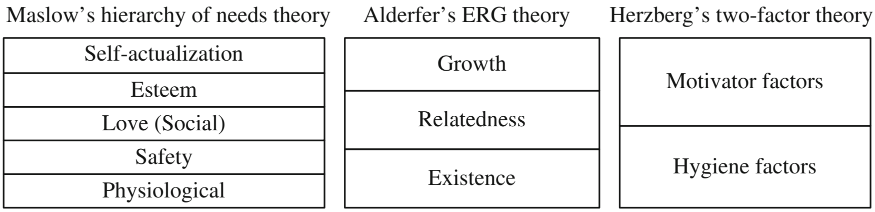


Fig. 4.3 Linking Maslow's, Alderfer's, and Herzberg's theories of motivation

factors include sense of achievement, opportunities for personal growth, recognition, autonomy, and responsibility. These factors are critical to job satisfaction, motivation, and performance.

Figure 4.3 illustrates the link between Maslow's hierarchy of needs theory, Alderfer's ERG theory, and Herzberg's two-factor theory, highlighting and matching the need components of each theory.

4.5.3 Process Theories of Motivation

Process theories of motivation include equity theory, expectancy theory, goal theory, and attribution theory. This section explains the equity theory and the expectancy theory, and examines their links with organizational change.

4.5.3.1 Equity Theory

The equity theory is based on the phenomenon of social comparison and is best known through the writing of Adams (1963, 1966). This theory posits that felt inequity is a motivating state of mind, and that people will act to reduce or eliminate such inequity in the rewards received compared with others.

People tend to make comparisons of their job inputs and outcomes relative to those of others. Inputs are what a person brings to exchange, such as time, effort, loyalty, hard work, commitment, ability, tolerance, determination, enthusiasm, personal sacrifice, trust in superiors, skill, and experience. Outcomes are what this person receives from the organization in exchange for the inputs, such as pay, recognition, fringe benefits, promotion, and status. Both inputs and outputs are weighted by their importance to the person, and these weights vary from one person to another. People tend to compare their outcome–input ratio with that of relevant others. Thus, the equity theory explains why pay alone does not determine motivation. Besides the outcome–input ratio, the referent choice is another important variable in the equity theory. People are likely to compare themselves to their friends and colleagues in their organizations, or their past jobs (Robbins 2003). The

Table 4.4 Outcome–input ratio comparisons and perceptions

Outcome–input ratio comparison	Perceptions
$O/I_A = O/I_B$	Equity
$O/I_A > O/I_B$	Positive inequity due to being over-rewarded
$O/I_A < O/I_B$	Negative inequity due to being under-rewarded

Note O/I_A represents the outcome–input ratio of the person; and O/I_B represents the outcome–input ratio of relevant others

referent choice could be influenced by gender, length of tenure, level in the organization, and amount of education or professionalism (Kulik and Ambrose 1992).

Through the comparison of the outcome–input ratio with that of others, the person may feel equity or inequity, as exhibited in Table 4.4 (adapted from Robbins 2003). Based on the equity theory, a person is motivated to reduce or eliminate his or her perception of inequity through six possible ways (Adams 1966):

1. Change the work inputs;
2. Change the outcomes;
3. Distort the inputs and outcomes cognitively;
4. Leave the field, e.g., quit the job, obtain a transfer, and absenteeism;
5. Action others, e.g., alter or cognitively distort the referent's inputs and outcomes, or force the referent to leave the field; and
6. Change the object of his or her comparison.

The equity theory can be employed to explain the sources of some resistance to organizational change (Hayes 2007). Whether individuals will be motivated to support or resist change depends on their expectation about whether the net benefits accruing to them will be equitable when compared to the net benefits accruing to the referents in the changed situation. Individuals who expect that comparable others will receive more favorable outcomes as a result of the change will feel that they are being treated unfairly, thereby resisting the change. Hence, even if expecting to receive a net increase in outcomes, people still tend to resist the change due to the perception of negative inequity. Conversely, there will be less resistance or more support when people feel they are being treated equitably relative to others. Hence, change agents need to identify the individuals who may feel that they are being treated inequitably, and explore the possibilities of improving the availability of valued outcomes for them and of redistributing costs and benefits between them in order to produce greater equity.

4.5.3.2 Expectancy Theory

The expectancy theory, originally developed by Vroom (1964), provides cognitive explanations of the human behavior that cast a person as an active, thinking, predicting creature in his or her environment. The expectancy theory indicates that work motivation is determined by individual beliefs relating to effort–performance relationships and work outcomes. People make decisions based on their perceptions of the degree to which behavior can satisfy a desired want or need. Vroom (1964) suggested that motivation was a function of expectancy, instrumentality, and valence. Expectancy refers to the perceived probability that an individual's effort will lead to a desired level of performance. Instrumentality is the perceived probability that the level of performance will lead to the attainment of a desired outcome. Valence is the perceived value of the work outcomes and ranges from −1 (very undesirable outcome) to +1 (very desirable outcome). Vroom (1964) claimed that motivation, expectancy, instrumentality, and valence were related to one another by the following equation:

$$\text{Motivation} = \text{Expectancy} \times \text{Instrumentality} \times \text{Valence} \tag{4.1}$$

The expectancy theory captures the important role of cognitions in motivation (Stroh et al. 2002). This theory suggests that managers should always try to intervene actively in work situations to maximize work expectancies, instrumentalities, and valences that support organizational objectives (Vroom 1964). The managerial implications of the expectancy theory are summarized in Table 4.5 (adapted from Schermerhorn et al. 2011).

Moreover, Hayes (2007) argued that whether individuals would be motivated to support or resist change depended on their expectations or beliefs about their ability to deliver a satisfactory level of performance (expectancy), and whether a satisfactory level of performance would lead to valued outcomes in the changed situation (instrumentality).

Individuals are more likely to resist change when they expect that the change will undermine their ability to achieve a satisfactory level of performance,

Table 4.5 Managerial implications of the expectancy theory

Variable	Managerial implications
Expectancy	Select people with the required ability
	Provide required training and clarify job requirements
	Identify clear performance goals
	Support them with sufficient resources
	Provide examples of similar people who have successfully performed the task
	Provide counseling and coaching to employees who are not confident
Instrumentality	Clarify possible rewards for performance
	Confirm performance–reward relationships by providing performance contingent rewards
	Provide examples of other people whose good performance has resulted in higher rewards
Valence	Identify the needs important to each person
	Match available rewards to the needs
	Minimize the presence of counter-valence outcomes

regardless of how hard they work. This expectation may derive from the misunderstandings about the processes and procedures to be applied in the changed situation, which is perceived to undermine their abilities to produce satisfactory performance. Thus, change agents need to help individuals develop a clear understanding of how the change will affect the way they work and their abilities to deliver satisfactory performance. The change agents need to consider redeploying some individuals to the roles that will better utilize their existing competencies, and provide training to develop more relevant competencies. Individuals should also be involved in the redeployment and the planning of the change to assure that the factors that are considered to undermine their abilities to deliver satisfactory performance will be minimized (Hayes 2007).

In addition, individuals are more likely to resist change when they expect the change to undermine their achievement of valued outcomes. Individuals may fear that they will lose some outcomes they value in the existing situation. However, they may also anticipate some gains. Hence, change agents need to empathize with them in order to gain a better understanding of how they expect the change to affect the performance–outcome relationship. Thus, managers may modify the change to strengthen the performance–outcome relationship and involve individuals in the planning of change to assure them that the change will strengthen this relationship (Hayes 2007).

4.6 Leadership

4.6.1 Definition of Leadership

Robbins (2003) defined leadership as the ability to influence a group toward the achievement of goals. The source of influence may be formal or informal. The possession of a formal managerial rank in an organization does not necessarily enable a manager to lead effectively. The ability to influence may arise outside the formal structure of an organization. Thus, management and leadership are different.

Kotter (1990, 1996) argued that management was about coping with complexity, while leadership was about coping with change. Management is a set of processes that can keep a complicated system of people and technology running smoothly and includes some important aspects, such as planning, budgeting, organizing, staffing, controlling, and problem solving. Leadership is a set of processes that creates organizations in the first place or adapts them to significantly changing circumstances. Leaders set a direction by developing a vision of the future along with strategies for producing the changes necessary to achieve the vision, align people by communicating this direction, and keep people moving in the right direction by motivation and inspiration to achieve the vision (Kotter 1990). Bedeian and Hunt (2006) suggested viewing leadership as a subset of management, yet they indicated that both were important to facilitate organizational performance.

Robbins (2003) and Mullins (2007), as well as Senior and Fleming (2006) have insightfully reviewed the literature on various theories relating to leadership.

4.6.2 Trait Theories of Leadership

Trait theories focus on the traits of leaders and consider that personal qualities and characteristics that differentiate leaders from non-leaders (Robbins 2003). Some studies revealed strong evidence of an identifiable set of personality and cognitive traits that are expected to characterize successful leaders. Lord et al. (1986) found that six traits distinguished successful leaders from others: intelligence, having an extrovert personality, dominance, masculinity, conservatism, and being better adjusted. Kirkpatrick and Locke (1991) summarized six key traits, including drive (achievement, motivation, ambition, energy, tenacity, and initiative), leadership motivation (the desire to lead but not to seek power as an end in itself), honesty and integrity, self-confidence (including emotional stability), and cognitive ability, as well as knowledge of the business.

Obviously, trait theories of leadership have some limitations. Robbins (2003) claimed that traits appeared to predict leadership in selective situations. Bass (1990b) found that more than 300 studies had failed to produce a definitive list of agreed-on traits common to all effective leaders. Additionally, trait theories involve subjective judgments in determining who is a so-called good or successful leader. Even if there are some inborn traits making for good or successful leaders, these talents still need encouragement and development (Mullins 2007).

4.6.3 Behavioral Theories of Leadership

Behavioral theories of leadership posit that specific behavior differentiates leaders from non-leaders (Robbins 2003). One of the most extensive studies on these theories was the Ohio State studies, which began at Ohio State University in the late 1940s (Stogdill and Coons 1951). The results indicated that two major dimensions accounted for leadership behavior: (1) initiating structure and (2) consideration. Initiating structure refers to the extent to which a leader is likely to define and structure his or her role and those of subordinates in the search for goal achievement, while consideration describes the extent to which a leader is likely to have job relationships characterized by mutual trust, respect for subordinates' ideas and regard for their feelings.

Similarly, the studies undertaken at the University of Michigan proposed two dimensions of leadership behavior: (1) employee-oriented and (2) production-oriented (Likert 1961). Employee-oriented leaders, also known as person-oriented leaders, emphasized interpersonal relations. They cared about the needs of their employees and accepted individual differences among members. In contrast, production-oriented leaders, also known as task-oriented leaders, tended to be more concerned with the accomplishment of their groups' tasks.

It merits attention that employee-oriented leadership is similar to consideration, and production-oriented leadership is similar to initiating structure (Robbins and Judge 2007). In the Michigan studies, employee-oriented leaders were found to be associated with higher group productivity and higher job satisfaction, while production-oriented leaders were associated with low productivity and low job satisfaction. Hence, the Michigan studies emphasized employee-oriented leadership over production-oriented leadership. However, the Ohio State studies concluded that both consideration and initiating structure were important to effective leadership.

In addition, Blake and Mouton (1964) proposed a managerial grid based on the styles of concern for people and concern for production. These styles represent the dimensions of consideration or employee-oriented leadership and initiating structure or employee-oriented leadership. Blake and Mouton (1964) found that managers performed best under a 9,9 style. However, they did not really provide any new information in addition to the above two studies (Robbins and Judge 2007).

4.6.4 Contingency Theories of Leadership

Contingency theories of leadership propose that the best leadership style can only be determined when the situation (task) and the followers (willingness, training, interdependence, etc.) are considered. Certain situations and certain follower types need certain leadership styles (Mills et al. 2009). Major contingency theories of leadership include Fielder's contingency model, the path-goal theory, Hersey and Blanchard's situational leadership theory, and Vroom and Yetton's leader-participation model.

4.6.4.1 Fielder's Contingency Model

Fielder's (1967) contingency model proposes that effective group performance depends on the appropriate match between the leader's style and the degree to which the situation gives control to the leader. For identifying the leadership style, Fiedler (1967) created the least preferred co-worker (LPC) scale in which the leaders were asked about the person with whom they least enjoyed working. The scale was a questionnaire consisting of 16 items used to reflect a leader's underlying disposition toward others. Fiedler (1967) stated that leaders with high LPC scores would be relationship-oriented (person-oriented) and the ones with low scores would be task-oriented. In addition, Fiedler (1967) identified three contingency dimensions, which defined key situational factors that would strongly influence leadership effectiveness. These were given as follows:

1. Leader–follower relationship: The degree of confidence, trust, and respect members have in their leader.
2. Task structure: The degree to which the group's task is structured or unstructured.
3. Position power: The power of the leader by virtue of the organizational position and the degree to which the leader can exercise authority on group members in order to comply with and accept his direction and leadership.

Hence, eight combinations of group-task situations were constructed by Fiedler (1967) who argued that leadership effectiveness may be improved by changing the leadership situation. Leader–follower relations, task structure, and position power can be changed to make the situation more compatible with the characteristics of the leader. As shown in Table 4.6 (adapted from Fiedler 1967), when the situation is very favorable (good leader–follower relationship, structured task, and strong position power) or very unfavorable (poor leader–follower relationship, unstructured task, and weak position power), a task-oriented leader (low LPC score) would be more effective. When the situation was moderately favorable and the variables were mixed, a relationship-oriented leader would be more effective.

4.6.4.2 Path-Goal Theory

Developed by House (1971, 1996), the path-goal theory maintains that it is the leaders' job to assist followers in achieving their goals and to provide the necessary direction and/or support to ensure that their goals are compatible with overall organization objectives.

House (1996) identified four leadership behaviors. The directive leader gives specific guidance of performance to followers. The supportive leader is friendly and shows concerns for the needs of followers. The participative leader consults with followers and considers their suggestions before making decisions. The achievement-oriented leader sets high goals and expects followers to have high-level performance. In contrast to Fiedler's (1967) model, House (1996) assumed that

Table 4.6 Fiedler's contingency model

Category	Leadership-member relationships	Task structure	Position power	Leadership style
1	Good	Structured	Strong	Task-oriented style recommended
2	Good	Structured	Weak	
3	Good	Unstructured	Strong	
4	Good	Unstructured	Weak	Relationship-oriented recommended
5	Poor	Structured	Strong	
6	Poor	Structured	Weak	
7	Poor	Unstructured	Strong	Task-oriented style recommended
8	Poor	Unstructured	Weak	

leaders are flexible and that the same leader can practice different types of behavior at different times in varying situations.

4.6.4.3 Situational Leadership Theory

Hersey and Blanchard (1974, 1993) developed the situational leadership theory, which argued that the right leadership style should be contingent on the readiness of the leaders' followers. The readiness refers to the extent to which people have the ability and willingness to accomplish a specific task. The most effective behavior depends on the ability and motivation of a follower. The situational leadership theory provides four scenarios:

1. If followers are unable and unwilling to do a task, the leader needs to give clear and specific guidance but with limited supportive behavior (telling);
2. If followers are unable but willing, the leader needs to display high task orientation and high relationship (selling);
3. If the followers are able but unwilling, the leader needs to emphasize two-way communication and supportive behavior but with limited guidance (participating); and
4. If the followers are able and willing, the leader does not need to do much (delegating).

4.6.4.4 Leader-Participation Model

Vroom and Yetton (1973) developed a leader-participation model that related leadership behavior and participation in decision-making. This model consists of a sequential set of rules which should be followed in determining the form and amount of participation in decision-making. This model is a decision tree incorporating seven contingency variables and five leadership styles. The leadership styles range from the leader's making decisions completely by himself or herself to sharing the problem with the group and developing a consensus decision. Vroom and Jago (1988) revised this model and expanded the contingency variables to twelve. These variables relate to quality requirement, commitment requirement, leader information, problem structure, commitment probability, goal congruence, subordinate conflict, subordinate information, time constraint, geographic dispersion, and motivation time, as well as motivation development.

4.6.5 Transformational Leadership

Burns (1978) developed the initial ideas on transactional and transformational leadership in the political context. Bass (1985) applied these concepts to the organizational context. Most of the leadership theories (trait, behavior, and contingency theories) focus on transactional leadership (Mills et al. 2009). Transactional leadership is based on legitimate authority within the bureaucratic structure of the organization. It emphasizes the clarification of goals and objectives, tasks and outcomes, as well as organizational rewards and punishments. Followers obtain some valued outcomes when they act according to the leader's wishes (Bass 1985; Burns 1978). By contrast, transformational leadership occurs when leaders broaden and elevate the interests of their followers, when they generate awareness and acceptance of the purposes and mission of the group, and when they inspire their followers to transcend their own interests for the good of the group (Bass 1990a). Transformational leadership is also associated with terms such as "visionary" and "charismatic" leadership (Keegan and Den Hartog 2004).

Transformational leadership is composed of four basic components: (1) idealized influence (charisma of the leader, and the respect and admiration of the followers); (2) individualized consideration (the concern of the leaders to the growth and developmental needs of followers); (3) intellectual stimulation (motivation for followers to propose new approaches for improving work performance and creative problem solutions); and (4) inspirational motivation (the behavior of the leader which provides meaning and challenge to the followers' work) (Bass and Avolio 1990). The followers of transformational leaders were found to show higher levels of commitment to their organizational mission, a willingness to work harder, greater levels of trust in their leader, and higher levels of cohesion (Avolio 1999). However, transformational leadership does not detract from transactional; rather it builds on top of the transactional base to augment leader effectiveness (Bass and Avolio 1990). The best leaders should typically display both transformational and transactional leadership (Bass and Avolio 1993).

4.6.6 Leadership in Times of Change

Leadership was found to be the key to successful change (AMA 1994). The characteristics and behavior of the organizational leaders who act as change agents influence the success or failure of organizational change initiatives (Battilana et al. 2010). All leaders must act as role models, tackle resistance, create readiness for change, and build commitment at all levels of an organization (Holbeche 2006). They have to develop a constructive process, get people involved in the change process, provide clear change goals, and help develop a culture supportive of learning and experimentation. The key attributes for effective change leaders are honesty/integrity/trustworthiness, inspiration, competence, high level of emotional intelligence, and strong interpersonal skills (Graetz et al. 2006). Task-oriented behavior and person-oriented behavior (Likert 1961; Stogdill and Coons 1951) were important to influence organizational change (Nadler and Tushman 1999). As Beer and Nohria (2000b) indicated, leaders adopting Theory E tended to be more task-oriented, while leaders adopting Theory O would be more person-oriented.

Transformational leadership seemed to be appropriate for leading change (Eisenbach et al. 1999; Holbeche 2006; Senior and Fleming 2006). Tichy and Devanna (1986) suggested that transformational leaders engaged in a process which consisted of three sequential phases: recognizing the need for revitalization, creating a new vision, and institutionalizing change. Bommer et al. (2005) found that transformational leadership was associated with lower employees' cynicism about organizational change. Herold et al. (2008) found that transformational leadership was significantly positively related to followers' support for change but not associated with leaders' change-appropriate behavior. Dulewicz and Higgs (2004) found a preference for transformational leadership style on complex change projects and a preference for transactional leadership style on simple change projects. However, Jaskyte and Dressler (2005) indicated that transformational leadership was not significantly correlated with the organization's ability to implement change in nonprofit human service organizations.

In addition, as the contingency theories of leadership have indicated, leadership styles should vary according to the different characteristics of different situations, which included an organization's stage of development and the nature of the change process, as well as the forces that drive and resist organizational change (Senior and Fleming 2006). Dunphy and Stace (1993) linked four styles of change leadership (collaborative, consultative, directive, and coercive) with four types of change (fine-tuning, incremental adjustment, modular transformation, and corporate transformation). Transformational change tended to demand directive/coercive leadership.

Furthermore, the leadership of change should take account of both drivers for and resistance to change (Strebel 1994). Hence, leading change is concerned with overcoming the resistance to change (Tichy and Devanna 1986), which depends on the identification of the sources of resistance. It also depends on leaders' ability to be task-oriented (both strategically and tactically) when time requires it, and to be person-oriented to deal with more individualized resistance to change (Senior and Fleming 2006).

Several errors made by leaders tend to undermine the organizational change programs. Kotter (1995, 1996) suggested that transformational change efforts failed through eight big errors of leaders: not establishing a great enough sense of urgency, not creating a sufficiently powerful guiding coalition, lacking a vision, under-communicating the vision by a factor of ten, permitting obstacles to the new vision, not systematically planning for and creating short-term wins, declaring victory too soon, and not anchoring changes in the corporate culture. Kotter (1995, 1996) also proposed an eight-stage process for leading organizational change of any magnitude (see Fig. 4.4). Each stage is associated with one of the eight errors.

More recently, Battilana et al. (2010) emphasized three key activities involved in the implementation of planned organizational change: communicating the need for organizational change, mobilizing others to support the change, and evaluating the change implementation. They found that leaders who were more effective at person-oriented behavior were more likely to focus on the communicating activities in implementing planned organizational change, and that leaders who were more

1 Establishing a Sense of Urgency
Examining market and competitive realities
Identifying and discussing crises, potential crises, or major opportunities

2 Forming a Powerful Guiding Coalition
Assembling a group with enough power to lead the change effort
Encouraging the group to work together as a team

3 Creating a Vision
Creating a vision to help direct the change effort
Developing strategies for achieving that vision

4 Communicating the Vision
Using every vehicle possible to communicate the new vision and strategies
Teaching new behaviors by the example of the guiding coalition

5 Empowering Others to Act on the Vision
Getting rid of obstacles to change
Changing systems or structures that seriously undermine the vision
Encouraging risk taking and nontraditional activities and actions

6 Planning for and Creating Short-Term Wins
Planning for visible performance improvements, or "wins"
Creating those improvements
Visibly recognizing and rewarding employees involved in the improvements

7 Consolidating Improvements and Producing More Change
Using increased credibility to change systems, structures, and policies that do not fit the vision
Hiring, promoting, and developing employees who can implement the vision
Reinvigorating the process with new projects, themes, and change agents

8 Institutionalizing New Approaches
Creating better performance through customer- and productivity-oriented behavior, more and better leadership, and more effective management
Articulating the connections between the new behaviors and corporate success
Developing the means to ensure leadership development and succession

Fig. 4.4 Kotter's eight-stage process for leading change

effective at task-oriented behavior were more likely to focus on both the mobilizing and evaluating activities.

4.7 Relationships Among the Theories of Organizational Behavior

This section elaborates the relations among organizational change, organizational learning, organizational culture, motivation, and leadership theories. As shown in Fig. 4.5, organizational change is affected by a number of factors, which are indicated by arrows pointing to organizational change. These factors can further be

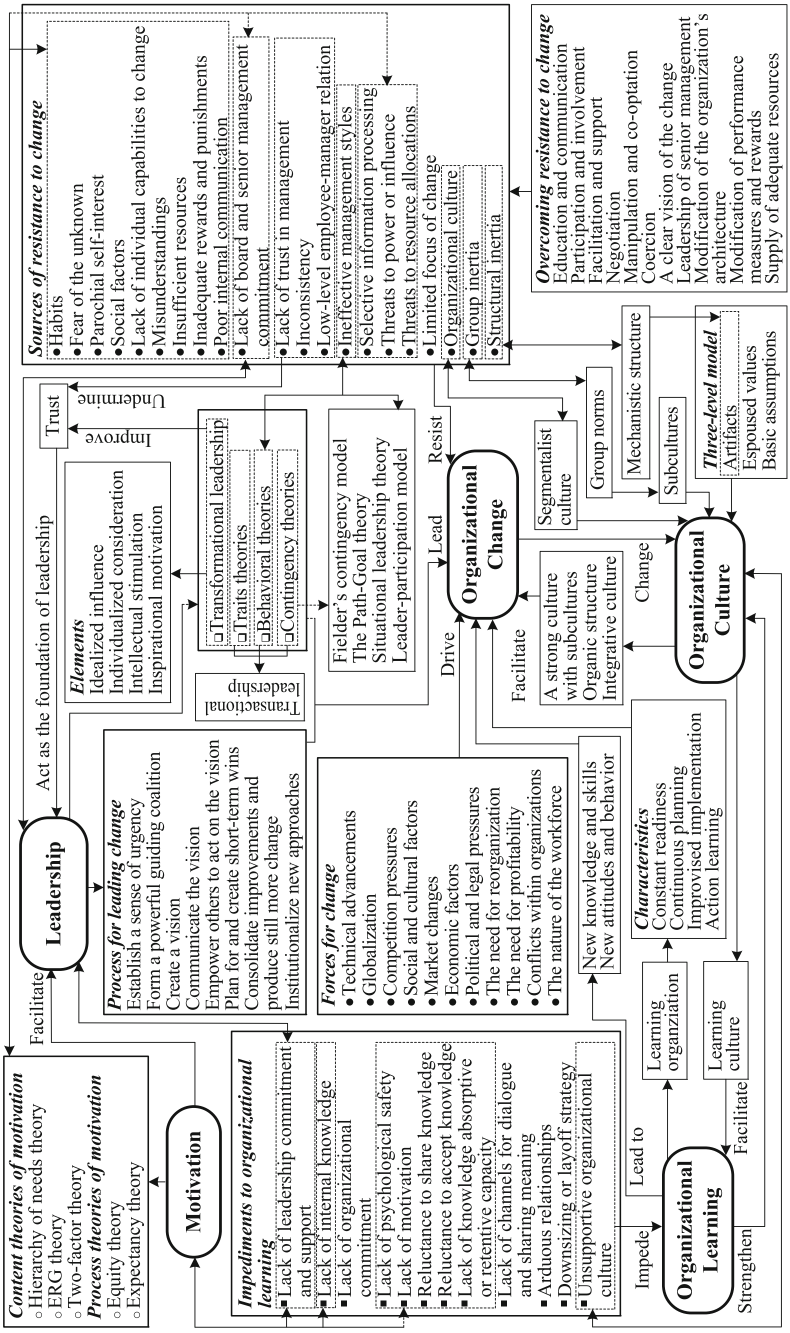


Fig. 4.5 Relationships among theories of organizational change, organizational learning, organizational culture, motivation, and leadership

linked to the other four theories of organizational behavior, indicating that the other four theories can indirectly affect organizational change.

There are forces that drive and resist organizational change. Driving forces derive from the internal and external environments of organizations, while resistance to change tends to stem from inside the organizations, at the individual and organizational levels. As Fig. 4.5 indicates, some sources of resistance to change shown in the dash-line boxes can be linked to other organizational behavior theories.

Organizational change tends to take place within the culture of an organization due to the pervasive nature of the organizational culture (Austin and Ciaassen 2008). Unsupportive organizational culture, structural inertia, and group inertia are the sources of resistance that can be linked to the organizational culture theory. Some types of organizational culture are unsupportive of change. For instance, although a strong culture contributes to the cohesion, organizational commitment, and desirable behavior, it is likely to undermine the organization's ability to respond to change (Nemeth 1997). The segmentalist culture (Kanter 1983) is an extreme example that stifles organizational change.

In addition, according to the level model of Schein (1990, 1992), organizational structure is at the observable artifacts level of organizational culture. The mechanistic organizational structure (Burns and Stalker 1961) is a type of structure suitable for the stable environment and unsupportive of some types of change (Senior and Fleming 2006).

Moreover, group inertia tends to be the result of group norms, which can be considered as a subculture of the organization. Such norms tend to distinguish appropriate and inappropriate behavior and identify the tasks and roles within the group. Some group norms may reduce the willingness of group members to change and thus hinder organizational change. However, subcultures may also propagate the dominant organizational culture, prevent individuals from blindly following one set of values (McShane and Von Glinow 2007; Sinclair 1993), and enable organizations to be more appropriate to the changing environment (Boisnier and Chatman 2003). Hence, a strong culture with several subcultures tends to be appropriate to change. However, if the dominant culture is unsupportive of change, cultural change is necessary. An integrative culture linked to an organic structure tends to facilitate organizational change.

Some of the sources of resistance to change can be linked to motivation theories. According to the two-factor theory of Herzberg (1966), salary, rewards, job security, status, psychological safety, and power are hygiene factors. Hence, failure to fulfill the hygiene factors can be related to the following sources of resistance: habits, parochial self-interest, inadequate rewards, and punishments, as well as threats to power, influence, and resource allocation. These sources will bring about job dissatisfaction and resistance to change. Other content theories of motivation are also applicable to the sources of resistance. For instance, some social factors may be linked to the esteem needs and love (social) needs in Maslow's (1943) hierarchy of needs theory, and the relatedness in Alderfer's (1969) ERG theory.

In addition, inadequate rewards and punishments during the change process may affect the expectation of individuals over whether their net benefits will be equitable in comparison with the net benefits of others in the changed situation. According to the equity theory, individuals who expect inequity in the changed situation will be motivated to resist the proposed change.

Moreover, according to Vroom's (1964) expectancy theory, motivation is a function of expectancy, instrumentality, and valence. These three variables can be linked to some sources of resistance to change. Insufficient resources and lack of capability to change tend to make individuals feel they are unable to achieve the desired performance. Lack of the board and senior management commitment indicates that the change is not perceived as a priority by the leaders, so the resources for the change cannot be ensured and individuals tend to be skeptical about the change. Poor internal communication mechanisms and selective information processing can lead to misunderstandings. The misunderstandings by individuals over the processes and procedures of the change may lead to individuals' perceptions that the change would undermine their ability to deliver satisfactory performance. Hence, these sources of resistance tend to lower the expectancy variable and the motivation to change. Inadequate rewards can lead to misunderstandings about the performance–outcome relationship and thus affect individuals' judgments on the instrumentality. If the change is perceived to threaten individuals' interests, accustomed ways and psychological safety, or some groups' power, influence, and resource allocations, the values of the outcomes for them will be undesirable, which indicates low valence and low motivation to change. Therefore, the motivation mechanisms of an organization with change initiative should concern individuals' and groups' needs, increase the expectancy, instrumentality, and valence, and try to avoid inequitable rewards. Such motivation mechanisms can also facilitate the leadership of change agents.

Leadership is necessary and key to the success of organizational change. Several sources of resistance to change can be linked to the leadership theories. Trust is the foundation of leadership and the effectiveness of leadership depends on the ability to gain the trust of followers (Robbins 2003). Inconsistency in change agents' words and the actual change initiative will threaten individuals' trust in change agents. In times of change, individuals will turn to personal relationships for guidance. A low level of employee–manager relationships indicates a low level of trust in change agents. Lack of trust in management arises from doubts of employees about the change agents' abilities to lead an effective change, thus resulting in skepticism and cynicism about the change. Therefore, these three sources of resistance tend to undermine individuals' trust in change agents, and thereby weaken the leadership of change agents. Furthermore, management styles of change agents also influence individuals' attitudes and readiness to change. Szabla (2007) found that collaborative change leaders tended to be effective in reducing resistance to change, while leaders using power and coercion seemed to be ineffective. The behavioral theories and contingency theories of motivation concern selecting appropriate and effective management styles. According to the contingency theories of leadership, the best leadership style can only be determined when the situation and the followers are considered. Ineffective management styles usually fail to match the situation and followers.

Compared to transactional leaders (trait, behavior, and contingency theories of leadership), transformational leaders inspire their followers to transcend their own interests for the good of the organization (Bass 1990a). Transformational leadership is composed of idealized influence, individualized consideration, intellectual stimulation, and inspirational motivation (Bass and Avolio 1990) and has been considered appropriate for leading change (Eisenbach et al. 1999; Holbeche 2006; Senior and Fleming 2006). Transformational leadership can improve the trust of followers in their leader (Avolio 1999) and lower their cynicism about change (Bommer et al. 2005). However, it merits attention that both transformational and transactional leadership are necessary for leading organizational change (Kanter 1992; Tourish and Pinnington 2002). Regardless of leadership styles, change leaders have to follow a process to implement organizational change. Kotter's (1995, 1996) eight-stage process can be used for leading organizational change of any magnitude.

Organizational learning is necessary for organizations to respond to the external environment (Clarke 1994; Nadler 1993). Organizational learning has been considered as a medium (Alas and Sharifi 2002) or preconditions for change (Pettigrew and Whipp 1993). Organizational learning results in new knowledge and skills, as well as new attitudes and behavior (Mullins 2007). Organizational learning and the learning organization can and should co-exist (Gorelick 2005). A learning organization typically has four characteristics: constant readiness, continuous planning, improvised implementation, and action learning (Rowden 2001), which contribute to the organization's readiness to change and improve its ability to respond to change.

There are also several impediments to organizational learning in the literature, which would indirectly impede organizational change. As indicated in Fig. 4.5, some impediments in the dash-line boxes can be linked to the organizational culture, motivation, and leadership theories. Organizational culture unsupportive of learning, which is embodied by blame culture and defensive routines, can be linked to the organizational culture theory. A learning culture, which requires people to have "a willingness to embrace the dynamic challenges to learn while they work and work while they learn" (Burghardt and Tolliver 2010: p. xi), facilitates organizational learning. In turn, organizational learning can contribute to the strength and degree of internal consistency of an organizational culture (Schein 1990).

Moreover, motivation is necessary for sharing and accepting knowledge. Individuals may be reluctant to spend time sharing knowledge because of the time constraint (Husted and Michailova 2002) and the fear of losing privilege and superiority (Szulanski 1996). Individuals may also be reluctant to accept the knowledge due to idleness. Hence, measures should be taken to motivate people to share and accept knowledge, thereby facilitating organizational learning.

Furthermore, the commitment and support of the leaders is essential for organizational learning in terms of cultivating a learning culture, creating psychological safety and organizational commitment, and institutionalizing organizational learning mechanisms (Popper and Lipshitz 2000). Lack of leadership commitment and support to organizational learning can be linked to the leadership theory. In addition, leaders also need to allocate resources for learning. Hence, lack of leadership commitment and support will lower people's expectancy variable in Vroom's (1964) expectancy theory and can thus be linked to motivation theory. Similarly, lack of internal knowledge and lack of knowledge absorptive and retentive capability make people feel that the probability that their efforts cause desirable performance is relatively low. In addition, psychological safety is a hygiene factor of Herzberg's (1966) two-factor theory, which can be represented by fear of the unknown, social factors, and self-interest in the sources of resistance to change. Failure to fulfill this factor leads to job dissatisfaction and thus impedes organizational learning.

It is worth noting that some impediments to organizational learning overlap the sources of resistance to organizational change, such as lack of psychological safety, unsupportive organizational culture, lack of leadership commitment and support, and arduous relationships, as well as lack of motivation. This also suggests that the impediments to organizational learning indirectly raise the resistance to organizational change.

4.8 Summary

ERM can be considered as a change from silo-based risk management to holistic and integrated risk management. Implementing ERM in construction firms is also an organizational change because individuals in these firms tend to be accustomed to PRM. Besides driving forces, this change also encounters resistance arising from the organization or individuals, and influence from other aspects of organizational behavior. In this chapter, five theories of organizational behavior, including organizational change, organizational learning, organizational culture, motivation, and leadership, are reviewed. In addition, the relationships among these organizational behavior theories are presented by linking organizational change to the other four theories. The literature review in this chapter sets the foundation for interpreting the critical drivers for and hindrances to ERM implementation, as stated in the fourth research objective.

References

Adams JS (1963) Towards an understanding of inequity. J Abnorm Soc Psychol 67(5):422–436

Adams JS (1966) Inequity in social exchange. In: Berkowitz L (ed) Advances in experimental social psychology. Academic Press, New York, pp 267–299

Alas R, Sharifi S (2002) Organizational learning and resistance to change in Estonian companies. Hum Res Dev Int 5(3):313–331

Alderfer CP (1969) An empirical test of a new theory of human needs. Organ Behav Hum Perform 4(2):142–175

Alderfer CP, Kaplan RE, Smith KK (1974) The effect of variations in relatedness need satisfaction on relatedness desires. Adm Sci Q 19(4):507–532

AMA (1994) Survey on change management. American Management Association, New York

Anderson JR, Greeno JG, Reder LM, Simon HA (2000) Perspectives on learning, thinking, and activity. Educ Researcher 29(4):11–13

Argyris C (1977) Double loop learning in organizations. Harvard Bus Rev 55(5):115–125

Argyris C (1986) Skilled incompetence. Harvard Bus Rev 64(5):74–79

Argyris C (1990) Overcoming organizational defences: facilitating organizational learning. Allyn & Bacon, Boston

Argyris C (1995) Action science and organizational learning. J Manag Psychol 10(6):20–26

Argyris C, Schön D (1978) Organizational learning: a theory-in-action perspective. Addison-Wesley, Reading

Argyris C, Schön D (1996) Organizational learning II: theory, method and practice. Addison-Wesley, Reading

Ashkanasy NM, Broadfoot LE, Falkus S (2000) Questionnaire measures or organizational culture. In: Ashkanasy NM, Wilderom PM, Peterson MF (eds) Handbook of organizational culture and climate. Sage, Thousand Oaks, pp 131–145

Atak M, Erturgut R (2010) An empirical analysis on the relation between learning organization and organizational commitment. Procedia Soc Behav Sci 2(2):3472–3476

Austin MJ, Ciaassen J (2008) Impact of organizational change on organizational culture. J Evid Based Soc Work 5(1):321–359

Avolio BJ (1999) Full leadership development: building the vital forces in organizations. Sage, Thousand Oaks

Bass BM (1985) Leadership and performance beyond expectations. Free Press, New York

Bass BM (1990a) From transactional to transformational leadership: learning to share the vision. Org Dyn 18(3):19–31

Bass BM (1990b) Stogdill's handbook of leadership: theory, research, and managerial applications, 3rd edn. Free Press, New York

Bass BM, Avolio BJ (1990) Developing transformational leadership: 1992 and beyond. J Eur Ind Training 14(5):21–27

Bass BM, Avolio BJ (1993) Transformational leadership: a response to critiques. In: Chemmers M, Ayman R (eds) M., Leadership theory and research: perspectives and directions. Academic Press, San Diego, pp 49–88

Bate P (1998) Strategies for cultural change. Butterworth-Heinemann, Oxford

Battilana J, Gilmartin M, Sengul M, Pache AC, Alexander JA (2010) Leadership competencies for implementing planned organizational change. Leadersh Quart 21(3):422–438

Bedeian AG, Hunt JG (2006) Academic amnesia and vestigial assumptions of our forefathers. Leadersh Q 17(2):190–205

Beer M (2001) How to develop an organization capable of sustained high performance: embrace the drive for results-capability development paradox. Org Dyn 29(4):233–247

Beer M, Nohria N (2000a) Cracking the code of change. Harvard Bus Rev 78(3):133–141

Beer M, Nohria N (2000b) Breaking the code of change. Harvard Business Press, Boston

Beer M, Nohria N (2000c) Resolving the tension between theories E and O of change. In: Beer M, Nohria N (eds) Breaking the code of change. Harvard Business School Press, Boston, pp 1–34

Beer M, Eisenstat R, Spector B (1994) Why change programs don't produce change. In: Mabey C, Mayon-White B (eds) Managing change, 2nd edn. Paul Chapman Publishing, London, p 309

Benjamin G, Mabey C (1993) Facilitating radical change. In: Mabey C, Mayon-White B (eds) Managing change. The Open University/Paul Chapman Publishing, London, pp 181–186

Bennett R (1998) Charities, organisational learning and market orientation: a suggested measure of the propensity to behave as a learning organisation. J Mark Pract Appl Mark Sci 4(1):5–25

Bereiter C (2002) Education and mind in the knowledge age. Lawrence Erlbaum, Hillsdale

Blake RR, Mouton JS (1964) The managerial grid: key orientations for achieving production through people. Gulf, Houston

Boisnier A, Chatman JA (2003) The role of subcultures in agile organizations. In: Peterson R, Mannix E (eds) Leading and managing people in dynamic organizations. Lawrence Earlbaum Associates, Mahwah, pp 87–112
Bommer WH, Rich GA, Rubin RS (2005) Changing attitudes about change: longitudinal effects of transformational leader behavior on employee cynicism about organizational change. J Organ Behav 26(7):733–753
Brimley V, Garfield RR (2009) Financing education in a climate of change, 10th edn. Pearson Allyn and Bacon, Boston
Brown A (1995) Organizational culture. Pitman, London
Brown JS, Duguid P (1991) Organizational learning and communities-of-practice: toward a unified view of working, learning, and innovation. Organ Sci 2(1):40–57
Brown DR, Harvey D (2005) An expertimental approach to organizational development, 7th edn. Pearson Prentice Hall, Upper Saddle River
Burghardt S, Tolliver W (2010) Stories of transformative leadership in the human services: why the glass is always full. Sage, Singapore
Burnes B (2004) Managing change: a strategic approach to organisational dynamics. Financial Times Prentice Hall, Harlow
Burnes B, Cooper C, West P (2003) Organisational learning: the new management paradigm? Manag Decis 41(5):452–464
Burns JM (1978) Leadership. Harper and Row, New York
Burns T, Stalker GM (1961) The management of innovation. Tavistock, London
Child J (1972) Organizational structure, environment and performance: the role of strategic choice. Sociology 6(1):1–22
Choi M, Ruona WEA (2011) Individual readiness for organizational change and its implications for human resource and organization development. Hum Resour Dev Rev 10(1):46–73
Clarke L (1994) The essence of change. Prentice Hall, London
Coch L, French JRP (1948) Overcoming resistance to change. Hum Relat 1(4):512–532
Cohen WM, Levinthal DA (1990) Absorptive capacity: a new perspective on learning and innovation. Adm Sci Q 35(1):128–152
Cummings T, Worley CG (2005) Organization development and change, 8th edn. Thompson South-Western, Mason
Davenport TH, Prusak L (1998) Working knowledge: how organization manage what they know. Harvard Business School Press, Boston
Deal TE, Kennedy AA (1982) Corporate cultures: the rites and rituals of corporate life. Addison-Wesley, Reading
Dent EB, Goldberg SG (1999) Challenging "resistance to change". J Appl Behav Sci 35(1):25–41
DiBella AJ, Nevis EC (1998) How organizations learn: an integrated strategy for building learning capability. Jossey-Bass, San Francisco
Dimovski V, Škerlavaj M, Kimman M, Hernaus T (2008) Comparative analysis of the organisational learning process in Slovenia, Croatia, and Malaysia. Expert Syst Appl 34 (4):3063–3070
DiTomaso N (1987) Symbolic media and social solidarity: the foundations of corporate culture. Res Sociol Organ 5:105–134
Dixon NM (1997) The hallways of learning. Org Dyn 25(4):23–34
Dulewicz S, Higgs M (2004) Design of a new instrument to assess leadership dimensions and styles. Sel Dev Rev 20(2):7–12
Dunphy D (2000) Embracing paradox: top-down versus participative management of organizational change. In: Beer M, Nohria N (eds) Breaking the code of change. Harvard Business School Press, Boston, pp 123–135
Dunphy D, Stace D (1993) The strategic management of corporate change. Hum Relat 46(8):905–920
Edmondson A (1999) The view through a different lens: investigating organizational learning at the group level of analysis. In: Proceedings of the 3rd international conference on organizational learning. Lancaster, UK, pp 6–8

Egan G (1988) Change-agent skills B: managing innovation and change. University Associates, San Diego

Eisenbach R, Watson K, Pillai R (1999) Transformational leadership in the context of organizational change. J Organ Change Manag 12(2):80–89

Ellström PE (2010) Organizational learning. In: Penelope P, Eva B, Barry M (eds) International encyclopedia of education. Elsevier, Oxford, pp 47–52

Engeström Y (1999) Innovative learning in work teams: analyzing cycles of knowledge creation in practice. In: Engeström Y, Miettinen R, Punamaki RL (eds) Perspectives on activity theory. Cambridge University Press, Cambridge, pp 377–404

Fiedler FE (1967) A theory of leadership effectiveness. McGraw-Hill, New York

Fiol CM, Lyles MA (1985) Organisational learning. Acad Manag Rev 10(4):803–813

Fisher SR, White MA (2000) Downsizing in a learning organization: Are there hidden costs? Acad Manag Rev 25(1):244–251

Ford BY, Ford LW (2009) Decoding resistance to change. Harvard Bus Rev 87(4):99–104

Fuegen K, Brehm JW (2004) The intensity of affect and resistance to social influence. In: Knowles ES, Linn JA (eds) Resistance and persuasion. Lawrence Erlbaum, Mahwah, pp 39–64

Furst SA, Cable DM (2008) Employee resistance to organizational change: managerial influence tactics and leader-member exchange. J Appl Psychol 93(2):453–462

García-Morales V, Lopez-Martín FJ, Llamas-Sánchez R (2006) Strategic factors and barriers for promoting educational organizational learning. Teach Teach Edu 22(4):478–502

Garratt B (1995) The learning organisation: an old idea that has come of age. People Manag 1 (9):25–28

Garvin DA (1993) Building a learning organization. Harvard Bus Rev 71(4):78–91

George JM, Jones GR, Sharbrough WC (2008) Understanding and managing organizational behavior, 5th edn. Pearson Prentice Hall, Upper Saddle River

Gersick CJG (1991) Revolutionary change theories: a multilevel exploration of the punctuated equilibrium paradigm. Acad Manag Rev 16(1):10–36

Giangreco A, Peccei R (2005) The nature and antecedents of middle manager resistance to change: evidence from an Italian context. Int J Hum Res Manag 16(10):1812–1829

Goeser L, Davenport T (1996) How can David Martin save the company and take it into the future. Harvard Bus Rev 74(3):27–28

Gordon GG, DiTomaso N (1992) Predicting corporate performance from organizational culture. J Manag Stud 29(6):783–798

Gorelick C (2005) Organizational learning vs learning organization: a conversation with a practitioner. Learn Organ 12(4):383–388

Graetz F, Rimmer M, Lawrence A, Smith A (2006) Managing organizational change, 2nd Australasian edn. Wiley, Milton

Handy CB (1993) Understanding organizations, 4th edn. Penguin, London

Hayes J (2007) The theory and practice of change management, 2nd edn. Palgrave Macmillan, New York

Hedberg B (1981) How organizations learn and unlearn. In: Nystrom PC, Starbuck WH (eds) Handbook of organizational design. Oxford University Press, Oxford, pp 3–27

Herold DM, Fedor DB, Caldwell S, Liu Y (2008) The effects of transformational and change leadership on employees' commitment to a change: a multilevel study. J Appl Psychol 93 (2):346–357

Hersey P, Blanchard KH (1974) So you want to know your leadership style? Training Dev J 28 (2):22–37

Hersey P, Blanchard KH (1993) Management of organizational behavior: utilizing human resources, 6th edn. Prentice Hall, Englewood Cliffs

Herzberg FI (1966) Work and the nature of man. World, Cleveland

Heylighen F (1992) A cognitive systemic reconstruction of maslow's theory of self-actualization. Behav Sci 37(1):39–58

Holbeche L (2006) Understanding change: theory, implementation and success. Elsevier, Boston

House RJ (1971) A path goal theory of leader effectiveness. Adm Sci Q 16(3):321–339

House RJ (1996) Path goal theory of leadership: lessons, legacy and a reformulated theory. Leadersh Q 7(3):323–352

Huber GP (1991) Organizational learning: the contributing processes and the literatures. Organ Sci 2(1):88–115

Husted K, Michailova S (2002) Diagnosing and fighting knowledge-sharing hostility. Org Dyn 31 (1):60–73

Janjua SY, Sobia J (2010) The change drivers in business context: evidence from Pakistan. World 2(3):101–114

Jaskyte K, Dressler WW (2005) Organizational culture and innovation in nonprofit human service organizations. Adm Soc Work 29(2):23–41

Jerez-Gómez P, Céspedes-Lorente J, Valle-Cabrera R (2005) Organizational learning capability: a proposal of measurement. J Bus Res 58(6):715–725

Jick TD (1995) Accelerating change for competitive advantage. Org Dyn 24(1):77–82

Johnson G, Scholes K, Whittington R (2008) Exploring corporate strategy, 8th edn. Financial Times Prentice Hall, Harlow

Kaestle P (1990) A new rationale for organizational structure. Strategy Leadersh 18(4):20–27

Kanter RM (1983) The change masters: innovation and entrepreneurship in the american corporation. Simon & Schuster, New York

Kanter RM (1992) When giants learn to dance. Routledge, London

Keegan AE, Den Hartog DN (2004) Transformational leadership in a project-based environment: a comparative study of the leadership styles of project managers and line managers. Int J Proj Manag 22(8):609–617

Kim DH (1993) The link between individual and organizational learning. Sloan Manag Rev 35 (1):37–50

Kimbrough RL, Componation PJ (2009) The relationship between organizational culture and enterprise risk management. Eng Manag J 21(2):18–26

Kirkpatrick SA, Locke EA (1991) Leadership: Do traits mater? Acad Manag Executive 5(2):48–60

Kontoghiorghes C, Awbre SM, Feurig PL (2005) Examining the relationship between learning organization characteristics and change adaptation, innovation, and organizational performance. Hum Res Dev Q 16(2):185–212

Kotter JP (1990) What leaders really do. Harvard Bus Rev 68(3):103–111

Kotter JP (1995) Leading change: Why transformation efforts fail. Harvard Bus Rev 73(2):59–67

Kotter JP (1996) Leading change. Harvard Business School Press, Boston

Kotter JP, Heskett JL (1992) Corporate culture and performance. Free Press, New York

Kotter JP, Schlesinger LA (1979) Choosing strategies for change. Harvard Bus Rev 57(2):106–114

Kulik CT, Ambrose ML (1992) Personal and situational determinants of referent choice. Acad Manag Rev 17(2):212–237

Kululanga GK (1999) a framework to facilitate construction contractors' learning. Unpublished Ph.D. thesis, Loughborough University, Loughborough

Lähteenmäki S, Toivonen J, Mattila M (2001) Critical aspects of organizational learning research and proposals for its measurement. Br J Manag 12(2):113–129

Larson GS, Tompkins PK (2005) Ambivalence and resistance: a study of management in a concertive control system. Commun Monogr 72(1):1–21

Levy A (1986) Second-order planned change: definition and conceptualization. Org Dyn 15(1):5–17

Lewin K (1947) Frontiers in group dynamics: concept, method and reality in social science; social equilibria and social change. Hum Relat 1(2):5–41

Lewin K (1951) Field theory in social science. Harper and Row, New York

Lewitt B, March JG (1988) Organizational learning. Ann Rev Sociol 14:319–340

Likert R (1961) New patterns of management. McGrill-Hill, New York

Lippitt R, Watson J, Westley B (1958) The dynamics of planned change. Harcourt Brace, New York

Lipshitz R, Popper M, Friedman VJ (2002) A multifacet model of organizational learning. J Appl Behav Sci 38(1):78–98

Lord RG, De Vader CL, Alliger GM (1986) A meta-analysis of the relation between personality traits and leadership perceptions: an application of validity generalization procedures. J Appl Psychol 71(3):402–410
Louis MR (1985) An investigator's guide to workplace culture. In: Frost PJ, Moore LF, Louis MR, Lundberg CC, Martin J (eds) Organizational culture. Sage, Beverly Hills, pp 73–93
Low SP (1998) Managing total service quality: a systemic view. Manag Serv Qual 8(1):34–45
Lunenburg FC (2010) Forces for and resistance to organizational change. Nat Forum Educ Adm Supervision J 27(4):1–10
Lüscher LS, Lewis MW (2008) Organizational change and managerial sensemaking: working through paradox. Acad Manag J 51(2):221–240
Maslow AH (1943) A theory of human motivation. Psychol Rev 50(4):370–396
McCarthy DJ, Puffer SM, May RC, Ledgerwood DE, Stewart WH Jr (2008) Overcoming resistance to change in Russian organizations: the legacy of transactional leadership. Org Dyn 37(3):221–235
McGill ME, Slocum JW (1993) Unlearning the organization. Org Dyn 22(2):79–89
McShane SL, Von Glinow MA (2007) Organizational behavior, 4th edn. McGraw-Hill, Irwin, New York
Mills JH, Dye K, Mills AJ (2009) Understanding organizational change. Routledge, New York
Mitchell TR (1982) Motivation: new directions for theory, research, and practice. Acad Manag Rev 7(1):80–88
Morgan G (1997) Images of organization. Sage, London
Mullins LJ (2007) Management and organisational behaviour, 8th edn. Prentice Hall Financial Times, Harlow
Nadler DA (1993) Concepts for the management of organizational change. In: Mabey C, Mayon-White B (eds) Managing change. The Open University/Paul Chapman Publishing, London, pp 85–98
Nadler DA, Tushman ML (1999) The organization of the future: strategic imperatives and core competencies for the 21st century. Org Dyn 28(1):45–60
Nemeth CJ (1997) Managing innovation: when less is more. Calif Manag Rev 40(1):59–74
Nemeth CJ, Staw BM (1989) The tradeoffs of social control and innovation in groups and organizations. In: Berkowitz L (ed) Advances in experimental social psychology. Academic Press, San Diego, pp 175–210
Newman KL (2000) Organizational transformation during institutional upheaval. Acad Manag Rev 25(3):602–619
Nonaka I (1991) The knowledge creating company. Harvard Bus Rev 69(6):96–104
Nonaka I (1994) A dynamic theory of organizational knowledge creation. Organ Sci 5(1):14–37
O'Reilly C (1989) Corporations, culture, and commitment: motivation and social control in organizations. Calif Manag Rev 31(4):9–25
O'Reilly CA, Chatman JA (1996) Culture as social control: corporations, culture and commitment. In: Staw BM, Cumming LL (eds) Research in organizational behavior. JAI Press, Greenwich, pp 157–200
Oreg S (2006) Personality, context, and resistance to organizational change. Eur J Work Organ Psychol 15(1):73–101
Ouchi WG, Price RL (1978) Hierarchies, clans, and theory Z: a new perspective on organization development. Org Dyn 7(2):25–44
Paavola S, Lipponen L, Hakkarainen K (2004) Models of innovative knowledge communities and three metaphors of learning. Rev Educ Res 74(4):557–576
Pascale R, Millemann M, Gioja L (1996) Changing the way we change. Harvard Bus Rev 75 (6):126–139
Peters TJ (1992) Liberation management. A. A. Knopf, New York
Peters TJ, Waterman RH (1982) In search of excellence: lessons from America's best-run companies. Harper and Row, New York
Pettigrew A, Whipp R (1993) Understanding the environment. In: Mabey C, Mayon-White B (eds) Managing change. The Open University/Paul Chapman Publishing, London, pp 5–19

Pfeffer J (1998) The human equation: building profits by putting people first. Harvard Business School Press, Cambridge
Piderit SK (2000) Rethinking resistance and recognizing ambivalence: a multidimensional view of attitudes toward an organizational change. Acad Manag Rev 25(4):783–794
Popper M, Lipshitz R (2000) Installing mechanisms and instilling values: the role of leaders in organizational learning. Learn Organ 7(3):135–145
Porras JI, Robertson PJ (1992) Organizational development: theory, practice, and research. In: Dunnette MD, Hough LM (eds) Handbook of industrial and organizational psychology, 2nd edn. Consulting Psychologists Press, Palo Alto, CA, pp 719–822
Rauschenberger J, Schmitt N, Hunter JE (1980) A test of the need hierarchy concept by a Markov model of change in need strength. Adm Sci Q 25(4):654–670
Recardo RJ (1995) Overcoming resistance to change. Natl Prod Rev 14(2):5–12
Reigle RF (2003) Organizational culture assessment: development of a descriptive test instrument. Unpublished Ph.D. thesis, University of Alabama in Huntsville, Huntsville
Robbins SP (2003) Organizational behavior, 10th edn. Prentice Hall, Upper Saddle River
Robbins SP, Judge TA (2007) Organizational behavior, 12th edn. Prentice Hall, Upper Saddle River
Rowden RW (2001) The learning organization and strategic change. SAM Adv Manag J 66(3):11–16
Rowe PA, Boyce RA (2009) Deutero-learning: implications for managing public health change. Learn Organ 16(4):298–310
Salaman G, Butler J (1994) Why managers won't learn. In: Mabey C, Iles P (eds) Management learning. Routledge/The Open University, London, pp 33–42
Sanchez R (2005) Knowledge management and organisational learning: fundamental concepts for theory and practice. Lund Institute for Economic Research, Lund
Sathe V (1983) Implications of corporate culture: a manager's guide to action. Org Dyn 12(2):5–23
Schall MS (1983) A communication-rules approach to organizational culture. Adm Sci Q 28 (4):557–581
Schein EH (1990) Organizational culture. Am Psychol 45(2):109–119
Schein EH (1992) Organizational culture and leadership, 2nd edn. Jossey-Bass, San Francisco
Schein EH (2004) Organizational culture and leadership, 3rd edn. Jossey-Bass, San Francisco
Schermerhorn JR, Hunt JG, Osborn RN, Uhi-Bien M (2011) Organizational behavior, 11th edn. Wiley, Hoboken
Schott RL (1992) Humanistic psychology, and organization leadership. J Humanistic Psychol 32 (1):106–120
Seiler S, Lent B, Pinkowska M, Pinazza M (2012) An integrated model of factors influencing project managers' motivation—findings from a swiss survey. Int J Proj Manag 30(1):60–72
Senge PM (1990) The fifth discipline: the art and practice of the learning organization. Currency Doubleday, New York
Senge PM (1994) The leader's new work: building learning organizations. In: Mabey C, Iles P (eds) Managing learning. Routledge/The Open University, London
Senge PM, Roberts C, Ross RB, Smith BJ, Kleiner A (1994) The fifth discipline fieldbook: strategies and tools for building a learning organization. Currency Doubleday, New York
Senior B, Fleming J (2006) Organizational change, 3rd edn. Financial Times Prentice Hall, Harlow
Sense AJ (2011) The project workplace for organizational learning development. Int J Proj Manag 29(8):986–993
Sfard A (1998) On two metaphors for learning and the dangers of choosing just one. Educ Researcher 27(2):4–13
Shrivastava P (1983) A typology of organizational learning systems. J Manag Stud 20(1):7–28
Sinclair A (1993) Approaches to organisational culture and ethics. J Bus Ethics 12(1):63–73
Sørensen JB (2002) The strength of corporate culture and the reliability of firm performance. Adm Sci Q 47(1):70–91
Spector JM, Davidsen PI (2006) How can organizational learning be modeled and measured? Eval Prog Plann 29(1):63–69

Stanley DJ, Meyer JP, Topolnytsky L (2005) Employee cynicism and resistance to organizational change. J Bus Psychol 19(4):429–459

Stogdill RM, Coons AE (1951) Leader behavior: its description and measurement. Ohio State University and Bureau of Business Research, Columbus

Strebel P (1994) Choosing the right change path. Calif Manag Rev 36(2):29–51

Stroh LK, Northcraft GB, Neale MA (2002) Organizational behavior: a management challenge, 3rd edn. Lawrence Erlbaum, Mahwah

Szabla DB (2007) A multidimensional view of resistance to organizational change: exploring cognitive, emotional, and intentional responses to planned change across perceived change leadership strategies. Hum Res Dev Q 18(4):525–558

Szulanski G (1996) Exploring internal stickiness: impediments to the transfer of best practice within the firm. Strateg Manag J 17(Special issue):27–43

Thomas R, Hardy C (2011) Reframing resistance to organizational change. Scand J Manag 27 (3):322–331

Tichy NM (1983) Managing strategic change: technical, political, and cultural dynamics. Wiley, New York

Tichy NM, Devanna MA (1986) The transformational leader. Wiley, New York

Tourish D, Pinnington A (2002) Transformational leadership, corporate cultism and the spirituality paradigm: an unholy trinity in the workplace? Hum Relat 55(2):147–172

Tracy L (1984) A dynamic living systems model of work motivation. Syst Res 1(3):191–203

Tsang EWK (1997) Organizational learning and the learning organization: a dichotomy between descriptive and prescriptive research. Hum Relat 50(1):73–89

Tushman ML, Smith W (2002) Organizational technology. In: Baum JA (ed) The Blackwell companion to organizations. Blackwell Publishers, Malden, pp 386–414

Visser M (2007) Deutero-learning in organizations: a review and a reformulation. Acad Manag Rev 32(2):659–667

Vroom VH (1964) Work and motivation. Wiely, New York

Vroom VH, Jago AG (1988) The new leadership: managing participation in organizations. Prentice-Hall, Englewood Cliffs

Vroom VH, Yetton PW (1973) Leadership and decision-making. University of Pittsburgh Press, Pittsburgh

Wahba MA, Bridwell LG (1976) Maslow reconsidered: a review of research on the need hierarchy theory. Organ Behav Hum Perform 15(2):212–240

Watkins KE, Marsick VJ (1993) Sculpting the learning organization: lessons in the art and sience of systemic change. Jossey-Bass, San Francisco

Weick KE (1985) The significance of corporate culture. In: Frost P, Moore L, Louis M, Lundberg C, Martin J (eds) Organizational culture. Sage, Beverly Hills, pp 381–389

Weick KE, Quinn RE (1999) Organizational change and development. Annu Rev Psychol 50:361–386

Weick KE, Sutcliffe KM (2001) Managing the unexpected. Jossey-Bass, San Francisco

Chapter 5
Conceptual Model: Linking ERM Implementation to Theories of Organizational Behavior

Keywords Conceptual model · ERM implementation · Organizational change · Organizational learning · Organizational culture · Motivation theories · Leadership theories

5.1 Introduction

Implementing ERM in construction firms, where individuals are used to PRM, tends to be a steady and gradual process. It concerns changes in not only people's mind-set, but also the organizational context. Hence, this chapter first links ERM implementation in construction firms to the organizational change theory. ERM implementation in construction firms can be considered as an incremental, evolutionary, and continuous organizational change, which also requires organizational learning as a medium (Alas and Sharifi 2002), change in the organizational culture (including the organizational structure) (Senior and Fleming 2006), appropriate motivation measures, and the leadership of change agents. The drivers for organizational change can also drive ERM implementation, and the sources of resistance to change can be linked to the hindrances to ERM implementation. In addition, some hindrances to implementing ERM can also be linked to organizational learning, organizational culture, motivation, and leadership theories. The negative impacts of these hindrances can be reduced by implementing the corresponding components in the ERM framework for construction firms. As there have been no studies that link ERM to theories of organizational behavior, this research for the first time expands the literature by developing the linkages between ERM implementation and theories of organizational behavior. Finally, a conceptual model is proposed in this chapter to illustrate the relationship between ERM implementation in construction firms and the organizational behavior theories.

