Managerial Perception of Supply Chain Quality Risk: Risk Analysis and Decision Analysis

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PhD

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Management

December 2017

ABSTRACT

Due to increased supply chain complexity, ensuring the quality of supply materials or products from upstream suppliers has become a challenge for firms. A great deal has been written on possible solutions and strategies to deal with supply chain quality risk (SCQR) in recent years. However, the manager's decision-making process in relation to SCQR has not been fully researched. To close this gap, the aims of this study were to scrutinise managers' perceptions of SCQR, as well as the antecedents of and decision-making related to perceived SCQR. The relevant literature was comprehensively reviewed in order to build a foundation for the conceptualisation of perceived SCQR. This study proposed that the managerial perception of SCQR was a multi-dimensional concept with four representations. A rigorous scale development process was adopted to develop a set of reliable instruments to measure perceived SCQR. With a sample of 316 Chinese manufacturers, the validity and reliability of the measurement scales for the representations of SCQR perception were assessed. Based on the risky-decision making model, a theoretical framework of the managerial decision-making process in relation to perceived SCQR was proposed. Furthermore, the agency theory and resource dependence theory were drawn on to identify factors related to the supply chain relationship and supply chain quality barriers that might have effects on three of the representations of SCQR. Based on the resource dependence theory, it was found that buyer and supplier dependence affect the representations of SCQR differently. The empirical results indicate that the inability to test and inability to trace are significant drivers of the perception of SCQR. The representation of SCQR impact on the intention of adopting two oriented quality management practices was also examined. The result reveals that when managers face increasing SCQR, they tend to be conservative in applying the quality management practices.

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LIST OF ABBREVIATIONS

BD – Buyer Dependency

CFA – Confirmatory Factor Analysis

EFA – Exploratory Factor Analysis

OM – Operations Management

QELM – Quality Exploitation Management

QERM – Quality Exploration Management

QM – Quality Management

SCM – Supply Chain Management

SCR – Supply Chain Risk

SCRM – Supply Chain Risk Management

SCQR – Supply Chain Quality Risk

SD – Supplier Dependency

SEM – Structural Equation Modelling

RDT – Resource Dependency Theory

RP – Risk Probability

RM – Risk Management

ACKNOWLEDGEMENT

First, I would like to express my sincere appreciation to my supervisors, Dr Mike Tse and Professor Bob Doherty, for their guidance and support during these years. I will never forget the days of working with Dr Mike Tse in drafting and revising research manuscripts, when I've learnt rigour, patient and responsibility for him. I will never forget the days of meeting with Dr Mike Tse for my first job application, when I have known he is not only my supervisor but also, he is the light of my life. I could not become a researcher without his supervision and encouragement. My profound gratitude also goes to my another supervisor, Professor Bob Doherty. I will forever be thankful for his great help, support and advices during the past four years of study. I am also thankful for his honest and valuable suggestions on how to secure an academic post in the UK.

Second, I would like to thank Dr Dong Li, my thesis advisory panel member, for his valuable comments and suggestions in each half-year thesis review meeting. I want to thank Professor Jillian Macbryde for her efforts put into revising my first journal article. I am also thankful for the cross-disciplinary collaboration experience with Dr Paul Chappell from sociology department of the University of York, who shared his sociology knowledge to me and invited me as a co-author of his research. I also appreciate all the staff of our PhD research programme in the York Management School, for their assistance and help during my PhD journey. I would also like to take this opportunity to say thank you for all the friends I have met in York, who were listening to my struggling stories. Special thanks to Ms Wenjuan Zeng, who help me a lot in my final stage of thesis submission.

Third, I would also like to thank all my external co-authors, Dr Pervaiz Akharta from the University of Hull, Professor Hing Kai Chan from the University of Nottingham Ningbo, for providing me with the opportunities to work and learn from them during the process of manuscript drafting, revising and publishing. I also want to express my appreciation to Professor Shan Liu from Xi'an Jiaotong University, for his valuable comments and guidance on the empirical data analysis.

Fourth, I want to say love you and thank you for my wife, Lisa Si Li, for her priceless support to me and selfless help for my family.

Last but not least, I wish to dedicate this thesis to my parents, Mr Fan Zhang and Ms Suixin Feng. I cannot make this without your love, support and encouragement these years.