X. Zhao et al., *Enterprise Risk Management in International Construction Operations*, DOI 10.1007/978-981-287-549-5_5

5.2 Linking ERM Implementation to Organizational Change Theories

As construction firms usually deal with risks through PRM due to their project-based nature, implementing ERM in a construction firm requires changes in the organizations and, at the same time, is likely to spawn several benefits. As one of the most significant benefits is the improvement in firm performance (Barton et al. 2002; Gordon et al. 2009; Hoyt and Liebenberg 2011; Lam 2003; Nocco and Stulz 2006), ERM implementation is consistent with the OD perspective of organizational change, which is intended to improve organizational performance (Porras and Robertson 1992). However, as the ERM program matures, ERM becomes integrated into strategic planning (AON 2010), which is consistent with the strategic management perspective of organizational change.

Considering that implementing ERM in construction firms needs a clear implementation plan developed by the senior management and that lack of such a clear plan can hinder the ERM implementation (AON 2010), ERM implementation can be viewed as a planned change. In addition, ERM implementation is an ongoing process rather than a quick one-off exercise (Bowling and Rieger 2005) and should proceed in incremental steps (IMA 2007). In large organizations, it is likely to take three to five years to fully integrate ERM into the business process (Shortreed 2010). Thus, ERM implementation is consistent with the gradualist paradigm of organizational change, which indicates that fundamental change can be achieved through continuous adjustments without triggering a short episode of revolutionary change (Hayes 2007) and can be viewed as a continuous, evolutionary, incremental, and first-order organizational change. Furthermore, ERM implementation is likely to be driven by legal compliance and corporate governance requirements, advances in IT, and increasing complicated risks, which constitute the external demand for organizational change. Hence, ERM programs can be viewed as an adaption change, which is an incremental and adaptive response to a pressing external demand for change (Nadler and Tushman 1995).

Beer and Nohria (2000a, b) suggested that organizational change can be achieved through Theory E and Theory O. Although ERM implementation can bring earning growth and consistency, and improve shareholder value, the economic value is not the only focus of ERM. Implementing ERM needs not only the commitment from the top management, but also the involvement of the staff at all levels of a firm. It increases management accountability, creates a risk-aware culture, and integrates this culture into the organizational culture. It also contributes to decision-making and improves competitiveness. Hence, ERM implementation is the combination of Theory E and Theory O because it contributes to both economic value and organizational capability.

The drivers for ERM implementation can be linked to the drivers for organizational change. The legal compliance and corporate governance requirements are partly political and legal pressures from external environments. Benefits of ERM, which include earning growth and competitive advantages, can be linked to the need for higher profitability and competitive pressures. A broader scope of risks stems from globalization, market, social and cultural factors, market changes, and economic factors. Advances in IT can be seen as technical advancements. The request and encouragement of the board and senior management can be attributed to the above four categories of drivers and can thus be linked to the aforementioned drivers for organizational change.

Some of the hindrances to ERM implementation can be linked to the sources of resistance to organizational change, and these sources can be further linked to organizational learning, organizational culture, motivation, and leadership theories. The links between hindrances to ERM implementation and sources of resistance to organizational change (see Table 5.1) are indicated in Table 5.2.

The hindrances H01–H08, H21, H31, and H36 can be linked to insufficient resources (C07) in the sources of resistance to organizational change. Organizational change needs a variety of resources, which is also the case for ERM implementation. In addition to money, time, and people, ERM implementation also needs some resources that contribute to dealing with risks. For example, high-quality historical data (H01 and H02) and risk management techniques and tools (H05) are necessary for people to identify, analyze, evaluate, and respond to risks. A RMIS (H08) can be established to facilitate risk communication and reporting, as well as the ERM process. A set of metrics to measure ERM performance (H31) can be seen as a resource, which provides an understanding that efforts of individuals can lead to performance and helps them perceive the value and benefits of ERM. To enable individuals to fully understand ERM, successful business cases (H21) should be employed to illustrate how to implement ERM and to create the benefits or value. It merits attention that all the above resources cannot be ensured without the commitment of the board and senior management.

Table 5.1 Sources of resistance to organizational change

No.	Sources of resistance	No.	Sources of resistance
C01	Habits	C11	Lack of trust in management
C02	Fear of the unknown	C12	Inconsistency
C03	Parochial self-interest	C13	Low-level employee–manager relation
C04	Social factors	C14	Ineffective management styles
C05	Lack of individual capability to change	C15	Selective information processing
C06	Misunderstanding	C16	Threats to power or influence
C07	Insufficient resources	C17	Threats to resource allocations
C08	Inadequate rewards and punishments	C18	Limited focus of change
C09	Poor internal communication	C19	Organizational culture
C10	Lack of commitment of the board and senior management	C20	Group inertia
		C21	Structural inertia

Table 5.2 Linking hindrances to ERM implementation to sources of resistance to organizational change

Code	Hindrances to ERM implementation	Sources of resistance to organizational change																				
		C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21
H01	Low data quality							✓			✓											
H02	Lack of data							✓			✓											
H03	Insufficient resources (e.g., time, money, and people)							✓			✓											
H04	Lack of a formalized ERM process							✓			✓											
H05	Lack of risk management techniques and tools							✓			✓											
H06	Lack of internal knowledge, skills, and expertise					✓		✓			✓											
H07	Lack of qualified personnel to implement ERM					✓		✓			✓											
H08	Lack of a RMIS							✓			✓											
H09	Unsupportive organizational structure										✓											✓
H10	Unsupportive organizational culture										✓									✓	✓	

(continued)

Table 5.2 (continued)

Code	Hindrances to ERM implementation	Sources of resistance to organizational change																				
		C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21
H11	Lack of a common risk language						✓			✓	✓											
H12	Lack of risk awareness within the organization										✓									✓		
H13	Confidence in the existing risk management practices	✓														✓				✓	✓	
H14	Existence or re-emergence of the silo mentality	✓	✓													✓				✓	✓	
H15	Lack of shared understanding and approach to risk management across departments						✓			✓	✓	✓		✓								
H16	Lack of understanding relating to effective ERM process						✓			✓	✓	✓		✓								
H17	Perception that ERM adds to bureaucracy						✓			✓	✓	✓		✓		✓						

(continued)

Table 5.2 (continued)

Code	Hindrances to ERM implementation	Sources of resistance to organizational change																				
		C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21
H18	Perception that ERM increases costs and administration						✓			✓	✓	✓		✓		✓						
H19	Perception that ERM interferes with business activities						✓			✓	✓	✓		✓		✓						
H20	Inadequate training on ERM						✓			✓	✓	✓		✓		✓						
H21	Lack of an ERM business case						✓	✓		✓	✓											
H22	Lack of perceived value or benefits of ERM						✓			✓	✓	✓		✓								
H23	Lack of commitment of the board and senior management							✓			✓											
H24	Not perceived as a priority by senior management							✓														
H25	Lack of board or senior management leadership							✓			✓											

(continued)

Table 5.2 (continued)

Code	Hindrances to ERM implementation	Sources of resistance to organizational change																				
		C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21
H26	The movement of the ERM champion from senior management into other areas without a successor							✓			✓		✓									
H27	Lack of consensus on benefits of ERM among board members and senior management							✓			✓											
H28	Other management priorities							✓														
H29	Lack of a clear ERM implementation plan							✓			✓											
H30	Inability to coordinate with other departments					✓																
H31	Lack of a set of metrics for measuring performance of ERM							✓			✓											

(continued)

Table 5.2 (continued)

Code	Hindrances to ERM implementation	Sources of resistance to organizational change																				
		C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21
H32	Unclear ownership and responsibility for ERM implementation										✓											
H33	Organizational turf			✓													✓	✓				
H34	Employees' reluctance to give up power			✓	✓												✓					
H35	People's reluctance to share risk information			✓					✓	✓												
H36	Recession and business downturn							✓			✓											

Recession and business downturn (H36) tend to force the firm to curb the expenditures in the risk management area (Kleffner et al. 2003) and to employ downsizing or layoff strategies, which result in loss of knowledge, skills, and expertise due to the departure of qualified and experienced personnel (Fisher and White 2000; Pfeffer 1998). This would deteriorate the lack of internal knowledge, skills, and expertise (H06), and the lack of qualified employees to implement ERM (H07). Other competing priorities (H28) may grab the resources that should have been allocated for ERM programs (Gates 2006) and indirectly lead to insufficient resources (C07) for ERM programs.

Moreover, lack of internal knowledge and qualified personnel (H06 and H07) can also be viewed as lack of individual capability to change (C05), which makes individuals unable to adapt to the change and thus resist it. ERM implementation also requires an ability to coordinate with other departments to break down the silos. Inability to coordinate with other departments (H30) makes employees incompetent for the positions engaged in ERM implementation and can thus be linked to lack of individual capability to change (C05) in the sources of resistance to change.

Due to the pervasive nature of organizational culture, unsupportive organizational culture (C19) tends to lead to resistance to change. Constraints created by group norms (C20) also hinder group members to embrace the change. The negative cultural influence on change is also likely to hinder ERM implementation. Lack of risk awareness (H12), confidence in the existing risk management practices (H13), and existence of the silo mentality (H14) are examples of the passive mindset toward ERM, which hinders ERM implementation. People tend to respond to change in their accustomed ways when confronted with change (Robbins 2003). Thus, when confronted ERM implementation, employees who are accustomed to the existing silo-based risk management practices would be confident in the silo approach. Even after accepting training on ERM, employees may be influenced by the silo mentality. This is the influence from their long-established habits (C01), which are influenced by the organizational culture (C19) or group norms (C20). Selective information processing (C15) tends to make people harbor a biased view of a particular situation. This biased view can contribute to employees' confidence in the existing risk management practices (H13) and existence of the silo mentality (H14).

The organizational structure provides a strong element of stability. Mechanistic or bureaucratic structures make organizations less capable of responding to change. This is also the case for ERM implementation. Hence, unsupportive organizational structure (H09) that hinders ERM implementation can be linked to structural inertia (C21) in the sources of resistance.

Poor internal communication (C09) and selective information processing (C15) make people unclear of the vision, the need, and the impacts of the change or form biased perception on the change. In turn, poor communication renders change agents unable to understand people's concerns. Misunderstandings (C06) about ERM can be linked to some hindrances to ERM implementation, such as lack of shared understandings and approach to risk management across departments (H15), lack of understanding about an effective ERM process (H16), lack of perceived value or benefits (H22), and the perceptions that ERM adds to bureaucracy, increases costs and administration, and interferes with business activities (H17–H19). Adequate training on ERM (H20) and illustration of ERM business cases (H21) tend to reduce the misunderstandings (C06). However, the effectiveness of training programs depends on the employee–management relationship (C13), which is characterized by mutual trust and credibility (Kotter and Schlesinger 1979; Robbins 2003). Lack of trust in the management (C11) undermines the effectiveness of training programs and results in misunderstandings (C06) about ERM. A common risk language should be included in the training programs, and a glossary of risk terms need to be created and distributed across the organization. Lack of such a risk language (H11) would lead to misunderstandings (C06) about the ERM philosophy, process, and methodologies and cause the management to spend much time-resolving communication issues as a result of the confusion about risk terms (Espersen 2007).

Commitment of the board and senior management represents the support from the top management and is viewed as a driver for ERM implementation. Due to this commitment, resources can be allocated for ERM implementation, training programs can be sponsored, risk communication and reporting mechanisms can be created, ERM ownership and accountabilities are identified, and a risk-aware culture can be created and embedded into the organizational culture. By contrast, lack of commitment from the board and senior management (C10) may lead to insufficient resources (H01–H08, H21, H31) and training (H20), unclear understandings about ERM (H15–H19 and H22), as well as unclear ERM plans (H29), ownership, and responsibilities (H32). Even if there is such commitment, ERM may not be perceived as a priority by the board and senior management (H24) because a firm is likely to have other competing priorities (H28), which also need resources. For example, the priority of a construction firm tends to be to win bids or to complete projects, which directly affects the survival and development of a firm. Thus, true commitment of the top management should involve prioritizing ERM implementation.

In addition, ERM implementation should be led by a senior manager or a board-level committee. Acharyya (2008) considered the leadership of CEO is the key driving force of ERM. Moreover, ERM implementation takes a champion from senior management. Implementing ERM can be a multiyear process, during which there may be changes in senior management roles. The movement of the ERM champion from senior management into other areas without a successor (H26) may result in resource allocation cuts and would scuttle ERM implementation midway (Simkins 2008). This also represents the inconsistency (C12) in the commitment of the top management and the actual ERM implementation. Hence, even if the ERM program does not stop, employees will resist it due to the ambivalence of management. Recession and business downturn (H36) would also force the board and senior management to adjust the resource allocation to ensure the survival of the firm and thus lead to suspending the ERM program. Furthermore, top management may commit to ERM without consensus on the benefits of ERM (H27) if the chairman of the board or CEO has confidence in ERM. However, Gates (2006) found that the lack of such consensus (H27) resulted in the difficulty in persuading other leaders of the benefits. Hence, the commitment of the top management tends to be inconsistent and controversial and hinders ERM implementation at lower levels within the firm.

It is common for people to focus on their own best interests rather than those of the total organization (Hayes 2007; Kotter and Schlesinger 1979). Hence, people or groups resist the organizational change that causes them to lose something that they value. Organizational turf (H33) has been identified as a major barrier to ERM implementation (Miccolis 2003; Miccolis et al. 2000). These issues can be linked to the parochial self-interest (C03), threat to power or influence (C16), and resource allocations (C17) in the sources of organizational resistance to change. In addition, individuals with power tend to resist the ERM program that requires them to give up their power (H34). This is because the ERM programs threaten the influence or power of these groups and individuals, and losing their long-established influence or power makes them lose face and damages their social status (C04).

People's reluctance to share risk information (H35) with people from other projects will hinder ERM implementation in construction firms. The reluctance to share risk information (H35) may derive from the fear that the information would be used against them (Simkins 2008) and that others would benefit from the risk information at the expense of their resources spent in collecting the risk information, which indirectly undermines their own interests if there is no rewarding system within the organization. Also, reluctance to share risk information (H35) can result from the lack of motivation and internal communication mechanisms, which stifles their willingness to share risk information. Thus, the hindrance H35 can be linked to fear of the unknown (C02), parochial self-interest (C03), inadequate rewards and punishments (C08), and poor internal communication (C09) in the sources of resistance.

5.3 Linking ERM Implementation to Organizational Learning Theories

Learning is a medium for change (Alas and Sharifi 2002) and improves the ability to adapt to change, at both individual and organizational levels (Garvin 1993; Senge 1990). Organizational change and learning are parallel and interact with each other (Lähteenmäki et al. 2001). As a continuous, evolutionary, and incremental organizational change, ERM implementation cannot be isolated from organizational learning.

In project-based construction firms, it is necessary for the individuals who are accustomed to PRM to learn ERM fundamentals and how to further PRM contributions to ERM. Without this individual learning process, ERM cannot be implemented at all levels across the firm, because individual learning is the basis of organizational learning. In addition, the existing learning processes that support

PRM can also contribute to ERM implementation, because PRM is an integral part of ERM. The focus on learning from risks is likely to institutionalize risk information and change PRM practices to a corporate-level approach (Dikmen et al. 2008). Furthermore, Smallman (1996) indicated that organizational learning could provide a powerful tool that enabled organizations to learn from past errors and disasters, within their own organizations or from others. Smallman (1996) also argued that organizational learning, together with data collection and collation as well as forecasting, comprised holistic risk management. Organizational learning is the key of ERM and requires a no blame culture (Smallman 1996).

ERM implementation in a construction firm can be viewed as a combination of the cognitive-behavioral, sociocultural, and knowledge-creation approaches to learning. This is because ERM implementation involves acquiring knowledge relevant to ERM from inside and outside the firm and changing behavior or cognition. To achieve adequate risk communication, ERM implementation needs the participation of all the individuals from all the projects that the firm is engaged in. Risk communication across projects is situated in the relations or networks between the staff from different projects. In addition, because ERM implementation is a multi-year process, the firm can review the ERM framework, identify problems and solve them, and develop an improved framework. This aligns with Engeström's (1999) expansive learning model, described in Sect. 4.3.3. During the ERM implementation process, some tacit knowledge embedded in employees can be converted to the explicit knowledge and used by all employees in the firm. This process is consistent with Nonaka's (1991) knowledge-creation model, described in Sect. 4.3.3. ERM practices also tend to provide the firm with opportunities to build new knowledge and expertise that helps to implement ERM in the construction industry. This echoes Bereiter's (2002) knowledge building model, explained in Sect. 4.3.3.

There are intricate relationships among data, information, and knowledge. According to Liew (2007), the purpose of data is to record activities or situations, and thus, all the data are historical. Information comes from both current and historical sources. The source of data and information is activities and situations. Information from historical sources is actually the processed or analyzed data. According to Nonaka (1991), knowledge can be explicit or tacit. Explicit knowledge can be easily communicated and shared, and correspond to information. Thus, in some cases, data, information, and knowledge are interchangeable. It is necessary for a firm to collect adequate historical data for risk management at project and enterprise levels. High-quality data are selected and processed, and become information and a form of explicit knowledge. In a construction firm, projects are sources of data and information. Since there are various stakeholders of a project, people engaged in a project have opportunities to collect risk information and relevant knowledge in collaboration with other stakeholders (e.g., partnering, alliancing, joint ventures, subcontracting). Risk information from projects can be viewed as a form of explicit knowledge and should be communicated across the firm to facilitate ERM implementation.

Some of the 12 impediments to organizational learning (see Table 5.3) can be linked to hindrances to ERM implementation, as shown in Table 5.4. Similar to

Table 5.3 Impediments to organizational learning

Code	Impediments to organizational learning	Code	Impediments to organizational learning
L01	Lack of leadership commitment and support	L07	Reluctance to accept knowledge
L02	Lack of internal knowledge	L08	Lack of knowledge absorptive or retentive capacity
L03	Lack of organizational commitment	L09	Lack of channels for dialogue and sharing meaning
L04	Lack of psychological safety	L10	Arduous relationships
L05	Lack of motivation	L11	Downsizing or layoff strategies
L06	Reluctance to share knowledge	L12	Unsupportive organizational culture

ERM implementation, organizational learning also needs commitment from the leadership. Such commitment requires senior management to sustain organizational learning by articulating the vision and communicating the learning-oriented values of the firm. Without leadership commitment, organizational learning mechanisms would not be institutionalized, a learning culture would not be created, and resources for learning would not be allocated.

Hence, a majority of the hindrances to ERM implementation can be linked to lack of leadership commitment and support (L01), such as the hindrances directly related to the board and senior management (H23–H27), those related to various resources (H01–H08, H21, H28, H31 and H36), and those deriving from inadequate training on ERM (H11, H12, H15–H20 and H22).

As a change in the approach to risk management, ERM implementation needs to acquire knowledge. Data analysis is the heart of ERM (Driver and Bernard 2012). Lack of the high-quality historical data, which are the predecessor of information and knowledge, can lead to lack of internal risk information. Lack of internal knowledge about ERM, and lack of the qualified staff, who possess the knowledge about risk management and the ability to coordinate with other departments or units, may inhibit internal sharing of knowledge. This problem can be solved by employing external consultants, recruiting employees with the relevant skills or experience, or collaboratively learning with other firms.

In addition, a firm's lack of knowledge about risk management process, tools, and techniques, which also hinders its PRM, tends to result from lack of an organizational learning mechanism that helps to convert tacit knowledge to explicit knowledge. Thus, the hindrances related to data, information, knowledge, and ability (H01–H07 and H30) can be linked to lack of internal knowledge (L02) in the impediments to organizational learning. In some cases, lack of internal knowledge may be a facade, and the fact is that individuals are reluctant to share their tacit knowledge. Hence, people's reluctance to share risk information (H35) can also be linked to L02.

Organizational commitment is a psychological state which enables employees to feel that they work for the joint benefits of themselves, their fellow members, and

Table 5.4 Linking hindrances to ERM implementation to impediments to organizational learning

Code	Hindrances to ERM implementation	Impediments to organizational learning											
		L01	L02	L03	L04	L05	L06	L07	L08	L09	L10	L11	L12
H01	Low data quality	✓	✓										
H02	Lack of data	✓	✓										
H03	Insufficient resources (e.g., time, money, and people)	✓								✓			
H04	Lack of a formalized ERM process	✓	✓										
H05	Lack of risk management techniques and tools	✓	✓										
H06	Lack of internal knowledge, skills, and expertise	✓	✓						✓			✓	
H07	Lack of qualified personnel to implement ERM	✓	✓						✓			✓	
H08	Lack of a RMIS	✓								✓			
H09	Unsupportive organizational structure	✓											
H10	Unsupportive organizational culture	✓											✓
H11	Lack of a common risk language	✓											
H12	Lack of risk awareness within the organization	✓											✓
H13	Confidence in the existing risk management practices												✓
H14	Existence or re-emergence of the silo mentality				✓								✓
H15	Lack of shared understanding and approach to risk management across departments	✓											
H16	Lack of understanding relating to effective ERM process	✓											

(continued)

Table 5.4 (continued)

Code	Hindrances to ERM implementation	Impediments to organizational learning											
		L01	L02	L03	L04	L05	L06	L07	L08	L09	L10	L11	L12
H17	Perception that ERM adds to bureaucracy	✓			✓								
H18	Perception that ERM increases costs and administration	✓			✓								
H19	Perception that ERM interferes with business activities	✓			✓								
H20	Inadequate training on ERM	✓							✓	✓			
H21	Lack of an ERM business case	✓											
H22	Lack of perceived value or benefits of ERM	✓			✓	✓							
H23	Lack of commitment of the board and senior management	✓								✓			
H24	Not perceived as a priority by senior management	✓								✓			
H25	Lack of board or senior management leadership	✓								✓			
H26	The movement of the ERM champion from senior management into other areas without a successor	✓								✓			
H27	Lack of consensus on benefits of ERM among board members and senior management	✓											
H28	Other management priorities	✓											
H29	Lack of a clear ERM implementation plan	✓											
H30	Inability to coordinate with other departments		✓										

(continued)

Table 5.4 (continued)

Code	Hindrances to ERM implementation	Impediments to organizational learning											
		L01	L02	L03	L04	L05	L06	L07	L08	L09	L10	L11	L12
H31	Lack of a set of metrics for measuring performance of ERM	✓				✓							
H32	Unclear ownership and responsibility for ERM implementation												
H33	Organizational turf				✓								
H34	Employees' reluctance to give up power				✓								
H35	People's reluctance to share risk information		✓	✓	✓	✓	✓				✓		
H36	Recession and business downturn	✓		✓	✓							✓	

the organization (Lipshitz et al. 2002). Organizational commitment allows diffusion of individual learning into the organization (Lewitt and March 1988) and induces the willingness of employees to share their knowledge (Davenport and Prusak 1998). ERM implementation needs organizational commitment because the firm needs the tacit knowledge of employees about PRM that can contribute to ERM implementation. Such tacit knowledge can be their experience in using risk management tools, techniques, their views about risks, and anything that can contribute to ERM implementation. In addition, risk information from projects needs to be communicated across a firm to facilitate ERM implementation. People's reluctance to share risk information hinders individual learning from contributing to organizational learning and leads to fragmented learning. The arduous relationship between the risk information sharer and recipients can increase the difficulty in communicating or raise people's reluctance to share the risk information they have collected from all sources. Thus, people's reluctance to share risk information (H35) can be linked to lack of organizational commitment (L03) and arduous relationship (L10).

Lack of psychological safety (L04) is another issue affecting ERM implementation, during which individuals and groups in the firm may fear or worry that their own interests are being threatened. Anxiety may also derive from the perception that ERM has negative influence on the firm, such as additional bureaucracy, costs, administration, and unnecessary interference with business activities. As psychological safety can be seen as a hygiene factor (Herzberg 1966), lack of it results in job dissatisfaction. If the fear or anxiety continues to exist, individuals and groups will not be committed to ERM implementation, the silo mentality will continue, and the reluctance to share risk information will increase. Thus, the hindrances related to self-interest (H33 and H34) and individual perception (H14, H17–H19 and H22) can be linked to lack of psychological safety (L04).

Individuals need motivation to embrace ERM because ERM implementation will take their time, energy, and knowledge which are scarce resources in the workdays of most employees. They will not spend these scarce resources unless the return is meaningful and beneficial for them. Hence, without motivation mechanisms, individuals would be reluctant to share risk information and spend any resources learning the ERM philosophy. Although organizational commitment can also cause the knowledge sharers to assume that others accepting the knowledge are more willing to share knowledge with them (Davenport and Prusak 1998), motivation mechanisms are still necessary to ensure ERM implementation at all levels. In addition, ERM performance should be measured and linked to or complement the key performance indicators (KPIs). The lack of a set of metrics to measure ERM performance may undermine the ability of the firm to provide tangible benefits or value of ERM and to link ERM performance to KPIs. Thus, the hindrances H22, H31, and H35 can be linked to lack of motivation (L05).

In order to implement ERM, individuals should be trained and provided with knowledge relevant to ERM implementation and have to accept risk information from various projects. Employees' inability to absorb or retain such knowledge represents low-level individual learning. This threatens the effectiveness of knowledge transfer and causes employees to be unqualified for their role in ERM implementation. Thus, the hindrances H06, H07, and H20 can be linked to lack of knowledge absorptive or retentive capacity (L08).

Organizational learning needs a channel through which dialogue and knowledge sharing occurs. During ERM implementation, risk communication also needs a channel for internal knowledge sharing, which can be a periodical meeting, or a RMIS. Training programs, which allow external and internal trainers to share their experience and knowledge about ERM, can also serve as a communication channel. Hence, inadequate training on ERM (H20) and the lack of a RMIS (H08) can be linked to the lack of accessible channels for dialogue and sharing meaning (L09).

During a recession or business downturn (H36), a firm tends to adopt downsizing or layoff strategies (L11), which may aggravate the lack of knowledge and qualified personnel (H05 and H06). Also, the psychological safety of employees (L04) and organizational commitment (L03) are threatened. In addition, leadership commitment and support cannot persist (L01), which tend to lead to the stagnation of organizational learning and ERM programs. Thus, the hindrance H36 can be linked to L01, L03, L04, and L11 in the impediments to organizational learning.

Unsupportive organizational culture (L12), such as the blame culture and defensive routines, impedes people from learning from errors, failures, and challenging the existing rules and policies. ERM implementation involves learning from the past mistakes, errors, failures, and disasters and providing the rationale behind ERM. Organizational culture unsupportive of learning renders such mistakes, errors, failures, and disasters as taboos and discourages people from discovering the root causes of them. Hence, employees will still retain confidence in the existing risk management practices and silo mentality (H13 and H14) and cannot appreciate the necessity of implementing ERM throughout the firm to overcome the weaknesses of the current practices. The confidence in the current risk management practice and failure to learn from past experience contributes to the underlying assumption of employees that the current practices can deal with most of the risks faced by their firm. Thus, employees do not care about the potential risks and lack risk awareness (H12).

ERM implementation needs organizational learning and change in an unsupportive organizational culture (Smallman 1996). The next section explains how ERM implementation is linked to the organizational culture theory.

5.4 Linking ERM Implementation to Organizational Culture Theories

Organizational culture holds the organization together, guides, and shapes the individual behavior and attitudes in the organization (Robbins 2003). Strong culture contributes to organizational stability, which can be a liability or burden during change (Boisnier and Chatman 2003; Brown and Harvey 2005; Martin 1992; Tushman and Smith 2002). Subcultures enable organizations to become agile so as to generate responses to the environment without necessarily weakening the strong culture and the internal cohesion (Boisnier and Chatman 2003). However, some subcultures in various groups of an organization can also discourage group members from embracing change even if the organizational culture is supportive of change.

ERM programs have to be implemented within the corporate culture due to its pervasive nature. In reality, organizational culture has already been invoked in various ERM frameworks despite different terms being used to describe it. Examples are "establish context" (CAS 2003), "internal environment" (COSO 2004), and "context establishment" (ISO 2009). A strong organizational culture, which shapes the behavior and attitudes of employees toward the risk management approach and de-emphasizes risk awareness, contributes to confidence in the existing risk management practices, the silo mentality, and low risk awareness. Therefore, an unsupportive culture (H10) hinders ERM implementation through impeding change in behavior and attitudes. Kleffner et al. (2003) found that nearly half of the Canadian respondents identified a corporate culture that discouraged ERM as a major hindrance to ERM implementation. Miccolis (2003) identified an unsupportive organizational culture as the top barrier to implementing ERM in various industries.

As shown in Table 5.5, the lack of risk awareness (H12), confidence in the existing risk management practices (H13), and the silo mentality (H14) that hinder ERM implementation can be seen as examples of the passive attitudes toward ERM implementation and can thus be linked to the espoused value and basic assumption levels of Schein's (1990, 1992) three-level organizational culture model, described in Sect. 4.4.2. An unsupportive organizational structure (H09), which hinders ERM implementation, can be linked to the visible artifact level of the three-level organizational culture model.

A culture that is receptive to change, such as an organic or integrative culture, seems to facilitate successful ERM implementation. ERM implementation requires effective and open communication as well as coordination and collaboration across the firm, which leads to risk transparency throughout the organization (Lam 2003).

Table 5.5 Linking hindrances to ERM implementation to the three-level organizational culture model

No.	Hindrances to ERM implementation	Visible artifacts	Espoused values	Basic assumptions
H09	Unsupportive organizational structure	✓		
H10	Unsupportive organizational culture	✓	✓	✓
H12	Lack of risk awareness within the organization		✓	✓
H13	Confidence in the existing risk management practices		✓	✓
H14	Existence or re-emergence of the silo mentality		✓	✓

These qualities of ERM appear to align with the organic characteristics. However, some attributes of ERM are consistent with mechanistic characteristics. For example, ERM espouses following a risk management process and advocates the use of a common language and a centralized risk management approach. Although the attributes of ERM can be consistent with the characteristics of both the organic and mechanistic cultures, Kimbrough and Componation (2009) found that an organic culture enabled firms to make further progress in ERM implementation and suggested that the firms with cultures nearer the mechanistic end should take measures to modify their culture to support ERM. They also suggested that ERM deployment should demonstrate the desired cultural characteristics, such as cross-functional cooperation and open communication, trust in the competency of colleagues, and willingness to address the risks affecting the firm as a whole. In order to determine whether or not the culture needs modification, the firm can assess its corporate culture against the desirable cultural characteristics. Reigle's (2003) organizational culture assessment instrument can be adopted for this purpose.

A risk-aware culture (or risk culture) possesses the desirable cultural characteristics for ERM implementation. It is represented by risk awareness throughout the firm and thus helps detect risky incidents early and contributes to open risk communication. Such a risk-aware culture should be embedded in the organizational culture. Thus, managing risk is ingrained in the corporate culture (Barton et al. 2002), and potential risks are considered in decision-making.

5.5 Linking ERM Implementation to Motivation Theories

In some cases, individuals need motivation to accept organizational change. The motivation theory, in turn, can be used to explain some causes of the resistance to change. Hence, implementing ERM should consider the motivation, and its influence on the behavior and attitude of individuals or groups. Negative motivation can lead to hindrances to ERM programs. Some hindrances to ERM implementation have their root causes in motivation theories, as Table 5.6 indicates.

Some hindrances to implementing ERM concern the needs of individuals and can thus be explained by content theories of motivation. According to the two-factor theory of Herzberg (1966), salary, rewards, job security, status, psychological safety, and power are hygiene factors. Failure to fulfill these hygiene factors leads to job dissatisfaction. In the context of ERM implementation, the power of employees can correspond to their job security, and organizational turf can correspond to interests of groups. Hence, threats to the power of employees (H34) and organizational turf (H33) can be considered as lack of hygiene factors, thus leading to job dissatisfaction.

In addition, ERM implementation can raise fear or anxiety within the firm if there are inadequate training programs (H20). Employees may fear that the ERM program increases bureaucracy (H17), costs, and administration (H18) and exerts unnecessary interference with business activities (H19) and believe that the current

Table 5.6 Linking hindrances to ERM implementation to motivation theories

Code	Hindrances to ERM implementation	Hygiene factors	Expectancy theory		
			Expectancy	Instrumentality	Valence
H01	Low data quality		✓		
H02	Lack of data		✓		
H03	Insufficient resources (e.g., time, money, and people)		✓		
H04	Lack of a formalized ERM process		✓		
H05	Lack of risk management techniques and tools		✓		
H06	Lack of internal knowledge, skills, and expertise		✓		
H07	Lack of qualified personnel to implement ERM		✓		
H08	Lack of a RMIS		✓		
H14	Existence or re-emergence of the silo mentality	✓			
H15	Lack of shared understanding and approach to risk management across departments		✓		
H16	Lack of understanding relating to effective ERM process		✓		
H17	Perception that ERM adds to bureaucracy	✓	✓		
H18	Perception that ERM increases costs and administration	✓	✓		
H19	Perception that ERM interferes with business activities	✓	✓		
H20	Inadequate training on ERM		✓	✓	
H21	Lack of a business case for ERM		✓		
H22	Lack of perceived value or benefits of ERM		✓		

(continued)

Table 5.6 (continued)

Code	Hindrances to ERM implementation	Hygiene factors	Expectancy theory		
			Expectancy	Instrumentality	Valence
H23	Lack of commitment from the board and senior management		✓	✓	
H24	Not perceived as a priority by senior management		✓	✓	
H25	Lack of board or senior management leadership		✓	✓	
H26	The movement of the ERM champion from senior management into other areas without a successor		✓	✓	
H27	Lack of consensus on benefits of ERM among board members and senior management		✓	✓	
H28	Other competing priorities		✓		
H29	Lack of a clear ERM implementation plan				
H30	Inability to coordinate with other departments		✓		
H31	Lack of a set of metrics for measuring ERM performance		✓		
H33	Organizational turf	✓			✓
H34	Employees' reluctance to give up power	✓			✓
H35	People's reluctance to share risk information	✓			
H36	Recession and business downturn		✓		

silo-based approach does not need change. Employees may also worry that others may benefit from risk information sharing at the expense of their resources and are reluctant to share risk information (H35). Fear or anxiety represents the lack of psychological safety and results in job dissatisfaction. Hence, employees would be reluctant to support the ERM program and have silo mentality.

More hindrances to implementing ERM can be explained by the process theories of motivation. According to Vroom's (1964) expectancy theory, motivation is a function of expectancy, instrumentality, and valence. Under the circumstances of ERM implementation, lack of relevant resources (H01–H08, H21, and H30) and inadequate training on ERM (H20) lower the expectancy variable in employees.

Also, other competing priorities (H28), lack of commitment and leadership of the board and senior management (H23 and H25), the movement of the ERM champion (H26), lack of consensus on benefits of ERM (H27), and business downturn (H36) can lower the expectancy. Misunderstandings, such as the perception that ERM adds to bureaucracy (H17), costs, and administration (H18), and unnecessary interference with business activities (H19), lack of understanding about an effective process (H16), lack of perceived benefits or value (H22), and lack of shared understanding and approach to risk management across departments (H15) may make employees perceive that the ERM program would undermine their ability to deliver satisfactory performance and lower their expectancy.

In addition, instrumentality concerns the performance–outcome relationship. The hindrances related to the board and senior management (H23–H27) tend to make employees perceive that leaders are not likely to confirm performance contingent rewards. Even if there is an ERM performance contingent reward system, employees still need to understand this system. Internal training on ERM can show employees a clearer picture of how they can obtain ERM performance contingent rewards. Thus, inadequate training (H20) can cause misunderstandings about the reward system for ERM performance, and the probability that performance leads to the desired outcome would be perceived as being low.

Furthermore, valence plays a key role in motivation. The valence can be negative, if the outcome is undesirable, which renders the motivation negative. Hence, the threats to organizational turf (H33) and power (H34) can lead to negative valence and motivation.

The expectancy theory also provides some managerial implications for ERM implementation. Training programs are crucial to reduce or eliminate misunderstandings about ERM implementation. These programs should provide a clear view of the metrics to measure ERM performance, and how ERM implementation affects the way employees work and their ability to achieve a desirable level of performance. Employees also need to know that ERM implementation is supported by the board and senior management, who can ensure that the resources required are given. It is also possible for managers to redeploy the roles of employees to help them better use their competencies. These actions can ensure that employees have a relatively accurate estimation of the probability that their efforts lead to desirable performance, i.e., the expectancy. Moreover, an ERM performance contingent rewarding system should be created to strength the performance–outcome relationship. Training programs should help employees to understand this rewarding system. These measures can contribute to relatively accurate expectations of employees that the performance leads to their valued outcomes, i.e., the instrumentality. Furthermore, managers need to anticipate the consequences of ERM implementation, because some consequences can lead to negative valences for some individuals. Managers need to help them recognize all the potential gains available to them and ensure that they fully understand the possible losses if there is no ERM program in place.

According to Adams's (1963, 1966) equity theory, people act to reduce or eliminate such inequity in the rewards received compared with others. Hence, people who expect that comparable others receive more favorable outcomes spawned by the change are likely to feel that they are being treated unfairly relative to comparable others and thus resist the change (Hayes 2007). Although no hindrances to ERM implementation can be linked to this theory, this theory provides some managerial implications for ERM programs. The management needs to identify the employees who feel that they are being treated inequitably during ERM implementation and explores the possibilities of improving their valued outcomes as well as the possibilities of redistributing costs and benefits between them in order to produce greater equity.

5.6 Linking ERM Implementation to Leadership Theories

Leaders of the organization play a key role in ERM implementation. The commitment of the board and senior management is considered as a driver for ERM. Such tone at the top represents the support and ensures the resource allocation, the initiation of a training program, the creation of a risk communication mechanism and a risk language, the identification of ERM ownership and accountability, as well as the cultivation of a risk-aware culture throughout the firm. In contrast, lack of high-level commitment, which is also a source of resistance to change, can be linked to several hindrances to ERM implementation, as Table 5.2 indicates.

ERM requires a top-down view of the risks that a firm faces. Visible senior executive leadership is critical to an ERM process (Branson 2010). ERM implementation requires change in corporate culture or mind-set of management at all levels within a firm, and transparent sharing of risk information across silos. Senior executive leadership reinforces the importance of the movement toward a more transparent enterprise-wide view of risk management (Branson 2010). The leaders of ERM programs can be CROs, CFOs, and CEOs. The appointment of a CRO, who is exclusively devoted to leading ERM, can signal the firm's emphasis on risk management to its employees (Cendrowski and Mair 2009).

Kotter (1995, 1996) identified eight errors of leaders that result in the failure of transformational change efforts: not establishing a great enough sense of urgency, not creating a sufficiently powerful guiding coalition, lacking a vision, undercommunicating the vision, permitting obstacles to the new vision, not systematically planning for and creating short-term wins, declaring victory too soon, and not anchoring changes in the corporate culture. Some of these errors can be linked to the hindrances to ERM programs.

A vision is a picture of the future and helps clarify the direction in which an organization needs to move. This vision needs to be effectively communicated to individuals. If the vision of change concerns short-term sacrifices of employees, leaders need to inform them of some new growth possibilities that can be spawned by the change (Kotter 1995). Lack of a vision of ERM implementation and lack of an effective communication approach can lead to resistance to ERM programs because employees may perceive that ERM produces bureaucracy, costs, administration, and unnecessary interference with business activities.

Under-communicating the vision may also expand the side effects of ERM implementation, such as changes in somebody's power or threats to organizational turf. Thus, communication skills are a key attribute of change leaders. This attribute has been identified as one of the inborn traits that make for good or successful leaders in the trait theory of leadership (Graetz et al. 2006; Kirkpatrick and Locke 1991). Given the behavioral theories of leadership (Blake and Mouton 1966; Likert 1961; Stogdill and Coons 1951), Battilana et al. (2010) found that leaders more effective at person-oriented behaviors were more likely than other leaders to focus on communication activities.

In addition, there may be some obstacles to the new vision, such as the unsupportive organizational structures and culture, which hinders employees from embracing ERM. Leaders need to reduce or remove these obstacles and mobilize employees to accept the change. Battilana et al. (2010) found that leaders leaning toward task-oriented behaviors were more likely than other leaders to focus on mobilizing employees.

Moreover, lack of a short-term win tends to make employees lose momentum or even join the employees who resist the change (Kotter 1995). Since ERM implementation is a multiyear process, employees need compelling evidence that the program produces benefits or value. Leaders should provide employees with some perceivable benefits or value of ERM, which involves the metrics to measure ERM performance. Lack of such a set of metrics is likely to conceal ERM performance and renders employees unable to perceive the benefits or value of ERM. Creating a short-term achievement concerns the evaluation of a change program. Battilana et al. (2010) found that leaders who were more effective at task-oriented behaviors were more likely than other leaders to focus on evaluating change implementation.

Furthermore, change leaders should institutionalize the change. Once the pressure for change is removed, change is subject to degradation, unless new behaviors are rooted in social norms and shared values. This can explain why ERM should be integrated into the business process. Thus, a risk-aware culture that encourages full engagement and accountability at all levels needs to be fused into the corporate culture. Such a risk-aware culture is considered as a hallmark of an advanced ERM program (AON 2010). Thus, even if the ERM champion from the senior executive moves or retires, ERM practices will not disappear in the firm.

Based on the above analysis, it can be concluded that leaders of ERM programs need to adopt different leadership styles while dealing with different hindrances to ERM implementation. This aligns with the contingency theories of leadership. Dunphy and Stace (1993) linked four styles of change leadership (collaborative, consultative, directive, and coercive) with four types of change (fine-tuning, incremental adjustment, modular transformation, and corporate transformation). Most ERM implementation is incremental at the initial stage. Hence, a consultative style of change leadership is likely to be appropriate.

5.7 Conceptual Model

The conceptual model contributes to the fulfillment of the fourth research objective, which involves analyzing the drivers for and hindrances to ERM implementation in tandem with theories of organizational behavior. As shown in Fig. 5.1, the conceptual model describes the relationships between the proposed ERM framework (see Sect. 3.6) and the influential factors (i.e., drivers and hindrances), as well as the relationship between the theories of organizational behavior and the proposed ERM framework and factors.

The core of the conceptual model is the proposed ERM framework for construction firms, which describes key activities of ERM implementation. The proposed ERM framework is underpinned by drivers for and hindrances to ERM implementation in the conceptual model. Some components of the ERM framework can reduce the negative effects of the hindrances to ERM implementation, which is represented by one-way arrows.

This chapter has linked ERM implementation, especially the drivers for and hindrances to ERM implementation, to organizational change, organizational learning, organizational culture, motivation, and leadership theories, respectively. These linkages are represented by bold two-way arrows. The five interactive organizational behavior theories provide the rationale behind the forces that drive and hinder ERM implementation.

As ERM implementation is seen as an incremental, continuous, and evolutionary organizational change, the hindrances to and drivers for ERM can be linked to the

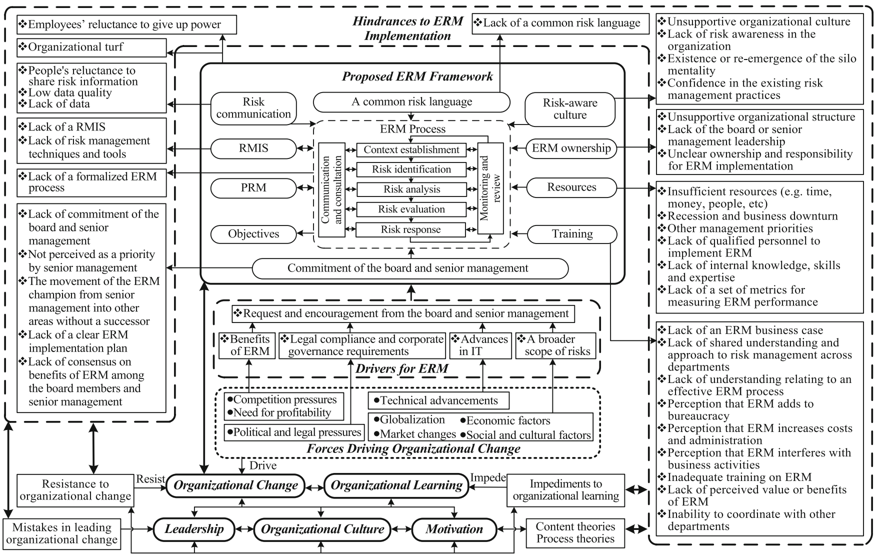


Fig. 5.1 Conceptual model

resistance to and drivers for organizational change. Organizational learning serves as a medium for change (Alas and Sharifi 2002). Several impediments to learning also hinder organizational change and can thus be linked to the hindrances to ERM implementation. Organizational culture, which influences employees' behavior and attitudes, has been considered in the organizational "context" (CAS 2003) or "environment" (COSO 2004; ISO 2009) component in the existing ERM frameworks. Motivation interacts with organizational change and learning and can be linked to some hindrances to ERM implementation by virtue of the content or process theories of motivation. Most organizational change needs leadership commitment, which concerns the motivation issues because such commitment can affect the expectation of employees about their performance and achievement of outcomes. Mistakes of leaders tend to result in failure of the change (Kotter 1995). Some of these mistakes can be linked to hindrances to ERM implementation.

The interactions among organizational change, organizational learning, organizational culture, motivation, and leadership are indicated in this conceptual model by two-way arrows in the conceptual model.

References

Acharyya M (2008) An empirical study on enterprise risk management in insurance. In: Olson DL, Wu D (eds) New frontiers in enterprise risk management. Springer, Heidelberg, pp 39–55

Adams JS (1963) Towards an understanding of inequity. J Abnorm Soc Psychol 67(5):422–436

Adams JS (1966) Inequity in social exchange. In: Berkowitz L (ed) Advances in experimental social psychology. Academic Press, New York, pp 267–299

Alas R, Sharifi S (2002) Organizational learning and resistance to change in Estonian companies. Hum Resour Dev Int 5(3):313–331

AON (2010) Global risk management survey 2010. AON plc, Chicago

Barton TL, Shenkir WG, Walker PL (2002) Making enterprise risk management pay off. Financial Times Prentice Hall, Upper Saddle River

Battilana J, Gilmartin M, Sengul M, Pache AC, Alexander JA (2010) Leadership competencies for implementing planned organizational change. Leadersh Quart 21(3):422–438

Beer M, Nohria N (2000a) Cracking the code of change. Harvard Bus Rev 78(3):133–141

Beer M, Nohria N (2000b) Resolving the tension between theories E and O of change. In: Beer M, Nohria N (eds) Breaking the code of change. Harvard Business School Press, Boston, pp 1–34

Bereiter C (2002) Education and mind in the knowledge age. Lawrence Erlbaum, Hillsdale

Blake RR, Mouton JS (1966) Managerial facades. Adv Manage J 31(3):30–37

Boisnier A, Chatman JA (2003) The role of subcultures in agile organizations. In: Peterson R, Mannix E (eds) Leading and managing people in dynamic organizations. Lawrence Earlbaum Associates, Mahwah, pp 87–112

Bowling DM, Rieger LA (2005) Success factors for implementing enterprise risk management. Bank Acc Finan 18(3):21–26

Branson BC (2010) The role of the board of directors and senior management in enterprise risk management. In: Fraser J, Simkins BJ (eds) Enterprise risk management. Wiley, Hoboken, pp 51–68

Brown DR, Harvey D (2005) An Expertimental approach to organizational development, 7th edn. Pearson Prentice Hall, Upper Saddle River

CAS (2003) Overview of enterprise risk management. Casualty Actuarial Society, Arlington

Cendrowski H, Mair WC (2009) Enterprise risk management and COSO: a guide for directors, executives, and practitioners. Wiley, Hoboken

COSO (2004) Enterprise risk management—integrated framework: executive summary and framework. Committee of Sponsoring Organizations of the Treadway Commission, Jersey City

Davenport TH, Prusak L (1998) Working knowledge: how organization manage what they know. Harvard Business School Press, Boston

Dikmen I, Birgonul MT, Anac C, Tah JHM, Aouad G (2008) Learning from risks: a tool for post-project risk assessment. Autom Constr 18(1):42–50

Driver J, Bernard R (2012) Enterprise risk management. In: Tichansky DS, Morton J, Jones DB (eds) The SAGES Manual of quality, outcomes and patient safety. Springer, New York, pp 529–539

Dunphy D, Stace D (1993) The strategic management of corporate change. Hum Relat 46(8):905–920

Engeström Y (1999) Innovative learning in work teams: analyzing cycles of knowledge creation in practice. In: Engeström Y, Miettinen R, Punamaki RL (eds) Perspectives on activity theory. Cambridge University Press, Cambridge, pp 377–404

Espersen D (2007) The language of risk: organizations can improve risk management and audit processes by communicating risks in terms that everyone understands. Intern Auditor 64 (3):69–73

Fisher SR, White MA (2000) Downsizing in a learning organization: are there hidden costs? Acad Manag Rev 25(1):244–251

Garvin DA (1993) Building a learning organization. Harvard Bus Rev 71(4):78–91

Gates S (2006) Incorporating strategic risk into enterprise risk management: a survey of current corporate practice. J Appl Corp Finan 18(4):81–90

Gordon LA, Loeb MP, Tseng CY (2009) Enterprise risk management and firm performance: a contingency perspective. J Account Public Policy 28(4):301–327

Graetz F, Rimmer M, Lawrence A, Smith A (2006) Managing organizational change, 2nd Australasian ed. Wiley, Milton Qld

Hayes J (2007) The theory and practice of change management, 2nd edn. Palgrave Macmillan, New York

Herzberg FI (1966) Work and the nature of man. World, Cleveland

Hoyt RE, Liebenberg AP (2011) The value of enterprise risk management. J Risk Insur 78(4):795–822

IMA (2007) Enterprise risk management: tools and techniques for effective implementation. Institute of Management Accountants, Montvale

ISO (2009) ISO 31000:2009 risk management—principles and guidelines. International Organization for Standardization, Geneva

Kimbrough RL, Componation PJ (2009) The relationship between organizational culture and enterprise risk management. Eng Manage J 21(2):18–26

Kirkpatrick SA, Locke EA (1991) Leadership: do traits mater? Acad Manage Executive 5(2):48–60

Kleffner AE, Lee RB, McGannon B (2003) The effect of corporate governance on the use of enterprise risk management: evidence from Canada. Risk Manag Insur Rev 6(1):53–73

Kotter JP (1995) Leading change: why transformation efforts fail. Harvard Bus Rev 73(2):59–67

Kotter JP (1996) Leading change. Harvard Business School Press, Boston

Kotter JP, Schlesinger LA (1979) Choosing strategies for change. Harvard Bus Rev 57(2):106–114

Lähteenmäki S, Toivonen J, Mattila M (2001) Critical aspects of organizational learning research and proposals for its measurement. Br J Manag 12(2):113–129

Lam J (2003) Enterprise risk management: from incentives to controls. Wiley, Hoboken

Lewitt B, March JG (1988) Organizational learning. Annu Rev Sociol 14:319–340

Liew A (2007) Understanding data, information, knowledge and their inter-relationships. J Knowl Manage Pract 8(2):102–122

Likert R (1961) New patterns of management. McGrill-Hill, New York

Lipshitz R, Popper M, Friedman VJ (2002) A multifacet model of organizational learning. J Appl Behav Sci 38(1):78–98

Martin J (1992) Cultures in organizations: three perspectives. Oxford University Press, Oxford
Miccolis J (2003) ERM lessons across industries. International Risk Management Institute, Dallas, TX. http://www.irmi.com/expert/articles/2003/miccolis03.aspx. Retrieved 3 Mar 2011
Miccolis J, Mueller H, Gruhl R (2000) Enterprise risk management in the insurance industry: 2000 benchmarking survey report. Tillinghast-Towers Perrin, Parsippany, NJ. http://www.towersperrin.com/tp/getwebcachedoc?webc=till/usa/2000/200001/2000060107.pdf. Retrieved 21 Apr 2011
Nadler DA, Tushman ML (1995) Types of organizational change: from incremental improvement to discontinuous transformation. In: Nadler DA, Shaw R, Walton AE (eds) Discontinuous change. Jossey-Bass, San Francisco, pp 15–34
Nocco BW, Stulz RM (2006) Enterprise risk management: theory and practice. J Appl Corp Finan 18(4):8–20
Nonaka I (1991) The knowledge creating company. Harvard Bus Rev 69(6):96–104
Pfeffer J (1998) The human equation: building profits by putting people first. Harvard Business School Press, Cambridge
Porras JI, Robertson PJ (1992) Organizational development: theory, practice, and research. In: Dunnette MD, Hough LM (eds) Handbook of industrial and organizational psychology, 2nd edn. Consulting Psychologists Press, Palo Alto, pp 719–822
Reigle RF (2003) Organizational culture assessment: development of a descriptive test instrument. Unpublished Ph.D. Thesis, University of Alabama in Huntsville, Huntsville
Robbins SP (2003) Organizational behavior, 10th edn. Prentice Hall, Upper Saddle River
Schein EH (1990) Organizational culture. Am Psychol 45(2):109–119
Schein EH (1992) Organizational culture and leadership, 2nd edn. Jossey-Bass, San Francisco
Senge PM (1990) The fifth discipline: the art and practice of the learning organization. Currency Doubleday, New York
Senior B, Fleming J (2006) Organizational change, 3rd edn. Financial Times Prentice Hall, Harlow
Shortreed J (2010) ERM framework. In: Fraser J, Simkins BJ (eds) Enterprise risk management. Wiley, Hoboken, pp 97–123
Simkins B (2008) Enterprise risk management: current initiatives and issues Journal of Applied Finance Roundtable. J Appl Finan 18(1):115–132
Smallman C (1996) Risk and organizational behaviour: a research model. Disaster Prev Manage 5 (2):12–26
Stogdill RM, Coons AE (1951) Leader behavior: its description and measurement. Ohio State University and Bureau of Business Research, Columbus
Tushman ML, Smith W (2002) Organizational technology. In: Baum JA (ed) The Blackwell companion to organizations. Blackwell Publishers, Malden, pp 386–414
Vroom VH (1964) Work and motivation. Wiley, New York

Chapter 6
Research Methodology

Keywords Case studies · Questionnaire survey · Semi-structured interviews · Data analysis methods · Research design · Data collection methods

6.1 Introduction

This chapter describes the research design and data collection methods used in this research. Combining multiple methods has been recommended to be used in construction management research because this approach overcomes some of the inherent limitations of a single approach and facilitates a complete understanding of a given construction management research phenomenon (Love et al. 2002). Also, combining both qualitative and quantitative approaches in research design and data collection has been advocated because of its greater utility, even though it is more expensive in terms of time, money, and energy (Abowitz and Toole 2010; Tashakkori and Teddlie 1998).

The overall research framework is illustrated in Fig. 6.1. A literature review on ERM (see Chap. 3) and theories of organizational behavior (see Chap. 4) was conducted. Based on the literature review, an ERM framework for construction firms is proposed, and ERM maturity criteria and best practices as well as potential factors that drive and hinder ERM implementation were identified in Chap. 3. The importance of the ERM maturity criteria and the applicability of the ERM best practices were checked using the data collected from the first survey (coded as Survey I). Thus, the significantly important criteria and the significantly applicable best practices were included in the proposed fuzzy ERM maturity model. Follow-up interviews were performed with the practitioners who were originally included in the questionnaire survey sample for their comments on the results of Survey I. Then, the second survey (coded as Survey II) was conducted to collect the data relating to the implementation of the best practices as well as the factors driving and hindering ERM implementation in CCFs based in Singapore. Organizational behavior theories were used to interpret the critical factors influencing ERM implementation.

X. Zhao et al., *Enterprise Risk Management in International Construction Operations*, DOI 10.1007/978-981-287-549-5_6

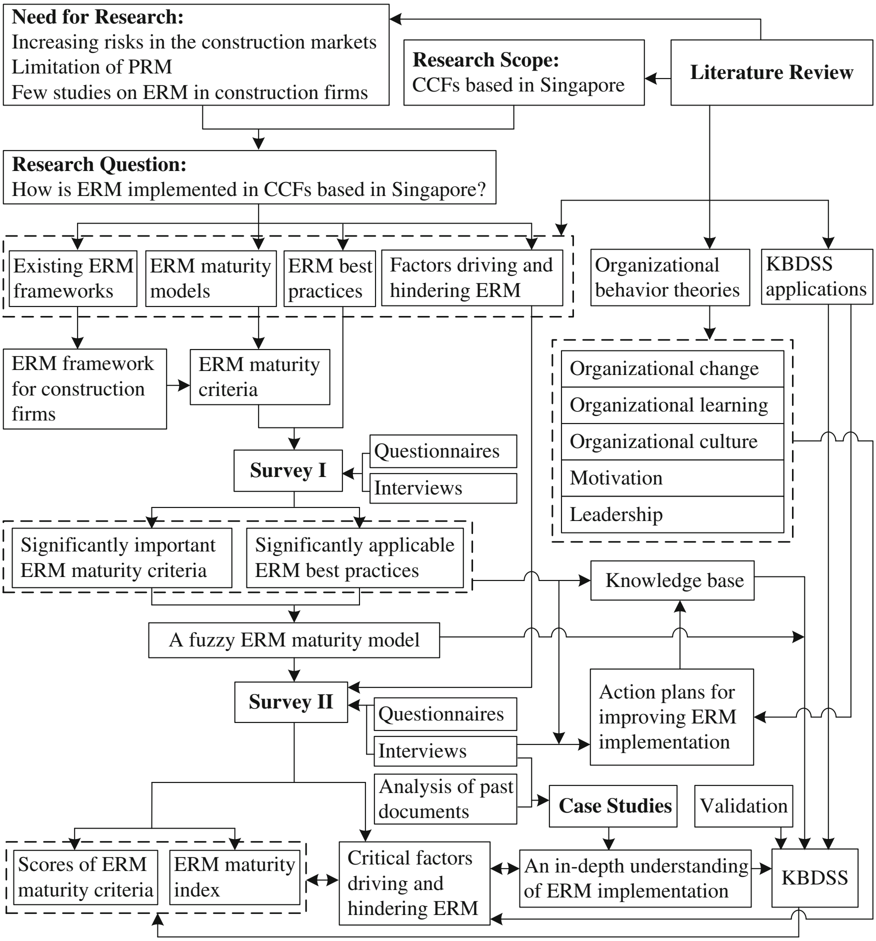


Fig. 6.1 The research framework

In addition, to get an understanding of ERM implementation in Singapore-based CCFs, case studies were conducted using the information collected from the interviews and past documents. Also, specific action plans for improving ERM practices were identified and checked through the interviews. Furthermore, this research developed a KBDSS, which contains a knowledge base comprised of the important ERM maturity criteria, the applicable ERM best practices, and the action plans, as well as the fuzzy ERM maturity model. The KBDSS can also be used to compute the scores of the maturity criteria and the ERMMI of each CCF. The KBDSS was validated through case testing (see Sect. 9.8).

6.2 Research Design

Research design is a plan for testing the hypothesis or for interpreting events. The common types of research designs include case studies, surveys, experiments, correlation or regression, comparisons, and historical designs (Tan 2012). Case studies are appropriate for the in-depth understanding or interpretation of particular instances; surveys are used to obtain broad population characteristics and reasons for certain actions or preferences; experiments are used to test cause and effect relations by controlling and manipulating variables; correlation or regression analysis is used when experiment control is difficult or impossible; comparative research is used to explain similarities and differences between multiple groups; and historical research seeks to explain the past to understand or draw lessons for the present and future (Tan 2012).

This research involves collection of professional views on ERM criteria and best practices as well as the perceived factors that drive and hinder ERM implementation. Hence, two rounds of surveys were conducted in this research. One obtained professional views on the importance of the ERM maturity criteria and the applicability of the best practices from the professionals in the industry and academia, while the other collected the ERM implementation levels and the significance of the factors influencing ERM implementation in CCFs based in Singapore.

In addition, Yin (2009) believed that a case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. Unlike surveys constrained by the rigid limits, case studies can lead to new and creative insights, development of new theories, and have high validity with practitioners (Voss et al. 2002). Yin (2009) recommended case studies to focus on the questions about "what, why, and how." As this research attempts to investigate how ERM is implemented in CCFs based in Singapore, cases studies were adopted.

6.2.1 Surveys

Two surveys were conducted with different groups of respondents. Survey I obtained the importance of the ERM maturity criteria and the applicability of the ERM best practices in CCFs. Survey II extracted the critical factors that could drive and hinder ERM implementation in CCFs based in Singapore, and collected the implementation levels of the ERM best practices.

Survey I intended to collect the views of professionals about the importance of the ERM maturity criteria, which could be used to calculate the criterion weights, as well as the applicability of the best practices of ERM. The population for this survey included all the industry practitioners with extensive experience in risk management in CCFs and all the academics who have gained in-depth knowledge of risk management in CCFs through research. As there was no sampling frame in this survey, the sample was a non-probability sample. The non-probability sampling plan can be used to obtain a representative sample (Patton 2001) and has been recognized as appropriate when the respondents were not randomly selected from the entire population, but were rather selected based on whether they were willing to participate in the study (Wilkins 2011). There are four types of non-probability samples: convenience samples, purposive samples, quota samples, and snowball samples. Convenience samples are not representative and are used mainly for exploratory work, pretesting of questionnaires or where a quick opinion is required. Purposive samples are drawn by judgment (Tan 2012). These are not applicable to this survey. Thus, quota and snowball sampling were used in Survey I. The use of multiple types of sampling methods can help overcome some of the inherent limitations of any particular sample of data (Abowitz and Toole 2010). The sample was stratified according to the institution types (CCFs and academic institutions). The sample consisted of (1) the industry practitioners from CCFs in Mainland China and their overseas subsidiaries and (2) the academics from universities located in Mainland China and Hong Kong Special Administrative Region. In addition, the respondents were asked to provide referrals for additional respondents.

Survey II intended to investigate the ERM maturity levels and to identify the critical factors influencing ERM implementation in CCFs based in Singapore. The population of Survey II was all the CCFs based in Singapore. At the time of this research, there were 46 CCFs registered with the Registry of Public Sector Contractors administered by the BCA of Singapore. As the registry serves the procurement needs of the public sector, contractors not registered with the BCA are not precluded from conducting business outside of the public sector. Hence, there may be more CCFs in Singapore. These 46 CCFs comprised the sampling frame of Survey II. Since the sampling frame was not large, it was used as the sample. As ERM generally adopts a top-down approach (Dickinson 2001; Olson and Wu 2008), the management staff at a higher level tends to know more about ERM implementation than lower level staff. The senior management from these CCFs was first contacted prior to the middle management, such as project managers, being approached as appropriate.

6.2.2 Case Studies

As Survey II uncovered the extent to which CCFs implemented ERM but not how to implement ERM, case studies were used to provide an understanding of how specific Singapore-based CCFs actually implemented ERM, and why they implemented ERM in such a manner.

For a given set of available resources, the fewer the case studies, the greater the opportunity for in-depth observations (Voss et al. 2002). Single, in-depth case studies are often used in longitudinal research (Karlsson and Åhlström 1995; Narasimhan and Jayaram 1998). However, a single case study has limitations related to the generalizability of the conclusions, the risks of misjudging of a single case, and of exaggerating easily available data (Voss et al. 2002). The ERM implementation in one CCF with a higher financial grade cannot be generalized to a relatively small one. Thus, multiple case studies were used in this research, and comparison across cases was made. Given the resource limitation, multiple cases may reduce the depth of study, but can augment external validity, and help guard against observer bias (Voss et al. 2002). To enhance the depth of case studies, three case studies were conducted. A large, medium, and small CCFs were selected for case studies because firm size has been identified as a variable positively related to ERM adoption (Beasley et al. 2005; Hoyt and Liebenberg 2011) and significantly affecting ERM system design (COSO 2004) and improvement of firm performance (Gordon et al. 2009).

6.3 Data Collection Methods

In this research, analysis of past documents, questionnaires, and interviews were used to collect both qualitative and quantitative data for gaining a clear understanding of ERM implementation in CCFs based in Singapore. This is because no single data collection method is ideal and combined methods such as using both qualitative and quantitative data collection methods have been highly recommended (Abowitz and Toole 2010).

6.3.1 Analysis of Past Documents

Past documents about the CCFs, which were the subjects of the case studies, were analyzed to obtain an overview of the risk management practices in these firms. These documents included their internal documents (such as operational and management manuals) about ERM, academic literature concerning risk management in the case firms, as well as media coverage. Internal documents were collected by interpersonal networking, while the literature and media coverage was available in the Internet. Analysis of past documents helped in the conduct of case studies, which intended to provide an understanding of how these CCFs implemented ERM and in what manner.

6.3.2 Questionnaires and Interviews

Among the various data collection methods, the questionnaire has been recognized as the most cost-effective and most popular mean to collect information (Gravetter and Forzano 2012) and has been widely used by researchers in the studies relating to risk management (Hwang et al. 2013a; Liu et al. 2011; Wang et al. 2004; Zhao et al. 2013). Thus, questionnaires were designed to collect data in this research. The terminology used was explained in the questionnaires to ensure that the respondents were clear about the questions.

The pilot study was performed with four professionals to solicit comments on the readability, comprehensiveness, and accuracy of the questionnaire. Three of them were from CCFs based in Singapore, while the other one was from a university in China. All of them had over 10 years of working or research experience. As they believed that the 16 criteria can comprehensively reflect the characteristics of a mature ERM program, no new criteria were added. In addition, based on their comments, new best practices were added, revisions were made to improve the readability and accuracy of the statement of the best practices, and footnotes were added to explain the terminologies used.

The finalized questionnaire of Survey I included four parts (see Appendix 1). The first part was an introductory letter, which explained the research objectives and contact details. The second part solicited the profile of the respondents, such as their affiliation and working or research experience. In the third part, the best practices related to each criterion were listed. Because these practices were collected from the literature relating to the successful or advanced ERM practices in various industries, their applicability in CCFs should be checked. The respondents were requested to rate the applicability of each practice in CCFs using another five-point Likert scale (1 = very inapplicable, 2 = inapplicable, 3 = medium, 4 = applicable, and 5 = very applicable). In this part, open-ended questions were also presented to ask for other suggested practices that the experts deemed important and applicable. In the fourth part, the respondents were asked to rate the importance of each ERM maturity criterion according to a five-point Likert scale (1 = very low, 2 = low, 3 = medium, 4 = high, and 5 = very high) based on their actual professional experience on risk management in CCFs.

In Survey I, the finalized questionnaires were sent to experts by email. Email questionnaires could provide an easier and more immediate means of response, and a potential decrease in delivery time and cost. These questionnaires are self-administered, provide geographical flexibility, and allow respondents time to think about the questions before responding (Tan 2012). The problem of poor response rate can potentially be lessened by follow-up calls.

After the questionnaire survey and data analysis, four practitioners who were originally included in the questionnaire survey sample were interviewed for their comments on the analysis results. These comments were used to support the exclusion of the ERM best practices that were found inapplicable in CCFs.

In Survey II, the questionnaire was structured in four parts (see Appendix 2). Similar to the questionnaire in Survey I, the first part explained the research objectives and contact details, while the second part was meant to profile the respondents and their firms, such as their designations, years of work experience, and the financial grade. In the third part, respondents were asked to rate the significance of the factors identified from the literature review in driving or hindering ERM implementation in their firms. They could make judgments based on the status quo in their firms and responded to questions using a five-point Likert scale (1 = very insignificant, 2 = insignificant, 3 = neutral, 4 = significant, and 5 = very significant). In the last part, the ERM best practices, which were found significantly applicable in Survey I, were presented, and the implementation level of each best practice was rated on a five-point Likert scale (1 = very low, 2 = low, 3 = medium, 4 = high, and 5 = very high). Respondents were rated by comparing similar current practices in their firms with the best practices under each criterion.

The questionnaires of Survey II were sent to the management in the CCFs registered with the BCA through emails, or handed to them personally. Handing to them personally was preferred to emails because it provided opportunities for conducting interviews to collect data for case studies.

Having conducted Survey II, semi-structured interviews, which are common in interviews (Tan 2012), were performed with the managers from Singapore-based CCFs, who agreed to be interviewed. A questionnaire was designed for the interview, including seven groups of questions (see Appendix 3). The first group was used to collect the basic information relating to the firm and interviewee. The following five groups of questions were used to collect their opinions relating to the factors affecting ERM implementation, ERM ownership, risk communication, the risk-aware culture, as well as the ERM process in the interviewees' firms, respectively. Most questions in the questionnaire were open-ended for the interviewees to supply their own answers without being constrained by a fixed set of possible responses. These questions served as an interview guide and can be asked in different ways, which helped the interviewers to tailor the questions to the interview context and to the interviewees. In addition, new questions were allowed to be raised during the semi-structured interviews to gain an understanding of ERM implementation in the interviewees' firms. The information from the semi-structured interviews was used in the case studies.

6.4 Data Analysis Methods

Cronbach's alpha coefficient was computed to test the reliability and internal consistency of the responses. The alpha can range from 0 to 1 and should be at least 0.7 for a scale to be reliable (Nunnally 1978).

The one-sample *t* test, which can test the null hypothesis that the population mean is equal to a specified value, was used to test whether all the maturity criteria were significantly important and whether all the best practices were significantly applicable in CCFs. This method has been applied in the construction management research that compared means with a test value (Hwang et al. 2013a, b; Ling et al. 2013; Low and Chuan 2006).

In addition, the ranking technique has been widely used to rank the relative importance of the factors in the construction management domain (El-Razek et al. 2008; Hwang et al. 2013b, 2014c; Yang et al. 2010; Zhao et al. 2013). In this research, the maturity criteria were ranked according to their mean importance scores and these scores were also used to calculate the weights of the criteria, using Eqs. 3.9 and 3.10 in Sect. 3.7.3.

Moreover, to measure the degree of agreement associated with the importance ranking of the ERM maturity criteria between the practitioners and academics in Survey I, the Spearman rank correlation coefficient was calculated and statistically tested. The Spearman rank correlation is a method of computing a correlation between the ranks of scores between two groups and has been widely used in construction management research (El-Razek et al. 2008; Hwang et al. 2014a, b; Yang et al. 2010; Zhao et al. 2013). The correlation coefficient is calculated on the ranks of scores, not the scores themselves. As a result, without the consideration of normality or equal variance of data, this statistical method can be used focusing on difference in rank orders of data rather than difference in means (Hwang et al. 2009). A significance level of 0.05 (two-tailed) was used for this analysis.

Together with the weights collated from Survey I, the implementation level of each best practice collected from Survey II was used to calculate the ERM maturity level. Using the fuzzy ERM maturity model, the maturity scores of each criterion and the overall maturity score (i.e., ERMMI) could be calculated. As these scores can be interpreted with linguistic terms, all the CCFs obtained a term representing their ERM maturity levels. Furthermore, to check the relationship between ERM maturity levels and firm characteristics, the chi-square (χ^2) contingency table analysis was performed at the significance level of 0.05. This method determines the extent to which a statistical relationship exists between two variables (McClave et al. 2010) and has been viewed as one of the most widely used statistical tools for categorical data analysis (Hwang et al. 2014b; Xia et al. 2012). Also, the criteria were ranked based on their scores to see which areas had relatively weak implementation, while the Spearman rank correlation was conducted to check the agreement on the maturity criterion score ranking between CCF groups with different characteristics.

Similarly, the drivers for and hindrances to ERM implementation were ranked according to their mean scores, respectively. The one-sample t test was also employed to test whether the influence of the drivers and hindrances was significant, and the Spearman rank correlation was conducted to examine whether there was agreement on the rankings between the respondent groups. In addition, the independent-sample *t* test, which can test whether there were differences in means between two independent samples, was conducted to check the differences in the mean scores of the drivers and hindrances between the respondent groups.

The Statistical Package for Social Sciences (SPSS) software, which has been widely adopted for statistical analysis in a variety of studies, was used to conduct the data analysis for this research.

6.5 Summary

This research adopted a combination of multiple methods in research design and data collection. Two rounds of surveys were conducted to examine the ERM maturity levels and critical factors affecting ERM implementation in CCFs based in Singapore. Survey I intended to obtain the importance of the ERM maturity criteria and the applicability of the best practices from the professionals in CCFs and their overseas subsidiaries as well as the academics who were familiar with ERM practices in CCFs. Survey II identified the critical drivers for and hindrances to ERM implementation, and obtained the actual implementation level of each best practice deemed to be significantly applicable in Survey I from the CCFs based in Singapore. Case studies were used to provide an understanding of how ERM was implemented in the CCFs. Analysis of past documents, questionnaires, and semi-structured interviews were conducted to collect data. Various statistical analysis methods were used to analyze the data collected from the two rounds of surveys.

References

Abowitz DA, Toole TM (2010) Mixed method research: fundamental issues of design, validity, and reliability in construction research. J Constr Eng Manage 136(1):108–116

Beasley MS, Clune R, Hermanson DR (2005) Enterprise risk management: an empirical analysis of factors associated with the extent of implementation. J Account Public Policy 24(6):521–531

COSO (2004) Enterprise risk management—integrated framework: executive summary & framework. Committee of Sponsoring Organizations of the Treadway Commission, Jersey City, NJ

Dickinson G (2001) Enterprise risk management: its origins and conceptual foundation. Geneva Papers Risk Insur: Iss Practice 26(3):360–366

El-Razek AM, Bassioni H, Mobarak A (2008) Causes of delay in building construction projects in Egypt. J Constr Eng Manage 134(11):831–841

Gordon LA, Loeb MP, Tseng CY (2009) Enterprise risk management and firm performance: a contingency perspective. J Account Public Policy 28(4):301–327

Gravetter FJ, Forzano LB (2012) Research methods for the behavioral sciences, 4th edn. Wadsworth, Cengage Learning, Belmont

Hoyt RE, Liebenberg AP (2011) The value of enterprise risk management. J Risk Insur 78(4):795–822

Hwang BG, Thomas SR, Haas CT, Caldas CH (2009) Measuring the impact of rework on construction cost performance. J Constr Eng Manage 135(3):187–198

Hwang BG, Zhao X, Gay MJS (2013a) Public private partnership projects in Singapore: factors, critical risks and preferred risk allocation from the perspective of contractors. Int J Project Manage 31(3):424–433

Hwang BG, Zhao X, Ng SY (2013b) Identifying the critical factors affecting schedule performance of public housing projects. Habitat Int 38:214–221

Hwang BG, Zhao X, Do THV (2014a) Influence of trade-level coordination problems on project productivity. Project Manage J 45(5):5–14

Hwang BG, Zhao X, Goh KJ (2014b) Investigating the client-related rework in building projects: the case of Singapore. Int J Project Manage 32(4):698–708

Hwang BG, Zhao X, Ong S (2014c) Value management in Singaporean building projects: implementation status, critical success factors, and risk factors. J Manage Eng 04014094. doi:10.1061/(ASCE)ME.1943-5479.0000342
Karlsson C, Åhlström P (1995) Change processes towards lean production: the role of the remuneration system. Int J Oper Prod Manage 15(11):80–99
Ling FYY, Ong SY, Ke Y, Wang S, Zou P (2013) Drivers and barriers to adopting relational contracting practices in public projects: comparative study of Beijing and Sydney. Int J Project Manage. doi:10.1016/j.ijproman.2013.04.008
Liu JY, Low SP, He X (2011) Current practices and challenges of implementing enterprise risk management (ERM) in Chinese construction enterprises. Int J Constr Manage 11(4):49–63
Love PED, Holt GD, Li H (2002) Triangulation in construction management research. Eng Constr Architectural Manage 9(4):294–303
Low SP, Chuan QT (2006) Environmental factors and work performance of project managers in the construction industry. Int J Project Manage 24(1):24–37
McClave J, Benson PG, Sincich T (2010) Statistics for business and economics, 11th edn. Pearson Education, NJ
Narasimhan R, Jayaram J (1998) Reengineering service operations: a longitudinal case study. J Oper Manage 17(1):7–22
Nunnally JC (1978) Psychometric theory, 2nd edn. McGraw-Hill, New York
Olson DL, Wu D (2008) Enterprise risk management. World Scientific Publishing, Singapore
Patton MQ (2001) Qualitative research & evaluation components, 3rd edn. Sage, Thousand Oaks
Tan W (2012) Practical research methods, 4th edn. Pearson Prentice Hall, Singapore
Tashakkori A, Teddlie C (1998) Mixed methodology: combining qualitative and quantitative approaches. Sage, Thousand Oaks
Voss C, Tsikriktsis N, Frohlich M (2002) Case research in operations management. Int J Oper Prod Manage 22(2):195–219
Wang SQ, Dulaimi MF, Aguria MY (2004) Risk management framework for construction projects in developing countries. Constr Manage Econ 22(3):237–252
Wilkins JR (2011) Construction workers' perceptions of health and safety training programmes. Constr Manage Econ 29(10):1017–1026
Xia B, Chan A, Molenaar K, Skitmore M (2012) Determining the appropriate proportion of owner-provided design in design-build contracts: a content analysis approach. J Constr Eng Manage 138(9):1017–1022
Yang J, Shen GQ, Drew DS, Ho M (2010) Critical success factors for stakeholder management: construction practitioners' perspectives. J Constr Eng Manage 136(7):778–786
Yin RK (2009) Case study research: design and methods, 4th edn. Sage, Thousand Oaks
Zhao X, Hwang BG, Yu GS (2013) Identifying the critical risks in underground rail international construction joint ventures: case study of Singapore. Int J Project Manage 31(4):554–566

Chapter 7
Data Analysis and Discussions

Keywords Data analysis · ERM maturity criteria · ERM best practices · CCFs based in Singapore · Drivers for ERM · Hindrances to ERM · ERM implementation

7.1 Introduction

This chapter presents the analysis of the data collected from the two rounds of surveys. Specifically, Survey I produced 89 completed questionnaires from 25 academics and 64 practitioners of CCFs. The analysis results indicated that all the 16 ERM maturity criteria were significantly important and that 66 out of the 71 ERM best practices were significantly applicable in the CCFs. The five practices that were found not significantly applicable were excluded, and the exclusion was supported by the relevant comments garnered from four interviews with the practitioners who were originally included in the survey sample. Thus, the 16 criteria and 66 best practices were included in the ERM maturity model.

Survey II was conducted with the practitioners from the CCFs based in Singapore and 35 responses were received. The analysis results reported that the overall ERM maturity level of the surveyed Singapore-based CCFs was low. Thus, Hypothesis 2 that "ERM maturity level in CCFs based in Singapore is low" was supported. Additionally, the analysis results indicated the significant association between ERM maturity level and firm size, which implied that the larger firms were likely to have higher level ERM maturity. Moreover, 13 factors were reported to significantly drive ERM implementation, and 25 factors were found to significantly hinder ERM implementation in these CCFs. Although there were differences in the mean scores of a couple of drivers and hindrances, this research reported the significant agreement on the rankings of the drivers and hindrances between the low- and medium-maturity CCFs, respectively. Furthermore, the significant drivers and hindrances were interpreted in tandem with the theories of organizational behavior.

X. Zhao et al., *Enterprise Risk Management in International Construction Operations*, DOI 10.1007/978-981-287-549-5_7

Specifically, the theories of organizational change were used to interpret the significant drivers for ERM implementation, while the theories of organizational change, organizational learning, organizational culture, motivation, as well as leadership theories, were employed to interpret the significant hindrances to ERM implementation.

7.2 Analysis Results and Discussions of Survey I

7.2.1 Sample Profile

Survey I intended to solicit the importance of the ERM maturity criteria and the applicability of the ERM best practices in CCFs. From April to June 2012, a total of 390 questionnaires were sent, and 89 completed questionnaires were received from 25 academics and 64 practitioners, representing a response rate of 22.8 %. This rate was consistent with the norm of 20–30 % with most questionnaire surveys in the construction industry (Akintoye 2000). The profile of the respondents is indicated in Table 7.1.

In terms of experience, 51.7 % of the respondents had more than 10 years of experience in the industry or academia, thus assuring the response quality. Specifically, 37.5 % of the practitioners and 88.0 % of the academics had over 10 years of experience, respectively, and around 18.0 % of all the respondents had over 20 years of experience.

As for the geographical locations, all the academic respondents were from universities located in Mainland China, but some of them had the knowledge of risk management in CCFs in the international market. Meanwhile, among the 64 respondents from the industry, 37 (57.8 %) were from China, while 12 (18.8 %), 11 (17.2 %), 2 (3.1 %), and 2 (3.1 %) were from the overseas divisions of CCFs in Asia, Africa, Europe, and Latin America, respectively. Some of the 37 practitioners had also worked in overseas divisions. Thus, the data can reflect the opinions on ERM maturity criteria from CCFs in the global construction market.

With respect to the designations of the respondents, 14 (56.0 %) of the 25 academics were professors, while 11 (44.0 %) were associate professors, representing 12.4 and 15.7 % of all the respondents, respectively. The designations of the practitioners were more diversified. In most CCFs, managing director, president, vice president, enterprise chief engineer, and president assistant were recognized at the senior level. Among the 64 practitioners, 14 (21.9 %) held positions in the senior management, occupying 15.7 % of all the respondents. In addition, 18 (28.1 %) and 32 (50.0 %) of the industry respondents held positions in the department management and project management, accounting for 20.2 and 36.0 % of all the respondents, respectively.

Table 7.1 Profile of the respondents in Survey I

Characteristics	Categorization	Industry (N = 64)		Academia (N = 25)		Overall (N = 89)	
		N	%	N	%	N	%
Work experience	5–10 years	40	62.5	3	12.0	43	48.3
	11–15 years	8	12.5	6	24.0	14	15.7
	16–20 years	7	10.9	9	36.0	16	18.0
	21–25 years	4	6.3	4	16.0	8	9.0
	Over 25 years	5	7.8	3	12.0	8	9.0
Location	China	37	57.8	25	100.0	62	69.7
	Asia (excluding China)	12	18.8	–	–	12	13.5
	Africa	11	17.2	–	–	11	12.4
	Europe	2	3.1	–	–	2	2.2
	Latin America	2	3.1	–	–	2	2.2
Designation	Professor	–	–	11	56.0	11	12.4
	Associate professor	–	–	14	44.0	14	15.7
	Managing director	1	1.6	–	–	1	1.1
	President	2	3.1	–	–	2	2.2
	Vice president	5	7.8	–	–	5	5.6
	Enterprise chief engineer*	4	6.3	–	–	4	4.5
	President assistant	2	3.1	–	–	2	2.2
	Deputy chief economist	1	1.6	–	–	1	1.1
	Operation director	2	3.1	–	–	2	2.2
	Manager of the department of contract and legal affairs	1	1.6	–	–	1	1.1
	Deputy manager of the department of engineering	2	3.1	–	–	2	2.2
	Market investment investigator	1	1.6	–	–	1	1.1
	Manager of the department of international market	1	1.6	–	–	1	1.1
	Business manager	3	4.7	–	–	3	3.4
	Contract and business manager	1	1.6	–	–	1	1.1
	Contract manager	4	6.3	–	–	4	4.5
	Technical director	1	1.6	–	–	1	1.1
	Safety director	1	1.6	–	–	1	1.1
	Project chief engineer**	4	6.3	–	–	4	4.5
	Project director	2	3.1	–	–	2	2.2
	Project execution management	1	1.6	–	–	1	1.1
	Project manager	6	9.4	–	–	6	6.7
	Deputy project manager	14	21.9	–	–	14	15.7
	Project schedule manager	2	3.1	–	–	2	2.2
	Site manager	2	3.1	–	–	2	2.2
	Project cost manager	1	1.6	–	–	1	1.1

*In CCFs, enterprise chief engineer is a senior management designation
**In CCFs, project chief engineer is the person who takes charge of the project technical issues

7.2.2 Importance of the ERM Maturity Criteria in CCFs

The Cronbach's alpha coefficient was calculated to test the reliability of the responses. The alpha should be at least 0.7 for a scale to be reliable (Nunnally 1978). The coefficient of 0.920 suggested that the data relating to the importance of the ERM maturity criteria had high reliability.

As indicated in Table 7.2, the criteria are ranked according to their mean scores and the overall importance mean scores of the criteria range from 3.40 to 4.55. To test whether each criterion was significantly important to a mature ERM program in CCFs, the one-sample t test was conducted. The p values of all the criteria were 0.000, suggesting that all the criteria had importance scores significantly different from the test value of 3.00. Thus, all the 16 criteria were significantly important to ERM maturity and used in the ERM maturity model. Hypothesis 1 that "ERM maturity level in CCFs depends on a set of critical criteria" was supported. Using Eqs. 3.9 and 3.10 in Sect. 3.7.3, the weights of the 16 criteria were also calculated. The calculation process is presented in Appendix 5. As Table 7.2 indicates, the criteria weights range from 7.21 to 5.40 %.

In addition, the Spearman rank correlation was applied. The correlation coefficient of 0.849 with the statistical significance at the 0.05 level (p value = 0.000) implied that the practitioners and academics agreed on the overall importance ranking of the 16 criteria.

A total of six criteria obtained overall importance mean scores over 4.00. "Commitment of the board and senior management" (mean = 4.55) was ranked first by both the practitioners and academics, suggesting that the tone at the top was perceived the most important to a mature ERM program in CCFs. This result was consistent with the survey finding of the Harvard Business Review Analytic Services (HBRAS 2011) that the support from the board and the senior executives was critical to establishing effective ERM. As ERM is a top-down approach (Dickinson 2001; Olson and Wu 2008), the support, encouragement, and commitment at the senior level are of great importance to ERM implementation. Also, the commitment of the board and senior management was found to be an internal force that can drive ERM implementation within firms in various industries (Gates 2006; Kleffner et al. 2003). Thus, the board and senior management in CCFs should be committed to ERM implementation. Such commitment should be visible to make employees perceive ERM as a priority for the leadership and, more importantly, should not be interrupted by changes in the ERM champion because ERM implementation is a multiyear journey (Bowling and Rieger 2005; Simkins 2008).

"Risk identification, analysis, and response" occupied the second position (mean = 4.28), implying that CCFs attached great importance to the actual execution of ERM because this criterion described the critical steps of a generic risk management process. More specifically, management needs to identify all categories of potential risks from internal and external sources and then prioritizes them using risk analysis techniques. Thus, a list of top risks or a risk map that has been used in the successful ERM cases (Aabo et al. 2005) can be developed, and

Table 7.2 Importance ranking of the ERM maturity criteria in CCFs

Code	ERM maturity criteria	Overall				Industry		Academia	
		Mean	Rank	*p* value	Weight (%)	Mean	Rank	Mean	Rank
M01	Commitment of the board and senior management	4.55	1	0.000*	7.21	4.47	1	4.76	1
M02	ERM ownership	4.16	4	0.000*	6.59	4.13	4	4.24	5
M03	Risk appetite and tolerance	3.51	15	0.000*	5.56	3.56	15	3.36	15
M04	Risk-aware culture	3.82	12	0.000*	6.06	3.78	13	3.92	10
M05	Sufficient resources	4.01	6	0.000*	6.36	3.95	6	4.16	6
M06	Risk identification, analysis, and response	4.28	2	0.000*	6.79	4.17	3	4.56	2
M07	Iterative and dynamic ERM process steps	3.97	8	0.000*	6.29	3.95	6	4.00	8
M08	Leveraging risks as opportunities	3.61	14	0.000*	5.72	3.63	14	3.56	14
M09	Risk communication	3.90	10	0.000*	6.18	3.92	9	3.84	12
M10	A common risk language	3.40	16	0.000*	5.40	3.48	16	3.20	16
M11	A RMIS	3.76	13	0.000*	5.97	3.83	12	3.60	13
M12	Training programs	3.92	9	0.000*	6.22	3.95	6	3.84	12
M13	Formalized KRIs	3.89	11	0.000*	6.16	3.88	11	3.92	10
M14	Integration of ERM into business processes	4.08	5	0.000*	6.47	3.92	9	4.48	3
M15	Objective setting	4.26	3	0.000*	6.75	4.20	2	4.40	4
M16	Monitoring, review, and improvement of ERM framework	3.97	8	0.000*	6.29	3.92	9	4.08	7

The Cronbach's alpha coefficient is 0.920
*The one-sample *t* test result is significant at the 0.05 level (two-tailed)
The Spearman rank correlation coefficient is 0.849 and significant at the 0.05 level (two-tailed)

appropriate risk response measures can be developed to deal with the critical risks. In addition, the high mean score of this criterion confirmed the validity of the COSO ERM framework (COSO 2004) because this criterion can reflect three components of this framework, i.e., event identification, risk assessment, and risk response.

The third-ranked criterion was "objective setting" (mean = 4.26), indicating that clearly identified objectives at various levels were perceived highly important to ERM implementation in CCFs. As risk is defined as the effect of uncertainty on objectives in ISO 31000:2009, risk is closely associated with objective setting. Objective setting was also recognized as the precondition to risk identification, assessment and response, and one of the eight components in the COSO ERM framework (COSO 2004). Thus, the objectives should be clearly identified and deviations from plans should be assessed against the objectives (Hopkinson 2011). More importantly, as ERM should be applied in strategy setting (COSO 2004), strategic objectives should attract more attention from the management (Bowling and Rieger 2005).

"ERM ownership" was ranked fourth (mean = 4.16), suggesting that successful ERM implementation in CCFs needed an owner to centralize risk management and to take charge of risk oversight. This was consistent with the ERM practices in other industries (Banham 2004). An ERM owner can be a dedicated senior executive, a stand-alone department, a board-level risk committee, or even a chief risk officer (CRO). Also, the creation of the ERM owner can signal the corporate emphasis on risk management to its employees and investors (Cendrowski and Mair 2009) and who the ERM owner is should be openly communicated to all the staff.

The fifth-ranked criterion was "integration of ERM into business processes" (mean = 4.08), indicating that the respondents believed that ERM implementation did not stand alone and should be embedded into other processes. This result echoed the guidance issued by the SASAC (2006), which stipulated that ERM should be fully integrated into the management and business processes of an enterprise. These processes include, but are not limited to decision-making and strategic planning. In all decision-making processes, especially in strategic decision-making, the risks identified should be consistently considered, and emerging risks should also be anticipated. Also, previous studies indicated that ERM should be incorporated at organizational planning and strategy stages (Sharman 2002) and integrated with other initiatives (Chitakornkijsil 2010). However, full integration of ERM is time-consuming. This would take from three to five years in large companies once ERM is initiated because of delays in moving level by level in the company and the need for change management to overcome inertia (Shortreed 2010).

Another highly ranked criterion was "sufficient resources" (mean = 4.01), implying sufficient resources, such as funds, qualified staff, time, knowledge, and expertise, were inevitable and necessary for ERM implementation in CCFs. Thus, to advance ERM implementation, resources should be consistently allocated for improving the risk management process, tools, techniques, and personnel skills. On the other hand, insufficient inputs of time, fund and staff, lack of internal knowledge and expertise, and lack of risk management techniques and tools would greatly hinder ERM implementation and success (Gates 2006; Muralidhar 2010; Rao 2007).

Although "leveraging risks as opportunities" (mean = 3.61), "risk appetite and tolerance" (mean = 3.51), and "a common risk language" (mean = 3.40) were the three least important criteria, they were still perceived significantly important to a mature ERM program. The perceived significant importance of "leveraging risks as opportunities" concurred with the viewpoints of previous research that ERM can not only deal with threats but also leverage and exploit opportunities for competitive advantages (Banham 2004; COSO 2004; Dafikpaku 2011; Miccolis and Shah 2000; Pagach and Warr 2010; Stroh 2005). In addition, the guidance issued by the SASAC (2006) stipulated that enterprises should identify their risk appetite and tolerance according to their internal and external environment and development strategies. Thus, "risk appetite and tolerance" obtained significant importance from the respondents. Lastly, the perceived significant importance of "a common risk language" echoed the viewpoint of Duckert (2011) that a well-defined risk language used throughout the enterprise was key to an effective ERM program, while the bottom rank of this criterion was in line with the findings of Liu et al. (2011) that most of CCFs lacked a uniform risk language and only 20.6 % of the surveyed CCFs used such a language.

7.2.3 Applicability of the ERM Best Practices in CCFs

As Table 7.3 indicates, the Cronbach's alpha coefficient values of the applicability of the best practices related to the maturity criteria range from 0.703 to 0.938, indicating the acceptable reliability of the data.

The mean scores of the best practice applicability ranged from 3.02 to 4.21. The one-sample *t* test was used to test whether each ERM best practice was significantly applicable in CCFs. The test value of 3.00 and the significance level of 0.05 were adopted in this research. Out of the 71 ERM best practices, five obtained *p* values over 0.05, indicating that their mean scores were not significantly different from 3.00. Thus, these five practices were not recognized significantly applicable in CCFs, despite their applicability in the organizations of other industries.

These five practices were given as follows: "All the staff actively participate in the ERM process" (mean = 3.15; *p* value = 0.223); "The authority and responsibility of risk owners is understood by staff at all levels of a firm" (mean = 3.17; *p* value = 0.167); "There is neither a blame culture nor defensive routines in a firm" (mean = 3.07; *p* value = 0.563); "The risk language is understood and maintained by all the staff within a firm" (mean = 3.13; *p* value = 0.259); and "Staff at all levels clearly understand how to apply the RMIS in ERM practices" (mean = 3.02; *p* value = 0.834).

Four practitioners who were originally included in the survey sample were interviewed (see Table 7.4) to garner their comments on the best practices that were

Table 7.3 Applicability of the ERM best practices in CCFs

Best practices		Mean	*p* value
M01 Commitment of the board and senior management (α = 0.703)			
B01.1	A written ERM policy is approved by the board and senior management and is made known to all the staff	4.00	0.000*
B01.2	An ERM plan is developed and tailored to the corporate objectives and context	4.21	0.000*
B01.3	All the risk-related decision-making and ERM practices are fully consistent with the ERM policy and plan	3.46	0.000*
B01.4	The board and senior management actively takes part in ERM	4.03	0.000*
B01.5	The commitment is continual and is not interrupted by changes in the board or senior management	3.87	0.000*
M02 ERM ownership (α = 0.759)			
B02.1	A dedicated senior executive, or a stand-alone department, or a board-level committee takes charge of risk oversight and centralizes risk management	3.84	0.000*
#	All the staff actively participate in the ERM process	3.15	0.223
B02.2	Each category of critical risk has a risk owner, who fully understands the risks falling within the limit of his or her accountability	3.63	0.000*
B02.3	All risk owners have sufficient authority to oversee any risk-related action and accept clear defined responsibility for managing the risks	3.58	0.000*
#	The authority and responsibility of risk owners is understood by staff at all levels of a firm	3.17	0.167
B02.4	ERM is incorporated into the performance review and assessment of risk owners	3.78	0.000*
M03 Risk appetite and tolerance (α = 0.835)			
B03.1	Risk appetite is formally and clearly defined according to the corporate strategy	3.82	0.000*
B03.2	Risk appetite is made known to all the staff in the firm	3.30	0.010*
B03.3	Risk tolerance for each specific risk is formally and clearly defined according to the corporate objectives	3.44	0.000*
B03.4	Differences between risk tolerance defined and actual risks are regularly assessed	3.65	0.000*
B03.5	Expected effects of risk response strategies are assessed against risk tolerance	3.67	0.000*
M04 Risk-aware culture (α = 0.801)			
B04.1	A risk-aware culture is created throughout a firm and makes staff at all levels have risk awareness	4.08	0.000*
B04.2	A climate of trust is built up within a firm and project teams	4.11	0.000*
B04.3	Risk-aware culture is incorporated into the corporate culture	3.74	0.000*
#	There is neither a blame culture nor defensive routines in a firm	3.07	0.563
B04.4	The expected behavior within the organization is explicitly expressed to sustain a strong risk-aware culture	3.44	0.000*

(continued)

Table 7.3 (continued)

Best practices		Mean	*p* value
M05 Sufficient resources (α = 0.812)			
B05.1	Resources are continuously invested in improving the risk management process, tools, techniques, personnel skills, etc.	3.96	0.000*
B05.2	Resources are allocated for risk response based on the results of risk analysis and risk priority	4.03	0.000*
B05.3	A firm has sufficient qualified staff and internal knowledge, skills, and expertise to implement ERM	3.73	0.000*
B05.4	External consultants or experts are used to reinforce and complement existing internal knowledge and skills about ERM	4.11	0.000*
B05.5	A comprehensive set of metrics is consistently applied to measure ERM performance	3.82	0.000*
M06 Risk identification, analysis, and response (α = 0.898)			
B06.1	A firm adopts a formalized and standardized ERM process at project and firm levels	3.91	0.000*
B06.2	The risk information collected is ensured to be relevant and reliable	4.04	0.000*
B06.3	Qualitative and quantitative risk management tools and techniques are consistently used	3.87	0.000*
B06.4	A firm comprehensively identifies sources of risk, areas of impacts, and their causes and potential impacts	3.96	0.000*
B06.5	The likelihood of occurrence and impact magnitude of all the risks identified are analyzed in order to identify the risk rank and management priority	4.01	0.000*
B06.6	The relationship of different risks is considered and assessed	3.71	0.000*
B06.7	The appropriate risk response strategy is identified through considering the risk significance, risk appetite and tolerance, resource availability, cost versus benefit comparisons, as well as the enterprise objectives	4.03	0.000*
B06.8	Risk response is designed to deal with critical risks at their sources	3.91	0.000*
M07 Iterative and dynamic ERM process steps (α = 0.901)			
B07.1	New and emerging risks are consistently identified in a timely and proactive manner	4.01	0.000*
B07.2	Risk information is collected from various sources and updated regularly	3.93	0.000*
B07.3	Risk identification, analysis, and response activities are continuously monitored, reviewed, and improved	3.91	0.000*
B07.4	The ERM process is clearly recorded to make it convenient to review and improve	3.79	0.000*
B07.5	Residual risks that still remain after the response measures have been fully implemented are assessed	3.66	0.000*
M08 Leveraging risks as opportunities (α = 0.817)			
B08.1	Its enterprise-widely recognized that opportunities are an aspect of risks	3.53	0.000*
B08.2	Opportunities are regularly identified and explored during risk management planning	3.63	0.000*

(continued)

Table 7.3 (continued)

Best practices		Mean	*p* value
B08.3	Opportunities are regularly assessed by weighing the expected benefits and relevant likelihood against the potential losses and their likelihood	3.69	0.000*
B08.4	Opportunities for the expected improvement of firm performance are actively pursued through ERM	3.70	0.000*
B08.5	Risk taking of a firm is aligned with its core competencies and risk appetite	3.71	0.000*
M09 Risk communication (α = 0.797)			
B09.1	Risk information is consistently communicated and shared across projects and departments within the firm	3.72	0.000*
B09.2	Critical risk information is reported to the board and senior management in a periodic or immediate manner according to risk severity or urgency	4.06	0.000*
B09.3	Clear communication lines are established to ensure line managers, project managers, and front-line staff are promptly notified of critical information and decisions from senior management	3.99	0.000*
B09.4	Individual comments and views of internal or external experts are encouraged during the ERM process	3.78	0.000*
M10 A common risk language (α = 0.868)			
B10.1	The risk language clearly explains the risk management terminologies and methodologies used within a firm	3.67	0.000*
#	The risk language is understood and maintained by all the staff within a firm	3.13	0.259
B10.2	The risk language is used consistently in all the communication within a firm	3.28	0.016*
M11 A RMIS (α = 0.801)			
B11.1	A RMIS serves as a platform for risk communication and reporting, records ERM activities, undertakes risk identification and analysis, and facilitates selecting response strategies	3.67	0.000*
#	Staff at all levels clearly understand how to apply the RMIS in ERM practices	3.02	0.834
B11.2	The functions of the RMIS are fully used in ERM practices	3.35	0.001*
M12 Training programs (α = 0.894)			
B12.1	Formalized training programs ensure that staff at all levels clearly understand the ERM policy, the ERM process, and the potential benefits of ERM, thus reducing misunderstanding and anxiety about ERM	3.93	0.000*
B12.2	Regular training is provided to staff to maintain their high-level knowledge and skills relating to ERM	3.81	0.000*
B12.3	Training programs make staff learn from successes and failures from both previous and on-going projects	3.99	0.000*
B12.4	The staff who are professional or experienced in ERM share their knowledge relating to ERM with trainees in training programs	4.11	0.000*

(continued)

Table 7.3 (continued)

Best practices		Mean	p value
M13 Formalized KRIs (α = 0.938)			
B13.1	KRIs are identified for all the critical risks that a firm faces	3.54	0.000*
B13.2	KRIs are continuously reviewed and updated	3.67	0.000*
B13.3	KRIs are regularly monitored and analyzed by risk owners	3.69	0.000*
B13.4	KRIs act as early warning signals of increasing risk exposures in a firm	3.80	0.000*
M14 Integration of ERM into business processes (α = 0.776)			
B14.1	Management across a firm consistently considers risk information, risk tolerance and appetite, and risk response strategies in all decision-making activities, especially in strategic decision-making	3.89	0.000*
B14.2	ERM is fully integrated into all daily management and business processes	3.56	0.000*
B14.3	The implementation levels of the ERM best practices are periodically assessed to identify gaps and improve ERM practices	3.60	0.000*
M15 Objective setting (α = 0.803)			
B15.1	Objectives of the firm are clearly identified and understood by staff at all levels	3.84	0.000*
B15.2	All objectives have performance measures and all performance measures are linked with objectives	3.71	0.000*
B15.3	Deviations from plans or expectations are assessed against the corporate objectives and project objectives	3.79	0.000*
M16 Monitoring, review and improvement of the ERM framework (α = 0.892)			
B16.1	A firm periodically monitors the progress of ERM implementation against, and deviation from, the ERM plan	3.81	0.000*
B16.2	A firm periodically reviews whether the ERM framework, policy, and plan are still appropriate, according to the firm's external and internal context	3.72	0.000*
B16.3	Decisions are made on improving the ERM framework, policy, and plan, based on results of monitoring and reviews	3.76	0.000*

*The one-sample t test result is significant at the 0.05 level (test value = 3.00)
#The best practice is not significantly applicable in CCFs

Table 7.4 Profile of the interviewees in Survey I

Interviewee	Work experience	Designation	Location
1	10 years	Contract manager	Saudi Arabia
2	11 years	Project manager	China
3	18 years	Vice president	China
4	12 years	International business director	Angola

not found significantly applicable in CCFs. These comments were used to support the exclusion of these practices.

According to Hofstede's cultural dimensions theory (Hofstede 1980, 1984; Hofstede et al. 2010), power distance describes the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally. Hofstede et al. (2010) reported that the power distance index (PDI) value of China was 80, ranked second in Asia and among the top 10 in the world. The high PDI value indicated that the inequalities among people were recognized acceptable in China, which could explain the high centralization of CCFs. As the interviewed project manager indicated, there was high-level centralization in most CCFs, which tended to prevent the lower level staff from participating in ERM because the superiors believed that the low-level staff should focus on project management and technical issues. This interviewee also reported that it would be impossible to get all the staff to actively participate in ERM due to the high personnel turnover in CCFs and the lack of timely training. In addition, as the majority of the workers in the Chinese construction industry are peasant-workers with little education (Tam et al. 2004), they are not knowledgeable enough to participate in the ERM process. Thus, "All the staff actively participate in the ERM process" was deemed not applicable in CCFs.

Similarly, as all the four interviewees indicated, it was impossible for the CCFs to get all their staff to understand the authority and responsibility of risk owners because of the presence of temporary workers and the high staff turnover, as well as the limited education of workers in CCFs. These characteristics can distinguish the construction industry from other industries, such as financial, energy, and manufacturing industries. Also, the staff focusing on technical issues may not be too concerned about the authority and responsibility of risk owners as they are not much involved with ERM.

"There is neither a blame culture nor defensive routines in a firm" was perceived not applicable, either. In CCFs, the subordinates are willing to follow their superiors because the superiors have more power. This can also be supported by the high PDI value in China (Hofstede et al. 2010), indicating that the subordinates accepted the inequalities of power distribution. The superiors have the power to punitively blame the subordinates that make the errors or troubles even if the superiors may not use it. To avoid the errors and blame as well as the consequent embarrassment, staff may perform defensive routines. Thus, it is difficult to remove either the blame culture or defensive routines from CCFs. In addition, the vice president interviewed believed that the absence of blame culture and defensive routines would allow employees to feel free to make errors. This interviewee argued that the freedom to make errors was likely to result in more unnecessary errors and that the negative effect far outweighed the positive effect on the firm.

Moreover, "The risk language is understood and maintained by all the staff within a firm" did not obtain significant applicability in CCFs. It is difficult to make all the staff to maintain the use of the risk language although training programs can help them understand this language. As the vice president indicated, the employees at the lower level (e.g., workers) just understand the risk terms relating to safety and do not need to understand the entire set of risk terms as they have limited knowledge. The staff whose work focuses on technical issues would not have much to do with respect to management issues, and thus, they may not have many opportunities to use the risk language. Moreover, the two interviewees working in the overseas market revealed that it was impossible for all the staff to understand the risk language because some staff and workers were indigenous people who cannot speak Mandarin, which was the main language in CCFs.

Lastly, in terms of the understanding of the RMIS application in ERM practices, the project manager and vice president reported that purchasing ERM software or setting up a RMIS could involve high expense, but the benefits would not be significant and tangible. This was echoed by Lu et al. (2009) and Shen et al. (2006) who indicated that although CCFs had applied the ICT in office automation, finance management, and communication, few of them used the ICT as tools for daily decision-making or construction management. Also, even if there was a RMIS in place, some older management staff in CCFs would be reluctant to learn how to use ICT in construction management and they may believe that their experience can solve most problems. In addition, the high staff turnover and the limited education levels of workers made it impossible that "staff at all levels clearly understand how to apply the RMIS in ERM practices."

Thus, these five practices without significant applicability were removed from the preliminary set of best practices, while the other 66 were retained and used as the subcriteria under the ERM maturity criteria in the fuzzy ERM maturity model. The second research objective, which involves the development of an ERM maturity assessment model for CCFs, was fulfilled.

7.3 Analysis Results and Discussions of Survey II

7.3.1 Sample Profile

Questionnaire Survey II intended to investigate the ERM maturity levels and to identify the critical factors that drove and hindered ERM implementation in CCFs based in Singapore. From September 2012 to January 2013, all the 46 CCFs based in Singapore, which were registered with the BCA, were contacted. A total of 35 professionals from different firms completed the questionnaires, representing a high response rate of 76.1 %. Although the sample size was relatively small, statistical analysis could still be performed because the central limit theorem holds true when the sample size is larger than 30 (Chong and Zin 2012; Hwang et al. 2013; Ling et al. 2009; Mann 2005; Ott and Longnecker 2001; Zhao et al. 2013). The profile of the 35 respondents and their firms is presented in Table 7.5.

In Singapore, the Contractors Registry functions as an administrative body only for the public sector procurement. Thus, the contractors unregistered with the BCA are not precluded from conducting business as contractors or suppliers outside the public sector. There are six major groups of registration workheads: Construction

Table 7.5 Profile of the CCFs and respondents in Survey II

Characteristics		Categorization	*N*	%
CCFs	Financial grade*	A1	8	22.9
		A2	1	2.9
		B1	5	14.3
		C1	10	28.6
		C3	5	14.3
		L6	2	5.7
		L5	2	5.7
		L1	1	2.9
		CR01	1	2.9
	Experience in Singapore	≤5 years	8	22.9
		6–10 years	6	17.1
		11–15 years	14	40.0
		16–20 years	7	20.0
Respondents	Designation	Managing director	1	2.9
		Vice president	2	5.7
		Director	3	8.6
		Chief accountant	1	2.9
		Manager of department of finance	2	5.7
		Manager of department of safety	2	5.7
		Safety director	1	2.9
		Technical director	2	5.7
		Project director	4	11.4
		Market manager	2	5.7
		Technical manager	2	5.7
		Project manager	9	25.7
		Business manager	1	2.9
		Cost manager	1	2.9
		Site manager	2	5.7
	Work experience	5–10 years	12	34.3
		11–15 years	8	22.9
		16–20 years	11	31.4
		21–25 years	1	2.9
		26–30 years	3	8.6

*If a CCF has multiple financial grades, this table presents the highest grade

Workheads (CW), Construction Related Workheads (CR), Mechanical and Electrical Workheads (ME), Maintenance Workheads (MW), Supply Workheads (SY), and Regulatory Workheads (RW) (BCA 2013). As shown in Table 7.6, there are seven financial grades for CW, from grade A1 without tendering limit, to grade C3 with a tendering limit of S$0.65 million. In addition, there are six financial

Table 7.6 Contractor registration system of the BCA

Construction workheads	CW01 and CW02	A1	A2	B1	B2	C1	C2	C3
	Tendering limit (S$ million)	Unlimited	85	40	13	4	1.3	0.65
Specialist workheads	CR, ME, MW, and SY	L6	L5	L4	L3	L2	L1	
	Tendering limit (S$ million)	Unlimited	13	6.5	4	1.3	0.65	

Note CW01 = General building; *CW02* = Civil engineering
Source BCA (2013)

grades for CR, ME, MW, and SY, from grade L6 without tendering limit, to L1 with a tendering limit of S$0.65 million. However, CR01 (minor construction works) has a single grade.

When firms were measured by the financial grades in the Contractors Registry of the BCA, 25.8 % of the surveyed CCFs were A1 and A2 contractors, and 14.3, 28.6, and 14.3 % were B1, C1, and C3 contractors, respectively. Additionally, six firms were under the specialist workheads (two for L6, two for L5, one for L1, and one for CR01). In this research, according to the financial grade and tendering limit, the 35 CCFs were divided into three groups: (1) large CCFs, with grades of A1, A2, and L6; (2) medium CCFs, with grades of B1 and L5; and (3) small CCFs, with grades of C1, C3, L1, and CR01. The large, medium, and small CCFs represented 31.4, 20, and 48.6 % of all the surveyed CCFs, respectively.

These 35 CCFs had an average of approximately 11 years of experience in the Singapore construction market. Specifically, 60 % of them had been founded for more than 10 years, but none had operated in Singapore for over 20 years.

Table 7.5 also indicates the profile of the 35 respondents. In terms of designations, a total of six respondents (17.1 %) held positions in the senior management, while four (11.4 %) and nine (25.7 %) respondents were project directors and managers, respectively. The remaining respondents held positions in the areas of finance, safety, business, market, technique, and cost, respectively. The diversified designations of the respondents ensured that the data can represent the opinions of the management of various areas in CCFs based in Singapore. In addition, 65.7 % of the respondents had over 10 years of experience in the construction industry and four of them had worked for over 20 years, thus assuring the response quality.

7.3.2 ERM Maturity of CCFs Based in Singapore

Using the fuzzy ERM maturity model described in Sect. 3.7.3 and the implementation levels of best practices collected from Survey II, this research calculated the ERMMI values of all the 35 CCFs. As Table 7.7 shows, 71.4 % of these CCFs had ERMMI values ranging from 0.125 to 0.375, which could be interpreted as the low

Table 7.7 ERMMI values of the CCFs based in Singapore

ERMMI	*N*	%	Linguistic term
0.125–0.250	11	31.4	Low
0.250–0.375	14	40.0	
0.375–0.500	6	17.1	Medium
0.500–0.625	4	11.4	

ERM maturity level. The remaining CCFs obtained ERMMI values between 0.375 and 0.625, indicating that their ERM maturity was at the medium level. The overall mean ERMMI of all the surveyed CCFs in Singapore was 0.325 (see Table 7.8), implying that their overall ERM maturity level was low. Thus, Hypothesis 2 that "ERM maturity level in CCFs based in Singapore is low" was supported.

In addition, firm size has been recognized as a variable that can influence ERM implementation. Previous studies suggested that larger firms were more likely to implement ERM because they were more complex, faced a wider range of risks, and had more resources to support ERM implementation (Beasley et al. 2005; Colquitt et al. 1999; Hoyt and Liebenberg 2011). Moreover, COSO (2004) indicated the importance of firm size when designing an ERM system, and Gordon et al. (2009) found that the ERM performance relation was dependent on the proper match between the firm size and the ERM system. Thus, it is worth investigating the relationship between the ERM maturity level and the size of the CCFs based in Singapore.

The χ^2 contingency table analysis was performed and the *p* value was 0.000 (see Table 7.8). This result suggested that the null hypothesis that ERM maturity was independent of firm size was rejected and that there was significant association between ERM maturity and firm size. Thus, the larger firms were likely to have higher level ERM maturity, which was consistent with the findings in the literature (Beasley et al. 2005; Colquitt et al. 1999; Hoyt and Liebenberg 2011).

Most of the large CCFs in Singapore were the overseas subsidiaries of Chinese central enterprises, which had to comply with the requirements in the guidance

Table 7.8 Relationship between ERM maturity level and firm size

Firm size	ERM maturity level		Total	Mean ERMMI
	Low	Medium		
Large (A1, A2, and L6)	3	8	11	0.449
	27.3 %	72.7 %	100.0 %	
Medium (B1 and L5)	6	1	7	0.309
	85.7 %	14.3 %	100.0 %	
Small (C1, C3, L1, and CR01)	16	1	17	0.251
	94.1 %	5.9 %	100.0 %	
Total	25	10	35	0.325
	71.4 %	28.6 %	100.0 %	

Note χ^2 = 15.497, *p* value = 0.000, and degree of freedom = 2 issued by the SASAC (2006). All the central enterprises, including those with subsidiaries in the international construction market, should formally submit a report of their ERM implementation status to the SASAC on an annual basis. As the information in the report should include the ERM implementation in their subsidiaries, the parent companies should audit their overseas subsidiaries every year. In addition, the parent companies of the large CCFs based in Singapore were the companies listed in either the Shanghai Stock Exchange or the Shenzhen Stock Exchange and thus had to comply with the regulations relating to internal controls and information disclosure. These listed companies were required to include the ERM implementation status in their annual reports, which should be accessible to their shareholders. Therefore, the large CCFs based in Singapore were more likely to implement ERM than the small and medium ones. Furthermore, the respective mean ERMMI values of large, medium, and small CCFs were 0.449, 0.309, and 0.251, which were in a descending order and therefore substantiated the χ^2 contingency table analysis result.

Thus, the third research objective, which involves the investigation of ERM maturity levels of Singapore-based CCFs, was fulfilled. ERM maturity is a "snapshot" of ERM implementation and can thus be influenced by the interactions between the drivers for and hindrances to ERM implementation. Thus, the following sections present the analysis of the driving and hindering factors.

7.3.3 Drivers for ERM Implementation in CCFs Based in Singapore

As Table 7.9 indicates, the Cronbach's alpha coefficient value of data relating to the influence of the drivers on ERM implementation in CCFs based in Singapore is 0.877, suggesting that the data had high reliability.