AUTHOR'S DECLARATION

I declare that this thesis is a presentation of original work and I am the sole author. This work has not previously been presented for an award at this, or any other, University. All sources are acknowledged as References.

CHAPTER 1. INTRODUCTION

1.1. Background of the Study

The recent large-scale recall of Samsung Electronic Co.'s Galaxy Note 7 smartphone has once again shone a spotlight on the quality control of electronics production (BBC, 2016). The recall of the Note 7 smartphone is also raising questions about the ability of today's electronics companies to manage product quality in complex supply networks. Not only this case, but an increasing number of product recalls, reveal that manufacturing firms are particularly vulnerable with regard to product quality and safety where goods and materials have been sourced globally; in other words, they incur supply chain quality risk (SCQR). The horsemeat scandal outbroke in 2013 when the Food Safety Authority of Ireland announced the presence of horse meat in' burgers produced by the famous brands, such as Tesco, Iceland, Aldi and Lidl. The suspected horsemeat was found in extensive ready meal in the European Market and the scandal severely dented consumer trust in the food industry (Tse et al., 2016a). Indeed, product recall could be a 'nightmare' for a company. Recent cases worldwide reveal that SCQR is one of the major reasons for product recall. In general, a buyer involved in a complex supply chain is more likely to encounter trouble than is a buyer involved in a relatively simple supply chain. In such cases, a defective component provided by a supplier might result in the buyer incurring significant losses. For example, in 2017, the transportation and manufacturing industries faced threats from supply chain quality issues. The products of Kobe Steel, a major Japanese steel manufacturer, were found to have false documentation regarding the thickness of steel. Around 3,793 tons of steel plates had been shipped to customers with potentially fake measurement data. Toyota, Honda and Nissan, the major customers of Kobe Steel, launched a large-scale investigation to determine whether the companies should recall those products that

contained the affected materials. After the scandal was exposed, the market share of Kobe Steel was plummeted (Terazono, 2017).

Most operations management (OM) researches have regarded the issue of poor product quality as a production quality problem (Karim et al., 2008, Hales and Chakravorty, 2006, Tannock and Balogun, 2007). However, nowadays the product quality problem is located not within individual firms, but within supply chains. According to Tse and Tan (2011), SCQR can be regarded as supply quality problems, which are associated with raw materials, ingredients, production or packaging and which have cascading effects in the supply chain.

A product recall can cause significant damage to an organization, directly and indirectly (Huo et al., 2014a). The direct costs of product recall include the cost of handling the tasks in the reverse logistics, compensation for customers and even legal expenses (Berman, 1999, Tang, 2008, Steven and Britto, 2016), while the indirect costs include the loss of future sales revenue, profitability, market value and reputation (Jarrell and Peltzman, 1985, Thirumalai and Sinha, 2011, Heerde et al., 2007, Steven and Britto, 2016).

Given the increased challenge of managing uncertainties that extend beyond the internal organization boundary, practitioners and researchers have shown growing interest in determining the optimal supply chain management (SCM) practices (Robinson and Malhotra, 2005, Tse and Zhang, 2017, Zu and Kaynak, 2012). Consequently, the last decade has seen the rapid development of research dedicated to supply chain risk management (SCRM), which combines the topics of risk management (RM) and supply chain management (SCM) and focuses on understanding how to reduce the negative outcomes of supply chain risk (SCR) (Finch, 2004, Jüttner et al., 2003, Norrman and Jansson, 2004). Specifically, SCRM can be regarded as the management practices for SCR through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity (Tang, 2006). In particular,

the practical issues related to the SCQR provide the operations management (OM) researcher with a great opportunity to further extend the knowledge system of SCRM and quality management (QM). The majority of SCRM studies are concerned with (1) exploring the most appropriate management practices in an SCRM framework (Norrman and Jansson, 2004, Manuj and Mentzer, 2008); (2) examining the antecedents and performance outcomes of the SCRM practices (Grötsch et al., 2013, Li et al., 2015) and (3) SCRs assessment (Wang et al., 2012, Tummala and Schoenherr, 2011). However, there is a gap in the SCRM literature with regard to understanding the nature of SCQR from a behavioural standpoint. Although risk perception is a particularly important factor influencing how top managers react to risk, the research in this area is still in the embryonic stage. This motivates the author to investigate how a manager's view of SCQR is developed, and how the perceived SCQR may affect the implementation of particular QM practices with different orientation.