7.3.3.1 Overall Ranking

As shown in Table 7.9, the mean scores of the 17 drivers range from 2.26 to 4.17. These drivers were ranked based on the overall mean scores. To test whether the influence of the drivers was statistically significant, the one-sample *t* test was performed. The analysis results indicated that 13 out of the 17 factors obtained *p* values lower than 0.05, implying that their mean scores were significantly different from the test value of 3.00. Thus, these 13 factors significantly drove ERM implementation in CCFs based in Singapore. The top five drivers are analyzed and discussed as follows.

"Improved decision-making" was recognized as the most significant factor in driving ERM implementation (mean = 4.17). This result implied that the potential of ERM in improving decision-making had attracted great attention from CCFs based in Singapore and motivated them to implement ERM. Also, this result confirmed the findings of previous research that ERM can contribute to better

Table 7.9 The overall scores and ranking of the drivers for ERM implementation

Code	Drivers for ERM implementation	Mean	Rank	*p* value
D01	Legal and regulatory compliance requirements	2.80	15	0.361
D02	Non-mandatory reports or standards	2.26	17	0.000*
D03	Credit rating agencies' requirements	2.63	16	0.085
D04	Reduced earnings volatility	3.89	4	0.000*
D05	Reduced costs and losses	3.97	2	0.000*
D06	Increased profitability and earnings	3.83	6	0.000*
D07	Improved decision-making	4.17	1	0.000*
D08	Better risk reporting and communication	3.31	13	0.039*
D09	Increased management accountability	3.54	8	0.000*
D10	Greater management consensus	3.46	11	0.002*
D11	Competitive advantages	3.94	3	0.000*
D12	Better resource allocation	3.49	10	0.001*
D13	Improved clients' satisfaction	3.51	9	0.000*
D14	Improved control of an enterprise over its projects	3.86	5	0.000*
D15	A broader scope of risks	3.80	7	0.000*
D16	Advances in information technology	3.09	14	0.619
D17	Request and encouragement from the board and senior management	3.43	12	0.011*

Cronbach's alpha = 0.877
*The one-sample *t* test result is significant at the 0.05 level (two-tailed)

decisions (Bugalla et al. 2010; Deloitte 2010; Gates 2006; HBRAS 2011; Kleffner et al. 2003; KPMG 2010; Lam 2003; Manab et al. 2010; Millage 2005; Narvaez 2011; Towers Perrin 2006; Williams 2005) and echoed the argument in the literature that this factor drove ERM implementation (Liu et al. 2011; Manab et al. 2010; Rao 2007). The operations and management of a construction firm inevitably involve various decision-making processes, such as those relating to strategy development, resource allocation, material or equipment procurement, and risk response selection. Effective ERM implementation involves risk awareness and risk communication across a firm, and identification, and explicit articulation of risks provides more information for decision makers. Thus, the management can think early about the likely outcomes of their decisions and try to mitigate the occurrence of what would cause the desired outcomes to fail.

"Reduced costs and losses" obtained the second position in the driver ranking (mean = 3.97), suggesting that CCFs in Singapore implemented ERM for less costs and losses. This result was consistent with the finding of Liu et al. (2011) that eliminating losses caused by risks was the most important motivator for ERM implementation in the top CCFs in the international market. According to previous studies, ERM implementation helped reduce costs and losses in various organizations (Beasley and Frigo 2010; Cumming and Hirtle 2001; Gregory 2003; Harrington et al. 2002; Kleffner et al. 2003; KPMG 2010; Manab et al. 2010; Meulbroek 2002; Towers Perrin 2006). In the international construction market, contracting projects usually involves higher risk exposure and possibility of losses (Zhi 1995). In recent years, some overseas subsidiaries of leading Chinese companies suffered huge losses in the international construction market (China 2011; Cienski 2011). Thus, the CCFs based in Singapore tried to avoid losses through risk management at both the project and firm levels, although Singapore had relatively good social order and security status. In addition, similar to the silo-based approach to risk management, overemphasizing PRM in construction firms would create inefficient coordination between various projects and departments as well as duplication risk management expenditure. From this angle, ERM implementation could reduce costs of risk management in construction firms.

"Competitive advantages" occupied the third position in the driver ranking (mean = 3.94), indicating that CCFs based in Singapore implemented ERM to obtain potential competitive advantages. Previous studies have recognized ERM implementation as a source of competitive advantages (Acharyya 2007; Gates 2006; Lam 2003; Nocco and Stulz 2006; Towers Perrin 2006; Walker et al. 2002) and indicated that this factor was an internal driver for ERM implementation (Gates 2006; Miccolis 2003; Muralidhar 2010). The analysis result was consistent with these arguments. Construction firms with mature ERM programs tend to have high-level capabilities of risk management at both project and firm levels, and are better prepared to take risks and seize opportunities instead of blindly bearing risks and offering bids with low profits. Construction projects are the main revenue and profit sources of construction firms, and the international construction market is usually characterized by intense competition. Thus, the construction firms with high-level risk management capabilities have the advantages of managing project risks effectively and efficiently, compared with their competitors, and are more likely to assure the achievement of project objectives and to win contracts.

"Reduced earnings volatility" was ranked fourth (mean = 3.89), suggesting that this potential benefit drove CCFs based in Singapore to implement ERM. Previous research identified lower volatility of earnings as a potential benefit of ERM implementation (Gates 2006; Hoyt and Liebenberg 2011; Lam 2003; Liebenberg and Hoyt 2003; Manab et al. 2010; Miccolis 2003; Narvaez 2011; Walker et al. 2002) and recognized this benefit as a significant driver for ERM implementation (Accenture 2011; Manab et al. 2010; Rao 2007). Although traditional risk management would reduce earnings volatility from a specific source, it tends to overlook potential interdependences between risks (Liebenberg and Hoyt 2003) and cannot assure earnings consistency. As a holistic approach to risk management, ERM can identify risk interdependences and reduce earnings volatility by preventing the aggregation of risks across different sources (Hoyt and Liebenberg 2011; Liebenberg and Hoyt 2003). In the Singapore construction industry, CCFs also face interrelated risks. For instance, as the labor and construction material supply in Singapore greatly depends on imports, the risks relating to labor and material availability could be associated with schedule delays (Hwang et al. 2013) or other risks. Construction firms should therefore deal with risk interdependences by holding a portfolio view of these risks through ERM implementation and diminish earnings volatility.

“Improved control of an enterprise over its projects” was ranked fifth (mean = 3.86), implying that CCFs based in Singapore implemented ERM for better control their construction projects. This result substantiated the finding of Liu et al. (2011) that this factor was an important driver for ERM implementation in the leading CCFs in the international market. The construction industry is a project-based industry, where construction firms typically depend on their construction projects to earn revenues and profits. As the profitability of a construction firm is dependent on the profitability of the projects that it is engaged in, the firm needs to keep control over its projects. ERM implementation requires the establishment of ERM ownership and risk reporting mechanisms, which allows the firm to centralize risk management across the firm and control its projects. Thus, the executives and directors of the firm can be clear about the revenues and profits of all the projects and develop response strategies to timely deal with the losses that are likely to occur.

In addition to the top five drivers for ERM implementation in CCFs based in Singapore, there were some other noteworthy results. Although “advances in IT” was considered as a major external driver in other industries (Liebenberg and Hoyt 2003), this factor was not perceived as a significant driver in CCFs based in Singapore (mean = 3.09), implying that technological advancements might not significantly drive ERM implementation in these CCFs. As the CCFs in the international construction market had low-level ICT application in construction management and decision-making (Lu et al. 2009), the technological advancements would have limited influence on the management and decision-making processes in the CCFs. This result also confirmed the exclusion of the practice of “staff at all levels clearly understand how to apply the RMIS in ERM practices” in Sect. 7.2.3.

Moreover, the 11 drivers (D04-D11) relating to the potential benefits of ERM implementation were found to have significant positive influence on ERM implementation, while the three drivers (D01–D03) relating to compliance and corporate governance requirements were ranked bottom and their influence was not statistically significant. Although these results contradicted the findings of Manab et al. (2010) and Gates (2006) that compliance and corporate governance requirements were the top driving forces in financial and energy firms, they agreed with the viewpoints of Pagach and Warr (2011) that companies adopted ERM for its potential benefits and indicated that CCFs based in Singapore appeared not to comply with corporate governance requirements because most of these CCFs were medium and small firms.

7.3.3.2 Low- Versus Medium-Maturity CCFs

Out of the 35 surveyed CCFs, 10 obtained medium-level ERM maturity, while 25 had low-level. As the influence of the drivers tends to differ with maturity levels, this section investigates the differences in the scores and ranks of the drivers for ERM implementation between the low- and medium-maturity CCFs.

The mean scores ranged from 1.96 to 4.12 in the low-maturity CCFs, but appeared to be higher in the medium-maturity CCFs, ranging from 3.00 to 4.50. To check the differences in the mean scores between the two CCF groups, the independent-sample t test was performed. The p values below 0.05 represented the significant differences in the mean scores. The analysis results showed that the mean scores of five drivers significantly differed between the two groups at the 0.05 level (see Table 7.10).

"Legal and regulatory compliance requirements," "non-mandatory reports or standards," and "credit rating agencies' requirements" represented the external requirements that were likely to drive ERM implementation. The results indicated that these external drivers had lower influence on ERM implementation in the low-maturity CCFs than that in the medium-maturity firms. Specifically, "legal and regulatory compliance requirements" obtained a high score (mean = 4.09) in the medium-maturity CCFs, which was significantly higher than that in the other group (mean = 2.28). This result suggested that if a CCF had to comply with legal and regulatory requirements relating to ERM, this firm was very likely to initiate an ERM program. As Table 7.8 indicates, eight out of the 10 medium-maturity CCFs are large-sized firms. In Singapore, the large CCFs were the overseas subsidiaries of the Chinese central enterprises, which were companies listed in stock exchanges.

Table 7.10 Scores and ranks of the drivers: low- versus medium-maturity CCFs

Code	Drivers for ERM implementation	Low-maturity		Medium-maturity		p value
		Mean	Rank	Mean	Rank	
D01	Legal and regulatory compliance requirements	2.28	16	4.10	5	0.000*
D02	Non-mandatory reports or standards	1.96	17	3.00	16	0.003*
D03	Credit rating agencies' requirements	2.32	15	3.40	12	0.017*
D04	Reduced earnings volatility	3.88	2	3.90	8	0.929
D05	Reduced costs and losses	3.76	6	4.50	1	0.014*
D06	Increased profitability and earnings	3.72	7	4.10	5	0.200
D07	Improved decision-making	4.12	1	4.30	2	0.566
D08	Better risk reporting and communication	3.44	11	3.00	16	0.179
D09	Increased management accountability	3.64	8	3.30	13	0.250
D10	Greater management consensus	3.56	9	3.20	14	0.245
D11	Competitive advantages	3.84	4	4.20	3	0.213
D12	Better resource allocation	3.44	11	3.60	11	0.592
D13	Improved clients' satisfaction	3.36	12	3.90	8	0.038*
D14	Improved control of an enterprise over its projects	3.76	6	4.10	5	0.164
D15	A broader scope of risks	3.84	4	3.70	10	0.562
D16	Advances in information technology	3.12	14	3.00	16	0.756
D17	Request and encouragement from the board and senior management	3.24	13	3.90	8	0.062

*The independent-sample t test result is significant at the 0.05 level (two-tailed)
The Spearman rank correlation coefficient is 0.554 (p value = 0.021)

Given the real-world circumstances faced by the CCFs, the sources of such requirements were the guidance issued by the SASAC (2006) as well as the internal control regulations promulgated by the stock exchanges because there have been neither laws nor acts relating to ERM in China. In contrast, most of the low-maturity CCFs were the overseas subsidiaries of the firms owned and administrated by the provincial or municipal governments, rather than the central government. Thus, they would not face such regulatory requirements.

In addition, the mean score of "credit rating agencies' requirements" in the medium-maturity CCFs (mean = 3.40) was significantly higher than that in the low-maturity ones (mean = 2.32). This was because that most of the CCFs in this group were the overseas subsidiaries of the listed companies, whose credit rating influenced their reputation and the confidence of their shareholders. To obtain high credit ratings, these firms should implement ERM and audit the ERM implementation of their overseas subsidiaries. However, this driver exerted less influence on the ERM implementation in the low-maturity CCFs, suggesting that these firms might not face the pressures from the credit rating agencies.

"Non-mandatory reports or standards" gained the mean scores of 1.96 and 3.00 from the low- and medium-maturity CCFs, respectively. Although the difference was significant, it should be noted that this driver obtained the lowest score in both CCF groups. Thus, the non-mandatory requirements did not drive ERM implementation in the Singapore-based CCFs.

Moreover, "reduced costs and losses" was ranked top (mean = 4.50) and sixth (mean = 3.76) in the medium- and low-maturity CCF groups, respectively. The difference in the mean scores between the two groups was significant, which implied that the medium-maturity CCFs focused more on this potential economic benefit, and that this driver had greater influence on this group. This was probably because the medium-maturity CCFs, most of which were large CCFs, faced more pressures of reducing costs and losses, and ERM implementation can help relieve such pressures.

"Improved clients' satisfaction" received a significantly higher mean score (mean = 3.90) in the medium-maturity CCFs than that in the low-maturity CCFs (mean = 3.36). This result implied that this driver contributed more to the ERM implementation in the medium-maturity CCFs and was consistent with the finding of Liu et al. (2011) that improved satisfaction of clients was a motivator for ERM implementation in the CCFs in the international market. As the Singapore construction market was not large, it was important for the CCFs to obtain good reputations in this market. Obtaining the satisfaction of clients was likely to contribute positively to their reputations and would increase the probability of winning contracts. Thus, to improve the satisfaction, the CCFs would implement ERM to better deal with risks and assure the achievement of project objectives.

Furthermore, despite significant differences in the mean scores of the five drivers, the Spearman rank correlation coefficient of 0.554 with a p value of 0.021 indicated statistically significant agreement on the rankings of all the drivers between the low- and medium-maturity CCFs. The two groups shared seven common drivers in their respective top 10 rankings, despite differences in the ranks of some drivers.

7.3.3.3 Interpretation from the Perspective of Organizational Behavior

It is worth reiterating that ERM implementation in construction firms can be considered as an incremental, evolutionary, and continuous organizational change, which also requires organizational learning as a medium (Alas and Sharifi 2002), change in the organizational culture (including the organizational structure) (Senior and Fleming 2006), appropriate motivation measures, and the leadership of change agents. This section adopts the theories of organizational change to interpret the analysis results relating to drivers for ERM implementation.

Beer and Nohria (2000a, b) suggested that organizational change can be achieved through Theory E and Theory O described in Sect. 4.2.4. Some drivers, such as "reduced earnings volatility" (D04), "reduced costs and losses" (D05), and "increased profitability and earnings" (D06), are closely associated with economic performance and shareholder value, which suggested that Theory E could be used to implement ERM in the Singapore-based CCFs. Meanwhile, "improved decision-making" (D07), "better risk reporting and communication" (D08), "increased management accountability" (D09), "greater management consensus" (D10), "better resource allocation" (D12), and "improved control of an enterprise over its projects" (D14) represent the development of organizational capability, indicating that Theory O was applicable to ERM implementation. This therefore implied that both two theories can be used to implement ERM in the Singapore-based CCFs and substantiated the argument of Beer and Nohria (2000a, b) that the combination of Theory E and Theory O was the most successful strategy for organizational change.

In addition, Mullins (2007), Robbins (2003), and Senior and Fleming (2006) summarized several drivers for organizational change, some of which can be linked to the drivers for ERM implementation with significant influence.

For example, "reduced earnings volatility" (D04), "reduced costs and losses" (D05), and "increased profitability and earnings" (D06) are internal drivers that represent the need for higher profitability within a company. Also, the potential "competitive advantages" (D11) resulting from ERM implementation can be seen as a response to the external competition pressures that drive companies to conduct organizational change to obtain advantages over the competitors. Moreover, external driving forces of organizational change, such as globalization, social and cultural factors, political and legal pressures, market changes, and economic factors, are actually the sources of risks. Thus, these driving forces can be linked to "a broader scope of risks" (D15) that drive ERM implementation.

7.3.4 Hindrances to ERM Implementation in CCFs Based in Singapore

As Table 7.11 indicates, the Cronbach's alpha coefficient value of data relating to the influence of the hindrances to ERM implementation in CCFs based in Singapore is 0.895, showing the high data reliability.

Table 7.11 Overall scores and ranks of the hindrances to ERM implementation

Code	Hindrance to ERM implementation	Mean	Rank	*p* value
H01	Low data quality	3.34	25	0.032*
H02	Lack of data	3.49	20	0.002*
H03	Insufficient resources (e.g., time, money, and people)	4.54	1	0.000*
H04	Lack of a formalized ERM process	3.69	16	0.000*
H05	Lack of risk management techniques and tools	3.71	15	0.000*
H06	Lack of internal knowledge, skills, and expertise	3.89	7	0.000*
H07	Lack of qualified personnel to implement ERM	3.97	6	0.000*
H08	Lack of a RMIS	3.46	22	0.004*
H09	Unsupportive organizational structure	3.77	11	0.000*
H10	Unsupportive organizational culture	4.06	4	0.000*
H11	Lack of a common risk language	3.40	24	0.009*
H12	Lack of risk awareness within the organization	3.77	11	0.000*
H13	Confidence in the existing risk management practices	3.43	23	0.017*
H14	Existence or re-emergence of the silo mentality	2.40	36	0.007*
H15	Lack of shared understanding and approach to risk management across departments	2.97	28	0.869
H16	Lack of understanding relating to effective ERM process	3.11	26	0.501
H17	Perception that ERM adds to bureaucracy	2.49	35	0.004*
H18	Perception that ERM increases costs and administration	4.09	3	0.000*
H19	Perception that ERM interferes with business activities	2.80	31	0.242
H20	Inadequate training on ERM	4.03	5	0.000*
H21	Lack of an ERM business case	3.86	8	0.000*
H22	Lack of perceived value or benefits of ERM	4.26	2	0.000*
H23	Lack of commitment of the board and senior management	3.54	18	0.001*
H24	Not perceived as a priority by senior management	3.74	13	0.000*
H25	Lack of board or senior management leadership	3.83	9	0.000*
H26	The movement of the ERM champion from senior management into other areas without a successor	2.74	32	0.083
H27	Lack of consensus on benefits of ERM among board members and senior management	2.94	29	0.701
H28	Other management priorities	3.74	13	0.000*
H29	Lack of a clear ERM implementation plan	3.83	9	0.000*
H30	Inability to coordinate with other departments	2.69	33	0.07
H31	Lack of a set of metrics for measuring performance of ERM	3.63	17	0.000*
H32	Unclear ownership and responsibility for ERM implementation	3.49	20	0.005*
H33	Organizational turf	2.69	33	0.078
H34	Employees' reluctance to give up power	2.86	30	0.377
H35	People's reluctance to share risk information	3.09	27	0.571
H36	Recession and business downturn	3.49	20	0.004*

Cronbach's alpha = 0.895
*The one-sample t test result is significant at the 0.05 level (two-tailed)

7.3.4.1 Overall Ranking

The mean scores of the 36 hindrances ranged from 2.40 to 4.54. These hindrances were ranked based on the overall mean scores and their mean scores, respectively.

Similar to the analysis of the drivers, the one-sample *t* test was also performed to check whether the hindrances had statistically significant influence on ERM implementation. The analysis results indicated that 25 out of the 36 hindrances obtained mean scores above 3.00 and *p* values below 0.05, implying that their mean scores were significantly higher than the test value of 3.00. Thus, these 25 factors significantly hindered ERM implementation in CCFs based in Singapore.

"Insufficient resources (e.g., time, money, and people)" received the highest overall rating among the 36 hindrances (mean = 4.54). This result indicated that CCFs based in Singapore did not invest sufficient time, money, and manpower in ERM implementation. In CCFs based in Singapore, the majority of time, money, and people were invested into project construction, and insufficient resources were allocated for ERM programs, signaling that these firms did not attach adequate importance to ERM. In addition, considering that the criterion of "sufficient resources" obtained a high importance score in Survey I, the high score of this hindrance supported the low-level ERM maturity in the Singapore-based CCFs. Thus, ERM maturity of these CCFs cannot be improved without sufficient investments of resources. Moreover, the high rating of this hindrance confirmed the findings of past studies in other industries (AON 2010; Beasley et al. 2010b; Blades 2010; Bowling and Rieger 2005; CFO/Crowe 2008; Gates 2006; KPMG 2010; Miccolis 2003; Miccolis et al. 2000; Rao 2007; RMA 2006; Roth 2006).

"Lack of perceived value or benefits" was the second most significant hindrance, indicating that CCFs based in Singapore did not perceived adequate value or benefits of ERM that motivated them to implement ERM. Although Hallowell et al. (2013) argued that the benefits of ERM could far outweigh the costs related to ERM initiation, more previous studies indicated that lack of tangible value or benefits was a significant barrier to ERM implementation (AON 2010; Beasley et al. 2010b; Blades 2010; KPMG 2010; Roth 2006), which was in line with the high rating of this hindrance in this research. Also, the high rating of this hindrance partly contributed to the high rating of "insufficient resources." If the executives of a firm did not perceive value or benefits of ERM, they would neither emphasize ERM nor invest sufficient resources in ERM initiation and misunderstand that ERM implementation was a waste of resource and could lower the profitability. Thus, unless there was external compliance and governance requirements, ERM implementation would not be approved by the board and senior management.

"Perception that ERM increases costs and administration" was ranked third (mean = 4.09). This result suggested that the perception of the management of Singapore-based CCFs that ERM led to additional costs and administration significantly hindered the ERM implementation in these firms. Also, this result was consistent with the findings of the KPMG survey, which reported that this hindrance was among the top five reasons for not implementing ERM in the Singapore-based firms in various industries (KPMG 2010). In reality, ERM initiation and implementation inevitably involve additional costs and administration, but these have been expected to be exceeded by the benefits of ERM (Hallowell et al. 2013). This hindrance can be seen as a biased perception or misunderstanding of ERM implementation, which resulted from the difficulty in demonstrating tangible value or benefits of ERM.

The fourth most significant hindrance was “unsupportive organizational culture” (mean = 4.06), implying that the existing corporate cultures of most CCFs in Singapore did not support ERM implementation. More specifically, this result indicated that the current corporate cultures of these CCFs were not likely to be in accordance with the risk appetite and tolerance and that the behaviors directed by the corporate culture were not conducive to ERM implementation. In addition, according to Low et al. (2008), the national working culture of Chinese firms was likely to value efficiency over effectiveness. Thus, top management would not attach great importance to the risks faced by their firms and seem impatient and eager to win available projects even through an unreasonably low price (Low et al. 2008). The high score of this hindrance also substantiated the finding in the literature that ERM implementation was discouraged by the culture in firms in a wide range of industries (Blades 2010; De la Rosa 2006; Kimbrough and Componation 2009; Kleffner et al. 2003; Merkley 2001; Miccolis 2003; Miccolis et al. 2000; Muralidhar 2010; Rao 2007; Shimpi 2010).

“Inadequate training on ERM” occupied the fifth position in the overall ranking (mean = 4.03), implying that the inadequate training to the relevant staff significantly hindered ERM implementation in CCFs based in Singapore. Without adequate training, the relevant staff would not gain a clear understanding of ERM philosophy and policy, the ERM process, the application of ERM techniques and tools, and the potential benefits, and risk-aware culture would not be built up across the firm, even if the executives had initiated an ERM program. This result was consistent with the finding of Gupta (2011) that inadequate training posed difficulty in implementing ERM in organizations in various industries. Also, as training programs on ERM requires sufficient investments of time, money, and human resources, this result confirmed the significance of “insufficient resources (e.g., time, money, and people)” in hindering ERM implementation.

“Lack of qualified personnel to implement ERM” was ranked sixth among the 36 hindrances (mean = 3.97). This result suggested that the Singapore-based CCFs did not have sufficient qualified personnel, which significantly hindered ERM implementation in these firms. Also, this result was consistent with the finding of Kleffner et al. (2003) that insufficient qualified personnel was an important deterrent to ERM implementation in the insurers. The staff qualified to implement ERM possess the knowledge, skills, and expertise relating to ERM and can therefore be actively involved in ERM implementation. Without these qualified staff, the CCFs would face the difficulty in carrying out ERM. Under this circumstance, the CCFs would employ external consultants to provide training programs for the relevant staff, or to help initiate ERM.

“Lack of internal knowledge, skills, and expertise” received the seventh highest rating (mean = 3.89), implying that CCFs based in Singapore lacked internal knowledge, skills, and expertise relating to ERM, which significantly hindered

ERM implementation in these firms. Thus, this result was consistent with the research that identified this factor as a hindrance to ERM implementation in various industries (AON 2010; CFO/Crowe 2008; KPMG 2010; Miccolis 2003; Miccolis et al. 2000; Rao 2007; Tang et al. 2007), and those reporting the low-level knowledge of risk management in CCFs in both domestic and international markets (Liu et al. 2007; Low et al. 2008). Because ERM was advocated in Chinese firms after the SASAC issued the guidance in 2006 and the overseas subsidiaries of the leading CCFs initiated ERM after 2009, the Singapore-based CCFs were not likely to possess adequate internal knowledge, skills, and expertise relevant to ERM and most of them obtained these resources from their parent companies. Moreover, the lack of qualified staff to implement ERM interacted with this hindrance because insufficient qualified human resources led to difficulty in generating the relevant knowledge, skills, and expertise from inside these CCFs.

"Lack of an ERM business case" was ranked eighth among the 36 hindrances, indicating that the inadequate ERM business cases negatively influenced ERM implementation in CCFs based in Singapore, which supported the argument of Aabo et al. (2005). Although there has been no one-size-fits-all approach to ERM, companies can benefit from adopting the best practices in successful ERM programs. The business cases that describe successful ERM implementation can also be used in the training programs on ERM, thus making it easier for the relevant management staff to understand the ERM fundamentals and perceive the potential value and benefits. Despite the case studies that present successful ERM implementation in the energy (Aabo et al. 2005), manufacturing (Vedpuriswar 2010), healthcare (Stroh 2005), and insurance (Acharyya and Johnson 2006) industries, there have been few cases describing successful ERM practices in the construction industry. Thus, CCFs lacked ERM business cases, which also undermined the effectiveness of the training on ERM.

"Lack of the board or senior management leadership" occupied the ninth position (mean = 3.83), indicating that the absence of the senior-level leadership significantly hindered ERM implementation in CCFs based in Singapore. ERM has been seen as a top-down approach (Dickinson 2001; Olson and Wu 2008) and involves strategic planning and decision-making (AON 2010). Thus, the visible leadership from the board and senior executives has been recognized as a critical component to an effective ERM program (Acharyya 2008; Beasley et al. 2005), while the lack of such leadership would contribute to ERM failure (AON 2010; Beasley et al. 2010b). The leadership should be visible, signaling the support from the top management to ERM implementation. The high rating of this hindrance might be attributed to the invisibility of the senior-level leadership on ERM implementation because several respondents indicated that the leadership from the top management was not visible to the staff at the department or project level.

Also, "lack of a clear ERM implementation plan" was ranked ninth, with the same mean score as "lack of the board or senior management leadership" (mean = 3.83). This result revealed that the Singapore-based CCFs lacked a clear plan to implement ERM, which significantly hindered ERM implementation. As an effective ERM program requires several years to develop (Hallowell et al. 2013), an organization needs to develop a clear plan, which should be tailored to its objectives and real-world circumstances, to guide the ERM implementation. The directors and senior executives should be involved in the ERM plan development because ERM has been recognized as a top-down approach to risk management (Dickinson 2001; Olson and Wu 2008). In the CCFs, the lack of a clear ERM implementation plan tended to pose difficulty in resource allocations for ERM implementation and made the management staff unable to be clear about the tasks and objectives relating to ERM implementation in different periods.

Furthermore, "existence or re-emergence of the silo mentality" was ranked bottom (mean = 2.40), which was different from the findings of Kleffner et al. (2003) that the existence, and in some cases the re-emergence, of the silo mentality was the main obstacle to ERM implementation of Canadian firms in various industries other than the construction industry. "Perception that ERM adds to bureaucracy" was ranked 35th, indicating that such passive perception did not influence ERM implementation in Singapore-based CCFs. This result significantly differed from the finding of Beasley et al. (2010a) that the concerns that ERM would add unnecessary bureaucracy could restrict the progress of ERM.

7.3.4.2 Low- Versus Medium-Maturity CCFs

Similar to the drivers, the influence of the hindrances was likely to differ between the low- and medium-maturity CCFs. Thus, this section investigates the differences in the scores and ranks of the hindrances to ERM implementation between the two CCF groups.

In the low-maturity CCFs, the mean scores ranged from 2.52 to 4.60, while in the other group, they ranged from 2.40 to 4.40. To test the differences in the mean scores between the two CCF groups, the independent-sample t test was performed. The p values below 0.05 represented the significant differences in the mean scores. The analysis results showed that the mean scores of four hindrances significantly differed between the two groups at the 0.05 level (see Table 7.12).

The mean score of "lack of risk management techniques and tools" in the low-maturity CCFs (mean = 3.88) was significantly higher than that in the medium-maturity firms (mean = 3.30). This result suggested that this hindrance exerted more negative influence on the ERM implementation in the low-maturity CCFs and that the medium-maturity CCFs tended to have applied risk management techniques and tools. Past studies have reported that most practitioners in the construction industry relied on professional judgment, intuition, and experience to manage risk (Akintoye and MacLeod 1997; Wood and Ellis 2003). The low-maturity CCFs might depend more on subjective judgment and experience than formal risk management techniques and tools. However, depending only on subjective judgment and experience may not be enough (Kartam and Kartam 2001; Shen 1997), and risk management techniques and tools should also be applied to deal with risk. It could be inferred that the application of risk management techniques and tools in the ERM implementation would enable CCFs to reach a higher level ERM maturity.

Table 7.12 Scores and ranks of the hindrances: low- versus medium-maturity CCFs

Code	Hindrances to ERM implementation	Low-maturity		Medium-maturity		*p* value
		Mean	Rank	Mean	Rank	
H01	Low data quality	3.44	24	3.10	24	0.323
H02	Lack of data	3.44	24	3.60	10	0.623
H03	Insufficient resources (e.g., time, money, and people)	4.60	1	4.40	1	0.390
H04	Lack of a formalized ERM process	3.84	14	3.30	18	0.123
H05	Lack of risk management techniques and tools	3.88	12	3.30	18	0.048*
H06	Lack of internal knowledge, skills, and expertise	4.00	9	3.60	10	0.162
H07	Lack of qualified personnel to implement ERM	4.04	7	3.80	5	0.443
H08	Lack of a RMIS	3.40	25	3.60	10	0.554
H09	Unsupportive organizational structure	3.84	14	3.60	10	0.413
H10	Unsupportive organizational culture	4.16	4	3.80	5	0.213
H11	Lack of a common risk language	3.56	20	3.00	27	0.077
H12	Lack of risk awareness within the organization	3.76	17	3.80	5	0.909
H13	Confidence in the existing risk management practices	3.48	22	3.30	18	0.640
H14	Existence or re-emergence of the silo mentality	2.24	36	2.80	32	0.233
H15	Lack of shared understanding and approach to risk management across departments	3.00	29	2.90	29	0.760
H16	Lack of understanding relating to effective ERM process	3.16	27	3.00	27	0.562
H17	Perception that ERM adds to bureaucracy	2.52	35	2.40	36	0.749
H18	Perception that ERM increases costs and administration	4.12	5	4.00	3	0.713
H19	Perception that ERM interferes with business activities	2.80	31	2.80	32	1.000
H20	Inadequate training on ERM	4.16	4	3.70	7	0.137
H21	Lack of an ERM business case	4.08	6	3.30	18	0.005*
H22	Lack of perceived value or benefits of ERM	4.32	2	4.10	2	0.409
H23	Lack of commitment of the board and senior management	3.68	18	3.20	22	0.166
H24	Not perceived as a priority by senior management	3.92	11	3.30	18	0.060
H25	Lack of board or senior management leadership	4.00	9	3.40	14	0.104

(continued)

Table 7.12 (continued)

Code	Hindrances to ERM implementation	Low-maturity		Medium-maturity		*p* value
		Mean	Rank	Mean	Rank	
H26	The movement of the ERM champion from senior management into other areas without a successor	2.76	32	2.70	34	0.854
H27	Lack of consensus on benefits of ERM among board members and senior management	3.00	29	2.80	32	0.548
H28	Other management priorities	3.84	14	3.50	12	0.139
H29	Lack of a clear ERM implementation plan	4.00	9	3.40	14	0.021*
H30	Inability to coordinate with other departments	2.52	35	3.10	24	0.048*
H31	Lack of a set of metrics for measuring performance of ERM	3.80	16	3.20	22	0.067
H32	Unclear ownership and responsibility for ERM implementation	3.64	19	3.10	24	0.058
H33	Organizational turf	2.60	33	2.90	29	0.441
H34	Employees' reluctance to give up power	2.96	30	2.60	35	0.315
H35	People's reluctance to share risk information	3.20	26	2.80	32	0.233
H36	Recession and business downturn	3.52	21	3.40	14	0.733

*The independent-sample t test result is significant at the 0.05 level (two-tailed)
The Spearman rank correlation coefficient is 0.830 (p value = 0.000)

In addition, "lack of an ERM business case" received a significantly higher mean score in the low-maturity CCFs (mean = 4.08) than in the medium-maturity firms (mean = 3.30). This result indicated that the negative influence of this hindrance on the ERM implementation was more significant in the low-maturity CCFs and that the medium-maturity CCFs were likely to have ERM cases in place. The medium-maturity CCFs had initiated formal ERM programs and were more likely to adopt business cases in their training programs on ERM. Also, the experience of implementing ERM in these CCFs could serve as business cases for themselves. It was more necessary for the low-maturity CCFs to collect ERM business cases and use them to convince the relevant staff that successful ERM implementation can bring about benefits and to provide a clear understanding of the ERM fundamentals. Thus, it could be inferred that adopting sufficient and effective ERM business cases in the training programs would help the CCFs improve their ERM maturity to a higher level.

"Lack of a clear ERM implementation plan" obtained the mean scores of 4.00 and 3.40 from the low- and medium-maturity CCFs, respectively. The difference between the two scores was significant, implying that this hindrance had more negative influence on the ERM implementation in the low-maturity CCFs. As the medium-maturity CCFs had initiated formal ERM programs, they were more likely to have ERM implementation plans and understand how to implement ERM step by step. By contrast, the low-maturity firms might not have such plans and tended to be unclear about the specific tasks for practicing ERM. Thus, the low-maturity CCFs should develop plans for the multiyear ERM journey, which can provide them with a clear understanding of the tasks and objectives relating to ERM, helping them climb to a higher level of ERM maturity.

Furthermore, the mean score of "inability to coordinate with other departments" in the medium-maturity CCFs (mean = 3.10) was significantly higher than that in the low-maturity ones (mean = 2.52), indicating that this hindrance was more influential in the medium-maturity CCFs than in the low-maturity firms. Specifically, this hindrance was ranked bottom in the low-maturity CCFs, implying that these firms had effective cross-department coordination. In comparison, the medium-maturity CCFs, most of which were large-sized firms, tended to face more problems relating to the coordination between departments than the other firms because they usually had more complex organizational structures.

Despite significant differences in the mean scores of the four hindrances, the Spearman rank correlation coefficient of 0.830 with a p value of 0.000 indicated strong and statistical significant agreement on the rankings of all the hindrances between the two CCF groups. Despite differences in the ranks of some hindrances, the two groups shared seven common hindrances among their respective top 10 rankings.

7.3.4.3 Interpretation from the Perspective of Organizational Behavior

This section intends to interpret the findings relating to hindrances to ERM implementation in the Singapore-based CCFs using the five theories of organizational behavior, i.e., organizational change, organizational learning, organizational culture, and motivation, as well as leadership theories. Specifically, the significant hindrances can be linked to the sources of resistances to organizational change, the impediments to organizational learning, the three-level organizational culture model, the hygiene factors, and the expectancy theory of motivation, as well as the potential errors of leaders.

1. Analysis from the perspective of organizational change

Chapter 4 has identified 21 sources of resistance to organizational change, and some of them are associated with the 25 significant hindrances to ERM implementation. Specifically, 10 significant hindrances (H01–H08, H21, and H31) can represent "insufficient resources" (C07) in the sources of resistance to organizational change. As an organizational change, ERM implementation needs a variety of resources, including not only the money, time, and people, but also the high-quality historical data, the internal knowledge, skills, expertise, the techniques, tools and information systems for risk management, the metrics to measure ERM performance, and business cases for training programs. Once an ERM program is initiated, sufficient resources should be allocated and the resource allocation should be considered in the ERM implementation plan approved by the board and senior management. Some resource investments would be prioritized to initiate ERM, thus signaling that the ERM program is really supported by the executives. Without necessary resources, the staff tend to feel frustrated while participating in the change and thus resist it (Hayes 2007). It should be noted that the resource investments need the approval from the senior level, and thus, these hindrances relating to resources can be associated with "lack of commitment of the board and senior management" (C10) in the sources of resistance. In turn, the significant hindrances relating to the top management (H23–H25) can be linked to "insufficient resources" (C07) in the sources of resistance.

Two hindrances (H28 and H36) could also be indirectly linked to "insufficient resources" (C07). When adopting change, organizations would also need to sustain their operation and business processes. Thus, other prioritized issues would occupy the resources for the change program, probably resulting in the resource scarcity of the change program. In addition, subject to the decisions of the executives, "recession and business downturn" (H36) would incur the reduction in the expenditures for the change programs and the use of downsizing or layoff strategies that would led to loss of knowledge, skills, and expertise because of the departure of qualified and experienced personnel (Fisher and White 2000; Pfeffer 1998). Thus, this hindrance would contribute to the resource shortage of ERM implementation.

The board and senior management should support the organizational change program in a visible and continuous manner, while the lack of the senior-level commitment tends to result in the skepticism and cynicism on the change program (Hayes 2007). ERM implementation also needs the visible leadership and support from the board and senior management (Gates 2006; Kleffner et al. 2003; Narvaez 2011). Most of the significant hindrances can be lined to "lack of commitment of the board and senior management" (C10) in the sources of resistance to change. This is because without such commitment, sufficient resources would not be invested; ERM ownership and accountability would not be set up; and internal communication and training mechanisms would not be initiated. Consequently, the ERM program cannot obtain the commitment and support from the relevant staff and tends to fail. It is worth reiteration that the senior-level commitment should be true, visible, and continuous, which means that the board and senior management should assign a higher priority to ERM implementation, despite other competing management priorities.

In addition, to implement an organizational change, the change agent should ensure that the relevant staff can adapt to the change and participate in the change program. Three hindrances (H06, H07, and H30) can represent the "lack of individual capability to change" (C05) in the resistance sources. The staff would unconsciously think about whether they are qualified in the ERM implementation in terms of their knowledge, skills, expertise, and capabilities. If they feel that are not likely to be competent in ERM implementation, they would not actively participate in ERM implementation, or even undermine it.

Moreover, organizational culture also plays a critical role in organizational change because of its pervasive nature (Austin and Ciaassen 2008). The hindrance “unsupportive organizational culture” (H10) could result from the constraints created by the group norms, i.e., “group inertia” (C20) in the resistance sources, as well as the specific cultural components of organizations that do not support ERM implementation (C19). One example of such components is the risk attitude that is not in accordance with the risk appetite and tolerance as well as the real-world circumstances faced by a firm. In addition, people tend to respond to change in their accustomed ways, when confronted with change, and harbor a biased view of change that fits most comfortably into a person’s own perception of the reality (Robbins 2003). Such behaviors and mind-sets toward change could be influenced by the organizational culture or group norms. Thus, the hindrance “confidence in the existing risk management practices” (H13) can be associated with “habits” (C01), “organizational culture” (C19), “group inertia” (C20), and “selective information processing” (C15) in the sources of resistance. Based on the long-established habits in dealing with risks, the staff would be still stuck to PRM at the initiative phase of ERM implementation. According to Hallowell et al. (2013), one challenge of ERM implementation was changing the thinking of all employees within an enterprise from considering only their function’s objectives to considering how decisions can affect the entire enterprise. Thus, some actions should be taken to change the passive mind-sets and behaviors toward ERM.

Furthermore, the change agent should allow the staff to understand the vision, the need, and the impacts of the change and try to remove their misunderstandings of the change program through adequate and effective internal communication (Hayes 2007; Mullins 2007; Robbins 2003). Five hindrances (H11, H18, and H20–H22) can be linked to “misunderstanding” (C06) and “poor internal communication” (C09) in the sources of resistance. Training programs on ERM can be a communication channel, through which the staff can understand the ERM philosophy, policy, and process, as well as the application of ERM techniques and tools. Adoption of successful ERM cases in training allows the staff to perceive that value and benefits of ERM can exceed the additional costs and administration. To enable the staff to better understand the terminologies used in the training, a glossary of risk terms need to be created and distributed throughout the firm, which facilitates the employment of a common risk language. Without such a language, the effectiveness and efficiency of the communication in the training programs and ERM implementation would not be assured because time could be wasted in resolving the issues caused by the confusion about the terminologies (Espersen 2007). In addition, it should be noted that the effectiveness of training programs and communication depends on the relationship between the management and employees (Furst and Cable 2008), which is characterized by mutual trust and credibility (Kotter and Schlesinger 1979; Robbins 2003). Thus, three out of the above five hindrances (H18, H20, and H22) relating to training and communication can be associated with “lack of trust in management” (C11) and “low-level employee–manager relation” (C13) in the sources of resistance. This implied that the ERM owner should ensure that they can obtain the trust from the relevant staff and sustain a good relation with them, to assure the effectiveness of training on ERM. Without effective and adequate training on ERM, the staff would hold a biased view of ERM from the angle that fits most comfortably into their perception, resulting from the "selective information processing" (C15).

2. Analysis from the perspective of organizational learning

Organizational change and learning are closely associated with each other (Lähteenmäki et al. 2001), and organizational learning was recognized as a critical component of holistic risk management (Smallman 1996). Thus, organizational learning is necessary for ERM implementation, and the factors that impede organizational learning would also negatively influence ERM implementation. Chapter 4 has identified 12 impediments to organizational learning, and some of them can be used to interpret the significant hindrances to ERM implementation.

Without the senior-level commitment and support, the learning culture would not be created; resources would not be invested into the learning and training programs; the staff would not perceive the learning as being emphasized; and finally, organizational learning mechanisms would not be set up and institutionalized. Thus, the significant hindrances relating to the top management (H23–H25), the organizational culture and structure (H09 and H10), and the resource investments (H01–H08, H21, and H31), as well as the training and understanding of ERM (H11, H18, and H20–H22) can be linked to "lack of leadership commitment and support" (L01) in the impediments to organizational learning.

According to the literature, organizational learning is associated with knowledge acquisition (Huber 1991; Shrivastava 1983; Tsang 1997), participation in the learning process (i.e., situated learning) (Brown and Duguid 1991), and knowledge creation (Bereiter 2002; Engeström 1999; Nonaka 1991). In the CCFs, ERM implementation involves knowledge acquisition from inside and outside the firm, the participation of the relevant staff in the training programs and risk communication, as well as the creation of knowledge from the ERM practices. Six factors (H01, H02, and H04–H07) significantly hindered ERM implementation because they contributed to the "lack of internal knowledge" (L02) relating to ERM. Specifically, as the data are the predecessor of information and knowledge, the lack of high-quality data can result in the lack of internal knowledge. Also, the lack of a formalized ERM process, relevant techniques, and tools represents a low level of knowledge relating to ERM. In addition, the staff qualified to implement ERM are likely to have the relevant knowledge, skills and expertise, and the lack of such staff can therefore led to the lack of internal knowledge.

There should be a channel through which people share their ideas and knowledge. A RMIS can serve as a platform where the relevant staff can communicate the risk information as well as the lessons learned in ERM implementation, while training programs allow external and internal trainers to share their experience and knowledge relating to ERM with others. Thus, "lack of a RMIS" (H08) and "inadequate training on ERM" (H20) hindered ERM implementation because they represented the lack of channels for sharing knowledge. As setting up such channels needs resource investments and senior-level support, the negative influence of the four hindrances (H03 and H23–H25) can also be interpreted using this impediment to organizational learning.

Even though there are channels for dialogue and sharing knowledge, the effectiveness of knowledge acquisition depends on the individuals' ability to absorb and retain the knowledge (Cohen and Levinthal 1990; Szulanski 1996). The personnel unqualified to implement ERM may also lack the capacity for absorbing and retaining the knowledge relating to ERM, thus contributing to the lack of internal knowledge, skills, and expertise. Therefore, the two hindrances (H06 and H07) can be linked to "lack of knowledge absorptive or retentive capacity" (L08) in the impediments to organizational learning. In addition, downsizing or layoff strategies are often used when a firm faces a recession or business downturn. These strategies involve the departure or turnover of the staff, who may be experienced and knowledgeable, and would lead to the loss of the experience and knowledge (Fisher and White 2000; Pfeffer 1998). Thus, the two hindrances (H06 and H07) can also be linked to "downsizing or layoff strategies" (L11) in the impediments to learning.

In some cases, the staff would fear that their self-interest would be threatened due to organizational learning, thus leading to the lack of psychological safety. "Perception that ERM increases costs and administration" (H18) is representative of "lack of psychological safety" (L04) because some staff may believe that the additional costs and administration threaten the firm performance, which is associated with the bonus or interest of them. Such a misunderstanding derives from the "lack of perceived value or benefits of ERM" (H22). Thus, the two significant hindrances (H18 and H22) can be linked to "lack of psychological safety" (L04).

Motivation measures are necessary for organizational learning (Szulanski 1996). As the relevant employees need to spend time, energy, and knowledge in ERM implementation, they should be convinced that these resources can pay off. Thus, the metrics to measure ERM performance should be developed and used. The tangible increase in firm performance can motivate the relevant staff to actively participate in the ERM implementation. In turn, the lack of such metrics and perceived benefits of ERM would discourage the staff from contributing to the learning process relating to ERM, thus hindering ERM implementation.

Organizational learning can be impeded by the unsupportive organizational culture, such as the blame culture (Hayes 2007) and defensive routines (Argyris 1995). Three significant hindrances (H10, H12, and H13) can be linked to "unsupportive organizational culture" (L12) in the impediments to organizational learning. As ERM implementation includes learning from the past mistakes, errors, failures, and disasters, the unsupportive culture would render these negative issues as taboos and discourage the staff from investigating the root causes of them. Consequently, the employees would remain confident in the existing risk management practices and not believe that it is necessary to implement ERM, which is likely to lead to the underlying assumption that the risks can be dealt with by the current risk management practices. Thus, the staff would not attach adequate importance to the potential risks and lack risk awareness.

3. Analysis from the perspective of organizational culture

ERM implementation is immersed in the organizational culture, and organizational culture has been invoked in existing ERM frameworks (CAS 2003; COSO 2004; ISO 2009). A strong but unsupportive organizational culture tends to hinder ERM implementation through stabilizing the behavior and attitudes of staff toward the existing risk management practices, creating inappropriate risk awareness, or stifling the ability to adapt to the change in the risk management approach.

Four significant hindrances (H09, H10, H12, and H13) can be linked to the three-level culture model. Specifically, the organizational structure is at the visible artifact level of the three-level organizational culture model because the structure carries implications for the organizational culture (Graetz et al. 2006). "Unsupportive organizational structure" (H10) would increase the difficulty of change occurrence (Senior and Fleming 2006). In addition, to implement ERM smoothly, a risk-aware culture should be created and embedded in the organizational culture (Barton et al. 2002). Risk awareness represents the attitudes and mind-sets of the staff toward risk, promotes employee vigilance, and makes risk events more likely to be detected early. Thus, "lack of risk awareness within the organization" (H12) is at the level of espoused values. Moreover, in a mature ERM program, the risk awareness should be deeply embedded in the corporate culture and comprise the underlying and basic assumptions. Thus, this hindrance can be linked to the deepest level. Furthermore, a strong organizational culture would strengthen the confidence in the existing risk management practices, thus increasing the difficulty of the staff in embracing ERM practices. Such confidence indicates the positive attitudes toward the existing risk management practices and the underlying assumption that the existing practices are taken-for-granted and adequate to the company. Thus, "confidence in the existing risk management practices" (H13) can be associated with the levels of espoused values and basic assumptions of organizational culture.

4. Analysis from the perspective of motivation

The employees usually need motivation to embrace organizational change and in turn, the motivation theory, can be used to interpret sources of resistance to change. ERM implementation, as a change in the paradigm of risk management, requires the employment of motivation measures, and the hindrances may be related to motivation.

Content theories of motivation emphasize the nature of needs and what motivates. ERM implementation can raise fear or anxiety within the firm. For instance, employees would the fear that the ERM program increases costs and administration, which may add to their work and threaten their self-interests. This perception represents the lack of psychological safety, which is a hygiene factor in the two-factor theory of Herzberg (1966). Thus, "perception that ERM increases costs and administration" (H18) tends to result in job dissatisfaction that hinders ERM implementation.

The expectancy theory of motivation (Vroom 1964) regards motivation as a function of expectancy, instrumentality, and valence. Expectancy represents the perceived probability that the effort of an employee will lead to a desired level of performance. Most of the significant hindrances to ERM implementation can be linked to the expectancy variable. For example, the hindrances relating to resources (H01–H08, H21, and H31) tend to lower the expectancy variable in employees. This is because employees would not perceive that their efforts for ERM implementation are likely to result in the desired performance, without the sufficient investments of time, money, people, and necessary intellectual resources. “Other competing priorities” (H28) and “recession and business downturn” (H36) involve the reduction in the resources invested in the ERM program, thus lowering the expectancy variable.

In addition, the misunderstandings relating ERM, such as the hindrances H18 and H22, could impress the related staff that they would have additional work and make them confused about the impact of ERM on firm performance. Thus, there is the possibility that the staff underestimated the expectancy variable. The negative influence of these misunderstandings could have been relieved by training on ERM. However, without adequate training, the misunderstandings would remain and the staff cannot obtain the knowledge and experience related to ERM practices, which contributes to a lower level of expectancy.

Moreover, the lack of the senior-level commitment and leadership could render the employees the perception that their efforts relating to ERM implementation are not emphasized by the top management, which is likely to lower the probability that their efforts contribute to the desired performance. Thus, the significant hindrances relating to the senior-level commitment and leadership (H23–H25) can be linked to the variables of expectancy.

Furthermore, instrumentality is the perceived probability that the performance will lead to the achievement of a desired outcome. The significant hindrances relating to the senior-level commitment and leadership (H23–H25) imply that the senior management would not confirm performance contingent rewards and can thus be linked to the instrumentality variable. Another scenario is that there is an ERM performance contingent rewarding system, but the staff may not understand this system and underestimate the instrumentality variable. Thus, the training programs, which provide the staff with a clear understanding of ERM fundamentals, should also help them gain a clear understanding of the rewarding system. Conversely, inadequate training on ERM would not enable the staff to clearly understand the system even though the system exists in the company, thus resulting in the misperception of the probability that performance leads to the desired outcome.

5. Analysis from the perspective of leadership

The role of the leadership in ERM implementation has been emphasized in previous studies (Acharyya 2008; Beasley et al. 2005; Gates 2006; Kleffner et al. 2003; Narvaez 2011) because ERM requires a top-down view of the risks that a firm faces. Thus, the lack of the visible commitment and leadership at the senior level was identified as the significant hindrance to ERM implementation. Also, the errors made by leaders would hinder ERM implementation, and some of the significant hindrances can be linked to these errors identified in the literature relating to leadership (Kotter 1995, 1996). These errors are given as follows: not establishing a great enough sense of urgency, not creating a sufficiently powerful guiding coalition, lacking a vision, under-communicating the vision, permitting obstacles to the new vision, not systematically planning for and creating short-term wins, declaring victory too soon, and not anchoring changes in the corporate culture.

The lack of a clear understanding of ERM, such as the "perception that ERM increases costs and administration", indicates an unclear vision of ERM implementation provided by the leaders or the under-communication of the vision. Thus, the leaders should launch effective training programs to present a clear vision of ERM and deal with the concerns of employees when the ERM program is initiated. To obtain the organizational commitment, the vision would be focused on how the employees benefit from the ERM programs. In addition, the leaders should attach importance to the communication skills used in the training programs to avoid the under-communication. According to the trait theory of leadership, the good communication skill is an inborn trait of good leaders (Graetz et al. 2006; Kirkpatrick and Locke 1991). In terms of the behavioral theories of leadership (Blake and Mouton 1966; Likert 1961; Stogdill and Coons 1951), the leaders leaning toward the person-oriented behaviors were found to be more appropriate for communication activities (Battilana et al. 2010).

The existing organizational culture and structure may be unsupportive of ERM implementation, thus hindering the achievement of the vision. If the leaders do not intend to change the unsupportive culture and structure, these obstacles tend to continue undermining the ERM program. Thus, to make the relevant staff embrace ERM, the leaders should set to clear up all the obstacles, even though it would be time-consuming.

In addition, as ERM implementation is a long-term journey spanning many years (Bowling and Rieger 2005), the leaders of the ERM program should provide short-term wins to convince the senior management and the staff that the ERM implementation is beneficial, thus obtaining the continuous support and commitment from them. This tactic has been used in the case study conducted by Aabo et al. (2005). Such short-term achievement should be perceivable benefits. To clearly demonstrate the short-term wins of ERM implementation, a set of metrics to measure ERM performance should be developed and the successful business ERM cases could be used, although it is difficult to demonstrate these benefits (KPMG 2010). The significant hindrances relating to the lack of short-term wins or failure to demonstrate these benefits (H21, H22, and H31) would discourage the senior management and the relevant staff. Thus, the leaders of the ERM program would adopt the task-oriented behavior to focus on the achievement and demonstration of short-term wins.

Furthermore, once the pressure for change disappears, change is subject to degradation, unless new behaviors are rooted in social norms and shared values (Kotter 1996). To sustain the ERM implementation in a company, the leaders need to integrate ERM into the business process. This involves creating a risk-aware culture and embedding it into the supportive corporate culture. The risk-aware culture indicates the risk awareness across the company and the subsequent behaviors. Thus, even though the ERM champion from the senior executive moves or retires, ERM practices will be sustained in the firm. The lack of risk awareness indicates the lack of the risk-aware culture and can therefore be linked to the error of not anchoring changes in the corporate culture.

7.4 Summary

A total of 16 ERM maturity criteria and 66 ERM best practices was validated by Survey I and included in the proposed ERM maturity model. Using the data collected from Survey II, this model was employed to assess the ERM maturity in Singapore-based CCFs, and the results reported a low-level overall ERM maturity of these CCFs as well as the positive association between ERM maturity and firm size. In addition, 13 drivers for and 25 hindrances to ERM implementation were found to be significantly influential. Although a couple of drivers and hindrances had significantly different influence on ERM implementation between the low- and medium-maturity CCFs, there was agreement on the rankings of the drivers and hindrances between the two CCF groups, respectively. Furthermore, the drivers were interpreted using the theories of organizational change, while the hindrances were explained in tandem with the theories of organizational change, organizational learning, organizational culture, motivation, as well as leadership. Thus, the second, third, and fourth research objectives are fulfilled.

References

Aabo T, Fraser JRS, Simkins BJ (2005) The rise and evolution of the chief risk officer: enterprise risk management at Hydro One. J Appl Corp Finan 17(3):62–75

Accenture (2011) Report on the Accenture 2011 global risk management study. Accenture, New York

Acharyya M (2007) Proposing a conceptual framework to measure the performance of enterprise risk management from an empirical study of four major European insurers. The 34th seminar of the European Group of Risk and Insurance Economists, 17–19 Sept, Cologne, Germany

Acharyya M (2008) An empirical study on enterprise risk management in insurance. In: Olson DL, Wu D (eds) New frontiers in enterprise risk management. Springer, Berlin, pp 39–55

Acharyya M, Johnson J (2006) Investigating the development of enterprise risk management in the insurance industry: an empirical study on four major European insurers. Geneva Papers Risk Insur Issues Pract (special issue):55–80

Akintoye A (2000) Analysis of factors influencing project cost estimating practice. Constr Manag Econ 18(1):77–89

Akintoye AS, MacLeod MJ (1997) Risk analysis and management in construction. Int J Project Manage 15(1):31–38

Alas R, Sharifi S (2002) Organizational learning and resistance to change in Estonian companies. Hum Resour Dev Int 5(3):313–331

AON (2010) Global risk management survey 2010. AON plc, Chicago

Argyris C (1995) Action science and organizational learning. J Manag Psychol 10(6):20–26

Austin MJ, Ciaassen J (2008) Impact of organizational change on organizational culture. J Evid Based Soc Work 5(1):321–359

Banham R (2004) Enterprising views of risk management. J Accountancy 197(6):65–71

Barton TL, Shenkir WG, Walker PL (2002) Making enterprise risk management pay off. Financial Times Prentice Hall, Upper Saddle River

Battilana J, Gilmartin M, Sengul M, Pache AC, Alexander JA (2010) Leadership competencies for implementing planned organizational change. Leadersh Quart 21(3):422–438

BCA (2013) Contractors registry. Building and Construction Authority, Singapore. Retrieved 30 May 2013, from: http://www.bca.gov.sg/ContractorsRegistry/contractors_tendering_limits.html

Beasley MS, Frigo ML (2010) ERM and its role in strategic planning and strategy execution. In: Fraser J, Simkins BJ (eds) Enterp Risk Manag. Wiley, Hoboken, pp 31–50

Beasley MS, Clune R, Hermanson DR (2005) Enterprise risk management: an empirical analysis of factors associated with the extent of implementation. J Account Public Policy 24(6):521–531

Beasley MS, Branson BC, Hancock BV (2010a) Enterprise risk oversight: a global analysis. Chartered Institute of Management Accountants, American Institute of Certified Public Accountants and the ERM Initiative at North Carolina State University, Raleigh, NC

Beasley MS, Branson BC, Hancock BV (2010b) Developing key risk indicators to strengthen enterprise risk management. ERM Initiative at North Carolina State University and the Committee of Sponsoring Organizations of the Treadway Commission, Raleigh, NC

Beer M, Nohria N (2000a) Cracking the code of change. Harvard Bus Rev 78(3):133–141

Beer M, Nohria N (2000b) Resolving the tension between theories E and O of change. In: Beer M, Nohria N (eds) Breaking the code of change. Harvard Business School Press, Boston, pp 1–34

Bereiter C (2002) Education and mind in the knowledge age. Lawrence Erlbaum, Hillsdale

Blades M (2010) Is ERM leaving security behind? SecurityinfoWatch. Retrieved 11 February 2011, from: http://www.securityinfowatch.com/is-erm-leaving-security-behind

Blake RR, Mouton JS (1966) Managerial facades. Adv Manag J 31(3):30–37

Bowling DM, Rieger LA (2005) Success factors for implementing enterprise risk management. Bank Account Finan 18(3):21–26

Brown JS, Duguid P (1991) Organizational learning and communities-of-practice: toward a unified view of working, learning, and innovation. Organ Sci 2(1):40–57

Bugalla J, Franklin B, Gooch C (2010) Climbing the ERM tree. Risk Manag 57(4):40–43

CAS (2003) Overview of enterprise risk management. Casualty Actuarial Society, Arlington

Cendrowski H, Mair WC (2009) Enterprise risk management and COSO: a guide for directors, executives, and practitioners. Wiley, Hoboken

CFO/Crowe (2008) The changing landscape of risk management. CFO Research Services and Crowe, Boston, MA

China (2011) Head office takes over CRCC's Light Rail Project, Beijing. Retrieved 13 July 2011, from: http://www.china.org.cn/business/2011-01/22/content_21798050.htm

Chitakornkijsil P (2010) Enterprise risk management. Int J Organ Innov 3(2):309–337

Chong HY, Zin RM (2012) Selection of dispute resolution methods: factor analysis approach. Eng Constr Arch Manag 19(4):428–443

Cienski J (2011) China group sees collapse of Poland ambitions. Financial Times, Warsaw, Poland. Retrieved 31 July 2011, from: http://www.ft.com/intl/cms/s/0/d17dda5a-96b7-11e0-baca-00144feab49a.html#axzz1Tgz4hTH5

Cohen WM, Levinthal DA (1990) Absorptive capacity: a new perspective on learning and innovation. Adm Sci Q 35(1):128–152

Colquitt LL, Hoyt RE, Lee RB (1999) Integrated risk management and the role of the risk manager. Risk Manage Insur Rev 2(3):43–61

COSO (2004) Enterprise risk management—integrated framework: executive summary and framework. Committee of Sponsoring Organizations of the Treadway Commission, Jersey City, NJ

Cumming C, Hirtle B (2001) The challenges of risk management in diversified financial companies. FRBNY Econ Policy Rev 7(1):1–17

Dafikpaku E (2011) The strategic implications of enterprise risk management: a framework. In: Enterprise risk management symposium, 14–16 March 2011, Chicago, IL

De la Rosa S (2006) Cultivating the best board. Intern Auditor 63(4):69–75

Deloitte (2010) Risk Intelligence in the Energy & Resources Industry: enterprise risk management benchmark survey. Deloitte Touche Tohmatsu Limited, New York, NY

Dickinson G (2001) Enterprise risk management: its origins and conceptual foundation. Geneva Papers Risk Insur Issues Pract 26(3):360–366

Duckert GH (2011) Practical enterprise risk management: a business process approach. Wiley, Hoboken

Engeström Y (1999) Innovative learning in work teams: analyzing cycles of knowledge creation in practice. In: Engeström Y, Miettinen R, Punamaki RL (eds) Perspectives on activity theory. Cambridge University Press, Cambridge, pp 377–404

Espersen D (2007) The language of risk: organizations can improve risk management and audit processes by communicating risks in terms that everyone understands. Intern Auditor 64 (3):69–73

Fisher SR, White MA (2000) Downsizing in a learning organization: are there hidden costs? Acad Manag Rev 25(1):244–251

Furst SA, Cable DM (2008) Employee resistance to organizational change: managerial influence tactics and leader-member exchange. J Appl Psychol 93(2):453–462

Gates S (2006) Incorporating strategic risk into enterprise risk management: a survey of current corporate practice. J Appl Corp Finan 18(4):81–90

Gordon LA, Loeb MP, Tseng CY (2009) Enterprise risk management and firm performance: a contingency perspective. J Account Public Policy 28(4):301–327

Graetz F, Rimmer M, Lawrence A, Smith A (2006) Managing organizational change, 2nd Australasian edn. Wiley, Milton

Gregory CA (2003) Minimizing enterprise risk. Financial Times Prentice Hall, London

Gupta PK (2011) Risk management in Indian companies: EWRM concerns and issues. J Risk Finan 12(2):121–139

Hallowell MR, Molenaar KR, Fortunato BR (2013) Enterprise risk management strategies for state departments of transportation. J Manag Eng 29(2):114–121

Harrington SE, Niehaus G, Risko KJ (2002) Enterprise risk management: the case of United Grain Growers. J Appl Corp Finan 14(4):71–81

Hayes J (2007) The theory and practice of change management, 2nd edn. Palgrave Macmillan, New York

HBRAS (2011) Risk management in a time of global uncertainty. Harvard Business Review Analytic Services, Cambridge

Herzberg FI (1966) Work and the nature of man. World, Cleveland

Hofstede G (1980) Culture's consequences: international differences in work-related values. Sage Publications, London

Hofstede G (1984) Cultural dimensions in management and planning. Asia Pac J Manag 1(2):81–99

Hofstede G, Hofstede GJ, Minkov M (2010) Cutures and organizations: software of the mind, 3rd edn. McGraw-Hill, New York

Hopkinson M (2011) The project risk maturity model: measuring and improving risk management capability. Gower, Burlington

Hoyt RE, Liebenberg AP (2011) The value of enterprise risk management. J Risk Insur 78(4):795–822

Huber GP (1991) Organizational learning: the contributing processes and the literatures. Organ Sci 2(1):88–115

Hwang BG, Zhao X, Ng SY (2013) Identifying the critical factors affecting schedule performance of public housing projects. Habitat Int 38:214–221

ISO (2009) ISO 31000:2009 risk management—principles and guidelines. International Organization for Standardization, Geneva

Kartam NA, Kartam SA (2001) Risk and its management in the Kuwaiti construction industry: a contractors' perspective. Int J Project Manage 19(6):325–335

Kimbrough RL, Componation PJ (2009) The relationship between organizational culture and enterprise risk management. Eng Manag J 21(2):18–26

Kirkpatrick SA, Locke EA (1991) Leadership: do traits mater? Acad Manag Executive 5(2):48–60

Kleffner AE, Lee RB, McGannon B (2003) The effect of corporate governance on the use of enterprise risk management: evidence from Canada. Risk Manag Insur Rev 6(1):53–73

Kotter JP (1995) Leading change: why transformation efforts fail. Harvard Bus Rev 73(2):59–67

Kotter JP (1996) Leading change. Harvard Business School Press, Boston

Kotter JP, Schlesinger LA (1979) Choosing strategies for change. Harvard Bus Rev 57(2):106–114

KPMG (2010) Charting a safe and sustainable growth journey: Singapore enterprise risk management survey 2010. KPMG in Singapore, Singapore

Lähteenmäki S, Toivonen J, Mattila M (2001) Critical aspects of organizational learning research and proposals for its measurement. Br J Manag 12(2):113–129

Lam J (2003) Enterprise risk management: from incentives to controls. Wiley, Hoboken

Liebenberg AP, Hoyt RE (2003) The determinants of enterprise risk management: evidence from the appointment of chief risk officers. Risk Manag Insur Rev 6(1):37–52

Likert R (1961) New patterns of management. McGrill-Hill, New York

Ling FYY, Low SP, Wang SQ, Lim HH (2009) Key project management practices affecting Singaporean firms' project performance in China. Int J Project Manage 27(1):59–71

Liu JY, Li BG, Lin BS, Nguyen V (2007) Key issues and challenges of risk management and insurance in China's construction industry—an empirical study. Indus Manage Data Syst 107 (3):382–396

Liu JY, Low SP, He X (2011) Current practices and challenges of implementing enterprise risk management (ERM) in Chinese construction enterprises. Int J Constr Manag 11(4):49–63

Low SP, Liu JY, He SQ (2008) Management of external risks: case study of a Chinese construction firm at infancy stage in Singapore. Int J Constr Manag 8(2):1–15

Lu W, Li H, Shen L, Huang T (2009) Strengths, weaknesses, opportunities, and threats analysis of Chinese construction companies in the global market. J Manag Eng 25(4):166–176

Manab NA, Kassim I, Hussin MR (2010) Enterprise-wide risk management (EWRM) practices: between corporate governance compliance and value creation. Int Rev Bus Res Papers 6 (2):239–252

Mann PS (2005) Introductory statistics using technology. Sample distribution. Wiley, New York

Merkley BW (2001) Does enterprise risk management count? Risk Manag 48(4):25–28

Meulbroek L (2002) A senior manager's guide to integrated risk management. J Appl Corp Finan 14(4):56–70

Miccolis J (2003) ERM lessons across industries. International Risk Management Institute, Dallas. Retrieved 3 March 2011, from: http://www.irmi.com/expert/articles/2003/miccolis03.aspx

Miccolis J, Shah S (2000) Enterprise risk management: an analytic approach. Tillinghast-Towers Perrin, Parsippany

Miccolis J, Mueller H, Gruhl R (2000) Enterprise risk management in the insurance industry: 2000 benchmarking survey report. Tillinghast-Towers Perrin, Parsippany, NJ. Retrieved 21 April 2011, from: http://www.towersperrin.com/tp/getwebcachedoc?webc=till/usa/2000/200001/2000060107.pdf

Millage A (2005) ERM is still in its infancy. Intern Auditor 62(5):16–17

Mullins LJ (2007) Management and organisational behaviour, 8th edn. Prentice Hall Financial Times, Harlow

Muralidhar K (2010) Enterprise risk management in the Middle East oil industry: an empirical investigation across GCC countries. Int J Energy Sect Manage 4(1):59–86

Narvaez K (2011) Success stories: public entities adopt ERM best practices. Public Entity Risk Institute, Fairfax

Nocco BW, Stulz RM (2006) Enterprise risk management: theory and practice. J Appl Corp Finan 18(4):8–20

Nonaka I (1991) The knowledge creating company. Harvard Bus Rev 69(6):96–104

Nunnally JC (1978) Psychometric theory, 2nd edn. McGraw-Hill, New York

Olson DL, Wu D (2008) Enterprise risk management. World Scientific Publishing, Singapore

Ott RL, Longnecker M (2001) An introduction to statistical methods and data analysis. Pacific Grove, Duxbury

Pagach DP, Warr RS (2010) The effects of enterprise risk management on firm performance. North Carolina State University, Raleigh

Pagach DP, Warr RS (2011) The characteristics of firms that hire chief risk officers. J Risk Insur 78 (1):185–211

Pfeffer J (1998) The human equation: building profits by putting people first. Harvard Business School Press, Cambridge

Rao A (2007) Evaluation of enterprise risk management (ERM) in Dubai: an emerging economy. Risk Manag 9(3):167–187

RMA (2006) Enterprise risk management survey 2006. Risk Management Association, Philadelphia

Robbins SP (2003) Organizational behavior, 10th edn. Prentice Hall, Upper Saddle River

Roth J (2006) An enterprise risk catalyst. Intern Auditor 63(2):81–87

SASAC (2006) Guidance to enterprise risk management for central enterprises. State-owned Assets Supervision and Administration Commission of the State Council of China, Beijing

Senior B, Fleming J (2006) Organizational change, 3rd edn. Financial Times Prentice Hall, Harlow

Sharman R (2002) Enterprise risk management-The KPMG approach. Br J Adm Manage 31:26–28

Shen LY (1997) Project risk management in Hong Kong. Int J Project Manag 15(2):101–105

Shen LY, Zhao ZY, Drew DS (2006) Strengths, weaknesses, opportunities, and threats for foreign-invested construction enterprises: a China study. J Constr Eng Manag 132(9):966–975

Shimpi P (2010) Financial crisis exposes need for all to adopt enterprise risk management. Nat Underwriter Property Casualty 114(3):22–23

Shortreed J (2010) ERM framework. In: Fraser J, Simkins BJ (eds) Enterprise risk management. Wiley, Hoboken, pp 97–123

Shrivastava P (1983) A typology of organizational learning systems. J Manag Stud 20(1):7–28

Simkins B (2008) Enterprise risk management: current initiatives and issues—journal of applied finance roundtable. J Appl Finan 18(1):115–132

Smallman C (1996) Risk and organizational behaviour: a research model. Disaster Prev Manag 5 (2):12–26

Stogdill RM, Coons AE (1951) Leader behavior: its description and measurement. Ohio State University and Bureau of Business Research, Columbus

Stroh PJ (2005) Enterprise risk management at United Healthcare. Strateg Finan 87(1):26–35

Szulanski G (1996) Exploring internal stickiness: impediments to the transfer of best practice within the firm. Strateg Manag J 17(special issue):27–43

Tam CM, Zeng SX, Deng ZM (2004) Identifying elements of poor construction safety management in China. Saf Sci 42(7):569–586

Tang WZ, Qiang MS, Duffield CF, Young DM, Lu YM (2007) Risk management in the Chinese construction industry. J Constr Eng Manag 133(12):944–956

Towers Perrin (2006) A changing landscape: a study of corporate ERM in the US. Towers Perrin, Stamford

Tsang EWK (1997) Organizational learning and the learning organization: a dichotomy between descriptive and prescriptive research. Hum Relat 50(1):73–89

Vedpuriswar AV (2010) Enterprise risk management: industry experiences. ICFAI University Press, Hyderabad

Vroom VH (1964) Work and motivation. Wiely, New York

Walker PL, Shenkir WG, Barton TL (2002) Enterprise risk management: pulling it all together. Institute of Internal Auditors Research Foundation, Altamonte Springs

Williams K (2005) How is your company managing risk? Strateg Finan 87(3):21–22

Wood GD, Ellis RCT (2003) Risk management practices of leading UK cost consultants. Eng Constr Arch Manag 10(4):254–262

Zhao X, Hwang BG, Yu GS (2013) Identifying the critical risks in underground rail international construction joint ventures: case study of Singapore. Int J Project Manag 31(4):554–566

Zhi H (1995) Risk management for overseas construction projects. Int J Project Manag 13(4):231–237

Chapter 8
Case Studies

Keywords ERM implementation · ERM ownership · ERM communication · Risk-aware culture · ERM framework

8.1 Introduction

This chapter presents case studies of the ERM implementation in three CCFs based in Singapore. They were large-, medium-, and small-sized firms, respectively, and participated in the Survey II. Table 8.1 shows the profile of the six interviewees who provided information for the three case studies. In addition to the interviews, their past documents, including the internal documents about ERM and the reports in the mass media, were also reviewed.

Also, this chapter presents the cross-case comparisons, which substantiated the association between ERM implementation and firm size as well as the key role of the parent companies in the ERM implementation of the overseas subsidiaries.

8.2 Case Study I: A Large-Sized CCF in Singapore

8.2.1 Background

Firm A was a Singapore-based subsidiary of Firm PA, which was a state-owned central enterprise and has been a listed corporation in the Shanghai Stock Exchange since 2009. By the end of 2010, Firm PA had established 16 overseas subsidiaries, including Firm A.

Since the foundation in 1992, Firm A has completed approximately 150 projects in Singapore. Firm A has been registered under CW01 (general building) with a financial grade of A1 and under CW02 (civil engineering) with a financial grade of B1 with the BCA. Hence, Firm A enjoyed unlimited tendering capacity in all types of building projects and had a tendering limit of S$40 million in civil engineering

X. Zhao et al., *Enterprise Risk Management in International Construction Operations*, DOI 10.1007/978-981-287-549-5_8

Table 8.1 Profile of interviewees for case studies

No.	Title	Experience	Firm	BCA grade	Firm size
1	Deputy director	16 years	Firm A	CW01 A1 CW02 B1	Large
2	Project manager	12 years			
3	Cost manager	5 years			
4	Project manager	14 years	Firm B	CW01 B1 CW02 B1	Medium
5	Project manager	9 years			
6	Director	31 years	Firm C	CW01 C3	Small

projects. In addition, Firm A attained a turnover of S$561 million in 2008, S$569 million in 2009, and S$677 million in 2010. Its net profits had doubled from S$10 million in 2008 to S$20 million in 2010. At the time of this study, Firm A had over 700 staff, over 4500 skilled workers, and four subsidiaries.

The board of Firm A consisted of six members, including the managing director (MD), who actually took charge of the business and operations of Firm A. The directors were also the senior executives. The chairman of Firm A was also the vice president of Firm PA and the general manager of the Overseas Business Department in the headquarters of Firm PA, which indicated that he took charge of the entire overseas business of Firm PA.

A deputy director, a project manager, and a cost manager were interviewed to collect information. The deputy director can attend the board meeting and monthly operating meetings presided over by the MD, while the project manager and cost manager would be involved in PRM. Thus, the three interviewees were involved in risk management practices at project and firm levels and competent to provide adequate and reliable information about ERM implementation in Firm A. In addition, information about the ERM practices in Firm A and Firm PA was collected from past documents, including internal documents about ERM and reports in the mass media. The internal documents, including operational and management manuals, were not marked confidential and were obtained through networking, while the reports were collected through reviewing the Web sites of Firm A and Firm PA.

8.2.2 Factors Affecting ERM Implementation

ERM implementation in Firm A was closely related to directions from its parent company. As a listed company and a state-owned central enterprise, Firm PA had to comply with the internal control rules in the Shanghai Stock Exchange as well as the Guidance to ERM for Central Enterprises promulgated by the SASAC in 2006. The SASAC is responsible for the supervision and administration of the existing state-owned central enterprises. The SASAC has already taken ERM implementation into the performance evaluation system of central enterprises. The recent huge losses in Saudi Arabia and Poland of central enterprises (China 2011; Cienski 2011) compelled the SASAC to intensively supervise central enterprises' investments outside of China and to push for ERM implementation in these enterprises. To comply with the requirements from the SASAC, Firm PA took the following steps:

1. In August 2007, Firm PA issued the ERM Implementation Plan (Trial);
2. In March 2008, Firm PA established an ERM leadership group, whose leader was the chairman of Firm PA, and the deputy leader was the vice president and the CFO;
3. In December 2008, Firm PA issued the Firm PA Guidance to ERM Implementation, which referred to the Guidance issued by the SASAC and replaced the ERM Implementation Plan (Trial);
4. In 2009, Firm PA issued the Guidance to ERM Implementation in Subordinate Enterprises of Firm PA; and
5. In 2009, ERM implementation was included in the Firm PA Internal Control Manual and its annual Sustainability Report.

These steps also drove the ERM implementation in Firm A, because the Firm PA Guidance to ERM Implementation requires all its subsidiaries to adopt ERM and report implementation status to the headquarters of Firm PA at the end of each year. Based on the ERM implementation in its subsidiaries, Firm PA developed a comprehensive annual report and submitted it to the SASAC. Hence, the ERM implementation in Firm A was directly driven by the compliance requirements from Firm PA and indirectly driven by the requirements from the SASAC. The ERMMI of Firm A was 0.407, as found in Survey II, indicating its ERM maturity was at the medium level.

Increasing and more complicated risks that Firm A faced were another factor that drove its ERM implementation. The recent European sovereign debt crisis and the uncertain political situation in the Middle East and North Africa would increase the volatility of prices of raw materials and bring about some uncertainties to the international construction market. The risks whose origins were perceptibly faraway from Singapore might also threaten the profitability and even the survival of the firms in Singapore. Although Singapore has a stable political situation, the firms should still emphasize risk management with the management having a strong risk-aware culture. Thus, Firm A implemented ERM to proactively control the risks within its risk appetite.

The compliance requirements from Firm PA and a broader scope of risks caused the board and senior management to encourage ERM implementation in Firm A. The chairman of Firm A was a member of the ERM leadership group in Firm PA and thus had commitment to ERM implementation. The other members of the board and senior management in Firm A were influenced by the chairman and were therefore committed to ERM implementation. The request and encouragement from the board and senior management drove the ERM implementation and ensured that risks were considered in strategic decision-making within the firm. The ERM implementation in Firm A was announced at an operating meeting.

According to the deputy director, the lack of perceived benefits of ERM would hinder ERM implementation. He explained that employees needed to perceive the underlying benefits to themselves and the firm, before the firm adopted ERM as a new risk management paradigm to complement the existing PRM practice. Otherwise, they would regard ERM implementation as an additional burden. In addition, he indicated that the chairman did not stay in Singapore and had to visit other overseas subsidiaries because he was in charge of the entire overseas business of Firm PA. However, the lack of the leadership of the chairman appeared to have little negative influence on ERM implementation in Firm A because the specific ERM implementation was led by the MD, who actually took charge of the business of Firm A.

8.2.3 ERM Ownership

In Firm A, the chairman was ultimately responsible for ERM, but the MD actually took charge of ERM. The board collectively made decisions concerning ERM. Because projects were the only revenue source, the board was involved in risk management at all stages of the projects that Firm A was engaged in, especially the large-scale ones. The decisions relating to tendering strategies, material procurement, and measures to deal with cost overrun were made by the board, because these decisions were related to not only project revenue, but also the profitability of the firm. For example, although the Department of Project Management was responsible for project tenders, the MD was the final decision maker of all tenders in Firm A. In addition, the project director indicated that he was empowered to deal with project cost overrun of no more than S$10,000. Any cost overrun more than S$10,000 needed to be reported to the headquarters of Firm A to obtain the approval. All the critical decisions were discussed at the operating meeting, at which macroeconomic risks were also discussed and analyzed.

There was not a position dedicated to ERM in Firm A, such as a CRO position. The ERM responsibility was actually included in the function of the MD. The active participation of the board contributed to the effectiveness of ERM. In addition, there was no specialized risk management department or risk management committee of the board in Firm A, even though the Firm PA Guidance to ERM Implementation suggested establishing such a department or committee in the subsidiaries. The Department of Safety in Firm A focused only on the management of safety risks. In reality, in the operations of Firm A, the board itself had served as a risk management committee and was involved in critical decision-making at both project and firm levels. The board also oversaw the entire risk profile of the firm and centralized the risk management practice of each project team. Moreover, it is worth reiterating that construction firms are project based and the construction projects that they are engaged in are their only revenue source. PRM was still emphasized in Firm A and was considered as a critical part of ERM. Each project had its own project team comprised of people with the necessary management skills and experience. The project team conducted PRM with the involvement of the board.

8.2.4 Risk Communication

Within Firm A, the monthly operating meeting acted as a platform for communicating risk information. The MD presided over such meetings. The board members, heads of all the departments, as well as project directors and managers of all the ongoing projects attended this meeting at the headquarters of Firm A. At this meeting, the progress status of the ongoing projects was reported to the board, which could thus have a clear perspective of the entire risk profile of the firm. Risk information collected from various sources was communicated at this meeting, and the decisions made by the board were notified to the leaders of the departments and projects. However, the interviewees explained that cost overruns or profits were not discussed at this meeting because such information was sensitive and considered as confidential and was only available to the directors and chief representatives from the headquarters. The costs of the projects that Firm A was engaged in were reviewed monthly. The cost information was directly reported to the headquarters of Firm A and discussed at the bimonthly cost meetings.

Besides the regular meetings, emails and telephone calls were the main communication methods across project teams and departments in Firm A. Although every computer in Firm A can access the Internet, there was neither an intranet in Firm A, nor a RMIS in place. In each project team or department, there was a local area network (LAN) for sharing documents, but communication between projects and departments greatly depended on emails and telephone calls. The interviewees deemed these methods as convenient and effective, because using these methods did not hinder Firm A from attaining an increasing turnover.

Firm A was supervised by Firm PA and had to report its operational status to Firm PA to account for all its losses or profits every year. In order to ensure the accuracy of the annual reports and to implement internal controls, Firm PA audited Firm A twice a year. Such internal audits from Firm PA began in 2006, just after the SASAC issued the Guidance. The Guidance suggested that an enterprise's audit department should audit all the departments, business units, and subsidiaries of the enterprise at least once a year (SASAC 2006). In this context, the control of Firm PA over Firm A was relatively strong because the chairman of Firm A was also the vice president of Firm PA.

Firm PA cooperated with several consulting companies to analyze both the domestic and international macroeconomic situations, identify the macroeconomic risks, and develop relevant risk response measures. Firm PA also collected the risks identified by most of its subsidiaries. Based on all the available information, Firm PA identified the major risks. All the risks identified, the response plans for the major ones, as well as the lessons learned were issued to all the subsidiaries in the forms of the Annual ERM Report of Firm PA (confidential) and the Risk Monitoring and Analysis Report.

To ensure the effectiveness and efficiency of risk communication, Firm PA provided a glossary of risk terms in the Guidance to ERM Implementation. This glossary included explanation of 27 risk terms that would frequently be used in risk communication and would facilitate forming a common risk language. As the deputy director and project manager revealed, these risk terms were understood by the middle and senior management, and widely communicated at operating meetings. However, the cost manager indicated that he was not unfamiliar with the risk language because this risk language was seldom used on the site.

8.2.5 Risk-Aware Culture

In the Firm PA Guidance to ERM Implementation, the risk-aware culture was defined as the attitudes, values, and behavior toward risks created in the firm's operations based on the corporate risk philosophy and corporate culture. The guidance emphasized creating the risk-aware culture and incorporating the culture into the corporate culture. The deputy director and project manager indicated that Firm A had cultivated a risk-aware culture through training and instituting clear accountability.

Firm A emphasized training its staff and workers. The staff from middle management (e.g., project directors and managers) to frontline managers (e.g., quantity surveyors and engineers) needed to attend various training courses held inside or outside Firm A. The workers employed by Firm A needed to accept safety training before working on-site. These training programs, which served as an organizational learning mechanism, involved the staff at middle and lower levels and the workers on-site and helped to embed risk awareness into the minds of the staff and workers.

Besides training programs, accountability also facilitated cultivating the risk-aware culture in Firm A. At the senior level, ERM implementation was included in the KPIs of the executives. Firm PA identified the KPIs, and reviewed and assessed the attainment of the KPIs. To attain the KPIs, the senior executives had high-level risk awareness, and the MD made decisions for project tenders. At the middle level, project directors and managers signed accountability pledges, which clearly announced their responsibility for achieving safety, cost, quality, and schedule objectives, and linked their bonuses to these objectives. Failure to attain safety, cost, and schedule objectives would lead to reduction in bonuses, while surpassing the objectives or getting BCA rewards can bring about additional performance bonuses. Thus, the accountability pledges made project directors and managers aware of potential risks and contributed to high-level risk awareness among the middle management. Hence, the accountability established in Firm A motivated the management at senior and middle levels to be vigilant against risks and to consider risks in decision-making.

8.2.6 ERM Framework

The ERM framework in the Firm PA Guidance to ERM Implementation included the following components: initial risk information collection, risk identification and evaluation, response plan for major risks, risk response plan implementation, risk management review and improvement, RMIS establishment, and risk-aware culture creation. However, not all the components had been fulfilled in Firm A.

Firm A collated risk information from all available sources, and this risk information helped to identify potential risks. Firm A had a risk checklist, which listed the strategic risks and the potential risks they had identified in previous projects. This risk checklist was reviewed every year, and some new risks were added. The renewed risk checklist was then reported to Firm PA. After collecting the risks identified by its subsidiaries, Firm PA identified the major risks. By the end of 2010, Firm PA had identified 1314 risks, among which 280 risks occurred in 2010. 94 out of the 280 risks were new risks. Finally, Firm PA identified six major risks in 2010: (1) macroeconomic risks; (2) strategic management risks; (3) investment risks; (4) receivables risks; (5) overseas operational risks; and (6) quality and safety risks. All the risks identified, the response plans for the major ones, as well as the lessons learned were issued to all the subsidiaries in the forms of the Annual ERM Report of Firm PA (confidential) and the Risk Monitoring and Analysis Report. Firm A then updated its checklist by using the information from Firm PA at the beginning of the year.

Instead of using software to evaluate risks, Firm A depended on experience and subjective judgments to analyze risks. However, Firm A had to be more serious in safety and health risks for the compliance with the Workplace Safety and Health (Risk Management) Regulations in Singapore, which stipulated that a record of risk assessment should be kept for at least three years (MOM 2006b). The Ministry of Manpower (MOM) of Singapore proposed risk assessment guidelines, where risk assessment included three steps: hazard identification, risk evaluation, and risk control (MOM 2006a). The guidelines also recommended using a risk matrix to evaluate the risk level based on the severity and likelihood (MOM 2006a), which still depended on experience and subjective judgments.

Most decisions for developing and implementing risk response plans were made by the senior executives, who were very experienced in dealing with risks in the international construction market. For instance, the volatility of construction material prices is a critical risk in the macroeconomic environment. Once aware of the upward trend of the prices, the top management would decide to enter into contracts or agreements with suppliers to keep the continuity of material supplies for one to two years in order to hedge the price fluctuation risks. In addition, Firm PA also provided guidance to risk response, which contributed to better informed decisions in Firm A. For instance, Firm PA issued the Guidance to Engineering Contract Review Risk Management in December 2010, which identified the potential risks in contract review and tendering decision-making, provided optional risk response measures, and thus improved decision-making in tendering.

Although the deputy director stated that Firm A had risk appetite and tolerance, he could not clearly point out the specific tolerance of each risk, indicating that the risk appetite and tolerance were not clearly expressed. Moreover, if Firm A did not win sufficient project contract values according to the KPIs, it would tender with a very low price to win the project in order to fulfill the KPIs set by Firm PA. Such tendering decisions would overlook some risks and exceed the risk tolerance.

Firm A reviewed its ERM every year and reported the review results and plans for improvement to Firm PA. ERM implementation in Firm A was also reviewed and audited by Firm PA twice a year. The Risk Monitoring and Analysis Report issued by Firm PA also provided lessons of some successful risk management practices in other subsidiaries, which would help Firm A to improve its ERM implementation.

The Firm PA Guidance to ERM Implementation recommended establishing a RMIS for collecting, storing, analyzing, and communicating risk information, but Firm A did not have such a system. Risk-aware culture is also an important component in the ERM framework in Firm A. Firm A had created a risk-aware culture through training programs and accountability, and such a risk-aware culture surfaced risks for consideration in decision-making.

8.3 Case Study II: A Medium-Sized CCF in Singapore

8.3.1 Background

Firm B was founded in Singapore in 2006 and registered as a B1 contractor under the workheads of CW01 and CW02. Hence, this firm had a tendering limit up to S$40 million in general building and civil engineering projects. Firm PB, as the parent company of Firm B, was a state-owned enterprise administered by a provincial government, but not a central enterprise. Firm PB started to contract overseas construction projects in 1992 and had 12 overseas subsidiaries or branches over the world, including Firm B. At the time of this study, Firm B had over 200 staff and over 1000 skilled workers. The board consisted of five directors, and the MD took charge of the business and operations of Firm B.

The interviewees were two project managers. In Firm B, project managers were at the same hierarchy as the department manager. They directly reported to the deputy MD, who was a director and took responsibility to oversee all the construction projects that Firm B was engaged in. In addition, the interviewees can attend the regular meetings, which were held in the headquarters of Firm B and presided over by the MD. This allowed them to be informed of the latest decisions and the operation and business status of Firm B, and to participate in the risk management practices at the firm level. Thus, the interviewees were competent to provide reliable information for this study. Also, the relevant information was collected from the internal documents and reports relating to risk management.

8.3.2 Factors Affecting ERM Implementation

As the interviewees indicated, the parent company, Firm PB, had initiated a formal ERM program and developed the specific plan for ERM implementation in 2008. After the disclosure of the huge losses of China Railway Construction Corporation

Limited in Saudi Arabia (China 2011), Firm PB issued a Guidance to Overseas Project Risk Management in 2011, with the help of an external consultant. However, this guidance focused on PRM rather than ERM and thus had limited influence on the ERM in Firm B. Firm PB did not require ERM implementation in its overseas subsidiaries or branches although Firm PB set business objectives for its subordinates. Thus, Firm B did not have a formal ERM program although it had regular PRM practices, which implied that Firm B had informal and immature ERM practices. This was confirmed by the finding of Survey II that the ERMMI of this firm was 0.310, at the low level.

As for the factors that would drive ERM implementation, one interviewee focused on the potential benefits of ERM. He believed that it would be easier for ERM to be adopted by a company if ERM can demonstrate significant economic benefits that can exceed the costs associated with it. Meanwhile, the other interviewee indicated that the executives would adopt ERM if it can facilitate the achievement of project objectives and KPIs, which was among the primary concern of the project management staff. Thus, both interviewees paid attention to the potential benefits brought about by ERM implementation. Additionally, both of them revealed that the top management should be convinced of the potential benefits of ERM and agree to support ERM implementation. Without the support and commitment from the senior level, no new program can be initiated in Firm B.

Moreover, one interviewee said that the existing risk management practices were adequate and effective because Firm B seldom suffered losses in the Singapore construction market and that the management would not look for trouble to change these existing practices with a new set of management practices that went together with additional costs and administration. Hence, such confidence in the existing PRM practices would hinder the ERM initiation and made the staff perceive ERM as the source of additional costs and administration. More importantly, the top management did not show any intent to initiate an ERM program.

8.3.3 ERM Ownership

Under the existing risk management system, project managers were responsible for the management of project risks, suggesting that they were project risk owners. In most cases, project managers were empowered to determine the response measures for the ordinary risks, while they still needed to obtain the senior-level approval on the proposed response plans for the critical risks or those difficult to deal with.

At the firm level, as there was not a formal ERM program in Firm B, neither a position nor a stand-alone department dedicated to ERM implementation was established. As the MD was responsible for the business and operations of Firm B, the function of MD included the risk management responsibility.

8.3.4 Risk Communication

As the interviewees indicated, risk information was communicated across the firm at the regular meetings held every month in the headquarters. All the directors, project managers, and department managers attended these meetings, at which project managers also reported the construction progress and the cost status of the ongoing projects as well as the risk information collected from various sources.

In addition, emails and telephone calls were still the main and timely communication methods across the firm. Although there was not a RMIS that served as a platform for risk communication in Firm B, Firm PB set up a RMIS that focused on legal risk management in 2012. From 2013 on, all the subsidiaries and branches of Firm PB, including Firm B, would report the information relating to legal and contract risks to Firm PB via the RMIS every month. According to the interviewees, it was not necessary to set up a RMIS or buy software for risk communication in Firm B because it was not economical and the staff had been used to the traditional communication methods.

Moreover, Firm B needed to report its business and operations status to Firm PB on a quarterly basis, and Firm PB assigned the staff to audit Firm B every year to conduct internal control, as the ERM implementation plan of Firm PB required. Firm PB built up a risk information database, with the help of external consultants. This database consisted of risk checklists specifically for contracting projects in different overseas regions in the international market and a risk analysis model. Meanwhile, this database was accessible to the relevant staff of Firm B, which enabled them to identify risk in Singapore.

In the Guidance to Overseas Project Risk Management issued by Firm PB, there was a glossary of the risk terms that were frequently used in PRM, but not ERM. However, the interviewees indicated that Firm B had no specialized training programs on the guidance. Thus, the staff would learn and understand these risk terms from their own perspectives, and no consensus on the risk terms had been reached. Thus, this glossary of risk terms contributed little to the creation of a common risk language that should be used in risk communication across the firm.

8.3.5 Risk-Aware Culture

As the interviewees indicated, the primary concern of the top management was to ensure the attainment of the objectives set by Firm PB and no safety accidents. Also, the bonuses of management staff were closely associated with the project profitability, which was among the KPIs of the project management staff. From the perspective of the interviewed project managers, the risk awareness of project management staff mainly resulted from the pressures to achieve the project objectives and attain the KPIs because such pressures linked the economic interests of the staff to the project profitability that was associated with the firm profitability.

However, training programs did not play a key role in creating a risk-aware culture. Except the compulsory safety training, there was no formal training program for risk awareness cultivation.

8.3.6 ERM Framework

Firm B did not have a formal ERM program and thus did not adopt any existing ERM framework. Although some risk management practices were consistent with the fundamentals of ERM, their current risk management practices were more like PRM. According to the Guidance to Overseas Project Risk Management, Firm B had adopted a formal PRM process, consisting of risk identification, analysis, and response. However, the interviewees stated that Firm B did not have clearly defined its risk appetite and tolerance although they believed that the top executives had risk appetite in their mind. In addition, Firm B did not have a set of KRIs to help the relevant staff to proactively manage risks.

As for risk identification, the staff in Firm B collected risk information from various sources and merged this information at the regular meetings. Also, they can obtain risk information from the risk information database of Firm PB. With this information, discussions were made with the involvement of top management, and a risk checklist was developed. The risks in the checklist consisted of both project risks and external risks, but did not include strategic risks, which was not consistent with the ERM requirements. The risk checklist would be updated when new risks were identified, when accidents occurred, or when the risk information database in Firm PB was updated.

In terms of risk analysis, no risk management software and model was adopted to analyze risk. As the interviewees indicated, the relevant staff in Firm B estimated the likelihood of occurrence and the magnitude of impact of the risks in the checklist according to the experience or subjective judgments, resulting in a risk matrix that described the risk priority. In addition, the analysis of safety and health risks was documented to comply with the Workplace Safety and Health (Risk Management) Regulations in Singapore. If the likelihood of occurrence and the magnitude of impact of a risk had been discussed at a regular meeting, the risk analysis should have been recorded in the meeting summary. However, the analysis of other risks was not formally recorded for review.

In Firm B, project managers, as the owners of project risks, were empowered to determine the response measures for the risks that were not very critical. However, the response measures for the critical risks were discussed at the regular meetings and finally decided by the MD. For example, the rise in foreign worker levies was seen as a critical risk because most CCFs in Singapore employed foreign workers rather than local workers and this risk would have ripple effects on project cost and schedule. Project managers cannot determine the response measures for such a risk, and the senior executives were involved to propose the response measures, which included collaborating with multiple labor suppliers, employing skilled workers, and raising the productivity on-site.

Firm B did not need to submit an ERM report to Firm PB, while Firm PB did not report its ERM implementation to the provincial government. Thus, Firm B did not regularly review and improve its risk management practices unless accidents or losses occurred.

8.4 Case Study III: A Small-Sized CCF in Singapore

8.4.1 Background

Firm C was a Singapore-based subsidiary of Firm PC. Firm PC was a state-owned enterprise administered by a municipal government, but not a central enterprise. Firm C was relatively independent from its parent company. Thus, Firm C did not have to report its operations status to Firm PC, and Firm PC did not interfere with the business of Firm C. However, Firm C had to give overhead expenses to Firm PC because its staff would obtain pensions from Firm PC after their retirement.

Despite the early entry into Singapore in 1996, Firm C was registered as a CW01 C3 contractor under the BCA contractor registry system. Hence, this firm had a tendering limit up to S$0.65 million in general building projects. However, it should be noted that the BCA contractor registry functions as an administrative body only for the public sector procurement. Thus, Firm C can contract private projects without limits. Actually, Firm C only served as subcontractors under the main contractors with whom they had long-term collaboration. At the time of this study, Firm C had around 30 staff, over 1000 skilled workers, and no subsidiaries in Singapore. Additionally, the MD of Firm C took charge of the business and operations.

The interviewee was a director with 31 years of work experience. He came to Singapore and joined Firm C in 1996 when it was founded. As Firm C was small, the interviewee also served as a project manager and participated in important decision-making processes at the firm and project levels. Thus, the information provided by the interviewee can be seen as reliable.

8.4.2 Factors Affecting ERM Implementation

Although the interviewee had heard of ERM, he indicated that Firm C did not formally initiate a formal ERM program. According to the interviewee, it was not cost-effective to formally initiate an ERM program in Firm C because this firm was a small company that only acted as a subcontractor and most critical risks can be controlled or avoided through the long-term collaboration with main contractors. However, he believed that ERM was informally implemented across the firm.

As Firm PC was neither a central enterprise nor a listed company, it did not need to comply with the internal control rules and the guidance issued by the SASAC. In addition, the executives of Firm C were not required to initiate an ERM program by its parent company. Thus, the interviewee considered the lack of the senior-level request or encouragement as an important hindrance to ERM implementation in Firm C. Without such request, no resources would be invested in ERM and the staff would have no motivation to contribute to ERM implementation.

Although Firm C did not have a formal ERM program, the interviewee believed that informal risk management could bring about benefits and helped assure the achievement of corporate and project objectives. As an integral part of ERM, PRM was emphasized because projects were the revenue sources of Firm C. More profits or bonuses would be obtained if the project objectives were fulfilled or over fulfilled. Such economic benefits drove the staff to conduct PRM, which would also contribute to ERM implementation.

8.4.3 ERM Ownership

As the interviewee indicated, the majority of risks were faced in projects, rather than in company operation processes. In Firm C, project managers were responsible for the management of project risks, while the Department of Safety focused on the management of safety risks. According to the interviewee, all the project managers in Firm C were very experienced in dealing with various issues in the construction of projects. In addition, the MD was involved in decision-making relating to risk management at both company and project levels and was the final decision maker of project tenders. In addition, the interviewee believed that neither a position nor a stand-alone department dedicated to ERM was necessary for Firm C. The MD subconsciously served as the ERM owner, as there was no formal ERM implementation.

8.4.4 Risk Communication

In Firm C, there were quarterly meetings held in the headquarters. All the executives, project managers, and department managers attended such meetings. Risk information and the construction progress of the ongoing projects were reported at the meetings. Besides the formal communication channel, emails and telephone calls were the main communication methods across project teams and departments and there was neither an intranet nor a RMIS in Firm C. In addition, Firm C did not need to report the status of its operation or ERM implementation to Firm PC, and Firm PC did not audit Firm C periodically. Hence, the communication between Firm C and Firm PC was inadequate.

8.4.5 Risk-Aware Culture

As the interviewee indicated, most of the experienced staff in Firm C had risk awareness, and the executives identified and analyzed potential risks before tendering. These potential risks were mainly technical and safety risks because they were closely related to the achievement of project objectives. Credit risks of main contractors could be avoided through bidding for the projects, of which the main contractors were the business partners of Firm C. In addition, safety training was compulsory for all the new staff and workers and helped to instill safety awareness into their minds. Except the safety training, there were no formal training programs to cultivate risk awareness in Firm C. However, at the project level, the risk awareness of the staff was produced by the project performance assessment system in Firm C. The bonuses of the project staff were closely linked to the fulfillment of project objectives and profits. Thus, this performance assessment system rendered the staff aware of risks and facilitated the risk-aware culture in Firm C. However, this was different from using accountability to cultivate the risk-aware culture because of the lack of clear staff accountability statement in Firm C.

8.4.6 ERM Framework

Because Firm C did not initiate a formal ERM program, it did not adopt any existing ERM framework or formal risk management process. Moreover, although the interviewee indicated that Firm C had risk appetite and tolerance, they were not explicitly defined and specified.

As the interviewee indicated, Firm C did not have a formal risk checklist for risk identification. However, he believed that only safety and technology risks should be emphasized. Interestingly, the material price risks were not seen as critical because it was usually borne by the main contractors who procured materials from suppliers. Even if Firm C procured materials, they accepted the market price because the quantity was not large. In addition, strategic risks were not carefully considered because Firm C focused only on the short-term profits, rather than the long-term growth.

Firm C analyzed safety risks using the techniques recommended by the MOM (2006a, b) and depended on the experience of project managers to analyze technical risks. The risk response measures were discussed at the quarterly meetings where the senior management provided advice and comments. The final risk response measure was proposed by the project manager who was the owner of the risk and should be approved by the MD. However, the risk management practices were not periodically monitored and reviewed, which made Firm C lose the opportunities for improving its risk management practices. Moreover, the risk management activities were not documented, and the lessons cannot be learned.

8.5 Cross-Case Comparisons and Discussions

Comparisons were conducted to explain the differences and similarities in ERM implementation between the three cases (see Table 8.2). Only Firm A has formally initiated an ERM program although it was still at its infancy stage. Although Firm B and Firm C did not have formal ERM implementation, some of their risk management practices were consistent with the ERM fundamentals.

8.5.1 Factors Affecting ERM Implementation

In Firm A, the ERM implementation was primarily driven by the requirements from its parent company, Firm PA. Among the parent companies of the three case study firms, Firm PA was the only state-owned central enterprise and the only listed company. Thus, in order to meet the compliance requirements from the SASAC and the Shanghai Stock Exchange, Firm PA compelled its subsidiaries, including Firm A, to implement ERM.

In comparison, Firm PB and Firm PC were not listed companies and were administered by either provincial or municipal governments, which had not promulgated the regulations relating to ERM. Not faced with the requirements from the authorities, Firm PB and Firm PC did not compel Firm B and Firm C to formally implement ERM, respectively. Thus, this result echoed the finding of Survey II that the driver "legal and regulatory compliance requirements" obtained a high score and rank in the medium-maturity CCFs, most of which were large CCFs.

In addition, as a large-sized firm, Firm A was faced with increasing and more complicated risks as well as the higher likelihood to suffer losses. ERM can help it reduce losses in a proactive manner. Actually, the SASAC tried to promote ERM implementation due to a series of huge losses in the overseas subsidiaries of the central enterprises. Thus, the primary intent of the SASAC for ERM implementation was to avoid losses and protect the state-owned assets. This intent was also shared with Firm B, although it had no formal ERM program.

In terms of the hindrances, lack of perceived benefits hindered ERM implementation in Firm A because few tangible benefits resulted from the ERM implementation at the early stage. In comparison, Firm B still focused on PRM rather than the holistic approach, i.e., ERM. The staff in Firm B were confident in the existing PRM practices and tended to believe that ERM increased costs and administration. To shake the mind-sets on PRM, the top management should provide visible commitment and support to ERM. However, neither Firm B nor Firm C had such tone at the top, because of the lack of pressure from their respective parent companies.

Table 8.2 Cross-case comparisons

Case study firm	Firm A	Firm B	Firm C
Parent company	Firm PA, a state-owned central enterprise administered by China's central government and listed in the Shanghai Stock Exchange	Firm PB, a state-owned enterprise administered by a provincial government	Firm PC, a state-owned enterprise administered by a municipal government
BCA grade	CW01 A1; CW02 B1	CW01 B1; CW02 B1	CW01 C3
Firm history	20 years	7 years	16 years
Formal ERM	Yes	No	No
Drivers for ERM	Requirements from Firm PA	Potential economic benefits of ERM	None
	Increasing and more complicated risks		
	Request and encouragement from the board and senior management		
Hindrances to ERM	Lack of perceived benefits of ERM	Confidence in the existing risk management practices	Lack of commitment of the top management
		Increased additional costs and administration	
		Lack of commitment of the top management	
ERM ownership	The MD took the responsibility for ERM implementation	No ERM owner	No ERM owner
	The board itself had served as a risk management committee and oversaw the corporate risk profile	The MD was involved in decision-making relating to risk management at both company and project levels	The MD was involved in decision-making relating to risk management at both company and project levels
Risk communication	Communicate through monthly meetings, emails, and telephone calls	Communicate through monthly meetings, emails, and telephone calls	Communicate through quarterly meetings, emails, and telephone calls
	No RMIS	No RMIS	No RMIS
	Firm A reported to Firm PA every year, and Firm PA audited Firm A every half a year	Firm B reported to Firm PB quarterly, and Firm PB audited Firm B once a year	Firm C did not report to Firm PC, and Firm PC did not audit Firm C
	Firm PA collected various risk information, developed the response plans for the major risks and summarized the lessons learned every year, and shared these with Firm A	Firm PB built up a risk information database, containing risk checklists for contracting overseas projects and accessible to the relevant staff of Firm B	No common risk language
	Firm PA provided a glossary of risk terms, and a common risk language was used at the senior and middle levels	Firm PB provided a glossary of risk terms but no common risk language was created or used	

(continued)

Table 8.2 (continued)

Case study firm	Firm A	Firm B	Firm C
Risk-aware culture	Risk-aware culture was created through training programs and instituting clear accountability	The risk awareness of project management staff was mainly a result of the pressures to achieve the project profitability	The risk awareness of project management staff was mainly a result of the pressures to achieve the project profitability
	Training programs were provided for staff at all levels in Firm A		
	ERM implementation was included in the KPIs of the senior executives	Except the compulsory safety training, no formal training program was provided for risk awareness cultivation	Except the compulsory safety training, no formal training program was provided for risk awareness cultivation
	Project directors and managers signed accountability pledges		
ERM framework	Firm A adopted the ERM framework recommended by Firm PA	Firm B adopted the formal PRM process recommended by Firm PB	Have no formal risk management process
	No clearly defined risk appetite and tolerance	No clearly defined risk appetite and tolerance	No clearly defined risk appetite and tolerance
	No formalized KRIs	No formalized KRIs	No formalized KRIs
	Have a risk checklist including strategic risks	Have a risk checklist excluding strategic risks	Have no formal risk checklist
	Regularly review and update the risk checklist	Regularly review and update the risk checklist	Focusing only on safety and technology risks
	Depend on experience and subjective judgments to analyze risks	Depend on experience and subjective judgments to analyze risks	Firm C analyzed safety risks using the techniques recommended by the MOM and depended on experience to analyze technology risks
	The senior executives discussed and determined risk response measures, referring to the guidance to risk response issued by Firm PA	The senior executives determined risk response measures	The senior executives determined risk response measures
	Firm A reviewed its ERM every year and reported the results and plans for improvement to Firm PA		

8.5.2 ERM Ownership

As for the ERM ownership, in Firm A, the ERM responsibility was included in the function of the MD and the board of Firm A oversaw the entire corporate risk profile and centralized the risk management practices across project teams and departments. Although previous studies recommended creating a CRO position (Beasley et al. 2005; Cendrowski and Mair 2009; Lam 2003; Liebenberg and Hoyt 2003; Pagach and Warr 2010), it appeared that the lack of a CRO position and a stand-alone ERM department did not negatively influence ERM implementation in Firm A. By contrast, Firm B and Firm C had no ERM owners. However, their top management was involved in decision-making relating to risk management at both company and project levels. In addition, in all the three firms, project managers took the responsibility for the management of project risks, indicating that they appointed project managers as the project risk owners. These practices were consistent with some of the ERM best practices.

8.5.3 Risk Communication

In terms of internal risk communication, the three case study firms had similar practices. All of them communicated risk information through regular meetings, emails, and telephone calls. The frequencies of meetings were monthly in Firm A and Firm B, but quarterly in Firm C. However, none of them had a RMIS in place, which confirmed the finding of Lu et al. (2009) that the ICT applications for construction management and decision-making were limited in CCFs in the international market.

As for the communication between subsidiaries and parent firms, Firm A reported their operations status to Firm PA every year and Firm PA audited Firm A every six months. Firm B reported its operations status to Firm PB quarterly, and Firm PB audited Firm B every year. Thus, the frequencies of the reporting and auditing between parent firms and subsidiaries were different between Firm A and Firm B. The more frequent audit from Firm PA represented the stronger control of Firm PA over the business and operations of Firm A. Such control was also strengthened by appointing the vice president of Firm PA as the chairman of Firm A. Additionally, Firm PA and Firm PB shared risk information with Firm A and Firm B, respectively. Specifically, Firm PA collated risks information from various subsidiaries, developed the response plans for the major risks, summarized the lessons learned every year, and shared these with Firm A. Firm PB built up a risk information database, which contained risk checklists for contracting projects in different overseas regions and was accessible to the relevant staff of Firm B. In comparison, Firm C was relatively independent of its parent firm, and thus, there was a lack of reporting, auditing, and risk information sharing mechanisms between Firm C and Firm PC.

Firm PA and Firm PB issued a glossary of risk terms to Firm A and Firm B, respectively, which could facilitate the creation of a common risk language (Espersen 2007). In Firm A, a risk language had been created and used in the communication at the monthly operating meetings. In comparison, most of the risk terms in the glossary for Firm B were associated with PRM rather than ERM, and the management staff did not have a common understanding of the risk terms because there were no training programs on risk management. Thus, in fact, a common risk language was neither created nor used in Firm B.

8.5.4 Risk-Aware Culture

To cultivate a risk-aware culture, Firm A provided training programs for the staff at all levels and established clear accountability for the senior and middle management staff. The training programs involved all levels of staff in creating the risk-aware culture and can be seen as an organizational learning mechanism. This was consistent with the viewpoint of Hopkin (2010) that the involvement of organizational individuals and organizational learning was an approach to creating a risk-aware culture. Also, the clear accountability made the senior and middle management vigilant against risks during decision-making. This practice agreed with AON (2010), which recommended instituting clear accountability as a successful approach to creating the risk-aware culture. Compared with Firm A, Firm B and Firm C had no formal training programs for creating risk awareness, except the compulsory safety training. In addition, in these two firms, the risk awareness of project management staff mainly resulted from the pressures to achieve the project profitability, which was closely related to the firm profitability.

8.5.5 ERM Framework

As for the ERM framework, Firm A adopted the framework recommended by Firm PA. In comparison, Firm B and Firm C did not adopt any ERM framework. Instead, Firm B used the PRM process recommended by Firm PB, while Firm C did not have a formal risk management process.

In addition, none of the three firms had clearly defined risk appetite and tolerance. In CCFs, risk appetite and tolerance may vary according to their real-world circumstances. For instance, at the end of each year, CCFs may risk tendering with a low price to fulfill the annual KPIs related to the contract amount set by the parent firm.

Since risk identification, analysis, and response are the three most critical steps in various ERM frameworks, this section focuses on the differences and similarities in these three steps among the three firms. As for risk identification, both Firm A and Firm B used risk checklists and regularly review and update them.

The difference lied in that the former included strategic risks in the checklist, while the latter did not because the latter did not formally initiate an ERM program. In comparison, Firm C, usually serving as a subcontractor, did not have a risk checklist and focused only on safety and technology risks. In addition, although Firm A and Firm B had risk checklists, they did not develop a set of KRIs, which was the same with Firm C. The lack of KRIs would hinder these firms from dealing with risks in a proactive manner because the KRIs can help monitor risks and have predetermined thresholds (Beasley et al. 2010).

In terms of risk analysis, all the three case study firms adopted the techniques recommended by the MOM to analyze safety risks and depended on experience and subjective judgments to analyze risks. This was consistent with the findings of previous studies that most risk management practices in the construction industry depended on experience and subjective judgments (Kartam and Kartam 2001; Thevendran and Mawdesley 2004; Wang and Yuan 2011), instead of using the relevant risk analysis software.

In the case of risk response, in Firm A, the senior executives determined the response measures with references to the guidance to risk response provided by Firm PA. In Firm B and Firm C, such references from parent firms were not available, and their senior executives selected the response measures according to their experience and subjective judgments.

Among the three firms, only Firm A reviewed its ERM every year and developed plans for improvement. The review results and plans for improvement were included in the annual ERM report, which was submitted to Firm PA at the beginning of each year. Firm A also referred to the successful practices in other subsidiaries, which were collected by Firm PA, to improve the ERM practices. In comparison, Firm B and Firm C did not regularly review and improve their risk management practices.

8.5.6 Implications

Some implications can therefore be drawn from the cross-case comparisons. Firstly, the comparisons implied that firm size influenced ERM implementation, thus confirming the finding of Survey II that there was association between ERM maturity and firm size.

Secondly, the comparisons implied that the ERM implementation in Singapore-based CCFs was influenced by their respective parent companies. Because the parent companies of the large-sized CCFs in Singapore were either central enterprises or listed companies, they needed to implement ERM to comply with the requirements from the SASAC and the stock exchanges, thus driving their subsidiaries to initiate formal ERM programs. The requirements from the parent companies can result in the requests for and commitment to ERM implementation from the top management in the overseas subsidiaries. By contrast, parent companies of Firm B and Firm C were neither central enterprises nor listed companies;

hence, they did not face regulatory requirements and did not have similar senior-level requests and commitment.

Even if medium and small CCFs did not have formal ERM implementation, they may still have some practices consistent with the ERM fundamentals. For instance, Firm B had formal PRM implementation, while Firm C managed safety risk with the reference to the guidelines issued by the MOM. These practices were more or less consistent with the ERM fundamentals. In these firms, the formal ERM programs could be initiated based on these existing risk management practices.

8.6 Summary

Based on the information collected from interviews and past documents, the three case studies uncovered how ERM was actually implemented in three Singapore-based CCFs, in terms of the influential factors, ERM ownership, risk communication, risk-aware culture, and ERM framework or processes. Also, cross-case comparisons were performed, and the results implied that there was association between ERM implementation and firm size, that the parent firms influenced the ERM implementation in their subsidiaries in Singapore, and that some practices of these case study firms were consistent with the ERM fundamentals, regardless of their ERM implementation status.

References

AON (2010) Global risk management survey 2010. AON plc, Chicago

Beasley MS, Clune R, Hermanson DR (2005) Enterprise risk management: an empirical analysis of factors associated with the extent of implementation. J Acc Public Policy 24(6):521–531

Beasley MS, Branson BC, Hancock BV (2010) Developing key risk indicators to strengthen enterprise risk management. ERM Initiative at North Carolina State University and the Committee of Sponsoring Organizations of the Treadway Commission, Raleigh, NC

Cendrowski H, Mair WC (2009) Enterprise risk management and COSO: a guide for directors, executives, and practitioners. Wiley, Hoboken

China (2011) Head office takes over CRCC's light rail project, Beijing. http://www.china.org.cn/business/2011-01/22/content_21798050.htm. Retrieved 13 July 2011

Cienski J (2011) China group sees collapse of Poland ambitions. Financ Times Warsaw Pol. http://www.ft.com/intl/cms/s/0/d17dda5a-96b7-11e0-baca-00144feab49a.html#axzz1Tgz4hTH5. Retrieved 31 July 2011

Espersen D (2007) The language of risk: organizations can improve risk management and audit processes by communicating risks in terms that everyone understands. Intern Auditor 64 (3):69–73

Hopkin P (2010) Fundamentals of risk management. Kogan Page, London

Kartam NA, Kartam SA (2001) Risk and its management in the Kuwaiti construction industry: a contractors' perspective. Int J Proj Manage 19(6):325–335

Lam J (2003) Enterprise risk management: from incentives to controls, Wiley, Hoboken

Liebenberg AP, Hoyt RE (2003) The determinants of enterprise risk management: evidence from the appointment of chief risk officers. Risk Manag Insur Rev 6(1):37–52

Lu W, Li H, Shen L, Huang T (2009) Strengths, weaknesses, opportunities, and threats analysis of Chinese construction companies in the gobal market. J Manage Eng 25(4):166–176

MOM (2006a) Workplace safety and health risk management: risk assessment guidelines. Ministry of Manpower, Singapore

MOM (2006b) A guide to the workplace safety and health (risk management) regulations. Ministry of Manpower, Singapore

Pagach DP, Warr RS (2010) The effects of enterprise risk management on firm performance. North Carolina State University, Raleigh

SASAC (2006) Guidance to enterprise risk management for central enterprises. State-owned Assets Supervision and Administration Commission of the State Council of China, Beijing

Thevendran V, Mawdesley MJ (2004) Perception of human risk factors in construction projects: an exploratory study. Int J Proj Manage 22(2):131–137

Wang J, Yuan H (2011) Factors affecting contractors' risk attitudes in construction projects: case study from China. Int J Proj Manage 29(2):209–219

Chapter 9
Developing a KBDSS for ERM in CCFs

Keywords Knowledge-based decision support system (KBDSS) · Action plans · Knowledge base · Graphical user interface · Decision support engine · Case testing

9.1 Introduction

Following the introduction to the background information of knowledge-based decision support systems (KBDSSs), this chapter presents the development of the KBDSS for ERM in CCFs. This KBDSS intends to assess the ERM maturity, visualize the ERM maturity assessment results, provide action plans for improving ERM practices along the maturity continuum, and generate a printable ERM maturity assessment report. The KBDSS consists of three main components: a knowledge base, a graphical user interface (GUI), and a decision support engine (DSE). The knowledge base contains the ERM maturity criteria, the ERM best practices applicable in CCFs, and the action plans for improving the implementation of the ERM best practices, while the DSE computes the maturity scores, visualizes the results, selects the appropriate action plans for users, and generates a printable assessment report. The action plans for improving ERM implementation were acquired from the comprehensive literature review and the interviews with practitioners. Microsoft Visual Basic 2010 was used to develop the KBDSS. In addition, this chapter uses a hypothetical example to demonstrate how the KBDSS works, and validates the KBDSS with the views garnered from five industry experts. Thus, the fifth research objective, "develop a KBDSS that can assess the ERM maturity level of CCFs and provide recommendations to improve ERM implementation along the maturity continuum," was fulfilled.