Understanding managers' risk perception represents a critical contribution to the behavioural decision theory in the OM research. When there is uncertainty, and when consequences are significant in the decision-making process, the risk will be perceived by the decision maker (Kull et al., 2014, Baird and Thomas, 1985, Sitkin and Weingart, 1995). The topic of risk perception is widely studied in sociology (Slovic, 1987, Lee and Lemyre, 2009), accounting (Farrelly et al., 1985), marketing (Dholakia, 2001), project management (Adams, 2008) and business venturing (Simon et al., 2000). According to March and Shapira (1987), a manager's decision making is guided by the subjective risk perception rather than the objective risk assessment. Sitkin and Pablo (1992) analyse the decision-making behaviour under uncertainty, and emphasize that risk perception is a crucial mechanism. Managerial studies have demonstrated that risk perception is a significant determinant of decision making at an organizational level, such as switching supplier (Ellis et al., 2010), supplier selection (Kull et

al., 2014) and entrepreneur decision (Simon et al., 2000). Therefore, in the context of SCM, understanding how managers perceive SCQR is vital to identifying how to handle that SCQR.

In this study, the Yates and Stone (1992) risky decision-making model is adopted to investigate the decision-making process for SCQR. The theoretical framework includes three groups of factors, i.e. the representation of SCQR, antecedents of risk factors, and intention to adopt QM. To further extend the previous risk perception research in OM, this study conceptualizes and operationalizes four factors in representations of SCQR, namely risk probability, risk magnitude, psychological factor and overall risk perception. Drawing on the resource dependency theory (RDT) and agency theory, the causal relationships between the situation factors (i.e. buyer dependence, supplier dependence, inability to trace and inability to test) and representation of SCQR are examined. From a contingency theory perspective, no one management practice or theory can work in all instances. Regarding the adoption of QM, this study follows Zhang et al. (2012) to distinguish the traditional quality management practices into quality exploration and quality exploitation. The motivation for classifying the quality management is based on the notion of Sitkin et al. (1994) that using a single unique set of practices cannot allow for the customization that is critical to the success of adopting management practices (Westphal et al., 1997). Exploration and exploitation represent different orientations of decision makers in applying the QM practices. Specifically, quality exploration is aimed at exploring the unknown and identifying novel solutions (Zhang et al., 2012, Garvin, 1985), while quality exploitation aims at cybernetic control, which refers to the use of feedback loops in the form of standards of performance and budgets to evaluate the performance of the business, plan and make changes to correct any deviations (Green and Welsh, 1988).

1.2. Research Scope

The major objective of this thesis is to understand the managerial view of SCQR, which could be regarded as a subtopic of SCM studies. Generally, OM researchers observe the supply chain topics through a dyadic (i.e. buyer - supplier) or triadic (i.e. supplier - focal company - customer) perspective. Following the related risk perception studies in OM (Ellis et al., 2010, Tse et al., 2016a, Kull et al., 2014), this thesis adopts the dyadic view to study the nature of SCQR and the related decision-making process. In other words, the observation of SCQR focuses only on quality problems in the upstream supply chain. Quality issues that occur in the downstream supply chain are not included in the scope of this research.

This study focuses on the Chinese manufacturing industry. China is the second largest economy worldwide, and for the past three decades has been a global hub for manufacturing (Deloitte, 2016). Furthermore, as the world's largest manufacturer and exporter, China has been the source of the largest number of products withdrawn or recalled from the market. In the EU, the large-scale recalls of toys, food, and other products made in China have led to serious concerns among retailers and consumers (Huo et al., 2014a). According to the weekly overview report of the *Rapid Alert System for dangerous non-food products* (RAPEX) notifications, products made in China account for more than half of all dangerous non-food products in the EU (RAPEX, 2017). This is not simply because China has relatively backward technology, but can also be explained in terms of the scale of production. However, although China has been widely regarded as an ideal setting to research risk management or SCM (Cai et al., 2016), there has been only limited research that elucidates the managerial view of SCQR in this context. Consequently the Chinese manufacturing industry, as the world's manufacturing hub, represents an ideal case study for the research presented in this thesis.