X. Zhao et al., *Enterprise Risk Management in International Construction Operations*, DOI 10.1007/978-981-287-549-5_9

9.2 Background of KBDSSs

9.2.1 Definition of a KBDSS

A KBDSS can be defined as "a computer information system that provides information and methodological knowledge using analytical decision models, and providing access to data and knowledge bases to support decision makers in making decisions effectively in complex and illstructured problem domains (Zopounidis et al. 1997: p. 263)." Technically, KBDSSs originated from an integration of an expert system (ES) with a decision support system (DSS).

A DSS is an interactive, computer-based information system that utilizes decision rules and models, coupled with a comprehensive database (Turban and Watkins 1986). It can be used as a strategic planning tool to evaluate the efficiency and performance-based decision-making information. A basic objective of a DSS is to provide the necessary information in order to help decision makers better understand the complex situations and make good decisions (Wang 2005; Zopounidis et al. 1997).

Compared with a DSS, an ES is a computer program that includes a knowledge base containing experts' knowledge for a particular problem domain, and a reasoning mechanism for generating inferences over the knowledge base (Turban and Watkins 1986). It was viewed as a subarea of artificial intelligence (AI) (Kingsman and de Souza 1997). As a form of an ES, a knowledge-based system (KBS) holds the subject knowledge as a set of facts and rules that may be interrogated and manipulated to provide an inferred solution or explanation for a given problem (Ülengin and Topcu 2000). The performance of KBSs depends greatly on a knowledge base that stores rules, objects, facts, general cases, exceptions, and relations that contribute to decision-making (Uricchio et al. 2004).

DSSs derived mainly from management information systems and operations research, whereas ESs came from AI. Klein and Methlie (1990) combined the frameworks of DSSs and ESs and produced the frameworks of KBDSSs. Uricchio et al. (2004) also considered that a KBDSS was developed by incorporating AI or ES technologies into DSS architectures. Hence, KBDSSs can overcome the drawbacks of DSSs and ESs without missing their strengths (Zopounidis et al. 1997), provide smarter support to decision makers, and enable them to improve the decision quality (Bonczek et al. 1981). With the development of IT, the division between KBDs, DSSs, and KBDSS is no longer clear. A great number of papers about applications of KBDSSs have been published in international journals, such as Decision Support Systems, Knowledge-Based Systems, and Expert Systems with Applications.

9.2.2 Applications of KBDSSs in Previous Studies

KBDSSs have been applied in various domains. These include cost estimation and pricing decisions in versatile manufacturing firms (Kingsman and de Souza 1997), quantitative constructability analysis (Yu and Skibniewski 1999), selection of water crossing infrastructure alternatives (Ülengin and Topcu 2000), building project procurement (Kumaraswamy and Dissanayaka 2001), management in flexible manufacturing systems (Özbayrak and Bell 2003), national defense budget planning (Wen et al. 2005a), enterprise mergers and acquisitions (Wen et al. 2005b), measurement of the performance of real estate investment (Wang 2005), variation orders management (Arain and Low 2006), construction equipment selection and cost estimation (Eldrandaly and Eldin 2006), measurement of enterprise performance (Wen et al. 2008), tender call evaluation (Alexopoulos et al. 2009), as well as road safety analysis (Dell'Acqua et al. 2011; Jo et al. 2011). In addition, SPRING Singapore (2010), which is an agency under the Ministry of Trade and Industry of Singapore, developed a KBDSS, known as the Integrated Management of Productivity Activities (IMPACT) assessment tool to help businesses identify the strengths and weaknesses in their productivity, measure their productivity levels, and provide action plans for improving their productivity.

KBDSSs have also been applied in risk management in a variety of fields. Ferns (1995) developed a KBDSS called Lifenet in the social service domain for the risk assessment of adolescent suicide. Uricchio et al. (2004) presented a KBDSS to assess Italian groundwater pollution risks. Padma and Balasubramanie (2009) proposed a KBDSS to acquire and quantify the work-related risks on musculoskeletal disorder. Baloi and Price (2003) pointed out that probability theory, FST, and certainty factor theory had been widely used to deal with uncertainties in KBDSSs, and found increasing applications of the FST for modeling uncertainties in KBDSSs in the construction industry. Despite much attention has been paid to the KBDSSs for risk management, the issue of improving ERM practices through a KBDSS has not been much explored in the literature. This research presents a KBDSS for assessing ERM maturity and improving ERM practices in CCFs. After the comparison with other multicriteria analysis methods, the FST that can deal with the problems of vague and imprecise judgments was used to develop the ERM maturity model (see Sect. 3.7.3). This model was embedded in the proposed KBDSS.

9.3 Objectives of the KBDSS

The KBDSS for ERM in CCFs developed in this research serves as an internal assessment tool for management staff. The objectives of the KBDSS are to:

1. Assess the ERM maturity in a CCF,
2. Visualize the ERM maturity assessment results,

3. Provide action plans for improving ERM practices along the maturity continuum, and
4. Generate a printable ERM maturity assessment report.

A user can input their implementation level of each ERM best practice (see Sect. 7.2.3) under each criterion by comparing similar current practice in his or her firm with the best practice. Using the input data and the fuzzy ERM maturity model presented in Sect. 3.7.3, the KBDSS can compute the scores of the maturity criteria and the overall maturity score (i.e., ERMMI) in the firm. Each criterion score reflects the extent to which this criterion is implemented, while the ERMMI describes the overall maturity level of the ERM program in the firm. In addition, the criterion scores and the ERMMI are interpreted using linguistic terms, and each linguistic term is assigned a color (see Table 9.1). Thus, the KBDSS can visualize the assessment results by presenting a histogram of the criterion scores with bars in different colors. The bar colors represent the linguistic term assigned to the maturity criteria, and the lengths are in proportion to the scores. The KBDSS also highlights the criterion scores that are below and above the ERMMI in two different colors. Moreover, according to the implementation level of each ERM best practice, the KBDSS selects a specific action plan for the user to improve the implementation of each best practice, which contributes to better informed decisions relating to ERM. Furthermore, to make it easy for users to review the assessment results and action plans, the KBDSS produces a printable ERM maturity assessment report. The details are presented in the following sections.

By using the KBDSS, the management staff can gain an overview of the ERM maturity as well as the action plans for improving their ERM implementation. This allows them to identify the aspects of the ERM implementation that have the priority for improvement, according to the information available and the real-world circumstances faced by the firm. In addition, when assessing the ERM maturity, the management staff would think about the status quo of their ERM implementation and gain more innovative ideas relating to ERM. Thus, the ERM maturity assessment conducted can still contribute to the group decision-making relating to ERM. Furthermore, it should be noted that the assessment results and action plans provided by the KBDSS play a supportive rather than a dominative role in the decision-making relating to ERM. The KBDSS is not designed to make decisions for users, but rather it provides pertinent information in an efficient and easy-to-access format that enables users to make more informed decisions (Arain and Low 2006).

Table 9.1 Criterion scores and linguistic terms

Scores of maturity criteria	Linguistic term	Color
Score < 0.125	Very low	Red
0.125 ≤ Score < 0.375	Low	Orange
0.375 ≤ Score < 0.625	Medium	Yellow
0.625 ≤ Score < 0.875	High	Blue
0.875 ≤ Score	Very high	Green

9.4 Architecture of the KBDSS

The KBDSS for ERM consists of three main components: a knowledge base, a GUI, and a DSE. The architecture is described in Fig. 9.1.

9.4.1 Knowledge Base

The knowledge base is a repository of the knowledge and experience of experts. The knowledge base of the KBDSS contains the ERM maturity criteria, the ERM best practices applicable in CCFs, and the action plans for improving the implementation of the ERM best practices. The ERM maturity criteria and best practices were collected from the literature review, as described in Sect. 3.7.3. A total of 16 criteria and 66 best practices were found appropriate and retained in the ERM maturity model, according to the analysis results of the data collected from Survey I (see Sects. 7.2.2 and 7.2.3). In addition, the action plans for improving ERM practices were developed based on the literature review and the interviews that were conducted with the industry practitioners. These action plans are described in Sect. 9.5.

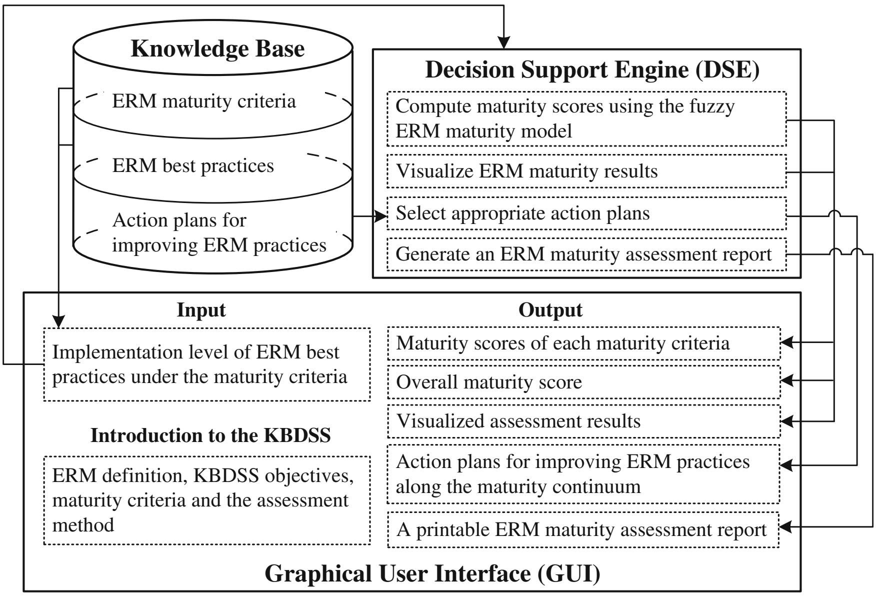


Fig. 9.1 Architecture of the KBDSS

9.4.2 Graphical User Interface

The GUI allows users to interact with the KBDSS using graphical icons and visual indicators. The GUI of this KBDSS consists of the entrance interface, the introduction interface, the ERM maturity assessment interfaces, the action plan interfaces, and the exit interface. Before the user proceeds to the ERM maturity assessment, the introduction interface presents a brief introduction to the KBDSS. In the assessment process, the interfaces display ERM maturity criteria and best practices and allow the user to input the implementation level of the 66 best practices using the five-point scale (1 = very low, 2 = low, 3 = medium, 4 = high, and 5 = very high). After the ERM maturity assessment and action plan selection processes, the GUI displays the maturity criterion scores, the ERMMI, and the action plans.

In addition, the criterion scores and the ERMMI are interpreted using the same set of linguistic terms (see Table 9.1). The five linguistic terms are represented by the colors of red, orange, yellow, blue, and green, respectively. The GUI presents a histogram of the assessment results. In the histogram, the color of each bar represents the linguistic term of each maturity criterion, and the length is in proportion to the respective criterion score. Moreover, the criterion scores can be compared with the ERMMI and the scores below and above the ERMMI are highlighted in pink and light green, respectively. Thus, it is easy and convenient for users to understand the implementation of the maturity criteria and find the weaker aspects that are represented by the shorter bars in the histogram. These weaker aspects are worth more attention from the management of the firm. Furthermore, a printable ERM maturity assessment report can be output, which makes it easy for the users to review the assessment results.

9.4.3 Decision Support Engine

The DSE transforms the input implementation levels of ERM best practices into TFNs, adopts the centroid method to produce the crisp implementation scores ranging from 0 to 1, and calculates the ERM maturity criterion scores and the ERMMI. Meanwhile, it sends commands to visualize the maturity scores. In addition, based on the assessment results, the DSE selects the action plans for the user from the knowledge base. Three rules that are coded in if–then conditional statements are adopted to select the action plans (see Table 9.2).

The threshold values are set according to Fig. 3.9. Specifically, if the score of a best practice is below 0.375, indicating that the implementation level of this practice is either very low or low, then the DSE selects the action plan that intends to improve the implementation to a medium level; if the score of a best practice is between 0.375 and 0.625, implying that the implementation of this practice is at a medium level, then the DSE selects the action plan that intends to improve the

Table 9.2 Rules of selecting action plans in the DSE

Rules	If (condition)	Then (execution)
Rule 1	$L_{ip} < 0.375$	Select the action plan for improving the practice to a medium level
Rule 2	$0.375 \leq L_{ip} < 0.625$	Select the action plan for improving the practice to a high level
Rule 3	$L_{ip} > 0.625$	Select the action plan for improving the practice to a very high level

L_{ip} is the score of the best practice p under criterion i

implementation to a high level; and if the score of a best practice is above 0.625, implying that the implementation level of this practice is high, then the DSE selects the action plan that intends to improve the implementation to a very high level. Meanwhile, this action plan could help the firm sustain the implementation at a very high level.

In addition, these action plans are divided into two groups in the KBDSS. One group intends to improve the implementation of the best practices scored below the ERMMI, and the other is aimed at those scored over the ERMMI. The management would prefer to strengthen the implementation of the weak aspects, i.e., the practices scored below the ERMMI, or continue focusing on the practices scored above the ERMMI, or undertake both sets of practices. Both tactics can contribute to a higher ERM maturity.

Furthermore, an ERM maturity assessment report, which includes the maturity scores, the visualization of the scores, and the action plans, can be generated and printed, enabling the users to easily review the assessment results.

9.5 Action Plans for Improving ERM Practices in CCFs

The action plans were firstly acquired through the comprehensive literature review (Barton et al. 2002; Cendrowski and Mair 2009; Duckert 2011; Fraser and Simkins 2010; Hopkinson 2011; Narvaez 2011; Segal 2011; Zou et al. 2010). These publications also include the statements relating to the best practices that were recognized to constitute a successful or advanced ERM program.

Specifically, most of the 66 ERM best practices were provided with three categories of action plans, which intended to help a firm improve the implementation of each best practice from a very low or low to a medium level, from a medium to a high level, and from a high to a very high level, respectively. The rationale behind assigning three action plans to a best practice was that it may not be meaningful to provide an action plan to help a firm improve from a very low level to a low level.

The preliminary set of action plans was presented to six industry interviewees, who were originally included in the samples of Survey I and II, to solicit insightful comments and additional action plans. These interviewees were involved in risk management in their firms and had over 10 years of work experience in the construction industry. According to the comments and inputs of the interviewees, the action plans were revised and updated. The finalized set consisted of 191 action plans for improving the implementation of the 66 ERM best practices (see Table 9.3).

It should be noted that not all the best practices had three action plans because it was difficult to distinguish between the two adjacent implementation levels of some best practices. In this case, two of the three action plans for the best practices were duplicated. In addition, an interviewee indicated that some best practices did not need to have three action plans in a real-world situation. The reason was that it would be meaningless to develop action plans for these best practices to improve the implementation from a low to a medium level. Thus, these best practices had only two action plans.

An example is presented in Sect. 9.7 to illustrate how to select action plans based on the assessment results.

9.6 Tools for Developing the KBDSS

The KBDSS for ERM was developed using Microsoft Visual Studio 2010. Microsoft Visual Studio 2010, developed by Microsoft Corporation, is a type of integrated development environment (IDE), which provides services and tools that enable a programmer to code, test, and implement a single program, or sometimes the series of programs that comprise an application (Shelly and Hoisington 2010).

Microsoft Visual Studio 2010 can be used to develop GUI applications along with Windows Forms applications, Web sites, Web applications, and Web services in both native code and managed code. It includes a code editor supporting IntelliSense. IntelliSense is the implementation of auto-completion and intends to document and disambiguate variable names, functions, and methods using reflection besides completing the symbol names typed by the programmer. In addition, the code editor supports code refactoring. Code refactoring is a technique for restructuring an existing body of code. This technique improves code readability and reduces complexity, thus improving the maintainability of the source code. Furthermore, Microsoft Visual Studio 2010 provides the Data Source Configuration Wizard, which enables programmers to connect the application to data from different sources, such as databases, Web services, and objects. Thus, programmers do not need to explicitly create a connection object for his or her form or component.

Microsoft Visual Studio 2010 supports different programming languages, including Visual Basic, Visual C/C++, Visual C#, and Visual F#. Visual Basic 2010 is based on the Visual Basic programming language developed by Microsoft Corporation in 1991 to allow easy, visual-oriented development of Windows applications (Schneider 2011). Visual Basic, in turn, was the Beginner's All-purpose Symbolic Instruction Code (BASIC) language, which was developed in the 1960s. Visual Basic 2010 allows programmers to easily build complex Windows

Table 9.3 Action plans for improving ERM implementation in CCFs

Code	Action plans for improving ERM implementation		
	Low → medium	Medium → high	High → very high
M01 Commitment of the board and senior management			
B01.1	Prepare a written ERM policy that at least covers the aim, principles and process of ERM, commitment, and relevant responsibilities and accountabilities Ensure that the ERM policy is approved by the board and senior management and understood by most of the risk owners	Include most of the critical aspects of ERM implementation (e.g., the aim, principles and process of ERM, commitment, responsibilities and accountabilities, risk appetite, risk communication, and timing for monitoring and review of policies) into the written ERM policy Ensure that the ERM policy with the top approval is understood by all the risk owners and made known to all the staff	Ensure that the written ERM policy with the top approval covers all the critical aspects of ERM implementation (e.g., the aim, principles, and process of ERM, commitment, responsibilities and accountabilities, risk appetite, risk communication, timing for monitoring and review of policies) Ensure that the written ERM policy is understood by all the risk owners and made known to all the staff
B01.2	Develop an ERM plan and tailor it to the corporate objectives and context Make the ERM plan understood by most of the risk owners	Ensure that the ERM plan is consistently tailored to the corporate objectives and context Ensure that the ERM plan is understood by all the risk owners and known to all the staff	
B01.3	Try to make decisions and implement ERM according to the ERM policy and plan	Ensure that most of the decision-making and ERM practices are fully consistent with the ERM policy and plan	Ensure that all the decision-making and ERM practices are fully consistent with the ERM policy and plan
B01.4	Involve the board and senior management in the risk oversight and the development of the ERM policy and plan	Ensure the active participation of the board and senior management in all the critical aspects of ERM implementation	
B01.5	Ensure the visible commitment to ERM from the board and senior management, making people perceive ERM as a priority for the leadership	Ensure the visible and continual commitment to ERM from the board and senior management	

(continued)

Table 9.3 (continued)

Code	Action plans for improving ERM implementation		
	Low → medium	Medium → high	High → very high
M02 ERM ownership			
B02.1	Appoint a dedicated senior executive, or set up a stand-alone department or a board-level committee to oversee the risks faced by the firm	Appoint a dedicated senior executive, or set up a stand-alone department or a board-level committee to oversee the risks faced by the firm and to centralize risk management Make the ERM owner known to all the risk owners	Appoint a dedicated senior executive, or set up a stand-alone department or a board-level committee as the ERM owner to take charge of ERM implementation Ensure that the ERM owner is known to all the relevant staff
B02.2	Appoint risk owners for most risks at the department and project levels	Appoint risk owners for all the risks at the department and project levels Ensure that most risk owners fully understand the risks falling within their respective accountability	Appoint risk owners for all the risks that have been identified Ensure that all the risk owners fully understand the risks falling within their respective accountability
B02.3	Clearly define the authority and responsibility of the risk owners	Ensure that most of the risk owners have sufficient authority to oversee any risk-related action, and accept clearly defined responsibility for managing the risks	Ensure that all the risk owners have sufficient authority to oversee any risk-related action, and accept clearly defined responsibility for managing the risks
B02.4	Consider ERM implementation when assessing owners' performance	Set up formal KPIs of all the risk owners Consider ERM implementation in the assessment of these KPIs	Include specific ERM-related KPIs into the formal set of KPIs to assess the performance of all the risk owners
M03 Risk appetite and tolerance			
B03.1	Consider the risk appetite when developing and executing the corporate strategy	Formally and clearly define the risk appetite through a written statement that is approved by the board of directors Align the risk appetite with the corporate strategy	Formally and clearly define the risk appetite through a written statement that is approved by the board of directors Ensure that the risk appetite is aligned with the corporate strategy Regularly review and update the risk appetite statement

(continued)

Table 9.3 (continued)

Code	Action plans for improving ERM implementation		
	Low → medium	Medium → high	High → very high
B03.2	Not applicable	Ensure that the risk appetite is understood by all the risk owners	Ensure that the risk appetite is understood by all the risk owners and known to all the relevant staff
B03.3	Consider the risk tolerance for most risks from the perspective of the achievement of the relevant corporate objectives	Formally and clearly define the risk tolerance for each specific risk according to the corporate objectives Ensure that the risk tolerance of a certain risk is understood by the risk owner	Formally and clearly define the risk tolerance for each specific risk according to the corporate objectives Ensure that the risk tolerance of a certain risk is understood by the risk owner and made known to the relevant staff Regularly review and update the risk tolerance
B03.4	Assess the differences between the risk tolerance and actual risks on an ad hoc basis	Assess the differences between the defined risk tolerance and actual risks on a sufficiently periodic basis	Regularly assess the differences between the defined risk tolerance and actual risks
B03.5	Consider the risk tolerance when developing risk response strategies	Assess the expected effects of most risk response strategies against risk tolerance	Ensure that the expected effects of all the risk response strategies are assessed against risk tolerance
M04 Risk-aware culture			
B04.1	Define the elements of a risk-aware culture for the firm Obtain the support from the top management to ensure their risk awareness and the resource inputs	Involve the relevant staff in the creation of the risk-aware culture and ensure their buy-in Launch training programs and create accountability at all levels to improve the risk awareness Encourage open and transparent communication, e.g., questioning current models and putting forward individual comments	Ensure the sustained and strong risk awareness among the staff at all levels Consistently encourage open and transparent communication, e.g., questioning current models and putting forward individual comments Involve the staff at all levels into the creation of the risk-aware culture and ensure their buy-in Align the reward and disciplinary systems with the creation of the risk-aware culture

(continued)

Table 9.3 (continued)

Code	Action plans for improving ERM implementation		
	Low → medium	Medium → high	High → very high
B04.2	Eliminate the distrust among staff and various projects and departments	Build up a climate of mutual trust within project teams and departments	Ensure that a climate of mutual trust is built up and enables open and transparent communication of risk information throughout the firm
B04.3	Envisage the ideal corporate culture with the key aspects that support ERM Assess the existing corporate culture against the ideal culture Identify the problems exposed in the assessment and prioritize them Obtain the visible leadership on cultural change from the top management	Ensure the visible leadership on cultural change from the top management Tackle the problems exposed in the corporate culture assessment in a priority order through a variety of methods (e.g., getting the staff at all levels involved, providing training, and aligning the reward and disciplinary systems with the risk-aware culture)	Ensure that all the problems exposed in the corporate culture assessment are tackled and that the corporate culture supports ERM Integrate risk thinking into all the decision-making and strategy planning processes
B04.4	Identify the expected behavior according to the expected risk-aware culture within the firm	Explicitly express the expected behavior within the firm and make it understood by all the risk owners Encourage the expected behavior and correct the behavior that is inconsistent with the risk-aware culture	Explicitly express the expected behavior within the firm and make it known by all the relevant staff Adopt a systematic process to encourage the expected behavior and correct the behavior that is inconsistent with the risk-aware culture
M05 Sufficient resources			
B05.1	Allocate resources to the ERM process, tools, techniques, personnel skill training on an ad hoc basis	Allocate sufficient resources and assure the availability of the ERM process, tools, techniques, personnel skill training, etc.	Continuously invest in improving the risk management process, tools, techniques, personnel skills, etc.
B05.2	Consider the risk significance and priority during allocating resources to risk response	Ensure that sufficient resources are allocated for the appropriate risk response strategies according to the risk significance and priority	
B05.3	Recruit the staff with knowledge, skills, and expertise about ERM	Employ the sufficient qualified staff with	Employ the sufficient qualified staff with

(continued)

Table 9.3 (continued)

Code	Action plans for improving ERM implementation		
	Low → medium	Medium → high	High → very high
		knowledge, skills, and expertise about ERM	knowledge, skills, and expertise about ERM Ensure that all the risk owners have sufficient knowledge, skills, and expertise about ERM
B05.4	Not applicable	Invite external consultants or experts to train the staff on ERM and to provide insights and suggestions for the ERM program	Build up the long-term collaboration with external experts and regularly use their knowledge, skills, and expertise to strengthen the ERM implementation
B05.5	Identify metrics to measure ERM performance	Ensure that the metrics can comprehensively reflect ERM performance Apply these metrics to measure ERM performance on a sufficiently periodic basis	Ensure that the metrics are comprehensive enough to measure ERM performance and are consistently applied in ERM performance assessment Review and update the metrics on a sufficient periodic basis
M06 Risk identification, analysis, and response			
B06.1	Adopts a formalized ERM process throughout the firm		Implement ERM according to the formalized and standardized ERM process throughout the firm on a regular basis
B06.2	Collect risk information from internal and external sources	Ensure that all the risk information collected from various sources is relevant and reliable	
B06.3	Use at least one risk management tool or technique in ERM	Use multiple qualitative and quantitative risk management tools and techniques in ERM	Consistently use the combination of appropriate qualitative and quantitative risk management tools and techniques
B06.4	Use at least one recognized technique to identify the risks at the department or project level	Use multiple techniques to identify risks at all levels (including risks related to the corporate strategy) and the sources of most risks	Ensure that the risks at all levels and their sources and potential impacts are comprehensively identified through multiple techniques

(continued)

Table 9.3 (continued)

Code	Action plans for improving ERM implementation		
	Low → medium	Medium → high	High → very high
B06.5	Depend on the individual experience and subjective judgment to assess the likelihood of occurrence and risk impacts and prioritize the risks	Estimate the likelihood as realistically as possible using the information available Assess the direct or immediate risk impacts on the relevant objectives Prioritize the risks with the correct application of a valid method	Realistically estimate the likelihood by evaluating sources of uncertainty associated with risk occurrence Assess both the direct and secondary risk impacts on the relevant objectives Prioritize the risks with the correct application of a valid method
B06.6	View risks as interrelated and consider the relationship among various risks	Assess the relationship among various risks in risk analysis	Consistently assess the relationship among various risks using appropriate methods in risk analysis
B06.7	Consider one or two response options for each risk as well as the costs of risk response options during the risk response selection Implement the appropriate risk responses without unnecessary delays	Select appropriate risk response strategies by considering various response options, risk significance, risk appetite and tolerance, resource availability, and the costs versus benefits Implement the selected risk response strategies without unnecessary delays	Select appropriate risk response strategies among all the relevant response options Ensure that the selected risk response strategies can optimize the firm performance Consistently implement the selected risk response strategies in a professional and timely manner
B06.8	Not applicable	Consider the risk sources and include actions that deal with risks at their sources into the risk responses	Design risk responses to deal with critical risks at their sources
M07 Iterative and dynamic ERM process steps			
B07.1	Identify new and emerging risks during ad hoc reviews	Identify new and emerging risks on a sufficiently periodic basis	Consistently identify new and emerging risks in a timely and proactive manner and report them to the appropriate persons
B07.2	Collect risk information from internal and external sources	Update the risk information collected from various sources when necessary	Regularly update the risk information collected from various sources

(continued)

Table 9.3 (continued)

Code	Action plans for improving ERM implementation		
	Low → medium	Medium → high	High → very high
B07.3	Monitor and review risk identification, analysis, and response activities on an ad hoc basis	Monitor and review risk identification, analysis, and response activities on a sufficiently periodic basis in order to assure the quality of these activities	Regularly monitor and review risk identification, analysis, and response activities Improve the quality of risk management activities according to the results of the monitoring and reviews
B07.4	Clearly record most information related to ERM	Clearly record most relevant ERM information and update it periodically Provide a convenient access to the information for the risk owners	Clearly record all the relevant ERM information and update it regularly Provide a convenient access to the information for all the relevant staff
B07.5	Identify the residual risks remaining after risk response	Identify and assess all the residual risks remaining after risk response Check whether the risk response is adequate or not	Assess all the residual risks remaining after risk response and check whether the risk response is adequate or not Develop new risk response strategies to tackle the residual risks according to the risk appetite and tolerance
M08 Leveraging risks as opportunities			
B08.1	Ensure that opportunities are recognized as one side of risks by the top management	Ensure that opportunities are recognized as one side of risks by the top management and risk owners	Ensure that opportunities are recognized as one side of risks by all the relevant staff
B08.2	Identify and explore opportunities on an ad hoc basis	Identify and explore most opportunities, including strategic opportunities, during risk management planning	Ensure that all the opportunities are regularly identified and explored during risk management planning
B08.3	Assess the expected benefits of opportunities and the likelihood of obtaining these benefits	Assess most of the opportunities by weighing their expected benefits and relevant likelihood against the potential losses and their likelihood	Ensure that all the opportunities are regularly assessed by weighing the expected benefits and relevant likelihood against the potential losses and their likelihood

(continued)

Table 9.3 (continued)

Code	Action plans for improving ERM implementation		
	Low → medium	Medium → high	High → very high
B08.4	Identify the opportunities for the expected improvement of firm performance and prioritize them	Pursue the opportunities for the expected improvement of firm performance in a priority order	Ensure that all the opportunities for the expected improvement of firm performance are actively sought
B08.5	Consider the core competencies and risk appetite when deciding to take risks	Ensure that most risk taking strategies are aligned with the core competencies and risk appetite	Ensure that all the risk taking strategies are consistently aligned with the core competencies and risk appetite
M09 Risk communication			
B09.1	Communicate and share risk information across most projects and departments on an ad hoc basis	Communicate and share risk information across most projects and departments on a sufficiently periodic basis	Regularly communicate and share all the relevant risk information across all the projects and departments in an effective and efficient manner
B09.2	Report risk information to the board and senior management on an ad hoc basis	Report relevant and critical risk information to the board and senior management in a timely manner	Report relevant and critical risk information (including the KRI data) to the board and senior management in an efficient manner according to risk severity or urgency
B09.3	Notify line managers, project managers and frontline staff of critical information and decisions from senior management on an ad hoc basis	Notify line managers, project managers and frontline staff of critical information and decisions from senior management in a timely manner	Establish clear communication lines to ensure that line managers, project managers and frontline staff are promptly notified of critical information and decisions from senior management
B09.4	Allow internal staff to provide reasonable comments and views on ERM implementation	Periodically hold workshops or seminars to encourage reasonable comments and views on ERM implementation of the relevant internal staff Invite external consultants or experts to train the staff on ERM and to provide insights	Regularly hold workshops or seminars to encourage reasonable comments and views on ERM implementation of all the relevant internal staff Build up the long-term collaboration with external experts and regularly use their

(continued)

Table 9.3 (continued)

Code	Action plans for improving ERM implementation		
	Low → medium	Medium → high	High → very high
		and suggestions for the ERM program	knowledge, skills and expertise to strengthen the ERM implementation
M10 A common risk language			
B10.1	Develop a risk language that explains most of the risk management terminologies and methodologies used within the firm	Ensure that the risk language clearly explains most of the risk management terminologies and methodologies used within the firm Review and update the risk language on a sufficiently periodic basis	Ensure that the risk language clearly explains all the risk management terminologies and methodologies used within the firm Regularly review and update the risk language
B10.2	Create a glossary of the risk terms that are included in the risk language Make the glossary accessible to all the relevant staff	Ensure that the risk language is understood by the top management and risk owners Use the risk language in most of the risk communication within the firm	Ensure that the risk language is understood by all the relevant staff and consistently used in all the risk communication within the firm
M11 A risk management information system (RMIS)			
B11.1	Update the existing management information system or build up a new RMIS in order to facilitate risk communication across projects and departments and to record relevant risk information	Embed the ERM-related functions into the existing management information system or build up a new RMIS that can improve risk communication across the firm, record ERM activities, undertake risk identification and analysis, facilitate selecting response strategies, and visualize the risk profile Ensure the accuracy, timeliness, consistency, comprehensiveness, and applicability of the data in the RMIS	Ensure that the updated management information system or the RMIS can improve risk communication across the firm, record ERM activities, undertake risk identification and analysis, facilitate selecting response strategies, and visualize the risk profile Ensure the accuracy, timeliness, consistency, comprehensiveness, and applicability of the data in the RMIS Maintain and update the RMIS with the permission on a regular basis
B11.2	Train the senior management and risk	Train all the relevant staff in the firm and ensure that they clearly	Regularly train all the relevant staff in the firm and ensure that they

(continued)

Table 9.3 (continued)

Code	Action plans for improving ERM implementation		
	Low → medium	Medium → high	High → very high
	owners on the application of the RMIS functions Apply the RMIS in risk communication across projects and departments	understand the application of all the RMIS functions Consistently apply the RMIS functions in ERM	clearly understand the application of all the RMIS functions, including the newly added functions Consistently apply all the RMIS functions in ERM
M12 Training programs			
B12.1	Formally train the risk owners to assure their clear understanding of the ERM policy, process, and potential benefits, and to remove their misunderstanding and anxiety about ERM	Formally train all the relevant staff to assure their clear understanding of the ERM policy, process, and potential benefits, and to remove their misunderstanding and anxiety about ERM	
B12.2	Provide ad hoc training on ERM for the staff to equip them with knowledge and skills relating to ERM	Provide periodic training for the staff to update their knowledge and skills relating to ERM	Provide regular training for the staff to maintain their high-level knowledge and skills relating to ERM
B12.3	Train the relevant staff to make them learn from the business cases available	Train all the relevant staff through making good use of the recorded ERM information and experience Ensure that they learn from the past successes and failures	Exploit learned experience for ERM using formal and informal methods Ensure that all the relevant staff learn from the successes and failures from both previous and ongoing projects
B12.4	Encourage the staff who are professional or experienced in ERM to share their knowledge and experience with others within the firm	Ensure that the staff who are professional or experienced in ERM share their knowledge and experience with trainees in internal training programs	
M13 Formalized key risk indicators (KRIs)			
B13.1	Identify quantifiable KRIs and the threshold levels for the risks at the department or project level	Identify quantifiable KRIs for most of the critical risks (including strategic risks) and assure the clarity in what is measured Link the KRIs to the sources or the	Ensure that quantifiable KRIs are clearly identified for all the critical risks and that all the KRIs are linked to the risk sources Ensure that the quantitative threshold levels of all the KRIs are

(continued)

Table 9.3 (continued)

Code	Action plans for improving ERM implementation		
	Low → medium	Medium → high	High → very high
		intermediate events of the risks Align the quantitative threshold levels of the KRIs with the risk appetite and tolerance	consistently aligned with the risk appetite and tolerance Prioritize the KRIs according to their relative importance
B13.2	Not applicable	Review and update the KRIs on a sufficiently periodic basis	Ensure that all the KRIs are consistently reviewed and updated
B13.3	Ensure that the relevant risk owners are clear about how to use the KRIs	Ensure that all the risk owners are clear about how to use the KRIs Make the risk owners to monitor and analyze the KRIs on a sufficiently periodic basis	Ensure that all the relevant staff understand how to use the KRIs, and that all the risk owners regularly monitor and analyze the KRIs relating to their respective accountability
B13.4	Not applicable	Use the KRIs to proactively assess the shifts in risk exposures on a sufficiently periodic basis	Use the KRIs as the regular early warning signals of increasing risk exposures and enable more timely actions to address the risks
M14 Integration of ERM into business processes			
B14.1	Ensure that at least the top management considers risk information, risk tolerance and appetite, risk priority and risk response in strategic decision-making	Ensure that most of the management across the firm consistently considers risk information, risk tolerance and appetite, risk priority and risk response in most of the decision-making processes, including strategic decision-making	Ensure that all the management across the firm consistently considers risk information, risk tolerance and appetite, risk priority, and risk response in all the decision-making processes
B14.2	Ensure that ERM is at least integrated into the strategic planning process	Review the integration process on a sufficiently periodic basis Ensure that ERM is integrated into most of the daily management and business processes	Regularly review the integration process Ensure that ERM is fully integrated into all daily management and business processes
B14.3	Assess the implementation of the ERM best practices an ad hoc basis and identify the	Periodically assess the implementation of the ERM best practices and identify the gaps between	Regularly and formally assess the implementation of the ERM best practices and

(continued)

Table 9.3 (continued)

Code	Action plans for improving ERM implementation		
	Low → medium	Medium → high	High → very high
	gaps between the status quo and the best practices	the status quo and the best practices Determine the actions to fill the gaps and fill most of the gaps in a priority	identify the gaps between the status quo and the best practices Take the selected actions to fill all the gaps in a priority order and to continuously improve ERM practices
M15 Objective setting			
B15.1	Clearly identify and express most of the objectives (e.g., strategic, operation, reporting, and compliance) Make the objectives understood by most of the risk owners	Ensure that most of the objectives (e.g., strategic, operation, reporting, and compliance) are measurable and clearly identified and expressed and that all the risk owners are clear about their relevant objectives	Ensure that objectives at all levels (e.g., strategic, operation, reporting and compliance) are measurable, clearly identified and expressed, and readily understood by all the relevant staff
B15.2	Consider objective achievement when developing performance indicators	Develop measurable performance indicators for most of the objectives	Develop measurable performance indicators for all the objectives Link all performance indicators with the objectives Regularly review and update the performance indicators
B15.3	Review deviations from plans or expectations on an ad hoc basis	Review and assess most deviations from plans or expectations against the corporate objectives and project objectives on a sufficiently periodic basis	Regularly review and assess all the deviations from plans or expectations against the corporate objectives and project objectives
M16 Monitoring, review, and improvement of the ERM framework			
B16.1	Monitor the progress of ERM implementation against, and deviation from, the ERM plan on an ad hoc basis	Monitor the progress of ERM implementation against, and deviation from, the ERM plan on a sufficiently periodic basis	Ensure the regular monitoring of the progress of ERM implementation against, and deviation from, the ERM plan
B16.2	Review whether the ERM framework, policy, and plan are appropriate according to the corporate external and	Review whether the ERM framework, policy, and plan are appropriate according to the corporate external and	Ensure the regular review of the appropriateness of ERM framework, policy, and plan according to the corporate external and internal context

(continued)

Table 9.3 (continued)

Code	Action plans for improving ERM implementation		
	Low → medium	Medium → high	High → very high
	internal context on an ad hoc basis	internal context on a sufficiently periodic basis	
B16.3	Consider how to improve the ERM framework, policy, and plan, based on results of ad hoc monitoring and reviews	Consider and select the actions to update and improve the ERM framework, policy, and plan, based on results of monitoring and reviews Take the selected actions when necessary	Ensure that the actions are consistently taken to update and improve the ERM framework, policy, and plan, based on results of monitoring and reviews

and Web programs, as well as other software tools. Visual Basic is the most widely used programming language in the world because it is English-like and is considered as one of the easier enterprise-level programming languages to learn. In addition, it is as powerful as the other programming languages in Microsoft Visual Studio 2010, such as Visual C++ and C# (Shelly and Hoisington 2010). Therefore, the KBDSS was developed using Visual Basic 2010 in this research.

9.7 Demonstration of the KBDSS

The KBDSS is in the exe format and consists of the entrance interface, the introduction interface, the ERM maturity assessment interfaces, the action plan interfaces, and the exit interface. In this section, a hypothesized example is used to demonstrate how the KBDSS works. The data of the example are shown in Table 9.4.

Table 9.4 Data of the hypothesized example

Code	Score	Code	Score	Code	Score	Code	Score	Code	Score	Code	Score
B1.1	4	B3.3	3	B5.5	2	B7.3	3	B9.4	3	B13.3	1
B1.2	3	B3.4	2	B6.1	5	B7.4	3	B10.1	4	B13.4	2
B1.3	3	B3.5	1	B6.2	4	B7.5	3	B10.2	3	B14.1	3
B1.4	5	B4.1	4	B6.3	4	B8.1	4	B11.1	1	B14.2	3
B1.5	4	B4.2	4	B6.4	3	B8.2	5	B11.2	1	B14.3	2
B2.1	5	B4.3	3	B6.5	4	B8.3	4	B12.1	3	B15.1	5
B2.2	3	B4.4	4	B6.6	2	B8.4	3	B12.2	3	B15.2	5
B2.3	3	B5.1	4	B6.7	3	B8.5	3	B12.3	3	B15.3	5
B2.4	2	B5.2	3	B6.8	3	B9.1	4	B12.4	2	B16.1	3
B3.1	4	B5.3	3	B7.1	4	B9.2	5	B13.1	2	B16.2	3
B3.2	3	B5.4	2	B7.2	4	B9.3	4	B13.2	2	B16.3	2

Firstly, the user needs to copy the KBDSS to the hard disk of a computer with the Windows operating system. The KBDSS is designed to print an ERM maturity assessment report. Thus, to print out the report, a printer needs to be linked to the computer; alternatively, the Adobe Acrobat Software could be installed to the computer to convert the report into a Portable Document Format (PDF) file.

To start the KBDSS, the user has to double-click the "KBDSS-ERM" icon, and then, the entrance interface is presented (see Fig. 9.2). To enter the KBDSS, the user needs to click "Enter."

Then, the introduction interface is presented and provides the user with the definition of ERM, the objectives of the KBDSS, the ERM maturity criteria, and the assessment method (see Fig. 9.3). After reading the introduction, the user needs to tick the checkbox, which indicates he or she has already read the introduction, and then click the "Proceed to Assessment" button to start the ERM maturity assessment. If the checkbox is not ticked, the "Proceed to Assessment" button is not enabled.

The ERM maturity assessment part of the KBDSS includes eight interfaces. The first seven interfaces allow the user to input the implementation level of each best practice (i.e., the data in Table 9.4) by clicking the radio button. The screenshots of these assessment interfaces are shown in Figs. 9.4, 9.5, 9.6, 9.7, 9.8, 9.9, and 9.10. Each best practice has five radio buttons, which use numbers of 1, 2, 3, 4, and 5 to represent very low, low, medium, high, and very high, respectively. In addition, each of the seven interfaces contains a "Back" button and a "Continue" button. If the user clicks the "Back" button, the KBDSS presents the previous interface and

Fig. 9.2 The entrance interface of the KBDSS

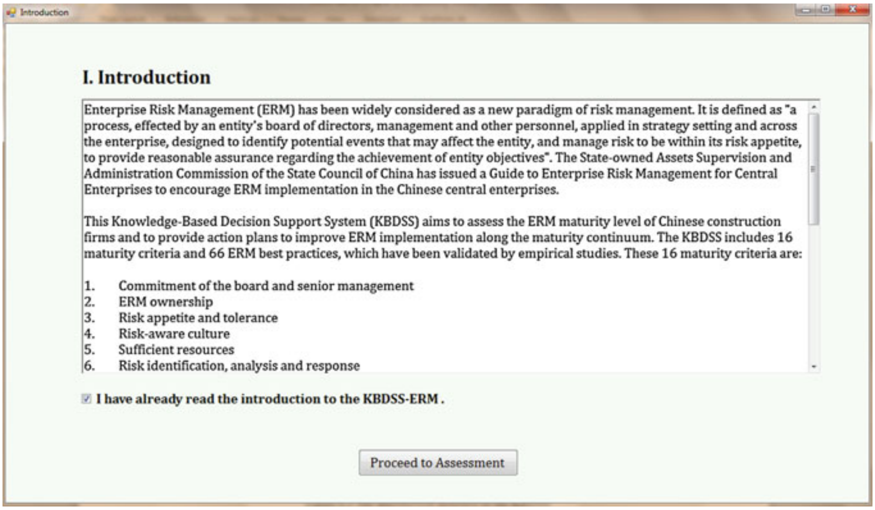


Fig. 9.3 The introduction interface of the KBDSS

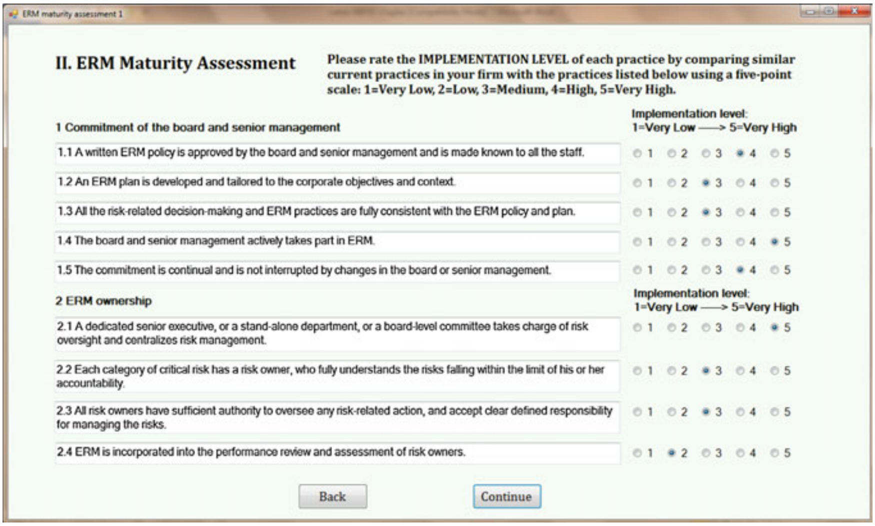


Fig. 9.4 Assessment interface 1 of the KBDSS

closes the current interface. If the user clicks the "Continue" button, the KBDSS presents the next interface and closes the current interface.

If not all the best practices on an interface are assessed by the user, the user cannot proceed to the next interface by clicking the "Continue" button and the KBDSS presents a message box to remind the user to check whether all the best practices on that interface have been assessed (see Fig. 9.11).

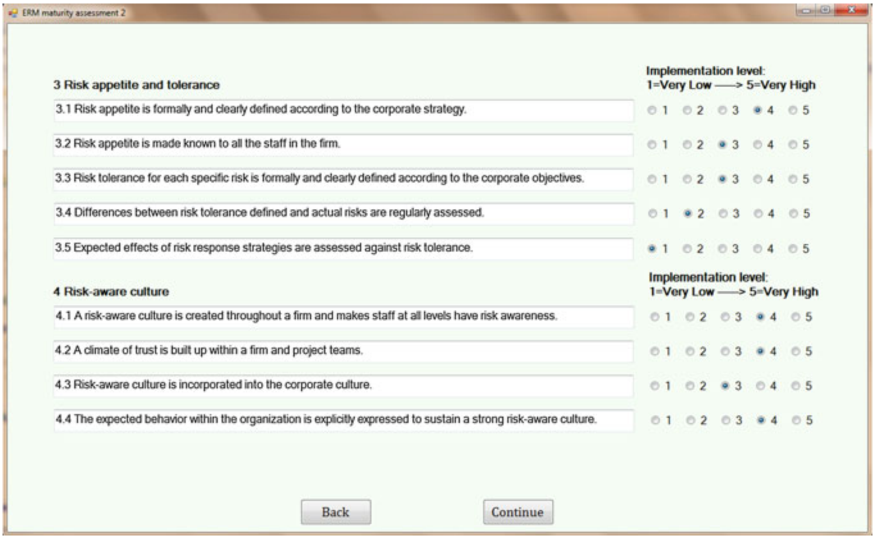


Fig. 9.5 Assessment interface 2 of the KBDSS

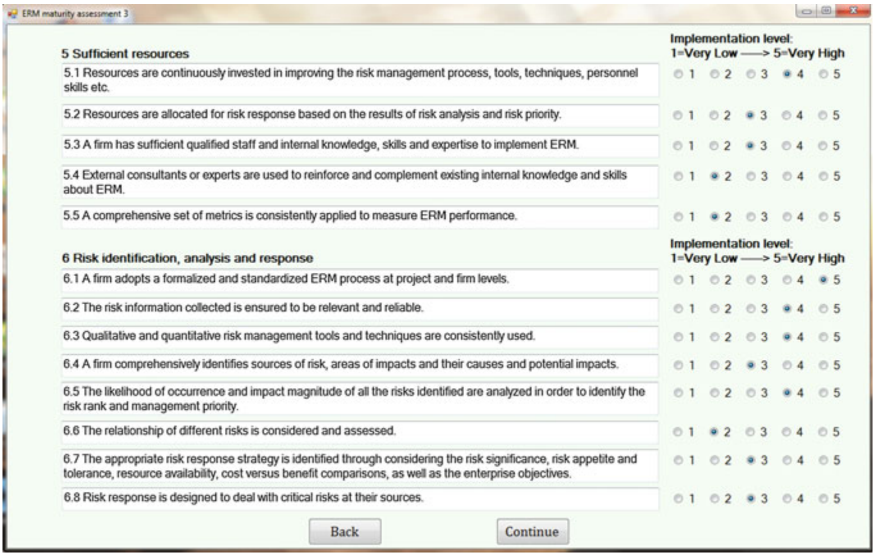


Fig. 9.6 Assessment interface 3 of the KBDSS

In addition, the KBDSS provides notes to explain some terminologies. These notes are invisible by default. To read the note, the user needs to put the cursor over a certain terminology. Figure 9.12 shows a note that explains what a KRI is.

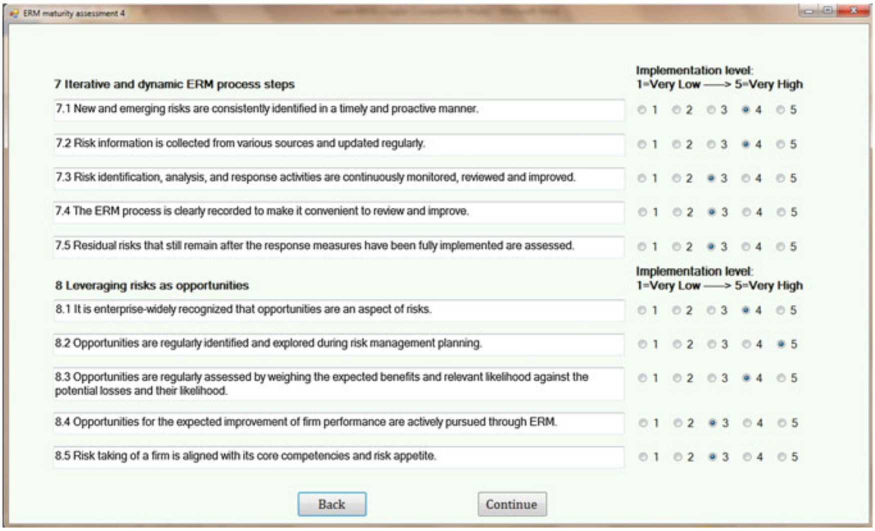


Fig. 9.7 Assessment interface 4 of the KBDSS

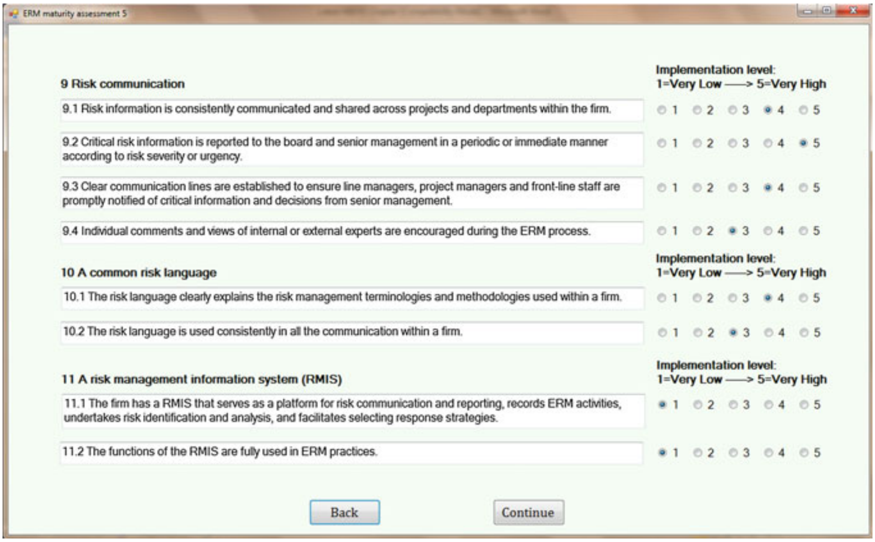


Fig. 9.8 Assessment interface 5 of the KBDSS

The KBDSS presents the results on the eighth interface of the ERM maturity assessment part (see Fig. 9.13). The user clicks the “See Results” button to obtain the criterion scores and the overall score (i.e., ERMMI). Each criterion score is in proportion to its respective bar of the histogram, and the bar color represents the

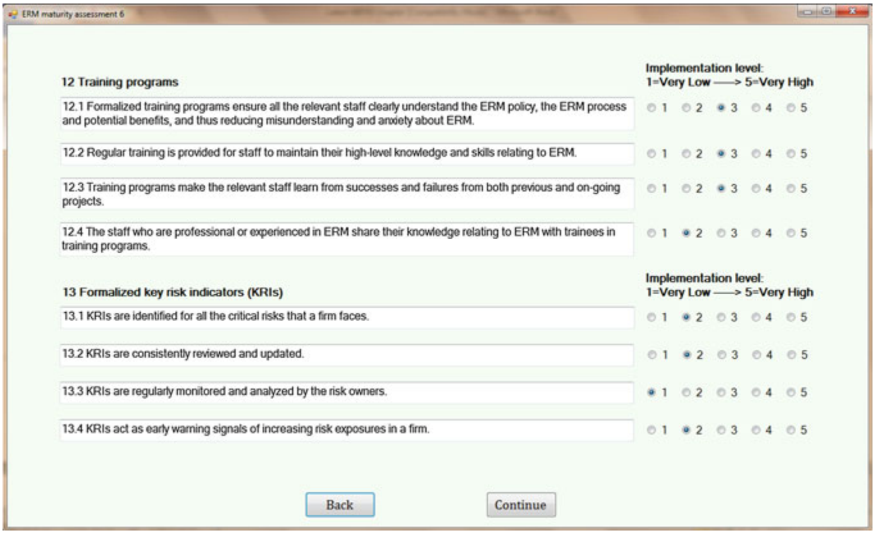


Fig. 9.9 Assessment interface 6 of the KBDSS

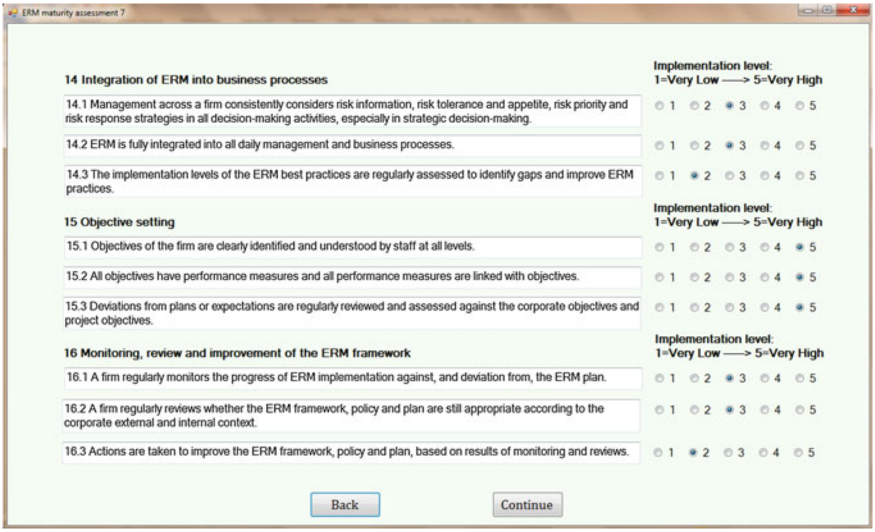


Fig. 9.10 Assessment interface 7 of the KBDSS

linguistic term that is corresponded to the score. The rules to correspond linguistic terms to scores are also provided on this interface. According to Fig. 9.13, "a RMIS" and "formalized KRIs" obtain a very low and a low implementation level, which are denoted by a red and an orange bar, respectively. The implementation of

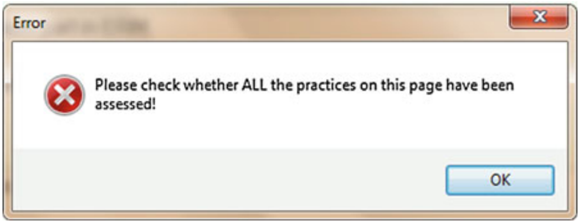


Fig. 9.11 The error message box of the KBDSS

Fig. 9.12 The note of a terminology in the KBDSS

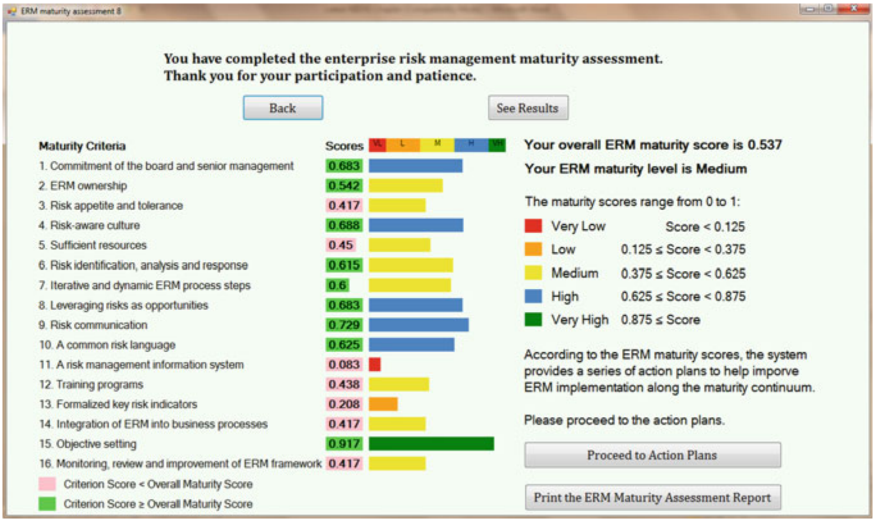


Fig. 9.13 Assessment interface 8 of the KBDSS

eight criteria is at the medium level and represented by bars in yellow, while five have high implementation levels with blue bars. Only one criterion, i.e., objective setting, has a very high implementation level, represented by a green bar. In addition, the ERMMI is 0.537, which means the ERM maturity is at the medium level. Nine criteria obtain scores with the light green backcolor, indicating that these scores are above the ERMMI, while seven have score with the pink backcolor, showing that these scores are below the ERMMI. After obtaining the assessment results, the user can proceed to see the action plans for improving ERM practices by clicking the “Proceed to Action Plans” button. Also, the user can obtain the ERM maturity assessment report by clicking the “Print the ERM Maturity Assessment Report” button. If no printer is linked to the computer, the report is printed as a PDF file.