1.3. Research Gap Identification

According to Tang (2006), SCR includes operational risk (inherent uncertainties such as uncertain customer demand, uncertain supply, and uncertain cost) and disruption risk (major disruption caused by natural and man-made disasters). Chopra and Sodhi (2004) categorized the supply chain risks as: disruptions, delays, systems, forecasts, intellectual property, procurement, inventory and capability. Generally, previous researches view the supply chain risks as coming from demand side, supply side and the external environment (Wagner and Bode, 2008). However, little research has been conducted to investigate the concept of SCQR. The specific research gaps related to the SCQR are presented below:

1) Controlling and reducing the quality risk has become one of the main objectives of managing the global supply chain. This objective is becoming more difficult to achieve, because of the high level of complexity in supply chain relationships, and low supply chain visibility. Most OM researchers have regarded the issue of poor product quality as a production quality problem (Karim et al., 2008, Hales and Chakravorty, 2006, Tannock and Balogun, 2007). However, nowadays the product quality problem is located not within individual firms, but within supply chains. Although SCRM has become a popular topic in OM research, the majority of studies have focused on supply chain disruption (Baiman et al., 2000, Tomlin, 2006, Yang et al., 2009). Moreover, while some studies among the existing literature have attempted to offer insights on how to manage product quality risk in a supply chain context (Tse and Tan, 2012, Tse and Tan, 2011, Zhu et al., 2007), the internalization process of the SCQR (i.e. perceived SCQR) has received relatively little research attention. As a result, managers and researchers have not been provided with sufficient guidance on the nature of SCQR or on how to establish appropriate management practices.

The concept of risk perception originated in the fields of psychology and sociology. Individuals might exaggerate fears and concerns due to inadequate or incorrect information. As a result, individuals might behave in an irrational manner and make wrong decisions. In the field of psychology, many scales and tools are adopted to measure the perceived risk. Particularly widely adopted in the literature is the psychometric paradigm developed by Slovic (1987), which aims to identify different factors (e.g. dread and controllability) of the perceived risk. Specifically, the psychometric paradigm adopts psychophysical scaling and multivariate analysis technique to produce quantitative representations or 'cognitive maps' of risk attitudes and perceptions (Slovic, 1987). However, although there is abundant literature related to risk perception, very few researchers have attempted to extend these established works in psychology and sociology to the context of supply chain study. In particular, there is still no valid measurement for perceived SCQR.

2) The previous OM empirical research has started to explore antecedents of purchasing managers' risk perception, such as, Tse et al. (2016a), Ellis et al. (2010). Specifically, Ellis et al. (2010) examine factors related to the external environment of the supply chain, namely market thinness, technology uncertainty, item customization and item importance. By extending Ellis's model, Tse et al. (2016a) investigate the antecedents of supply disruption risk from a broader perspective, focusing on the extent of the inherent uncertainties in the external environment of a firm. Tse et al. (2016a) define such uncertainty factors as environmental uncertainties, including demand uncertainty, quality uncertainty and logistics uncertainty. However, while the previous research has provided insights to aid understanding of the drivers of risk perception, these studies are still limited to the environmental factors and overlook the potential factors in the context of a buyer-supplier relationship. Hence, there is a research gap. A possible reason for this is that the previous risk perception research in the OM domain focuses more on supply disruption risks, which relate closely to the external environment, for

example natural disaster, labour dispute, supplier bankruptcy, war and terrorism (Chopra and Sodhi, 2004). However, the SCQR might be more related to factors like supply chain relationship, supply chain visibility or supply chain transparency. Therefore, to gain a comprehensive understanding of the construction of SCQR, it is critical to identify the drivers that derive from the buyer-supplier relationship and firm's capabilities. To the best of the author's knowledge, this thesis is the first attempt to study the antecedents of SCQR from the perspective of buyer-supplier relationship and firm's capabilities.

3) Previous studies have investigated the relationship between risk perception and decision making; however, the effect of perceived risk is largely neglected in the discussion of QM adoption. According to Zhang et al. (2012), QM can be categorized as quality exploitation management (QELM) and quality exploration management (QERM). Specifically, to improve a firm's quality performance, the QELM focuses on the activities of refining and improving the existing process, while the QERM focuses on the activities of exploring the unknown and identifying novel solutions (Herzallah et al., 2017). There is an emerging body of literature that investigates the impacts of QERM and QELM on firm performance (Zhang et al., 2012, Herzallah et al., 2017). However, there has been very little consideration of the antecedents of adopting QERM and QELM. Given that the QERM and QELM represent different orientations and risk attitudes of managers (Herzallah et al., 2017, Kristal et al., 2010), the perception of SCQR could be a significant antecedent. Surprisingly, to date no research has attempted to scrutinize the relationship between managers' risk perception and adoption of QERM and QELM.