The action plan part of the KBDSS consists of seven interfaces. The user can return to the previous interface and proceed to the next interface by clicking the “Back” button and a “Continue” button, respectively. The screenshots of these interfaces are shown in Figs. 9.14, 9.15, 9.16, 9.17, 9.18, 9.19, and 9.20. The user can click the “All the Action Plans” button to obtain all the action plans on an interface, which are selected by the KBDSS according to the assessment results. If an action plan is long and cannot be presented in one line in the textbox, the user can use the scroll bar to read the whole action plan. The screenshots in the seven figures present the action plans for improving the implementation of the 66 best practices. In addition to the “All the Action Plans” button, there are another two buttons on the top of these interfaces. On each action plan interface, only the action plans for the practices scored below the ERMMI are presented if the user clicks the “Action Plans for Practices with Scores < Overall Score” button, or only the action plans for the practices scored above the ERMMI are presented if the user clicks the “Action Plans for Practices with Scores ≥ Overall Score” button. Taking the first action plan interface as an example (see Fig. 9.14), Figs. 9.21 and 9.22 show the screenshots of the action plans for the practices scored below the ERMMI and those for the practices scored above the ERMMI, respectively.

After obtaining the action plans for improving ERM practices, the user would proceed to the exit interface (see Fig. 9.23). The user may return to the previous

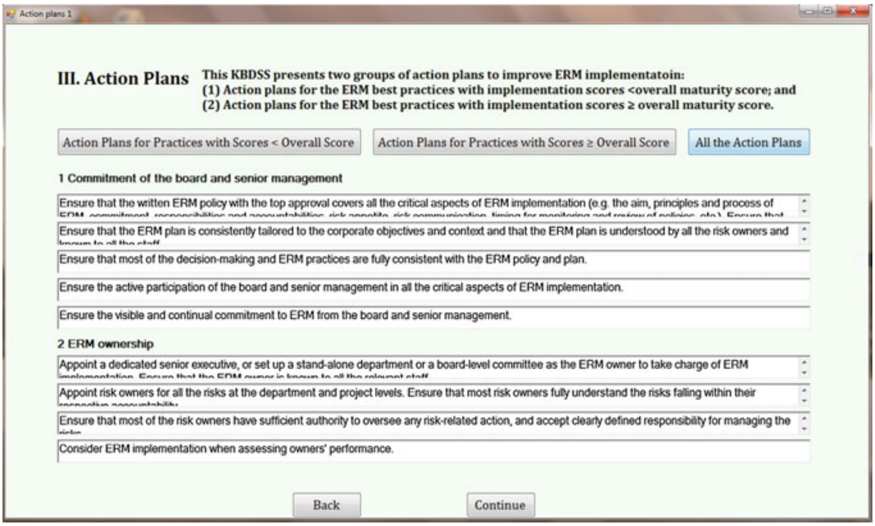


Fig. 9.14 Action plan interface 1 of the KBDSS

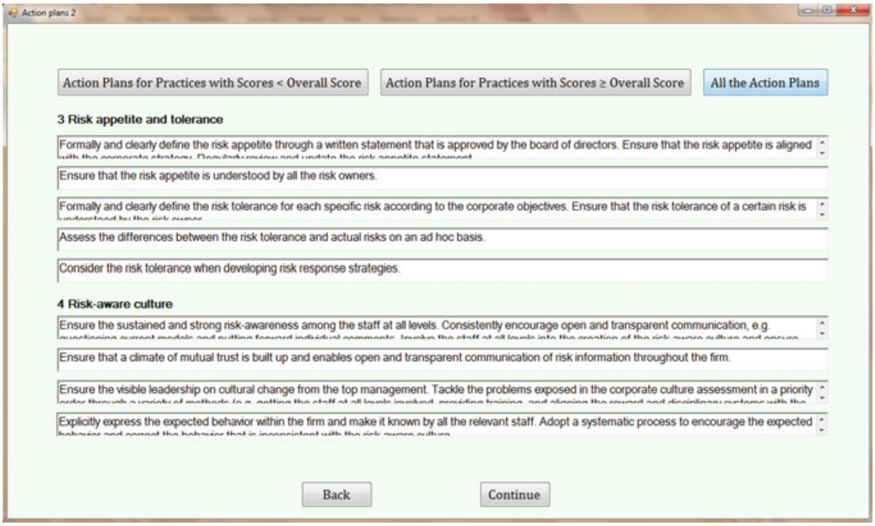


Fig. 9.15 Action plan interface 2 of the KBDSS

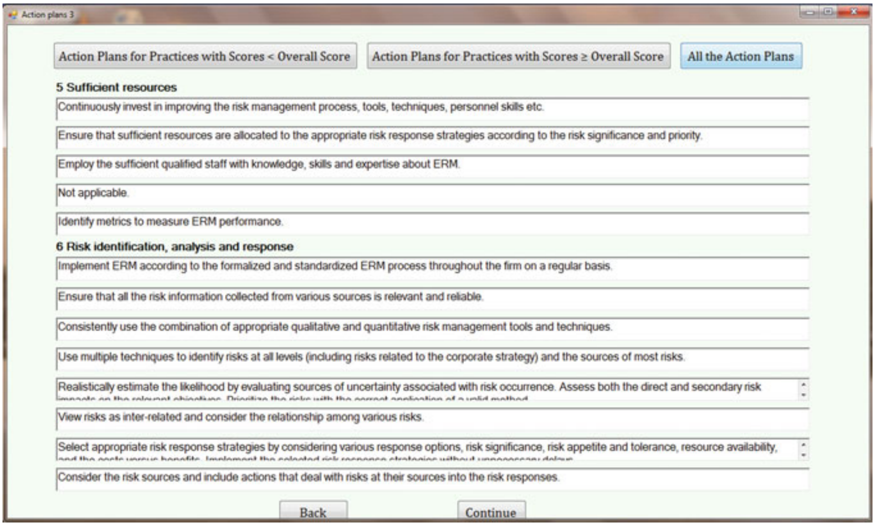


Fig. 9.16 Action plan interface 3 of the KBDSS

interface by clicking the "Back" button, exit by clicking the "Exit" button, or obtain the assessment report by clicking the "Print the ERM Maturity Assessment Report" button. The report produced here is the same as the one generated on the eighth interface of the ERM maturity assessment part.

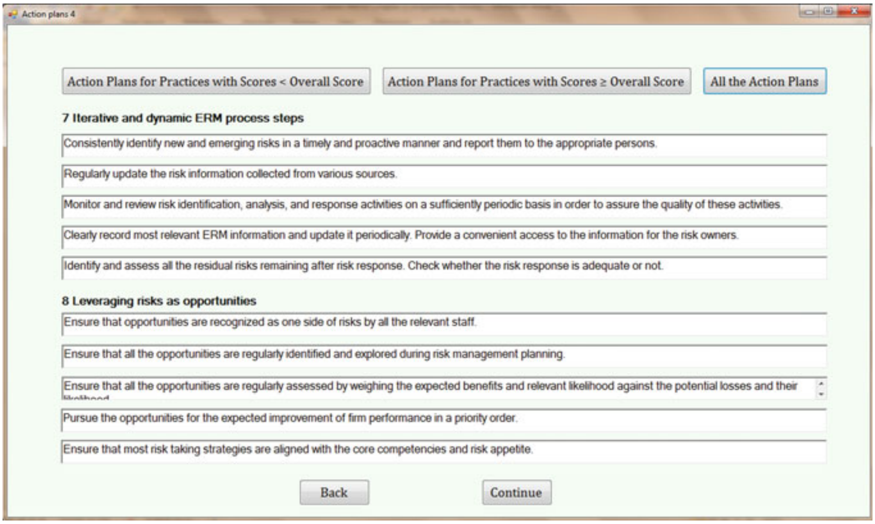


Fig. 9.17 Action plan interface 4 of the KBDSS

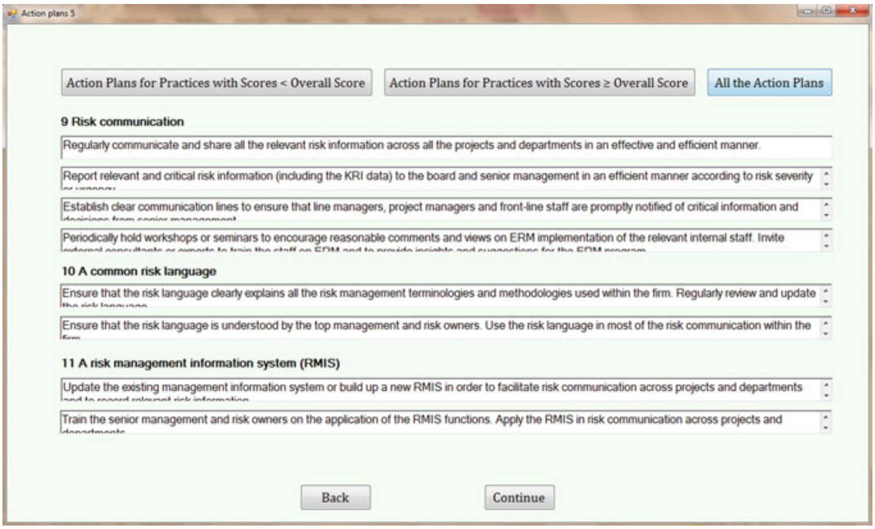


Fig. 9.18 Action plan interface 5 of the KBDSS

The printable ERM maturity assessment report consists of four pages and presents the maturity criterion scores, the overall maturity score, the visualization of the scores, and the selected action plans (see Figs. 9.24, 9.25, 9.26, and 9.27).

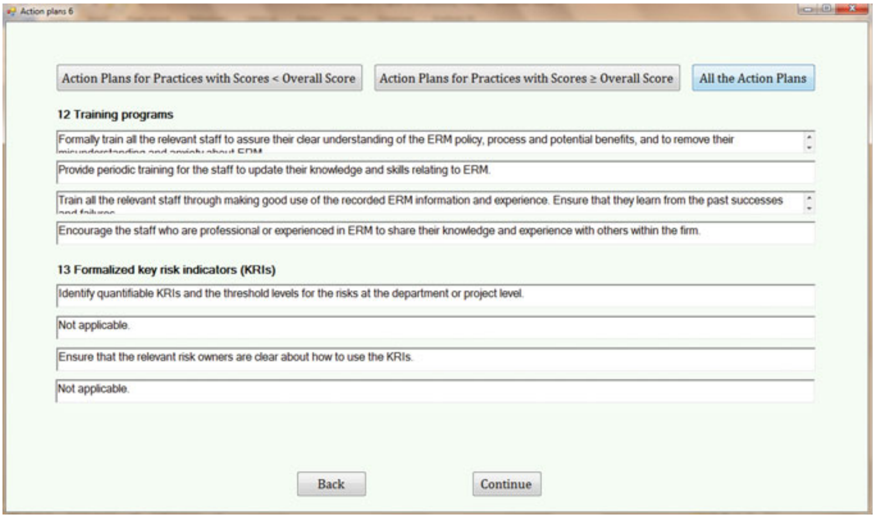


Fig. 9.19 Action plan interface 6 of the KBDSS

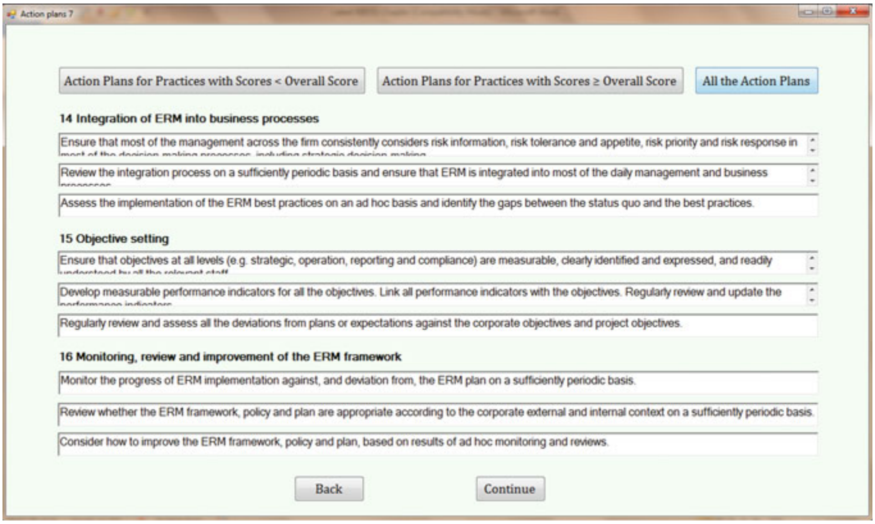


Fig. 9.20 Action plan interface 7 of the KBDSS

9.8 Validation of the KBDSS

Validation and verification techniques are used to evaluate the quality of software systems, such as KBDSSs. Verification is building the system right, while validation is building the right system (Boehm 1984). Thus, verification is aimed at

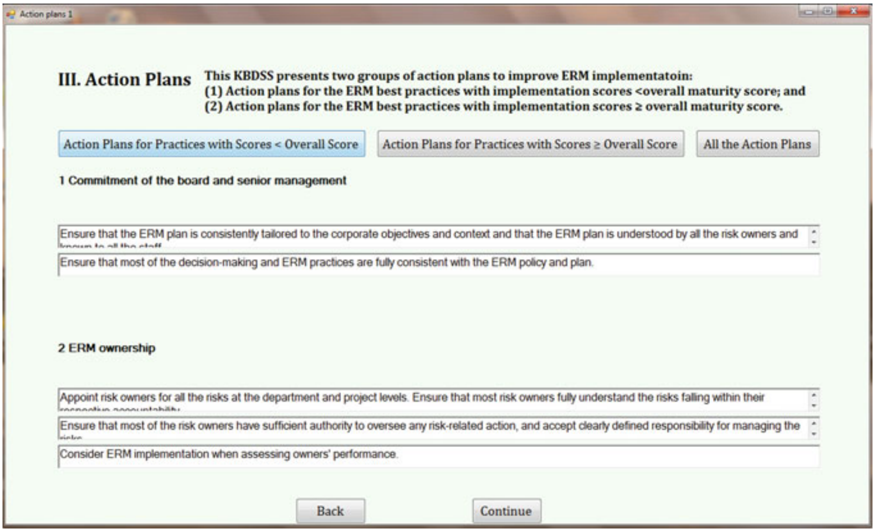


Fig. 9.21 Action plans for best practices scored below the ERMMI

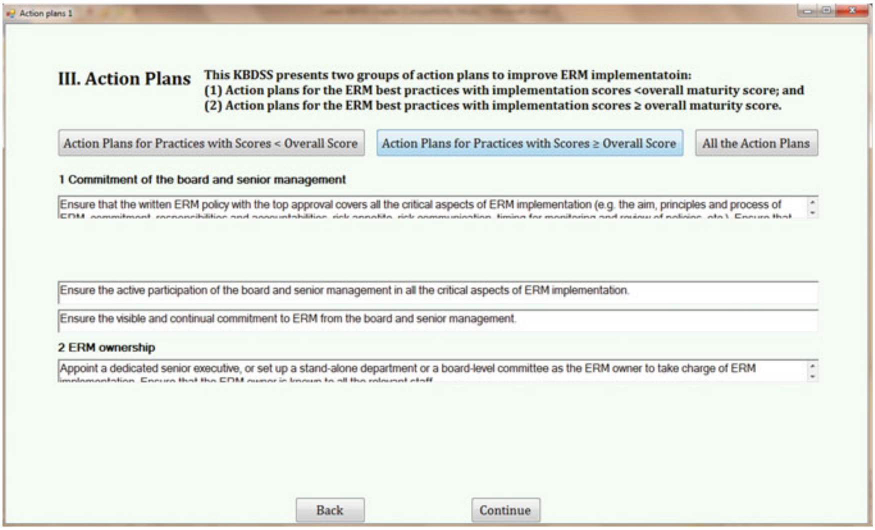


Fig. 9.22 Action plans for best practices scored above the ERMMI

eliminating errors in the system and is typically a software and programming task. Validation is more concerned with the quality of the system: the extent to which it performs its task, the degree of accuracy, and the observed robustness. Verification can be considered as part of validation: A system that is not “built right” is unlikely

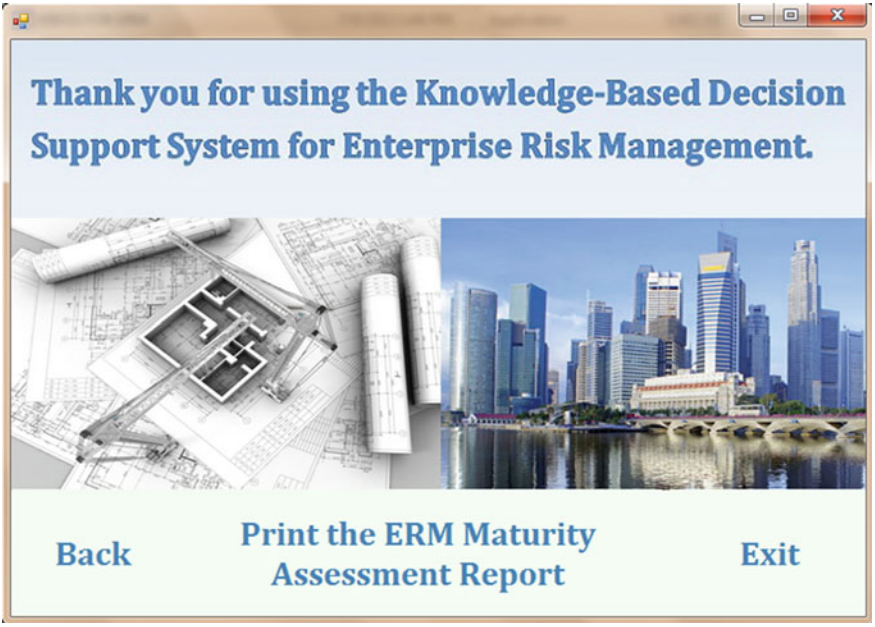
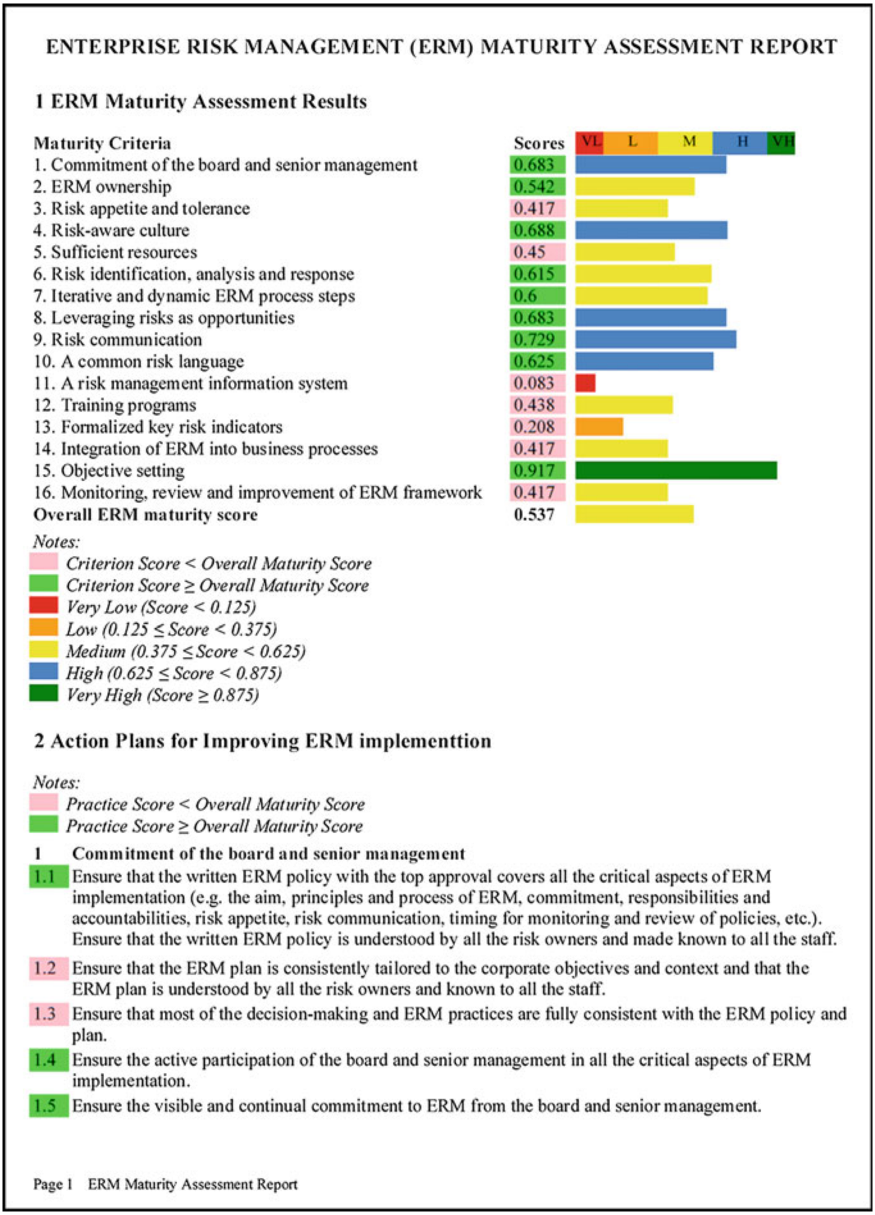


Fig. 9.23 The exit interface of the KBDSS

to be "the right system" (O'Keefe and Preece 1996; Preece 2001). Validation overshadows formal verification, and it seems that validation must always be more than verification (O'Keefe and Preece 1996). O'Keefe and O'Leary (1993) listed seven methods to validate ESs:

1. Case testing
   Cases previously solved by an expert are run through the system, or new cases are presented to both expert and system, and the solutions are compared. Case testing assumes that the experts against which the system is compared are always correct, which means if the system differs from the expert then it is wrong. Obviously, it is not always the case.
2. Turing tests
   A Turing test refers to a third-party expert comparing the results from an ES with those from a human expert. To ensure the objectivity, the process should be blinded so that it is not clear which result is the ES's and which is the human's. There is no assumption that the human expert is correct, and the third-party expert can compare, rank, or criticize as deemed appropriate.
3. Simulation
   An analogy to case testing is connecting the system to a simulation model. Each simulation run is a "test case" and different scenarios with various parameter settings can produce a number of different runs. This validation tool is powerful



ENTERPRISE RISK MANAGEMENT (ERM) MATURITY ASSESSMENT REPORT

1 ERM Maturity Assessment Results

Maturity Criteria	Scores
1. Commitment of the board and senior management	0.683
2. ERM ownership	0.542
3. Risk appetite and tolerance	0.417
4. Risk-aware culture	0.688
5. Sufficient resources	0.45
6. Risk identification, analysis and response	0.615
7. Iterative and dynamic ERM process steps	0.6
8. Leveraging risks as opportunities	0.683
9. Risk communication	0.729
10. A common risk language	0.625
11. A risk management information system	0.083
12. Training programs	0.438
13. Formalized key risk indicators	0.208
14. Integration of ERM into business processes	0.417
15. Objective setting	0.917
16. Monitoring, review and improvement of ERM framework	0.417
Overall ERM maturity score	**0.537**

Notes:
Criterion Score < Overall Maturity Score
Criterion Score ≥ Overall Maturity Score
Very Low (Score < 0.125)
Low (0.125 ≤ Score < 0.375)
Medium (0.375 ≤ Score < 0.625)
High (0.625 ≤ Score < 0.875)
Very High (Score ≥ 0.875)

2 Action Plans for Improving ERM implementtion

Notes:
Practice Score < Overall Maturity Score
Practice Score ≥ Overall Maturity Score

1 Commitment of the board and senior management

1.1 Ensure that the written ERM policy with the top approval covers all the critical aspects of ERM implementation (e.g. the aim, principles and process of ERM, commitment, responsibilities and accountabilities, risk appetite, risk communication, timing for monitoring and review of policies, etc.). Ensure that the written ERM policy is understood by all the risk owners and made known to all the staff.

1.2 Ensure that the ERM plan is consistently tailored to the corporate objectives and context and that the ERM plan is understood by all the risk owners and known to all the staff.

1.3 Ensure that most of the decision-making and ERM practices are fully consistent with the ERM policy and plan.

1.4 Ensure the active participation of the board and senior management in all the critical aspects of ERM implementation.

1.5 Ensure the visible and continual commitment to ERM from the board and senior management.

Page 1 ERM Maturity Assessment Report

Fig. 9.24 The ERM maturity assessment report sample (page 1)

for simple deterministic simulation models, but problematic in complex situations. This is because the simulation is not a perfect model that performs within an acceptable range.

2 ERM ownership

2.1 Appoint a dedicated senior executive, or set up a stand-alone department or a board-level committee as the ERM owner to take charge of ERM implementation. Ensure that the ERM owner is known to all the relevant staff.

2.2 Appoint risk owners for all the risks at the department and project levels. Ensure that most risk owners fully understand the risks falling within their respective accountability.

2.3 Ensure that most of the risk owners have sufficient authority to oversee any risk-related action, and accept clearly defined responsibility for managing the risks.

2.4 Consider ERM implementation when assessing owners' performance.

3 Risk appetite and tolerance

3.1 Formally and clearly define the risk appetite through a written statement that is approved by the board of directors. Ensure that the risk appetite is aligned with the corporate strategy. Regularly review and update the risk appetite statement.

3.2 Ensure that the risk appetite is understood by all the risk owners.

3.3 Formally and clearly define the risk tolerance for each specific risk according to the corporate objectives. Ensure that the risk tolerance of a certain risk is understood by the risk owner.

3.4 Assess the differences between the risk tolerance and actual risks on an ad hoc basis.

3.5 Consider the risk tolerance when developing risk response strategies.

4 Risk-aware culture

4.1 Ensure the sustained and strong risk-awareness among the staff at all levels. Consistently encourage open and transparent communication, e.g. questioning current models and putting forward individual comments. Involve the staff at all levels into the creation of the risk-aware culture and ensure their buy-in. Align the reward and disciplinary systems with the creation of the risk-aware culture.

4.2 Ensure that a climate of mutual trust is built up and enables open and transparent communication of risk information throughout the firm.

4.3 Ensure the visible leadership on cultural change from the top management. Tackle the problems exposed in the corporate culture assessment in a priority order through a variety of methods (e.g. getting the staff at all levels involved, providing training, and aligning the reward and disciplinary systems with the risk-aware culture).

4.4 Explicitly express the expected behavior within the firm and make it known by all the relevant staff. Adopt a systematic process to encourage the expected behavior and correct the behavior that is inconsistent with the risk-aware culture.

5 Sufficient resources

5.1 Continuously invest in improving the risk management process, tools, techniques, personnel skills etc.

5.2 Ensure that sufficient resources are allocated to the appropriate risk response strategies according to the risk significance and priority.

5.3 Employ the sufficient qualified staff with knowledge, skills and expertise about ERM.

5.4 Not applicable.

5.5 Identify metrics to measure ERM performance.

6 Risk identification, analysis and response

6.1 Implement ERM according to the formalized and standardized ERM process throughout the firm on a regular basis.

6.2 Ensure that all the risk information collected from various sources is relevant and reliable.

6.3 Consistently use the combination of appropriate qualitative and quantitative risk management tools and techniques.

6.4 Use multiple techniques to identify risks at all levels (including risks related to the corporate strategy) and the sources of most risks.

Page 2 ERM Maturity Assessment Report

Fig. 9.25 The ERM maturity assessment report sample (page 2)

4. Control groups
   A Turing test can be combined with a control group method for systems that rely on the combination of the human user and system to solve problems. Cases are presented to two separate groups: one with the system and the other without. It is anticipated that the group with the system outperforms the control

6.5 Realistically estimate the likelihood by evaluating sources of uncertainty associated with risk occurrence. Assess both the direct and secondary risk impacts on the relevant objectives. Prioritize the risks with the correct application of a valid method.

6.6 View risks as inter-related and consider the relationship among various risks.

6.7 Select appropriate risk response strategies by considering various response options, risk significance, risk appetite and tolerance, resource availability, and the costs versus benefits. Implement the selected risk response strategies without unnecessary delays.

6.8 Consider the risk sources and include actions that deal with risks at their sources into the risk responses.

7 Iterative and dynamic ERM process steps

7.1 Consistently identify new and emerging risks in a timely and proactive manner and report them to the appropriate persons.

7.2 Regularly update the risk information collected from various sources.

7.3 Monitor and review risk identification, analysis, and response activities on a sufficiently periodic basis in order to assure the quality of these activities.

7.4 Clearly record most relevant ERM information and update it periodically. Provide a convenient access to the information for the risk owners.

7.5 Identify and assess all the residual risks remaining after risk response. Check whether the risk response is adequate or not.

8 Leveraging risks as opportunities

8.1 Ensure that opportunities are recognized as one side of risks by all the relevant staff.

8.2 Ensure that all the opportunities are regularly identified and explored during risk management planning.

8.3 Ensure that all the opportunities are regularly assessed by weighing the expected benefits and relevant likelihood against the potential losses and their likelihood.

8.4 Pursue the opportunities for the expected improvement of firm performance in a priority order.

8.5 Ensure that most risk taking strategies are aligned with the core competencies and risk appetite.

9 Risk communication

9.1 Regularly communicate and share all the relevant risk information across all the projects and departments in an effective and efficient manner.

9.2 Report relevant and critical risk information (including the KRI data) to the board and senior management in an efficient manner according to risk severity or urgency.

9.3 Establish clear communication lines to ensure that line managers, project managers and front-line staff are promptly notified of critical information and decisions from senior management.

9.4 Periodically hold workshops or seminars to encourage reasonable comments and views on ERM implementation of the relevant internal staff. Invite external consultants or experts to train the staff on ERM and to provide insights and suggestions for the ERM program.

10 A common risk language

10.1 Ensure that the risk language clearly explains all the risk management terminologies and methodologies used within the firm. Regularly review and update the risk language.

10.2 Ensure that the risk language is understood by the top management and risk owners. Use the risk language in most of the risk communication within the firm.

11 A risk management information system (RMIS)

11.1 Update the existing management information system or build up a new RMIS in order to facilitate risk communication across projects and departments and to record relevant risk information.

11.2 Train the senior management and risk owners on the application of the RMIS functions. Apply the RMIS in risk communication across projects and departments.

Page 3 ERM Maturity Assessment Report

Fig. 9.26 The ERM maturity assessment report sample (page 3)

group. However, the two groups may have performed differently irrespective of one group with the system, and a small number of case studies may not show up this inherent difference.

12 Training programs

12.1 Formally train all the relevant staff to assure their clear understanding of the ERM policy, process and potential benefits, and to remove their misunderstanding and anxiety about ERM.

12.2 Provide periodic training for the staff to update their knowledge and skills relating to ERM.

12.3 Train all the relevant staff through making good use of the recorded ERM information and experience. Ensure that they learn from the past successes and failures.

12.4 Encourage the staff who are professional or experienced in ERM to share their knowledge and experience with others within the firm.

13 Formalized key risk indicators (KRIs)

13.1 Identify quantifiable KRIs and the threshold levels for the risks at the department or project level.

13.2 Not applicable.

13.3 Ensure that the relevant risk owners are clear about how to use the KRIs.

13.4 Not applicable.

14 Integration of ERM into business processes

14.1 Ensure that most of the management across the firm consistently considers risk information, risk tolerance and appetite, risk priority and risk response in most of the decision-making processes, including strategic decision-making.

14.2 Review the integration process on a sufficiently periodic basis and ensure that ERM is integrated into most of the daily management and business processes.

14.3 Assess the implementation of the ERM best practices on an ad hoc basis and identify the gaps between the status quo and the best practices.

15 Objective setting

15.1 Ensure that objectives at all levels (e.g. strategic, operation, reporting and compliance) are measurable, clearly identified and expressed, and readily understood by all the relevant staff.

15.2 Develop measurable performance indicators for all the objectives. Link all performance indicators with the objectives. Regularly review and update the performance indicators.

15.3 Regularly review and assess all the deviations from plans or expectations against the corporate objectives and project objectives.

16 Monitoring, review and improvement of the ERM framework

16.1 Monitor the progress of ERM implementation against, and deviation from, the ERM plan on a sufficiently periodic basis.

16.2 Review whether the ERM framework, policy and plan are appropriate according to the corporate external and internal context on a sufficiently periodic basis.

16.3 Consider how to improve the ERM framework, policy and plan, based on results of ad hoc monitoring and reviews.

Page 4 ERM Maturity Assessment Report

Fig. 9.27 The ERM maturity assessment report sample (page 4)

5. Sensitivity analysis
   Sensitivity analysis is performed by systematically changing a system's input variable values over some range of interest and observing the effect upon the system. One major pitfall with sensitivity analysis is that starting with a few cases and altering them is unlikely to cover a large part of the input domain.
6. Comparison against other models
   In some cases, there is likely to be a different type of model, such as an optimization or statistical model. Comparison of the system against this model can provide useful insights.
7. Line of reasoning
   Line of reasoning can be used as evidence in a Turing test. However, this requires that human experts articulate their reasoning and that it can be

presented to third-party experts in a form similar to the explanation facilities of the shell being used. A more complex approach is to compare aspects of the reasoning process, such as the relative time taken to reason, the amount of data used, or the number of hypotheses established and rejected.

Among these methods, case testing has been considered as the most prevalent method of validation (O'Keefe and Preece 1996). Some KBDSSs in the construction management area have been validated through case testing (Arain and Low 2006; Imriyas et al. 2007; Liu and Ling 2005). Although case testing assumed that experts are correct, other methods are also dependent on the subjective judgment of experts. Even if the Turing test employs a third-party expert to compare the results from the system and experts, this method still assumes that the third-party expert is correct. Thus, this research adopts case testing to validate the KBDSS because it is popular and fits the evolutionary development method common to many computerized systems (O'Keefe and O'Leary 1993).

Five experts from five different CCFs located in different countries were contacted for the validation of the KBDSS. It should be noted that these experts were not involved in the data collection of Survey I or the development of the action plans. They were coded as E1, E2, E3, E4, and E5 (see Table 9.5). Their work experience in the construction industry ranged from 11 to 31 years. Three of them held positions in the senior management, while two were department managers.

Five experts were adequate for validating the KBDSS, compared with prior studies: Arain and Low (2006) validated a KBDSS for managing variation orders by a team of four professionals and one case; Liu and Ling (2005) verified a fuzzy system for markup estimations by one expert using three cases; and Imriyas et al. (2007) validated a KBS for insurance premium rating by five experts and one hypothetical case.

During the validation process, these experts were first asked to rate the implementation levels of the 16 ERM maturity criteria as well as the overall ERM maturity of their firms according to their experience and judgments (see Appendix 4). To improve the accuracy of the rating, the scores were assigned in the form of percentage. Thus, there were at least two decimal places in the fractional part of the scores. Then, the experts applied the KBDSS to assess their ERM maturity and returned the ERM maturity assessment reports. The scores assigned by the experts (S_E) were compared with those calculated by the KBDSS (S_K). The comparison

Table 9.5 Profile of the validation experts

Expert	Experience	Designation	Location
E1	20 years	President	China
E2	18 years	Vice president	Sri Lanka
E3	11 years	Manager of Contract Department	United Arab Emirates
E4	12 years	Manager of International Marketing Department	Uganda
E5	31 years	Director	Singapore

intended to test the validity of the fuzzy ERM maturity model in the KBDSS. In addition, the experts were requested to comment on the KBDSS in terms of usefulness of the action plans to decision-making, as well as the user-friendliness of the KBDSS.

Specifically, the validity of the model was determined by calculating the percentage error (PE), mean PE (MPE), and mean absolute PE (MAPE). This approach has been adopted by Liu and Ling (2005), Lim et al. (2012), and Ling et al. (2012). The formulae are shown as below:

$$\mathrm{PE} = (S_\mathrm{E} - S_\mathrm{K})/S_\mathrm{E} \times 100\,\% \tag{9.1}$$

$$\mathrm{MPE} = \sum \mathrm{PE}_i/n \tag{9.2}$$

$$\mathrm{MAPE} = \sum |\mathrm{PE}_i|/n \tag{9.3}$$

where n is the number of experts.

The MPE is used to check whether the model result has a tendency to be over (negative sign) or below (positive sign) the respective expert judgment, while the MAPE indicates the magnitude of model errors (Liu and Ling 2005). A lower MAPE indicates a lower magnitude of errors and higher accuracy of the model.

The validation results are presented in Table 9.6. The PE values ranged from −25.0 to 39.0 %, while the MPE values ranged from −9.6 to 17.5 %. The MPE

Table 9.6 Validation results of the ERM maturity model

Code	PE					MPE (%)	MAPE (%)
	E1 (%)	E2 (%)	E3 (%)	E4 (%)	E5 (%)		
M01	−16.7	−5.7	7.1	−20.0	−12.5	−9.6	12.4
M02	−4.2	−11.0	−5.8	−5.8	−4.0	−6.2	6.2
M03	−16.7	8.5	14.3	11.1	8.5	5.1	11.8
M04	1.7	2.8	−13.1	3.8	27.0	4.4	9.7
M05	0.0	4.3	10.0	20.0	11.0	9.1	9.1
M06	10.7	11.5	10.7	6.2	−4.3	7.0	8.7
M07	20.0	−14.3	20.0	−12.5	25.0	7.6	18.4
M08	14.3	0.0	14.3	20.0	39.0	17.5	17.5
M09	1.0	12.4	8.9	14.0	12.4	9.7	9.7
M10	6.3	6.3	0.0	16.7	−25.0	0.9	10.9
M11	−25.0	17.0	17.0	17.0	16.5	8.5	18.5
M12	−12.6	16.7	−4.2	10.7	9.7	4.1	10.8
M13	12.4	17.0	16.5	−25.0	9.7	6.1	16.1
M14	2.8	16.7	0.0	−25.0	7.3	0.4	10.4
M15	−7.1	6.3	−0.8	16.6	30.5	9.1	12.3
M16	−4.2	30.5	16.8	2.8	35.3	16.2	17.9
ERMMI	−9.6	13.3	13.0	10.2	3.3	6.0	9.9

signs suggested that the model was likely to underestimate the implementation levels of 13 maturity criteria and ERMMI, and to overestimate the implementation levels of three maturity criteria. Only two maturity criteria obtained MPE values over 10 %, indicating that the results of the ERM maturity model were still consistent with the expert judgments.

In addition, the MAPE values ranged from 6.2 to 18.5 %, suggesting that the model had the accuracy ranging from 93.8 to 81.5 % in assessing the maturity criteria and the ERMMI. Fayek and Oduba (2005) reported that a fuzzy system could be seen as successful if the discrepancy between the defuzzified and actual values was less than 33 % of the actual value. Lee (2007) reported a fuzzy ES that showed the accuracy between 84.68 and 66.50 %. Ling et al. (2012) developed mathematical models to predict corporate competitiveness, with the MAPE values of 14.4 and 22.2 %. Compared with these previous studies, the fuzzy ERM maturity model in the KBDSS can be seen as robust and valid.

Moreover, the experts commented on the usefulness of the action plans to decision-making. All the five experts agreed that the action plans presented in the KBDSS were useful and helpful for making decisions relating to ERM implementation. Specifically, E1 opined that these action plans comprehensively described what a company should do to obtain a mature ERM program and included some new ideas about risk management, while E4 expressed that the action plans may serve as guidelines for the firm to implement ERM in the international market. However, E3 pointed out that the parent company should practice ERM according to the action plans and share some resources with its subsidiaries. E3 added that it was impossible to implement ERM in subsidiaries without the support from the parent company. Also, E5 expressed that the small firms would not need such complicated action plans, which substantiated the association between ERM implementation and firm size. But E5 admitted that these action plans can help the management make decisions relating to risk management. Therefore, the usefulness of the action plans to decision-making can be seen as valid.

Furthermore, all the five experts agreed that the KBDSS was user-friendly. Specifically, E2, E3, and E5 expressed that the clear interface layout made it easy for the user to assess the ERM maturity and understand how to effectively conduct risk management, while E4 pointed out that it was convenient to print out an assessment report, which allowed the users to take away the results and action plans. However, E1 suggested that it was better to provide a Chinese version of the assessment report because most of the senior management staff in CCFs had poor English ability.

9.9 Summary

This chapter presents the development of the KBDSS for ERM in CCFs. Developed using Microsoft Visual Basic 2010, the KBDSS can assess the ERM maturity, visualize the assessment results, provide action plans for improving ERM practices, and generate a printable ERM maturity assessment report. The KBDSS consists of a knowledge base, a GUI, and a DSE. The action plans in the knowledge base were acquired from the literature review and the interviews with practitioners. An example was used to demonstrate how the KBDSS works and five experts from CCFs were invited to validate the KBDSS. According to the validation results, the ERM maturity model in the KBDSS was seen as robust and valid, the action plans were useful to decision-making relating to ERM, and the KBDSS was user-friendly.

References

Alexopoulos P, Wallace M, Kafentzis K, Thomopoulos A (2009) A fuzzy knowledge-based decision support system for tender call evaluation. In: Proceedings of the 5th IFIP conference on artificial intelligence applications and innovations (AIAI' 2009)-artificial intelligence applications and innovations III, 23–25 April, Thessaloniki, Greece, pp 51–59

Arain FM, Low SP (2006) Knowledge-based decision support system for management of variation orders for institutional building projects. Autom Constr 15(3):272–291

Baloi D, Price ADF (2003) Modelling global risk factors affecting construction cost performance. Int J Project Manage 21(4):261–269

Barton TL, Shenkir WG, Walker PL (2002) Making enterprise risk management pay off. Financial Times Prentice Hall, Upper Saddle River

Boehm BW (1984) Verifying and validating software requirements and design specifications. IEEE Softw 1(1):75–88

Bonczek RH, Holsapple CW, Whinston AB (1981) Foundations of decision support systems. Academic Press, New York

Cendrowski H, Mair WC (2009) Enterprise risk management and coso: a guide for directors, executives, and practitioners. Wiley, Hoboken

Dell'Acqua G, De Luca M, Mauro R (2011) Road safety knowledge-based decision support system. Procedia-Soc Behav Sci 20:973–983

Duckert GH (2011) Practical enterprise risk management: a business process approach. Wiley, Hoboken, NJ

Eldrandaly K, Eldin N (2006) A knowledge-based decision support system for scraper selection and cost estimation. Int Arab J Inf Technol 3(4):337–341

Fayek AR, Oduba A (2005) Predicting industrial construction labor productivity using fuzzy expert systems. J Constr Eng Manage 131(8):938–941

Ferns WJ (1995) Lifenet: a knowledge-based decision support tool for the risk assessment of adolescent suicide. Expert Syst Appl 9(2):165–176

Fraser JRS (2010) How to prepare a risk profile. In: Fraser JRS, Simkins BJ (eds) Enterprise risk management. Wiley, Hoboken, pp 171–188

Hopkinson M (2011) The project risk maturity model: measuring and improving risk management capability. Gower, Burlington

Imriyas K, Low SP, Teo EAL (2007) A fuzzy knowledge-based system for premium rating of workers' compensation insurance for building projects. Constr Manage Econ 25(11):1177–1195

Jo JH, Lee JS, Ouyang Y, Peng F (2011) Integrated decision support for roadway safety analysis. J Comput Civ Eng 25(1):50–56

Kingsman BG, de Souza AA (1997) A knowledge-based decision support system for cost estimation and pricing decisions in versatile manufacturing companies. Int J Prod Econ 53(2):119–139

Klein M, Methlie LB (1990) Expert systems: a decision support approach. Addison-Wesley, Wokingham

Kumaraswamy MM, Dissanayaka SM (2001) Developing a decision support system for building project procurement. Build Environ 36(3):337–349
Lee S (2007) Application and verification of fuzzy algebraic operators to landslide susceptibility mapping. Environ Geol 52(4):615–623
Lim BTH, Ling FYY, Ibbs CW, Raphael B, Ofori G (2012) Mathematical models for predicting organizational flexibility of construction firms in Singapore. J Constr Eng Manage 138(3):361–375
Ling FYY, Li S, Low SP, Ofori G (2012) Mathematical models for predicting Chinese A/E/C firms' competitiveness. Autom Constr 24:40–51
Liu M, Ling FYY (2005) Modeling a contractor's markup estimation. J Constr Eng Manage 131 (4):391–399
Narvaez K (2011) Success stories: public entities adopt ERM best practices. Public Entity Risk Institute, Fairfax
O'Keefe RM, O'Leary DE (1993) Expert system verification and validation: a survey and tutorial. Artif Intell Rev 7(1):3–42
O'Keefe RM, Preece AD (1996) The development, validation and implementation of knowledge-based systems. Eur J Oper Res 92(3):458–473
Özbayrak M, Bell R (2003) A knowledge-based decision support system for the management of parts and tools in FMS. Decis Support Syst 35(4):487–515
Padma T, Balasubramanie P (2009) Knowledge based decision support system to assist work-related risk analysis in musculoskeletal disorder. Knowl-Based Syst 22(1):72–78
Preece A (2001) Evaluating verification and validation methods in knowledge engineering. University of Aberdeen, Aberdeen
Schneider DI (2011) An introduction to programming using Visual Basic 2010, 8th edn. Pearson, Upper Saddle River
Segal S (2011) Corporate value of enterprise risk management. Wiley, Hoboken, NJ
Shelly GB, Hoisington C (2010) Microsoft Visual Basic 2010 complete for Windows, Mobile, Web, Office Applications, International edn. Course Technology, Cengage Learning, Mason, OH
SPRING (2010) The integrated management of productivity activities (IMPACT) assessment tool. SPRING Singapore, Singapore. http://apps.enterpriseone.gov.sg/impact/web/home.html. Retrieved 28 March 2013
Turban E, Watkins PR (1986) Integrating expert systems and decision support systems. MIS Q 10 (2):121–136
Ülengin F, Topcu YI (2000) Knowledge-based decision support systems techniques and their application in transportation planning systems. In: Cornelius TL (ed) Knowledge-based systems. Academic Press, San Diego, pp 1403–1429
Uricchio VF, Giordano R, Lopez N (2004) A fuzzy knowledge-based decision support system for groundwater pollution risk evaluation. J Environ Manage 73(3):189–197
Wang WK (2005) A knowledge-based decision support system for measuring the performance of government real estate investment. Expert Syst Appl 29(4):901–912
Wen W, Wang WK, Wang CH (2005a) A knowledge-based intelligent decision support system for national defense budget planning. Expert Syst Appl 28(1):55–66
Wen W, Wang WK, Wang TH (2005b) A hybrid knowledge-based decision support system for enterprise mergers and acquisitions. Expert Syst Appl 28(3):569–582
Wen W, Chen YH, Chen IC (2008) A knowledge-based decision support system for measuring enterprise performance. Knowl-Based Syst 21(2):148–163
Yu W, Skibniewski MJ (1999) Quantitative constructability analysis with a neuro-fuzzy knowledge-based multi-criterion decision support system. Autom Constr 8(5):553–565
Zopounidis C, Doumpos M, Matsatsinis N (1997) On the use of knowledge-based decision support systems in financial management: a survey. Decis Support Syst 20(3):259–277
Zou PXW, Chen Y, Chan TY (2010) Understanding and improving your risk management capability: assessment model for construction organizations. J Constr Eng Manage 136(8):854–863

Chapter 10
Conclusions and Recommendations

Keywords Research findings · Research conclusions · Research limitations · Contributions to the literature · Contributions to the practices · Research recommendations

10.1 Research Findings and Conclusions

The major research findings and conclusions are presented in the following sections.

10.1.1 A Proposed ERM Framework for Construction Firms

The first objective of this research was to propose an ERM framework for construction firms. As Fig. 3.6 indicates, this ERM framework includes 12 components: (1) an ERM process; (2) commitment of the board and senior management; (3) training programs; (4) resources; (5) ERM ownership; (6) risk-aware culture; (7) objectives; (8) a common risk language; (9) PRM; (10) RMIS; (11) risk communication; and (12) monitoring, review, and continuous improvement of the ERM framework.

This ERM framework presents an outline of the functional activities that are necessary for ERM implementation in construction firms. According to the stage of development in ERM implementation and the real-world circumstances, construction firms can customize the framework by selecting the components that they deem as important and appropriate. Thus, the first objective, which intends to propose an ERM framework for construction firms, was fulfilled.

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10.1.2 An ERM Maturity Model for CCFs

The ERM implementation level can be described by a maturity continuum. The second objective of this research was to develop an ERM maturity model to assess the ERM maturity levels of CCFs. The keys of an ERM maturity model are the criteria or attributes that describe an effective or successful ERM program and that are related to the components of the existing ERM frameworks. Through the literature review, a total of 16 maturity criteria were identified. In addition, to enable users to easily understand the criteria and assess their ERM maturity by considering their current practices, 71 ERM best practices were identified from the literature review and the pilot study. These practices were related to the 16 criteria and served as the subcriteria.

Through Survey I with 89 professionals, the importance of the 16 maturity criteria and the applicability of the ERM best practices in CCFs were checked. The analysis results indicated that all the 16 criteria were statistically speaking, significantly important for a mature ERM program, and included in the model. Thus, Hypothesis 1, stating that "ERM maturity level in CCFs depends on a set of critical criteria," was supported. "Commitment of the board and senior management"; "risk identification, analysis, and response"; and "objective setting"; "ERM ownership"; "integration of ERM into business processes"; and "sufficient resources" were the top six important criteria with mean scores over 4.00. Using Eqs. 3.9 and 3.10, the weights of the 16 criteria in the model were calculated, ranging from 7.21 to 5.40 %. In addition, 66 out of the 71 ERM best practices were statistically speaking, significantly applicable in CCFs and thus included in the model, as the subcriteria. The five practices with *p*-values over 0.05 were not recognized as significantly applicable in CCFs and thus were excluded from the model. The exclusion of these five practices was supported by the comments from four practitioners, who participated in Survey I.

Furthermore, the FST was adopted in the model to deal with the problems relating to ambiguous, subjective, and imprecise judgments, which are inevitably involved in the ERM maturity assessment and cannot be handled by the classical set theory.

The ERM maturity model was embedded into the KBDSS and validated by five experts. They were from five different CCFs located in different countries and did not participate in the Survey I. It was found that the assessment results from the KBDSS were consistent with the expert judgments and that the accuracy of the model in assessing the maturity criteria and ERMMI ranged from 93.8 to 81.5 %. Therefore, the fuzzy ERM maturity model was considered as robust and valid. The second research objective, "develop an ERM maturity model to assess the ERM maturity in CCFs," was achieved.

10.1.3 ERM Maturity in CCFs Based in Singapore

The third research objective was to investigate the ERM maturity level in CCFs based in Singapore. Survey II was performed to collect the data relating to the implementation levels of the 66 ERM best practices from 35 CCFs in Singapore. By inputting these data into the ERM maturity model, the ERMMI values of these firms were obtained.

It was found that 71.4 % of these firms had low-level ERM maturity (i.e., $0.125 \leq \text{ERMMI} < 0.375$), while the remaining had medium-level ERM maturity (i.e., $0.375 \leq \text{ERMMI} < 0.625$). Also, this research investigated the relationship between ERM maturity and firm size and found that there appeared to be significant association between ERM maturity level and firm size. Thus, the larger firms tended to have higher-level ERM maturity. This finding was also substantiated by the three case studies.

Although some CCFs had medium-level ERM maturity, the overall mean ERMMI of all the 35 CCFs in Singapore was 0.325, implying that their overall ERM maturity level was low (i.e., $0.125 \leq \text{ERMMI} < 0.375$). Thus, Hypothesis 2 that "ERM maturity level in CCFs based in Singapore is low" was accepted, and the third research objective was fulfilled.

10.1.4 Critical Factors Driving and Hindering ERM Implementation in CCFs Based in Singapore

The ERM maturity can be influenced by the interactions between the drivers for and hindrances to ERM implementation. The fourth research objective was to examine the critical factors driving and hindering the implementation of ERM in CCFs based in Singapore and to analyze them in tandem with theories of organizational behavior. A total of 17 drivers and 36 hindrances were identified through the comprehensive literature review, and the data that could assess the significance of these factors in influencing ERM implementation were collected in Survey II.

In terms of the drivers for ERM implementation, the analysis results indicated that "improved decision-making," "reduced costs and losses," "competitive advantages," "reduced earnings volatility," and "improved control of an enterprise over its projects" were the top five influential drivers. Also, 13 out of the 17 drivers significantly drove ERM implementation in CCFs based in Singapore. Thus, Hypothesis 3, stating that "ERM implementation in CCFs based in Singapore is affected by a set of critical drivers," was partially supported. In addition, the drivers relating to the potential benefits of ERM were found to have significant positive influence on ERM implementation. By contrast, those relating to compliance and corporate governance requirements, i.e., "legal and regulatory compliance requirements," "non-mandatory reports or standards," and "credit rating agencies' requirements," did not have significant positive influence on ERM implementation.

However, these three drivers were found to have greater influence on ERM implementation in the medium-maturity CCFs than the low-maturity firms. In addition to these three drivers, “reduced costs and losses” and “improved clients’ satisfaction” had different mean scores between the two CCF groups. Despite statistical differences in the mean scores of the five drivers, there was statistically significant agreement on the rankings of all the drivers between the low- and medium-maturity CCFs.

As for the hindrances to ERM implementation, “insufficient resources (e.g., time, money, and people),” “lack of perceived value or benefits,” “perception that ERM increases costs and administration,” “unsupportive organizational culture,” “inadequate training on ERM,” “lack of qualified personnel to implement ERM,” “lack of internal knowledge, skills and expertise,” “lack of an ERM business case,” “lack of the board or senior management leadership,” and “lack of a clear ERM implementation plan” were the top ten influential hindrances. Also, the analysis results indicated that 25 out of the 36 hindrances significantly hindered ERM implementation in CCFs based in Singapore. Thus, Hypothesis 4, stating that “ERM implementation in CCFs based in Singapore is affected by a set of critical hindrances,” was partially supported. In addition, “lack of risk management techniques and tools,” “lack of an ERM business case,” and “lack of a clear ERM implementation plan” had greater negative influence on ERM implementation in the low-maturity CCFs, while “inability to coordinate with other departments” exerted more negative influence on ERM implementation in the medium-maturity CCFs. Despite significant differences in the mean scores of the four hindrances, there was strong and statistical significant agreement on the rankings of all the hindrances between the low- and medium-maturity CCFs.

In this research, ERM implementation can be seen as an incremental, evolutionary, and continuous organizational change in construction firms. Organizational change requires organizational learning as a medium (Alas and Sharifi 2002), change in organizational culture (Senior and Fleming 2006), appropriate motivation, and the leadership of change agents. Hence, the significant drivers and hindrances were interpreted in tandem with the organizational behavior theories. From the perspective of organizational change theories, some of the drivers for ERM implementation were consistent with Theory E, while others were in accordance with Theory O, indicating that both theories could be used to implement ERM in the Singapore-based CCFs. The 13 significant drivers for ERM implementation were also linked to the driving forces of organizational change (see Sect. 7.3.3.3). In addition, the 25 significant hindrances were linked to the sources of resistances to organizational change, the impediments to organizational learning, the three-level organizational culture model, the hygiene factors and the expectancy and instrumentality variables in the expectancy theory of motivation, as well as the potential errors of leaders, respectively (see Sect. 7.3.4.3). Therefore, the fourth research objective, stating that “examine the critical factors driving and hindering the implementation of ERM in CCFs based in Singapore, and analyze them in tandem with theories of organizational behavior,” was achieved.

10.1.5 A KBDSS for ERM

The last research objective was to develop a KBDSS for ERM in CCFs. This KBDSS can assess the ERM maturity, visualize the ERM maturity assessment results, provide action plans for improving ERM practices along the maturity continuum, and generate a printable ERM maturity assessment report. This KBDSS was developed using Microsoft Visual Basic 2010 and consisted of a knowledge base, a GUI, and a DSE. The knowledge base contained the 16 ERM maturity criteria, the 66 ERM best practices applicable in CCFs, and the 191 action plans for improving the implementation of the best practices that were acquired from the comprehensive literature review and the practitioner interviewees. The DSE can compute the maturity scores using the fuzzy ERM maturity model, visualize the results, select the appropriate action plans for users, and generate a report in the printable format. The action plans for improving ERM implementation were acquired from the comprehensive literature review and the interviews with practitioners. As the validation results indicated, the action plans were useful and helpful for making decisions relating to ERM implementation, and the KBDSS was user-friendly. Thus, the fifth research objective, involving the development of an ERM KBDSS, was fulfilled.

10.1.6 Conclusions

This research provided an understanding of how ERM was implemented in CCFs based in Singapore by fulfilling five research objectives and testing four hypotheses. Hypotheses 1 and 2 were fully supported, while Hypotheses 3 and 4 were partially supported because some drivers and hindrances were not significantly influential to ERM implementation. Some major conclusions can be drawn and are presented as follows:

1. The fuzzy ERM maturity model, consisting of 16 criteria and 66 subcriteria, can effectively assess ERM maturity in CCFs in the global market;
2. The overall ERM maturity level of CCFs based in Singapore is low, while larger firms are likely to have higher-level ERM maturity;
3. The ERM implementation in CCFs based in Singapore is significantly driven by 13 factors and significantly hindered by 25 factors;
4. The ERM implementation in CCFs based in Singapore is influenced by the parent companies of these CCFs; and
5. The computerized KBDSS is user-friendly and helpful for not only decision-making, but also ERM maturity assessment and development of plans for improvement.

10.2 Contributions to the Literature

A number of studies have uncovered ERM implementation in various industries, such as the banking (Ciorciari and Blattner 2008; Wu and Olson 2009), insurance (Hoyt and Liebenberg 2011; Nocco and Stulz 2006), and energy industries (Aabo et al. 2005; Muralidhar 2010). However, few have attempted to focus on ERM implementation status in the construction industry. Thus, this research expands the literature through providing an understanding of ERM implementation in construction firms.

The first contribution of this research is a proposed ERM framework to facilitate ERM implementation in construction firms (see Fig. 3.6). Compared with the existing ERM frameworks for various industries, this framework considers the project-based nature of construction firms and the key issues of ERM, thus clarifying the relationship between ERM and PRM.

The second contribution is an ERM maturity model for CCFs. Different from the existing ERMMMs, the proposed model adopts the FST because this theory can tackle the problems relating to ambiguous, subjective, and imprecise judgments. The FST can quantify the linguistic facets of data (Pedrycz et al. 2011; Zimmermann 2001). Thus, the proposed model is quantitative, different from most of the existing models that are qualitative. In addition, the proposed model consists of the 16 important maturity criteria and 66 ERM best practices, which have been validated in Survey I. These criteria and best practices are more comprehensive than the existing models and enable users to easily understand the criteria and assess their ERM maturity according to their current ERM practices. Using this model, this research investigates the degree of ERM maturity in CCFs based in Singapore.

Thirdly, few studies have identified the drivers for and hindrances to ERM implementation in construction firms. Thus, the identification of the critical factors driving and hindering the ERM implementation in Singapore-based CCFs can contribute to the literature.

Lastly, this research elaborates the relationship among the theories of organizational behavior, including the theories of organizational change, organizational learning, organizational culture, motivation, and leadership (see Fig. 4.7). Given that few studies have investigated the theoretical rational behind ERM implementation, this research interprets ERM implementation in construction firms in tandem with the theories of organizational behavior and provides the theoretical rational behind the ERM implementation in Singapore-based CCFs. Thus, this research expands the literature of ERM and contributes to the theories of organizational behavior.

10.3 Contributions to the Practices

This research significantly contributes to the practices. Specifically, this research identifies 16 important ERM maturity criteria and 66 applicable ERM best practices, which provide a comprehensive picture of a mature ERM program and can comprise a guide for ERM implementation in construction firms.

In addition, the ERM maturity model developed in this research allows users to assess its ERM maturity and to obtain a clear view of the status quo, strengths, and weaknesses of their ERM implementation. Based on the assessment results, the management staff of the company can take measures and prioritize resources to improve the weak areas of the ERM implementation.

As the ERM maturity model adopts the FST to calculate the maturity scores, the application of this model involves perceptibly complicated mathematical calculations. Thus, this research develops an ERM KBDSS, which includes the model and provides an easy-to-use computerized platform for the users to assess ERM maturity, thus ensuring the accuracy of the calculations of TFNs. Also, the KBDSS contains a series of action plans for improving ERM implementation. According to the assessment results, the KBDSS can select specific action plans for improving the implementation of specific best practices, thus effectively supporting the decision-making relating to ERM. In addition, the KBDSS can generate a printable ERM maturity assessment report, which includes the assessment results and the recommended action plans, thus making it easy for the users to keep the results and the action plans. Furthermore, the KBDSS serves as a learning tool for the users unfamiliar with ERM. When they use the KBDSS, they need to read the ERM best practices and think about the current practices in their firms. This thinking process is likely to contribute to their knowledge and practices relating to ERM.

Moreover, the identification of the critical drivers for and hindrances to ERM implementation allows practitioners to take measures to strengthen the positive influence of drivers and diminish the negative influence of hindrances. The management would refer to the action plans provided by the KBDSS to develop the specific measures, and determine the priority of the measures.

Lastly, case studies were performed to uncover how ERM was implemented in CCFs in Singapore and present managerial implications through cross-case comparisons. These implications allow practitioners to understand ERM implementation in reality and learn from the past experiences of other firms, thus contributing to the ERM practices.

10.4 Limitations

Despite the achievement of the research objectives, there are limitations to the conclusions drawn from this research.

Although the ERM maturity criteria, ERM best practices, and the factors driving and hindering ERM implementation were identified from the comprehensive literature review, they may not be exhaustive with the passage of time.

In addition, because of the difficulty in constructing a sampling frame in Survey I, this study used the non-probability sample, which has inherent limitations. Despite the inherent limitations, it can still be used to obtain a representative sample (Patton 2001) and has been recognized as being appropriate when the respondents were not randomly selected from the entire population, but were rather selected based on whether they were willing to participate in the study (Wilkins 2011).

10.5 Recommendations for Future Research

This research sets a foundation for future research on ERM implementation in the construction industry. Future research is recommended in the following areas.

Firstly, this research found that the potential benefits significantly drove ERM implementation. The management staff should be convinced that these benefits can outweigh the cost related to ERM implementation. Thus, future research would develop a set of metrics that can measure ERM performance, which could demonstrate the tangible ERM benefits to the management staff.

In addition, future research can examine the impact of implementing ERM on project performance, and the differences in project performance between construction firms with different ERM maturity levels. As construction firms are project-based, the positive impact on project performance can be a tangible benefit of ERM. If the improvement in project performance resulting from implementing ERM could be confirmed, more construction firms would be motivated to implement ERM.

Moreover, as ERM implementation can be seen as an organizational change, future research would investigate the appropriate organizational learning styles, motivation measures, and leadership styles for ERM implementation in construction firms, which can expand the literature relating to theories of organizational behavior.

Lastly, further research would develop a benchmarking system for ERM and establish a database containing the maturity scores collected from a large number of construction firms with various characteristics. The benchmarking system could be embedded into the KBDSS, which allows the users to compare their ERM implementation with the average implementation level of all the firms and those with certain firm characteristics, respectively. Such an updated KBDSS therefore allows the users to make better informed decisions relating to ERM.

References

Aabo T, Fraser JRS, Simkins BJ (2005) The rise and evolution of the chief risk officer: enterprise risk management at Hydro One. J Appl Corp Finance 17(3):62–75

Alas R, Sharifi S (2002) Organizational learning and resistance to change in Estonian companies. Hum Resource Dev Int 5(3):313–331

Ciorciari M, Blattner P (2008) Enterprise risk management maturity-level assessment tool. 2008 Enterprise risk management symposium, Chicago, IL, 14–16 April

Hoyt RE, Liebenberg AP (2011) The value of enterprise risk management. J Risk Insur 78(4):795–822

Muralidhar K (2010) Enterprise risk management in the Middle East oil industry: an empirical investigation across GCC countries. Int J Energy Sect Manage 4(1):59–86

Nocco BW, Stulz RM (2006) Enterprise risk management: theory and practice. J Appl Corp Finance 18(4):8–20

Patton MQ (2001) Qualitative research and evaluation components, 3rd edn. Sage, Thousand Oaks

Pedrycz W, Ekel P, Parreiras R (2011) Fuzzy multicriteria decision-making: models, methods and applications. Wiley, Chichester

Senior B, Fleming J (2006) Organizational change, 3rd edn. Financial Times Prentice Hall, Harlow

Wilkins JR (2011) Construction workers' perceptions of health and safety training programmes. Constr Manage Econ 29(10):1017–1026

Wu D, Olson DL (2009) Enterprise risk management: small business scorecard analysis. Prod Plann Control 20(4):362–369

Zimmermann HJ (2001) Fuzzy set theory and its applications, 4th edn. Kluwer Academic Publishers, Boston

Appendix 1
Questionnaire in Survey I

Survey on Enterprise Risk Management Maturity Criteria and the Best Practices of Chinese Construction Firms

Part I: Introduction

Risk management in construction firms should cover not just the project risks, but also the risks at the enterprise level. Hence, enterprise risk management (ERM), which has been widely used in financial and energy industries, is also necessary for construction firms, though few studies about ERM in construction firms have been conducted. The Committee of Sponsoring Organizations of the Treadway Commission (COSO) in the USA defined ERM as "*a process, effected by an entity's board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives.*" The State-owned Assets Supervision and Administration Commission (SASAC) of the State Council of China issued a *Guide to Enterprise Risk Management for Central Enterprises* in 2006 to encourage ERM implementation in the Chinese central enterprises.

This research aims to gain an understanding of ERM implementation in Chinese construction firms (CCFs) in Singapore. As part of the research, this survey is to ***identify the importance weightings of the criteria in an ERM maturity assessment model, and the applicability of the ERM best practices in CCFs***.

You are invited to rate the importance of the 16 criteria, the applicability of the 71 ERM best practices according to your experience and knowledge, and the significance of factors. In addition, you are welcomed to provide other best practice that you deem as important and rational for ERM in CCFs. The findings of this study will be used to establish an ERM maturity assessment model for CCFs.

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We assure you that the information provided by you will be used solely for the purpose of academic research. No individual company or person will be identified in the research.

Thank you for your kind assistance.

Yours sincerely,

Zhao Xianbo, Ph.D. Candidate
Department of Building
National University of Singapore

Part II: General Information

1. Your institution type:

   ☐(a) Chinese construction firm; ☐(b) Academic or research institution

2. Designation: __________

3. Years of your work or research experience in the construction industry:

   ☐(a) 5–10; ☐(b) 11–15; ☐(c) 16–20; ☐(d) 21–25; ☐(e) >25

4. If you are from a firm, where is the firm?

   ☐(a) China; ☐(b) Asia (without China); ☐(c) Africa; ☐(d) Europe;
   ☐(e) Latin America; ☐(f) North America; ☐(g) Oceania.

Part III: ERM Best Practices

Please rate the **APPLICABILITY** in applying the following best practices in CCFs using a five-point scale: **1 = very inapplicable, 2 = inapplicable, 3 = medium, 4 = applicable, 5 = very applicable**

No.	Criteria and best practices	Rating (1 = Very inapplicable; 5 = Very applicable)				
		1	2	3	4	5
Criterion 1 Commitment of the board and senior management						
B1.1	A written ERM policy is approved by the board and senior management and is made known to all the staff	☐	☐	☐	☐	☐
B1.2	An ERM plan is developed and tailored to the corporate objectives and context	☐	☐	☐	☐	☐
B1.3	All the risk-related decision-making and ERM practices are fully consistent with the ERM policy and plan	☐	☐	☐	☐	☐
B1.4	The board and senior management actively takes part in ERM	☐	☐	☐	☐	☐
B1.5	The commitment is continual and is not interrupted by changes in the board or senior management	☐	☐	☐	☐	☐
Criterion 2 ERM ownership						
B2.1	A dedicated senior executive, or a stand-alone department, or a board-level committee takes charge of risk oversight and centralizes risk management	☐	☐	☐	☐	☐
B2.2	All the staff actively participate in the ERM process	☐	☐	☐	☐	☐
B2.3	Each category of critical risk has a risk owner, who fully understands the risks falling within the limit of his or her accountability	☐	☐	☐	☐	☐
B2.4	All risk owners have sufficient authority to oversee any risk-related action and accept clear defined responsibility for managing the risks	☐	☐	☐	☐	☐
B2.5	The authority and responsibility of risk owners is understood by staff at all levels of a firm	☐	☐	☐	☐	☐
B2.6	ERM is incorporated into the performance review and assessment of risk owners	☐	☐	☐	☐	☐
Criterion 3 Risk appetite and tolerance[a]						
B3.1	Risk appetite is formally and clearly defined according to the corporate strategy	☐	☐	☐	☐	☐
B3.2	Risk appetite is made known to all the staff in the firm	☐	☐	☐	☐	☐
B3.3	Risk tolerance for each specific risk is formally and clearly defined according to the corporate objectives	☐	☐	☐	☐	☐
B3.4	Differences between risk tolerance defined and actual risks are regularly assessed	☐	☐	☐	☐	☐
B3.5	Expected effects of risk response strategies are assessed against risk tolerance	☐	☐	☐	☐	☐
Criterion 4 Risk-aware culture						
B4.1	A risk-aware culture is created throughout a firm and makes staff at all levels have risk awareness	☐	☐	☐	☐	☐
B4.2	A climate of trust is built up within a firm and project teams	☐	☐	☐	☐	☐
B4.3	Risk-aware culture is incorporated into the corporate culture	☐	☐	☐	☐	☐
B4.4	There is neither a blame-culture nor defensive routines[b] in a firm	☐	☐	☐	☐	☐
B4.5	The expected behavior within the organization is explicitly expressed to sustain a strong risk-aware culture	☐	☐	☐	☐	☐

(continued)

No.	Criteria and best practices	Rating (1 = Very inapplicable; 5 = Very applicable)				
Criterion 5 resources						
B5.1	Resources are continuously invested in improving the risk management process, tools, techniques, personnel skills, etc.	☐	☐	☐	☐	☐
B5.2	Resources are allocated for risk response based on the results of risk analysis and risk priority	☐	☐	☐	☐	☐
B5.3	A firm has sufficient qualified staff and internal knowledge, skills and expertise to implement ERM	☐	☐	☐	☐	☐
B5.4	External consultants or experts are used to reinforce and complement existing internal knowledge and skills about ERM	☐	☐	☐	☐	☐
B5.5	A comprehensive set of metrics is consistently applied to measure ERM performance	☐	☐	☐	☐	☐
Criterion 6 Risk identification, analysis, and response						
B6.1	A firm adopts a formalized and standardized ERM process at project and firm levels	☐	☐	☐	☐	☐
B6.2	The risk information collected is ensured to be relevant and reliable	☐	☐	☐	☐	☐
B6.3	Qualitative and quantitative risk management tools and techniques are consistently used	☐	☐	☐	☐	☐
B6.4	A firm comprehensively identifies sources of risk, areas of impacts, and their causes and potential impacts	☐	☐	☐	☐	☐
B6.5	The likelihood of occurrence and impact magnitude of all the risks identified are analyzed in order to identify the risk rank and management priority	☐	☐	☐	☐	☐
B6.6	The relationship of different risks is considered and assessed	☐	☐	☐	☐	☐
B6.7	The appropriate risk response strategy is identified through considering the risk significance, risk appetite and tolerance, resource availability, and cost versus benefit comparisons, as well as the enterprise objectives	☐	☐	☐	☐	☐
B6.8	Risk response is designed to deal with critical risks at their sources	☐	☐	☐	☐	☐
Criterion 7 Iterative and dynamic ERM process steps						
B7.1	New and emerging risks are consistently identified in a timely and proactive manner	☐	☐	☐	☐	☐
B7.2	Risk information is collected from various sources and updated regularly	☐	☐	☐	☐	☐
B7.3	Risk identification, analysis, and response activities are continuously monitored, reviewed, and improved	☐	☐	☐	☐	☐
B7.4	The ERM process is clearly recorded to make it convenient to review and improve	☐	☐	☐	☐	☐
B7.5	Residual risks that still remain after the response measures have been fully implemented are assessed	☐	☐	☐	☐	☐
Criterion 8 Leveraging risks as opportunities						
B8.1	It is enterprise-widely recognized that opportunities are an aspect of risks	☐	☐	☐	☐	☐
B8.2	Opportunities are regularly identified and explored during risk management planning	☐	☐	☐	☐	☐

(continued)

No.	Criteria and best practices	Rating (1 = Very inapplicable; 5 = Very applicable)				
B8.3	Opportunities are regularly assessed by weighing the expected benefits and relevant likelihood against the potential losses and their likelihood	☐	☐	☐	☐	☐
B8.4	Opportunities for the expected improvement of firm performance are actively pursued through ERM	☐	☐	☐	☐	☐
B8.5	Risk taking of a firm is aligned with its core competencies and risk appetite	☐	☐	☐	☐	☐
Criterion 9 Risk communication						
B9.1	Risk information is consistently communicated and shared across projects and departments within the firm	☐	☐	☐	☐	☐
B9.2	Critical risk information is reported to the board and senior management in a periodic or immediate manner according to risk severity or urgency	☐	☐	☐	☐	☐
B9.3	Clear communication lines are established to ensure line managers, project managers, and frontline staff are promptly notified of critical information and decisions from senior management	☐	☐	☐	☐	☐
B9.4	Individual comments and views of internal or external experts are encouraged during the ERM process	☐	☐	☐	☐	☐
Criterion 10 A common risk language[c]						
B10.1	The risk language clearly explains the risk management terminologies and methodologies used within a firm	☐	☐	☐	☐	☐
B10.2	The risk language is understood and maintained by all the staff within a firm	☐	☐	☐	☐	☐
B10.3	The risk language is used consistently in all the communication within a firm	☐	☐	☐	☐	☐
Criterion 11 A risk management information system (RMIS)						
B11.1	The firm has a RMIS that serves as a platform for risk communication and reporting, records ERM activities, undertakes risk identification and analysis, and facilitates selecting response strategies	☐	☐	☐	☐	☐
B11.2	Staff at all levels clearly understand how to apply the RMIS in ERM practices	☐	☐	☐	☐	☐
B11.3	The functions of the RMIS are fully used in ERM practices	☐	☐	☐	☐	☐
Criterion 12 Training programs						
B12.1	Formalized training programs ensure all the relevant staff clearly understand the ERM policy, the ERM process, and potential benefits, thus reducing misunderstanding and anxiety about ERM	☐	☐	☐	☐	☐
B12.2	Regular training is provided for staff to maintain their high-level knowledge and skills relating to ERM	☐	☐	☐	☐	☐
B12.3	Training programs make the relevant staff learn from successes and failures from both previous and ongoing projects	☐	☐	☐	☐	☐
B12.4	The staff who are professional or experienced in ERM share their knowledge relating to ERM with trainees in training programs	☐	☐	☐	☐	☐

(continued)

No.	Criteria and best practices	Rating (1 = Very inapplicable; 5 = Very applicable)				
Criterion 13 Formalized key risk indicators (KRIs)[d]						
B13.1	KRIs are identified for all the critical risks that a firm faces	☐	☐	☐	☐	☐
B13.2	KRIs are consistently reviewed and updated	☐	☐	☐	☐	☐
B13.3	KRIs are regularly monitored and analyzed by the risk owners	☐	☐	☐	☐	☐
B13.4	KRIs act as early warning signals of increasing risk exposures in a firm	☐	☐	☐	☐	☐
Criterion 14 Integration of ERM into business processes						
B14.1	Management across a firm consistently considers risk information, risk tolerance and appetite, risk priority and risk response strategies in all decision-making activities, especially in strategic decision-making	☐	☐	☐	☐	☐
B14.2	ERM is fully integrated into all daily management and business processes	☐	☐	☐	☐	☐
B14.3	The implementation levels of the ERM best practices are regularly assessed to identify gaps and improve ERM practices	☐	☐	☐	☐	☐
Criterion 15 Objective setting						
B15.1	Objectives of the firm are clearly identified and understood by staff at all levels	☐	☐	☐	☐	☐
B15.2	All objectives have performance measures and all performance measures are linked with objectives	☐	☐	☐	☐	☐
B15.3	Deviations from plans or expectations are regularly reviewed and assessed against the corporate objectives and project objectives	☐	☐	☐	☐	☐
Criterion 16 Monitoring, review and improvement of ERM framework						
B16.1	A firm regularly monitors the progress of ERM implementation against, and deviation from, the ERM plan	☐	☐	☐	☐	☐
B16.2	A firm regularly reviews whether the ERM framework, policy, and plan are still appropriate according to the corporate external and internal context	☐	☐	☐	☐	☐
B16.3	Actions are taken to improve the ERM framework, policy, and plan, based on results of monitoring and reviews	☐	☐	☐	☐	☐

[a]Risk appetite is the amount and type of risk that an organization is willing to pursue and retain, while risk tolerance is an organization's or stakeholder's readiness to bear the risk after risk response in order to achieve its objectives. Risk appetite relates primarily to the business model and is strategic, while risk tolerance relates primarily to the organization's objectives and is tactical

[b]Defensive routines are action, policy, or practice that prevents organizational participants from experiencing embarrassment or threat and, at the same time, prevents them from discovering the causes of the embarrassment or threat

[c]A common risk language explains the terminologies and methodologies and contributes to a common understanding of their meanings and context throughout the enterprise

[d]A key risk indicator (KRI) is a measure to indicate the potential, presence, level, or trend of a risk. KRIs can predict whether a risk occurred or is emerging

If there are other ERM best practices that you deem as important and rational, please list them below:

____

Part IV: ERM Maturity Criteria

There are 16 criteria identified from the literature review. Please rate the **IMPORTANCE** of each criterion toward ERM maturity assessment using a five-point scale: **1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high.**

No.	ERM maturity criteria	Rating importance				
		1	2	3	4	5
M01	Commitment of the board and senior management	☐	☐	☐	☐	☐
M02	ERM ownership	☐	☐	☐	☐	☐
M03	Risk appetite and tolerance	☐	☐	☐	☐	☐
M04	Risk-aware culture	☐	☐	☐	☐	☐
M05	Sufficient resources	☐	☐	☐	☐	☐
M06	Risk identification, analysis, and prioritization	☐	☐	☐	☐	☐
M07	Iterative and dynamic ERM process steps	☐	☐	☐	☐	☐
M08	Leveraging risks as opportunities	☐	☐	☐	☐	☐
M09	Risk communication	☐	☐	☐	☐	☐
M10	A common risk language	☐	☐	☐	☐	☐
M11	A risk management information system	☐	☐	☐	☐	☐
M12	Training programs	☐	☐	☐	☐	☐
M13	Formalized key risk indicators	☐	☐	☐	☐	☐
M14	Integration of ERM into business processes	☐	☐	☐	☐	☐
M15	Objective setting	☐	☐	☐	☐	☐
M16	Monitoring, review, and improvement of ERM framework	☐	☐	☐	☐	☐

Thank you for your kind assistance!
If you have any questions about the survey, please feel free to contact Zhao Xianbo.
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Email: zhaoxb1984@gmail.com; A0068226@nus.edu.sg

Appendix 2
Questionnaire in Survey II

Survey on Enterprise Risk Management Implementation in Chinese Construction Firms based in Singapore

Part I: Introduction

The research being conducted at the Department of Building, National University of Singapore aims to gain an understanding of ERM implementation in CCFs based in Singapore. As part of the research, this survey is to ***identify the critical factors driving and hindering the ERM implementation, and the implementation level of ERM in CCFs based in Singapore.***

You are invited to rate the extent to which the factors listed in this questionnaire drive or hinder ERM practice and the implementation level of several criteria in your firm according to your experience and knowledge. The findings of this study will be used to identify the critical drivers for and hindrances to ERM implementation as well as the ERM maturity level in CCFs based in Singapore. We assure you that the information provided by you will be kept strictly confidential and will be used for academic purpose only. Any reports resulting from this survey will make no identifiable reference to the specific sources of data. We reiterate that no individual company or person will be identified in this research.

Thank you for your kind assistance.

Yours sincerely

ZHAO Xianbo, Ph.D. candidate

Department of Building

National University of Singapore

X. Zhao et al., *Enterprise Risk Management in International Construction Operations*, DOI 10.1007/978-981-287-549-5

Part II: General Information

1. Your designation: ______
2. Your firm's financial grade under BCA: ______
3. Your firm has been in Singapore for ___ years.
4. Your total working experience: ___ years.
5. You have been working in Singapore for ____ years.

Part III: Drivers and Hindrances for Enterprise Risk Management

Please rate the **SIGNIFICANCE** of the following factors in driving and hindering ERM implementation in your firm using a five-point scale: **1 = very insignificant, 2 = insignificant, 3 = neutral, 4 = significant, 5 = very significant.**

No.	Drivers for ERM implementation	Rate significance				
		1	2	3	4	5
D01	Legal and regulatory compliance requirements	☐	☐	☐	☐	☐
D02	Non-mandatory reports or standards	☐	☐	☐	☐	☐
D03	Credit rating agencies' requirements	☐	☐	☐	☐	☐
D04	Reduced earnings volatility	☐	☐	☐	☐	☐
D05	Reduced costs and losses	☐	☐	☐	☐	☐
D06	Increased profitability and earnings	☐	☐	☐	☐	☐
D07	Improved decision-making	☐	☐	☐	☐	☐
D08	Better risk reporting and communication	☐	☐	☐	☐	☐
D09	Increased management accountability	☐	☐	☐	☐	☐
D10	Greater management consensus	☐	☐	☐	☐	☐
D11	Competitive advantages	☐	☐	☐	☐	☐
D12	Better resource allocation	☐	☐	☐	☐	☐
D13	Improved clients' satisfaction	☐	☐	☐	☐	☐
D14	Improved control of an enterprise over its projects	☐	☐	☐	☐	☐
D15	A broader scope of risks	☐	☐	☐	☐	☐
D16	Advances in information technology	☐	☐	☐	☐	☐
D17	Request and encouragement from the board and senior management	☐	☐	☐	☐	☐

No.	Hindrances to ERM implementation	Rate significance				
		1	2	3	4	5
H01	Low data quality	☐	☐	☐	☐	☐
H02	Lack of data	☐	☐	☐	☐	☐
H03	Insufficient resources (e.g., time, money, and people)	☐	☐	☐	☐	☐
H04	Lack of a formalized ERM process	☐	☐	☐	☐	☐
H05	Lack of risk management techniques and tools	☐	☐	☐	☐	☐
H06	Lack of internal knowledge, skills, and expertise	☐	☐	☐	☐	☐
H07	Lack of qualified personnel to implement ERM	☐	☐	☐	☐	☐
H08	Lack of risk management information system	☐	☐	☐	☐	☐
H09	Unsupportive organizational structure	☐	☐	☐	☐	☐
H10	Unsupportive organizational culture	☐	☐	☐	☐	☐
H11	Lack of common risk language	☐	☐	☐	☐	☐
H12	Lack of risk awareness within the organization	☐	☐	☐	☐	☐
H13	Confidence in the existing risk management practices	☐	☐	☐	☐	☐
H14	Existence or re-emergence of the silo mentality[a]	☐	☐	☐	☐	☐
H15	Lack of shared understanding and approach to risk management across departments	☐	☐	☐	☐	☐
H16	Lack of understanding relating to effective ERM process	☐	☐	☐	☐	☐
H17	Perception that ERM adds to bureaucracy	☐	☐	☐	☐	☐
H18	Perception that ERM increases costs and administration	☐	☐	☐	☐	☐
H19	Perception that ERM interferes with business activities	☐	☐	☐	☐	☐
H20	Inadequate training on ERM	☐	☐	☐	☐	☐
H21	Lack of an ERM business case	☐	☐	☐	☐	☐
H22	Lack of perceived value or benefits of ERM	☐	☐	☐	☐	☐
H23	Lack of commitment of the board and senior management	☐	☐	☐	☐	☐
H24	Not perceived as a priority by senior management	☐	☐	☐	☐	☐
H25	Lack of board or senior management leadership	☐	☐	☐	☐	☐
H26	The movement of the ERM champion from senior management to other areas without a successor	☐	☐	☐	☐	☐
H27	Lack of consensus on benefits of ERM among board members and senior management	☐	☐	☐	☐	☐
H28	Other management priorities	☐	☐	☐	☐	☐
H29	Lack of a clear ERM implementation plan	☐	☐	☐	☐	☐
H30	Inability to coordinate with other departments	☐	☐	☐	☐	☐
H31	Lack of a set of metrics for measuring performance of ERM	☐	☐	☐	☐	☐

(continued)

No.	Hindrances to ERM implementation	Rate significance				
		1	2	3	4	5
H32	Unclear ownership and responsibility for ERM implementation	☐	☐	☐	☐	☐
H33	Organizational turf[b]	☐	☐	☐	☐	☐
H34	Employees' reluctance to give up power	☐	☐	☐	☐	☐
H35	People's reluctance to share risk information	☐	☐	☐	☐	☐
H36	Recession and business downturn	☐	☐	☐	☐	☐

[a]Silo mentality means that persons in one department or unit do not care about risk management in other departments or units

[b]Organizational turf means that each organization has its "domain" or field of operation. It also has human and material resources, goals, and tasks related to the goals. The basic factor in triggering a "turf battle" is the degree of power surrendered or gained by the organizations involved. "Power" as used here is the ability to control or manage resources to accomplish a goal. If both organizations feel they will gain by working together or having access to an equal degree of power, cooperation continues. But if one organization feels it has too much to lose by continued cooperation, it begins to defend its "turf"

Part IV: Enterprise Risk Management Maturity Assessment

Please rate the **IMPLEMENTATION LEVEL of each practice** by comparing similar current practices in your firm with the best practices listed below using a five-point scale: **1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high**

No.	Criteria and best practices	Implementation (1 = Very low; 5 = Very high)				
Criterion 1 Commitment of the board and senior management						
B1.1	A written ERM policy is approved by the board and senior management and is made known to all the staff	☐	☐	☐	☐	☐
B1.2	An ERM plan is developed and tailored to the corporate objectives and context	☐	☐	☐	☐	☐
B1.3	All the risk-related decision-making and ERM practices are fully consistent with the ERM policy and plan	☐	☐	☐	☐	☐
B1.4	The board and senior management actively takes part in ERM	☐	☐	☐	☐	☐
B1.5	The commitment is continual and is not interrupted by changes in the board or senior management	☐	☐	☐	☐	☐
Criterion 2 ERM ownership						
B2.1	A dedicated senior executive, or a stand-alone department, or a board-level committee takes charge of risk oversight and centralizes risk management	☐	☐	☐	☐	☐
B2.2	Each category of critical risk has a risk owner, who fully understands the risks falling within the limit of his or her accountability	☐	☐	☐	☐	☐

(continued)

No.	Criteria and best practices	Implementation (1 = Very low; 5 = Very high)				
B2.3	All risk owners have sufficient authority to oversee any risk-related action and accept clear defined responsibility for managing the risks	☐	☐	☐	☐	☐
B2.4	ERM is incorporated into the performance review and assessment of risk owners	☐	☐	☐	☐	☐
Criterion 3 Risk appetite and tolerance[a]						
B3.1	Risk appetite is formally and clearly defined according to the corporate strategy	☐	☐	☐	☐	☐
B3.2	Risk appetite is made known to all the staff in the firm	☐	☐	☐	☐	☐
B3.3	Risk tolerance for each specific risk is formally and clearly defined according to the corporate objectives	☐	☐	☐	☐	☐
B3.4	Differences between risk tolerance defined and actual risks are regularly assessed	☐	☐	☐	☐	☐
B3.5	Expected effects of risk response strategies are assessed against risk tolerance	☐	☐	☐	☐	☐
Criterion 4 Risk-aware culture						
B4.1	A risk-aware culture is created throughout a firm and makes staff at all levels have risk awareness	☐	☐	☐	☐	☐
B4.2	A climate of trust is built up within a firm and project teams	☐	☐	☐	☐	☐
B4.3	Risk-aware culture is incorporated into the corporate culture	☐	☐	☐	☐	☐
B4.4	The expected behavior within the organization is explicitly expressed to sustain a strong risk-aware culture	☐	☐	☐	☐	☐
Criterion 5 Resources						
B5.1	Resources are continuously invested in improving the risk management process, tools, techniques, personnel skills, etc.	☐	☐	☐	☐	☐
B5.2	Resources are allocated for risk response based on the results of risk analysis and risk priority	☐	☐	☐	☐	☐
B5.3	A firm has sufficient qualified staff and internal knowledge, skills and expertise to implement ERM	☐	☐	☐	☐	☐
B5.4	External consultants or experts are used to reinforce and complement existing internal knowledge and skills about ERM	☐	☐	☐	☐	☐
B5.5	A comprehensive set of metrics is consistently applied to measure ERM performance	☐	☐	☐	☐	☐
Criterion 6 Risk identification, analysis, and response						
B6.1	A firm adopts a formalized and standardized ERM process at project and firm levels	☐	☐	☐	☐	☐
B6.2	The risk information collected is ensured to be relevant and reliable	☐	☐	☐	☐	☐
B6.3	Qualitative and quantitative risk management tools and techniques are consistently used	☐	☐	☐	☐	☐
B6.4	A firm comprehensively identifies sources of risk, areas of impacts, and their causes and potential impacts	☐	☐	☐	☐	☐
B6.5	The likelihood of occurrence and impact magnitude of all the risks identified are analyzed in order to identify the risk rank and management priority	☐	☐	☐	☐	☐
B6.6	The relationship of different risks is considered and assessed	☐	☐	☐	☐	☐

(continued)

No.	Criteria and best practices	Implementation (1 = Very low; 5 = Very high)				
B6.7	The appropriate risk response strategy is identified through considering the risk significance, risk appetite and tolerance, resource availability, and cost versus benefit comparisons, as well as the enterprise objectives	☐	☐	☐	☐	☐
B6.8	Risk response is designed to deal with critical risks at their sources	☐	☐	☐	☐	☐
Criterion 7 Iterative and dynamic ERM process steps						
B7.1	New and emerging risks are consistently identified in a timely and proactive manner	☐	☐	☐	☐	☐
B7.2	Risk information is collected from various sources and updated regularly	☐	☐	☐	☐	☐
B7.3	Risk identification, analysis, and response activities are continuously monitored, reviewed, and improved	☐	☐	☐	☐	☐
B7.4	The ERM process is clearly recorded to make it convenient to review and improve	☐	☐	☐	☐	☐
B7.5	Residual risks that still remain after the response measures have been fully implemented are assessed	☐	☐	☐	☐	☐
Criterion 8 Leveraging risks as opportunities						
B8.1	It is enterprise-widely recognized that opportunities are an aspect of risks	☐	☐	☐	☐	☐
B8.2	Opportunities are regularly identified and explored during risk management planning	☐	☐	☐	☐	☐
B8.3	Opportunities are regularly assessed by weighing the expected benefits and relevant likelihood against the potential losses and their likelihood	☐	☐	☐	☐	☐
B8.4	Opportunities for the expected improvement of firm performance are actively pursued through ERM	☐	☐	☐	☐	☐
B8.5	Risk taking of a firm is aligned with its core competencies and risk appetite	☐	☐	☐	☐	☐
Criterion 9 Risk communication						
B9.1	Risk information is consistently communicated and shared across projects and departments within the firm	☐	☐	☐	☐	☐
B9.2	Critical risk information is reported to the board and senior management in a periodic or immediate manner according to risk severity or urgency	☐	☐	☐	☐	☐
B9.3	Clear communication lines are established to ensure line managers, project managers, and front-line staff are promptly notified of critical information and decisions from senior management	☐	☐	☐	☐	☐
B9.4	Individual comments and views of internal or external experts are encouraged during the ERM process	☐	☐	☐	☐	☐
Criterion 10 A common risk language[b]						
B10.1	The risk language clearly explains the risk management terminologies and methodologies used within a firm	☐	☐	☐	☐	☐
B10.2	The risk language is used consistently in all the communication within a firm	☐	☐	☐	☐	☐

(continued)

No.	Criteria and best practices	Implementation (1 = Very low; 5 = Very high)				
Criterion 11 A risk management information system (RMIS)						
B11.1	The firm has a RMIS that serves as a platform for risk communication and reporting, records ERM activities, undertakes risk identification and analysis, and facilitates selecting response strategies	☐	☐	☐	☐	☐
B11.2	The functions of the RMIS are fully used in ERM practices	☐	☐	☐	☐	☐
Criterion 12 Training programs						
B12.1	Formalized training programs ensure all the relevant staff clearly understand the ERM policy, the ERM process, and potential benefits, and thus reducing misunderstanding and anxiety about ERM	☐	☐	☐	☐	☐
B12.2	Regular training is provided for staff to maintain their high-level knowledge and skills relating to ERM	☐	☐	☐	☐	☐
B12.3	Training programs make the relevant staff learn from successes and failures from both previous and ongoing projects	☐	☐	☐	☐	☐
B12.4	The staff who are professional or experienced in ERM share their knowledge relating to ERM with trainees in training programs	☐	☐	☐	☐	☐
Criterion 13 Formalized key risk indicators (KRIs)[c]						
B13.1	KRIs are identified for all the critical risks that a firm faces	☐	☐	☐	☐	☐
B13.2	KRIs are consistently reviewed and updated	☐	☐	☐	☐	☐
B13.3	KRIs are regularly monitored and analyzed by the risk owners	☐	☐	☐	☐	☐
B13.4	KRIs act as early warning signals of increasing risk exposures in a firm	☐	☐	☐	☐	☐
Criterion 14 Integration of ERM into business processes						
B14.1	Management across a firm consistently considers risk information, risk tolerance and appetite, risk priority and risk response strategies in all decision-making activities, especially in strategic decision-making	☐	☐	☐	☐	☐
B14.2	ERM is fully integrated into all daily management and business processes	☐	☐	☐	☐	☐
B14.3	The implementation levels of the ERM best practices are regularly assessed to identify gaps and improve ERM practices	☐	☐	☐	☐	☐
Criterion 15 Objective setting						
B15.1	Objectives of the firm are clearly identified and understood by staff at all levels	☐	☐	☐	☐	☐
B15.2	All objectives have performance measures and all performance measures are linked with objectives	☐	☐	☐	☐	☐
B15.3	Deviations from plans or expectations are regularly reviewed and assessed against the corporate objectives and project objectives	☐	☐	☐	☐	☐
Criterion 16 Monitoring, review and improvement of ERM framework						
B16.1	A firm regularly monitors the progress of ERM implementation against, and deviation from, the ERM plan	☐	☐	☐	☐	☐
B16.2	A firm regularly reviews whether the ERM framework, policy, and plan are still appropriate according to the corporate external and internal context	☐	☐	☐	☐	☐

(continued)

No.	Criteria and best practices	Implementation (1 = Very low; 5 = Very high)				
B16.3	Actions are taken to improve the ERM framework, policy, and plan, based on results of monitoring and reviews	□	□	□	□	□

[a]Risk appetite is the amount and type of risk that an organization is willing to pursue and retain, while risk tolerance is an organization's or stakeholder's readiness to bear the risk after risk response in order to achieve its objectives. Risk appetite relates primarily to the business model and is strategic, while risk tolerance relates primarily to the organization's objectives and is tactical
[b]A common risk language explains the terminologies and methodologies and contributes to a common understanding of their meanings and context throughout the enterprise
[c]A key risk indicator (KRI) is a measure to indicate the potential, presence, level, or trend of a risk. KRIs can predict whether a risk occurred or is emerging

Thank you for your kind assistance!
If you have any questions about the survey, please feel free to contact Zhao Xianbo.
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Email: zhaoxb1984@gmail.com; A0068226@nus.edu.sg

Appendix 3
Interview Guide

Interview Questions about Enterprise Risk Management

1 Basic information

1.1 Designation: _______
1.2 Working experience: _______years; and _______years in Singapore.
1.3 Grade of the firm according to BCA:
1.4 No. of the completed projects in Singapore:____
1.5 Annual revenue in Singapore: _________SGD
1.6 Private, State-owned, or Joint Venture?

2 Factors affecting enterprise risk management (ERM) implementation

2.1 What are the drivers for ERM implementation in your firm?
2.2 What are the hindrances to ERM implementation in your firm?

3 ERM ownership

3.1 Who is ultimately responsible for risk management in your firm?
3.2 Is there any independent RM department or RM committee of the board in your firm? How does it operate?
3.3 Who is in charge of the independent RM department or committee?

4 Risk communication

4.1 How do you communicate risk information in your firm?
4.2 Is there a common risk language in your firm? If no, what are the common terms in your firm to communicate about risks? If yes, how does your firm create the risk language?
4.3 How do you report the operation status and ERM implementation to your parent firm?
4.4 How and in what aspects does the parent firm affect your firm in Singapore?
4.5 Do you have risk management information systems (RMIS) or intranets facilitating risk communication?

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5 Risk-aware culture

5.1 How does the top management cultivate an ERM culture in your firm?
5.2 How does your firm establish risk management accountability in your firm?
5.3 Please introduce the training or organizational learning programs relating to ERM in your firm. Do the training programs employ external consultants?

6 ERM framework or process

6.1 Have you heard of the COSO ERM framework, SASAC (China's SASAC of the State Council) ERM framework, or ISO 31000:2009 risk management frameworks? And how much do you know about them?
6.2 What ERM framework do you use and does this framework refer to the above COSO, SASAC, and ISO frameworks?
6.3 Does your firm have risk appetite and tolerance? Please state the risk appetite and tolerance.
6.4 How do you identify risks? Do you have a risk checklist or inventory of risk indicators in place to help identify risks at the enterprise level? Do you review and update the risk checklist or inventory periodically?
6.5 How do you analyze risks? Do you use experience, techniques, or software (information system)?
6.6 How are the risk response measures decided in your firm? Who decides it?
6.7 How does ERM contribute to the decision-making in your firm?
6.8 How do you review and monitor risks? Do you use a set of key risk indicators (KRIs) for the critical risks to monitor risks?

Appendix 4
Questionnaire for the Validation of the KBDSS

Validation of the Knowledge-Based Decision Support System for Enterprise Risk Management in Chinese Construction Firms

You are invited to evaluate the knowledge-based decision support system (KBDSS) for ERM in CCFs. The KBDSS for ERM in CCFs serves as an internal assessment tool for management staff. The objectives of the KBDSS are to: assess the ERM maturity in a CCF; visualize the ERM maturity assessment results; provide action plans for improving the ERM practices along the maturity continuum; and generate a printable ERM maturity assessment report.

The information which you provide will be kept strictly confidential and will be used solely for academic purposes only. Your name and your firm name will not appear in the report. Thank you for your kind assistance.

Yours sincerely,

ZHAO Xianbo, Ph.D. candidate

Department of Building

National University of Singapore

Part I: General Information

1. Your designation:
2. Your total working experience in the construction industry: years.
3. Your firm name:
4. Your email address:

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Part I: Enterprise Risk Management (ERM) Maturity Assessment

ERM is defined as “a process, effected by an entity’s board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives.” ERM maturity reflects the sophistication of ERM implementation.

1. In the table, please rate the implementation level (1–100 %) of each criterion as well as the ERM maturity of your firm according to your relevant experience.
2. Please use the KBDSS software to assess the ERM maturity of your firm. Please click the “Print the ERM Maturity Assessment Report” button on the page of “ERM maturity assessment 8” in the software and return a copy of the report to Mr. Zhao Xianbo.

Code	ERM maturity criteria	The implementation level (%) of the ERM maturity criteria in your firm					
		0–12.5 (%)	12.5–37.5 (%)	37.5–62.5 (%)	62.5–87.5 (%)	87.5–100 (%)	Score (%)
M01	Commitment of the board and senior management	☐	☐	☐	☐	☐	
M02	ERM ownership	☐	☐	☐	☐	☐	
M03	Risk appetite and tolerance	☐	☐	☐	☐	☐	
M04	Risk-aware culture	☐	☐	☐	☐	☐	
M05	Sufficient resources	☐	☐	☐	☐	☐	
M06	Risk identification, analysis, and prioritization	☐	☐	☐	☐	☐	
M07	Iterative and dynamic ERM process steps	☐	☐	☐	☐	☐	
M08	Leveraging risks as opportunities	☐	☐	☐	☐	☐	
M09	Risk communication	☐	☐	☐	☐	☐	
M10	A common risk language	☐	☐	☐	☐	☐	
M11	A risk management information system	☐	☐	☐	☐	☐	
M12	Training programs	☐	☐	☐	☐	☐	
M13	Formalized key risk indicators	☐	☐	☐	☐	☐	
M14	Integration of ERM into business processes	☐	☐	☐	☐	☐	
M15	Objective setting	☐	☐	☐	☐	☐	
M16	Monitoring, review, and improvement of ERM framework	☐	☐	☐	☐	☐	
Overall ERM maturity score		☐	☐	☐	☐	☐	

3. Do you think the action plans provided by the KBDSS are useful to the decision-making relating to improving the ERM practice in your firm?
4. What do you think of the user-friendliness of the KBDSS for ERM?

Appendix 5
A Calculation Example of the ERM Maturity Model

The ERM maturity model in Sect. 3.7.3 is adopted to assess the ERM maturity level in a CCF based in Singapore to illustrate the calculation process. The relative importance scores of the maturity criteria were collected from Survey I. Using Eq. 3.9, the mean scores of these criteria (MS_i) were calculated and presented in Table 7.2. Then, using Eq. 3.10, criterion weights (W_i) can be calculated. For instance, the weight of criterion M01 was calculated as follows:

$$
\begin{aligned}
W_1 = \mathrm{MS}_1 \textstyle\sum_{i=1}^{16} \mathrm{MS}_i &= 4.55/(4.55 + 4.16 + 3.51 + 3.82 + 4.01 + 4.28 + 3.97 \\
&+ 3.61 + 3.90 + 3.40 + 3.76 + 3.92 + 3.89 + 4.08 + 4.26 + 3.97) = 7.21\,\%
\end{aligned}
$$

In this example, three professionals participate in the ERM maturity assessment the rate the implementation levels of the 66 best practices using the five-point scale (1 = very low, 2 = low, 3 = medium, 4 = high, and 5 = very high). The input data ($\tilde{L}_{\mathrm{ipj}}$) assigned by the three professionals are presented in Table A.1.

Using Eq. 3.11, the TFN of the implementation level of each best practice $\left(\tilde{L}_{\mathrm{ip}}\right)$ can be calculated, as shown in column $\tilde{L}_{\mathrm{ip}}$ of Table A.1. In this example, there are three participants in ERM maturity assessment, i.e., $k = 3$. As shown in Table A.1, the best practice B01.4 (The board and senior management actively takes part in ERM) obtained the linguistic values of "very high," "high," and "very high" from the three professionals. According to Table 3.3, the TFNs of "high" and "very high" are (0.50, 0.75, 1.00) and (0.75, 1.00, 1.00), respectively. Following the addition and scalar multiplication operation rules of TFNs (Eqs. 3.3 and 3.7), $\tilde{L}_{14}$ is calculated as follows:

$$
\begin{aligned}
\tilde{L}_{14} = (l_{141}, l_{142}, l_{143}) = 1/3 \times \sum_{j=1}^{3} \tilde{L}_{14j} &= 1/3 \times [(0.75, 1.00, 1.00) \\
&+ (0.50, 0.75, 1.00) + 0.75, 1.00, 1.00] \\
&= 1/3 \times (0.75 + 0.50 + 0.75, 1.00 + 0.75 \\
&+ 1.00, 1.00 + 1.00 + 1.00 = (0.67, 0.92, 1.00)
\end{aligned}
$$

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Table A.1 The calculation of the ERMMI of a CCF

Code		$\tilde{L}_{ip1}$	$\tilde{L}_{ip2}$	$\tilde{L}_{ip3}$	$\tilde{L}_{ip}$	$\tilde{L}_i$	W_i (%)	$\tilde{L}_i \times W_i$
M01	B01.1	H (0.5, 0.75, 1)	M (0.25, 0.5, 0.75)	H (0.5, 0.75, 1)	(0.42, 0.67, 0.92)	(0.33, 0.57, 0.78)	7.21	(0.024, 0.041, 0.056)
	B01.2	L (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	L (0, 0.25, 0.5)	(0.00, 0.17, 0.42)			
	B01.3	H (0.5, 0.75, 1)	L (0, 0.25, 0.5)	L (0, 0.25, 0.5)	(0.17, 0.42, 0.67)			
	B01.4	VH (0.75, 1, 1)	H (0.5, 0.75, 1)	VH (0.75, 1, 1)	(0.67, 0.92, 1.00)			
	B01.5	H (0.5, 0.75, 1)	M (0.25, 0.5, 0.75)	H (0.5, 0.75, 1)	(0.42, 0.67, 0.92)			
M02	B02.1	M (0.25, 0.5, 0.75)	VL (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	(0.08, 0.17, 0.42)	(0.02, 0.10, 0.35)	6.59	(0.001, 0.007, 0.023)
	B02.2	L (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	(0.00, 0.08, 0.33)			
	B02.3	L (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	(0.00, 0.08, 0.33)			
	B02.4	L (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	(0.00, 0.08, 0.33)			
M03	B03.1	L (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	L (0, 0.25, 0.5)	(0.08, 0.33, 0.58)	(0.13, 0.37, 0.62)	5.56	(0.007, 0.020, 0.034)
	B03.2	L (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	L (0, 0.25, 0.5)	(0.08, 0.33, 0.58)			
	B03.3	M (0.25, 0.5, 0.75)	M (0.25, 0.5, 0.75)	M (0.25, 0.5, 0.75)	(0.25, 0.50, 0.75)			
	B03.4	L (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	(0.08, 0.25, 0.50)			
	B03.5	L (0, 0.25, 0.5)	H (0.5, 0.75, 1)	L (0, 0.25, 0.5)	(0.17, 0.42, 0.67)			
M04	B04.1	H (0.5, 0.75, 1)	M (0.25, 0.5, 0.75)	M (0.25, 0.5, 0.75)	(0.33, 0.58, 0.83)	(0.40, 0.65, 0.88)	6.06	(0.024, 0.039, 0.053)
	B04.2	H (0.5, 0.75, 1)	H (0.5, 0.75, 1)	VH (0.75, 1, 1)	(0.58, 0.83, 1.00)			
	B04.3	H (0.5, 0.75, 1)	M (0.25, 0.5, 0.75)	M (0.25, 0.5, 0.75)	(0.33, 0.58, 0.83)			
	B04.4	M (0.25, 0.5, 0.75)	M (0.25, 0.5, 0.75)	H (0.5, 0.75, 1)	(0.33, 0.58, 0.83)			
M05	B05.1	H (0.5, 0.75, 1)	M (0.25, 0.5, 0.75)	H (0.5, 0.75, 1)	(0.42, 0.67, 0.92)	(0.27, 0.48, 0.73)	6.36	(0.017, 0.031, 0.047)
	B05.2	H (0.5, 0.75, 1)	M (0.25, 0.5, 0.75)	M (0.25, 0.5, 0.75)	(0.33, 0.58, 0.83)			
	B05.3	M (0.25, 0.5, 0.75)	L (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	(0.17, 0.42, 0.67)			
	B05.4	H (0.5, 0.75, 1)	H (0.5, 0.75, 1)	M (0.25, 0.5, 0.75)	(0.42, 0.67, 0.92)			
	B05.5	VL (0, 0.25, 0.5)	L (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	(0.00, 0.08, 0.33)			

(continued)

Table A.1 (continued)

Code		$\tilde{L}_{\mathrm{ip1}}$	$\tilde{L}_{\mathrm{ip2}}$	$\tilde{L}_{\mathrm{ip3}}$	$\tilde{L}_{\mathrm{ip}}$	$\tilde{L}_i$	W_i (%)	$\tilde{L}_i \times W_i$
M06	B06.1	H (0.5, 0.75, 1)	M (0.25, 0.5, 0.75)	H (0.5, 0.75, 1)	(0.42, 0.67, 0.92)	(0.26, 0.50, 0.74)	6.79	(0.018, 0.034, 0.050)
	B06.2	H (0.5, 0.75, 1)	VH (0.75, 1, 1)	H (0.5, 0.75, 1)	(0.58, 0.83, 1.00)			
	B06.3	H (0.5, 0.75, 1)	M (0.25, 0.5, 0.75)	H (0.5, 0.75, 1)	(0.42, 0.67, 0.92)			
	B06.4	M (0.25, 0.5, 0.75)	L (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	(0.17, 0.42, 0.67)			
	B06.5	M (0.25, 0.5, 0.75)	L (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	(0.17, 0.42, 0.67)			
	B06.6	VL (0, 0.25, 0.5)	L (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	(0.08, 0.25, 0.50)			
	B06.7	L (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	M (0.25, 0.5, 0.75)	(0.17, 0.42, 0.67)			
	B06.8	M (0.25, 0.5, 0.75)	L (0, 0.25, 0.5)	L (0, 0.25, 0.5)	(0.08, 0.33, 0.58)			
M07	B07.1	M (0.25, 0.5, 0.75)	L (0, 0.25, 0.5)	L (0, 0.25, 0.5)	(0.08, 0.33, 0.58)	(0.15, 0.38, 0.63)	6.29	(0.009, 0.024, 0.040)
	B07.2	H (0.5, 0.75, 1)	M (0.25, 0.5, 0.75)	M (0.25, 0.5, 0.75)	(0.33, 0.58, 0.83)			
	B07.3	M (0.25, 0.5, 0.75)	L (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	(0.17, 0.42, 0.67)			
	B07.4	M (0.25, 0.5, 0.75)	L (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	(0.17, 0.42, 0.67)			
	B07.5	L (0, 0.25, 0.5)	L (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	(0.00, 0.17, 0.42)			
M08	B08.1	L (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	M (0.25, 0.5, 0.75)	(0.17, 0.42, 0.67)	(0.33, 0.58, 0.83)	5.72	(0.019, 0.033, 0.048)
	B08.2	H (0.5, 0.75, 1)	M (0.25, 0.5, 0.75)	H (0.5, 0.75, 1)	(0.42, 0.67, 0.92)			
	B08.3	H (0.5, 0.75, 1)	M (0.25, 0.5, 0.75)	H (0.5, 0.75, 1)	(0.42, 0.67, 0.92)			
	B08.4	M (0.25, 0.5, 0.75)	L (0, 0.25, 0.5)	H (0.5, 0.75, 1)	(0.25, 0.50, 0.75)			
	B08.5	M (0.25, 0.5, 0.75)	H (0.5, 0.75, 1)	H (0.5, 0.75, 1)	(0.42, 0.67, 0.92)			
M09	B09.1	M (0.25, 0.5, 0.75)	H (0.5, 0.75, 1)	H (0.5, 0.75, 1)	(0.42, 0.67, 0.92)	(0.52, 0.77, 0.96)	6.18	(0.032, 0.048, 0.059)
	B09.2	VH (0.75, 1, 1)	H (0.5, 0.75, 1)	VH (0.75, 1, 1)	(0.67, 0.92, 1.00)			
	B09.3	H (0.5, 0.75, 1)	VH (0.75, 1, 1)	H (0.5, 0.75, 1)	(0.58, 0.83, 1.00)			
	B09.4	M (0.25, 0.5, 0.75)	H (0.5, 0.75, 1)	H (0.5, 0.75, 1)	(0.42, 0.67, 0.92)			

(continued)

Table A.1 (continued)

Code		$\tilde{L}_{ip1}$	$\tilde{L}_{ip2}$	$\tilde{L}_{ip3}$	$\tilde{L}_{ip}$	$\tilde{L}_i$	W_i (%)	$\tilde{L}_i \times W_i$
M10	B10.1	H (0.5, 0.75, 1)	L (0, 0.25, 0.5)	L (0, 0.25, 0.5)	(0.17, 0.42, 0.67)	(0.08, 0.33, 0.58)	5.40	(0.005, 0.018, 0.032)
	B10.2	L (0, 0.25, 0.5)	L (0, 0.25, 0.5)	L (0, 0.25, 0.5)	(0.00, 0.25, 0.50)			
M11	B11.1	VL (0, 0.25, 0.5)	L (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	(0.00, 0.08, 0.33)	(0.00, 0.04, 0.29)	5.97	(0.000, 0.002, 0.017)
	B11.2	VL (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	(0.00, 0.00, 0.25)			
M12	B12.1	M (0.25, 0.5, 0.75)	L (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	(0.17, 0.42, 0.67)	(0.17, 0.40, 0.65)	6.22	(0.010, 0.025, 0.040)
	B12.2	L (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	M (0.25, 0.5, 0.75)	(0.17, 0.42, 0.67)			
	B12.3	M (0.25, 0.5, 0.75)	M (0.25, 0.5, 0.75)	M (0.25, 0.5, 0.75)	(0.25, 0.50, 0.75)			
	B12.4	L (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	(0.08, 0.25, 0.50)			
M13	B13.1	L (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	L (0, 0.25, 0.5)	(0.00, 0.17, 0.42)	(0.04, 0.13, 0.38)	6.16	(0.003, 0.008, 0.023)
	B13.2	VL (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	(0.00, 0.00, 0.25)			
	B13.3	VL (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	VL (0, 0.25, 0.5)	(0.00, 0.00, 0.25)			
	B13.4	M (0.25, 0.5, 0.75)	VL (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	(0.17, 0.33, 0.58)			
M14	B14.1	M (0.25, 0.5, 0.75)	H (0.5, 0.75, 1)	H (0.5, 0.75, 1)	(0.42, 0.67, 0.92)	(0.17, 0.39, 0.64)	6.47	(0.011, 0.025, 0.041)
	B14.2	L (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	L (0, 0.25, 0.5)	(0.08, 0.33, 0.58)			
	B14.3	VL (0, 0.25, 0.5)	L (0, 0.25, 0.5)	L (0, 0.25, 0.5)	(0.00, 0.17, 0.42)			
M15	B15.1	H (0.5, 0.75, 1)	L (0, 0.25, 0.5)	H (0.5, 0.75, 1)	(0.33, 0.58, 0.83)	(0.36, 0.61, 0.86)	6.75	(0.024, 0.041, 0.058)
	B15.2	M (0.25, 0.5, 0.75)	H (0.5, 0.75, 1)	M (0.25, 0.5, 0.75)	(0.33, 0.58, 0.83)			
	B15.3	H (0.5, 0.75, 1)	M (0.25, 0.5, 0.75)	H (0.5, 0.75, 1)	(0.42, 0.67, 0.92)			
M16	B16.1	L (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	L (0, 0.25, 0.5)	(0.08, 0.33, 0.58)	(0.06, 0.31, 0.56)	6.29	(0.003, 0.019, 0.035)
	B16.2	L (0, 0.25, 0.5)	M (0.25, 0.5, 0.75)	L (0, 0.25, 0.5)	(0.08, 0.33, 0.58)			
	B16.3	L (0, 0.25, 0.5)	L (0, 0.25, 0.5)	L (0, 0.25, 0.5)	(0.00, 0.25, 0.50)			
Sum							100	(0.21, 0.42, 0.66)

Note *VL* Very low; *L* Low; *M* Medium; *H* High; *VH* Very High

Then, using Eq. 3.12, the TFN of the implementation level of each criterion $\left(\tilde{L}_i\right)$ can be calculated. For example, the TFNs of the implementation levels of the five best practices ($u = 5$) under the criterion M01 are indicated in Table A.1. Thus, $\left(\tilde{L}_1\right)$ is calculated as follows:

$$\begin{aligned}\tilde{L}_1 = (l_{11}, l_{12}, l_{13}) &= 1/5 \times \sum_{(p=1)}^{5} \tilde{L}_{1p} = 1/5 \times [(0.42, 0.67, 0.92) \\ &\quad + (0.00, 0.17, 0.42) + (0.17, 0.42, 0.67) \\ &\quad + (0.67, 0.92, 1.00) + (0.42, 0.67, 0.92)] \\ &= 1/5 \times (0.42 + 0.00 + 0.17 + 0.67 + 0.42, 0.67 \\ &\quad + 0.17 + 0.42 + 0.92 + 0.67, 0.92 \\ &\quad + 0.42 + 0.67 + 1.00 + 0.92) = (0.33, 0.57, 0.78)\end{aligned}$$

Using Eq. 3.13, The TFN of the ERM maturity level of Firm A can be calculated as follows:

$$\begin{aligned}\tilde{M} = (m_1, m_2, m_3) &= \sum_{i=1}^{16} \left(W_i \times \tilde{L}_i\right) = 7.21\% \times (0.33,\ 0.57,\ 0.78) + 6.59\% \\ &\quad \times (0.02,\ 0.10,\ 0.35) + 5.56\% \times (0.13,\ 0.37,\ 0.62) + 6.06\% \times (0.40,\ 0.65,\ 0.88) \\ &\quad + 6.36\% \times (0.27,\ 0.48,\ 0.73) + 6.79\% \times (0.26,\ 0.50,\ 0.74) + 6.29\% \times (0.15,\ 0.38,\ 0.63) \\ &\quad + 5.72\% \times (0.33,\ 0.58,\ 0.83) + 6.18\% \times (0.52,\ 077,\ 0.96) + 5.40\% \\ &\quad \times (0.08,\ 0.33,\ 0.58) + 5.97\% \times (0.00,\ 0.04,\ 0.29) + 6.22\% \times (0.17,\ 0.40,\ 0.65) \\ &\quad + 6.16\% \times (0.04,\ 0.13,\ 0.38) + 6.47\% \times (0.17,\ 0.39,\ 0.64) + 6.75\% \times (0.36,\ 0.61,\ 0.86) \\ &\quad + 6.29\% \times (0.06,\ 0.31,\ 0.56) = (0.21,\ 0.42,\ 0.66)\end{aligned}$$

Thus, m_1, m_2, m_3 are 0.21, 0.42, and 0.66, respectively, and the crisp ERMMI value of this CCF can be calculated using Eq. 3.16:

$$\text{ERMMI} = 1/3 \times (m_1 + m_2 + m_3) = 1/3 \times (0.21 + 0.42 + 0.66) = 0.43$$

The ERMMI value falls into the regions of "low" and "medium," and "medium" has a higher membership value than "low" when the X value is 0.43. As Fig. 3.9 shows, the ERMMI of 0.43 can be translated into the linguistic term "medium."