1.4. Research Questions, Research Aims and Objectives

In order to fill the three research gaps mentioned above, this thesis seeks to answer the following research questions:

RQ1: What would the measurement scales for perceived SCQR entail?

RQ2: What are the antecedents of perceived SCQR?

RQ3: What are the relationships between perceived SCQR and managers' intention to adopt QELM and QERM practices?

As the core of this thesis, RQ1 aims to provide insights into how managers' perceptions of SCQR are formed, and to contribute to the knowledge system of SCRM by developing a set of instruments to measure the perceived SCQR. To answer RQ1, Chapter 2 conducts a comprehensive review of the key literature related to risk perception, SCRM and QM; Chapter 3 conceptualizes the constructs of perceived SCQR, while Chapter 4 develops a valid scale for perceived SCQR. RQ2 and RQ3 aim to close the research gaps detailed above as 2) and 3) respectively. The hypothesis development in Chapter 5 and the empirical examination in Chapter 6 are used to answer both RQ2 and RQ3.

To address the above research questions, this research aims pursued in this thesis are as follows:

A1: Managers' perceptions of SCQR,

A2: The impact of supply chain dependency (SCD) and supply chain quality barriers (i.e. inability to test and inability to trace) on the perceived SCQR, and

A3: The impact of perceived SCQR on managers' intention to adopt QELM and QERM practices.

Based on the research questions, this study strives to achieve the following research objectives:

RO1: Conduct a literature review in the broad area of risk perception studies and critically review SCRM and QM research to guide the theoretical development;

RO2: Conceptualize the perceived SCQR to identify the potential instruments;

RO3: Conduct a scale development process to validate the instruments for measuring the perceived SCQR;

RO4: Develop a theoretical framework that sheds light on the antecedents and the outcome of perceived SCQR;

RO5: Empirically test the hypothesized relationships in the theoretical model;

RO6: Offer practical recommendations and theoretical implications for researchers and practitioners to better understand the mechanism of SCQR perception.

Table 1 clarifies the linkages between Research Questions, Aims and Objectives. Research aims 1, 2 and 3 are corresponding to the Research Questions 1, 2 and 3. Research Objectives 1, 2 and 3 are proposed to address the Research Question 1. To answer the Research Questions 2 and 3, this study aims to achieve the Research Objectives 4, 5 and 6.:

Table 1.1. Linkages between Research Questions, Aims and Objectives

Research Question	Research Aims	Research Objectives
RQ1: What would the measurement scales for perceived SCQR entail?	**A1:** Managers' perceptions of SCQR,	**RO1:** Conduct a literature review in the broad area of risk perception studies and critically review SCRM and QM research to guide the theoretical development **RO2:** Conceptualize the perceived SCQR to identify the potential instruments RO3: Conduct a scale development process to validate the instruments for measuring the perceived SCQR
RQ2: What are the antecedents of perceived SCQR?	**A2:** The impact of supply chain dependency (SCD) and supply chain quality barriers (i.e. inability to test and inability to trace) on the perceived SCQR.	**RO4:** Develop a theoretical framework that sheds light on the antecedents and the outcome of perceived SCQR **RO5:** Empirically test the hypothesized relationships in the theoretical model **RO6:** Offer practical recommendations and theoretical implications for researchers and practitioners to better understand the mechanism of SCQR perception
RQ3: What are the relationships between perceived SCQR and managers' intention to adopt QELM and QERM practices?	**A3:** The impact of perceived SCQR on managers' intention to adopt QELM and QERM practices.	

1.5. Structure of the Thesis

This thesis consists of seven chapters. The structure and relationships among the chapters are illustrated in Figure 1.1. An overview of each chapter is provided below:

Chapter One presents the research background and scope of the thesis. Based on the research gaps identified in the literature, three research questions are proposed. To close the research gaps, three research goals are set, and six research objectives are specified.

Chapter Two reviews the literature on the topic of risk perception in the broad areas of sociology, psychology and business studies. This chapter also critically reviews the definitions, key theories and methods with regard to the topics of risk, risk perception, RM, SCRM and QM.

Chapter Three presents an overview of the methodology adopted in this research. The chapter begins by justifying the research strategy and explaining the reasons why this thesis adopts the quantitative research approach and survey-based method. Then, it explains the data analysis framework, which includes content analysis, Q-sort method, exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and structural equation modelling (SEM).

Chapter Four adopts the multidimensional view of risk perception to conceptualize and operationalize the perceived SCQR, which includes risk probability, risk magnitude, psychological factor and overall risk perception. The theoretical basis of risk perception and the representations of SCQR are described in depth. The potential questionnaire items are generated from the relevant literature to measure the constructs of perceived SCQR. This chapter advances the current knowledge of risk perception in the domains of OM and SCM.

Chapter Five outlines the scale development process and examines the measurement items for the perception of SCQR through a sample of Chinese manufacturers. Various tests for assessing the construct reliability, convergent validity, discriminant validity and uni-dimensionality are conducted to empirically verify the constructs of risk probability, risk magnitude and psychological factor. Also, the structural model for the construction of a formative model of perceptual SCQR is examined through the SEM approach. This chapter contributes a set of reliable items for measuring the perception of SCQR.

Chapter Six applies the risky decision-making model to develop the theoretical framework. Drawing from RDT and agency theory, this chapter first establishes the hypotheses for the

relationship between antecedents and representations of SCQR. Then, from the perspective of ambidextrous QM, this chapter also develops the hypotheses for the impact of perceived SCQR on QERM and QELM.

Chapter Seven aims to assess empirically the hypotheses developed in Chapter Six. This chapter contains reliability and validity tests (such as EFA and CFA) for nine proposed constructs, including the antecedents of perceived SCQR, the representation of SCQR, and intention to adopt QERM and QELM. The theoretical framework is examined through the SEM approach, and the empirical results are discussed.

Chapter Eight concludes the thesis and provides final remarks. Based on the research findings, this chapter also provides theoretical contributions and managerial implications. Specifically, the chapter revisits the research aims and discusses how this thesis answers the research questions and achieves the research objectives. A summary of research findings is presented, limitations are acknowledged, and recommendations for future research are provided.

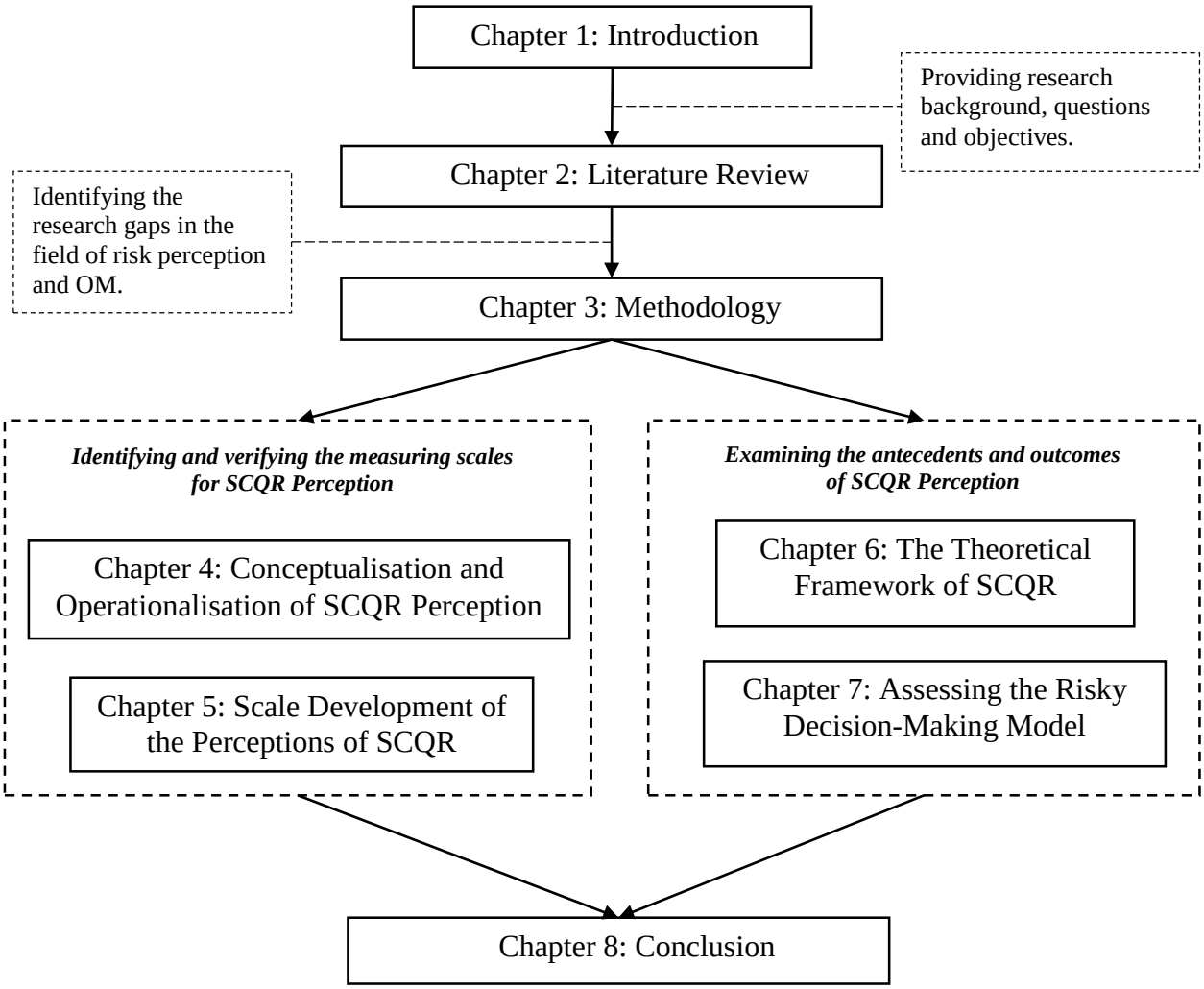

Figure 1.1. Structure and flow of the thesis

Chapter 2. LITERATURE REVIEW

2.1. Introduction

The major research aim of this thesis is to understand how managers perceive SCQR. A key difference between perceived risk and actual risk is that risk perception is the '*subjective assessment of the probability of a specified type of accident happening and how concerned we are with the consequences'* (Sjöberg et al., 2004). Therefore, before considering the central concept of this study (i.e., perceived SCQR), it is essential to have a comprehensive understanding of risk, SCR and SCQR. Therefore, the first objective of this chapter is to provide an overview and definitions for the concepts of risk, SCR and SCQR. As discussed in the Introduction Chapter, risk perception is a critical concept to understand how decision-makers respond to risk and propose the correct risk management strategies. According to Yates and Stone (1992), the actions of decision-makers in responding to uncertainties are mainly driven by overall risk perception. Ellis et al. (2010) similarly emphasised that the subjective judgement of risk (i.e. perceived risk) is the significant determinant of consumer behaviour and managerial decisions. Due to the interdisciplinary nature of risk perception, including psychology (Sjöberg, 2000), sociology (Wilkinson, 2001), OM (Tse et al., 2016a), consumer behaviour (Ross, 1975), accounting and financial investment (Koonce et al., 2005), the second objective of this chapter is to provide an overview of the relevant studies in these disciplines.

Risk perception is an interdisciplinary concept that can be approached through different research subjects. The existing literature has investigated risk perception from various perspectives, such as that of online shoppers (Hassan et al., 2006), tourists (Lepp and Gibson, 2008) and financial investors (Koonce et al., 2005). Indeed, the diversity of subjects in previous risk perception studies posted significant challenges for the researcher to identify and review

the most relevant literature for the major aim of this thesis – *managerial perception of SCQR*. According to Tranfield et al. (2003), a systematic literature review (SLR) enables a researcher to address a specific research question and precisely identify the relevant literature. While the study of public risk perception has continued to increase, the study of risk perception in OM has received much less attention compared to studies of sociology, psychology and consumer behaviour. In recent years, OM scholars have been devoting more attention to the risk perception of decision-makers in company (i.e., managerial risk perception) (Ellis et al., 2010, Tse et al., 2016a, Zsidisin, 2003a). Therefore, it is important to examine the existing risk perception studies to shed light on future research trends in the OM literature. There is currently no comprehensive and systematic review of managerial risk perception in OM studies. Thus, providing a SLR of risk perception within the OM discipline is the third objective of this chapter.

In response to risk and uncertainties, decision-makers within firms often have different risk management (RM) plans. The successful implementation of RM can be seen as the core of a company's competitive advantage, as it allows the company to mitigate the negative impact of a risk or reduce the probability of risk (Bettis, 1983). However, RM is a relatively generic topic that significantly differs from the concept of SCQR or perceived SCQR. To provide a more precise view of the management practices that deal with SCQR, there is a need to conduct a literature review on SCRM and QM. In contrast to the review method for the managerial perception of risk, this chapter applies a conventional review method. The reason for adopting the conventional review method is two-fold. First, substantive SLR articles have been previously published on the topics of SCRM (Colicchia and Strozzi, 2012, Jüttner et al., 2003, Bak, 2018) and QM (Sharma and Gupta, 2015, Sharma et al., 2012, Aquilani et al., 2017). It is not necessary to repeat those well-established works. The fourth objective of this chapter is to critically review the literature surrounding the concepts of RM, SCRM and QM.

The remainder of this chapter is organised by four main sections that correspond to the four review objectives discussed above. In section 2.2, a literature review of risk, SCR and SCQR is provided. Section 2.3 defines risk perception and provides an overview of the relevant studies in the disciplines of sociology, psychology and consumer behaviour. In addition, a SLR on the managerial perception of SCQR with the explanation of review process is provided. Section 2.4 subsequently provides a critical review of management practices (i.e., RM, SCRM and QM). Finally, this chapter concludes by identifying the research gaps and proposing future research directions. Figure 2.1 illustrates the scope of the literature review of this study.

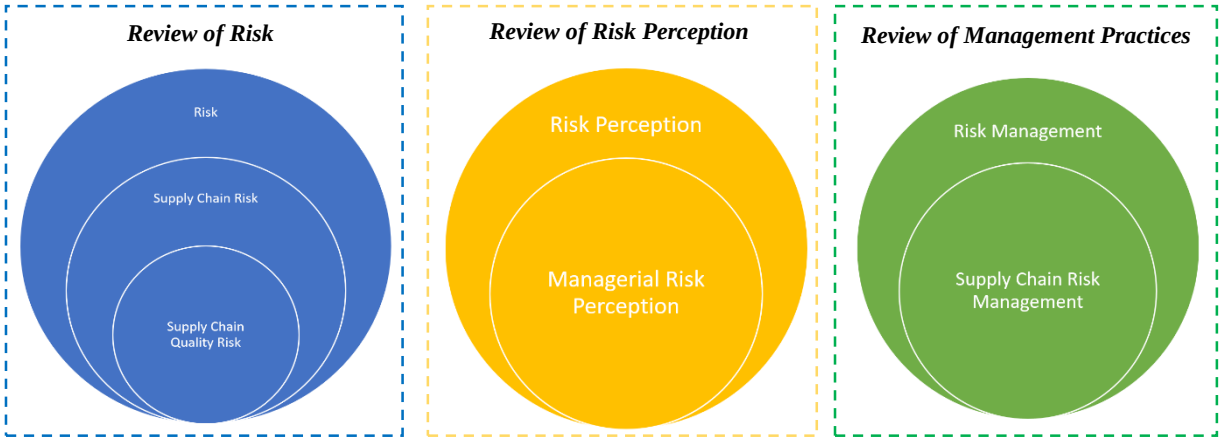

Figure 2.1. Scope of Literature Review

2.2. Review of Risk

2.2.1. Risk

In the literature, the definitions of the term 'risk' as well as the instruments that are used for risk measurement strongly depend on the chosen field of research. The meaning of risk has evolved over time, and it varies for different people, depending on their individual perceptions of the world (Slovic, 2000). Bernstein (1996) argued that risk is about choice, and thus depends on how free people are to make choices.

Common definitions of risk are based on the volatility of possible return, the concept of information deficits and the willingness to accept a potential loss if positive returns are expected (Baird and Thomas, 1990). In traditional decision theory, risk is defined as the variation in the distribution of potential results, their probability of occurrence, and the subjective value (Arrow, 1965). Under this definition, risk could indicate both positive and negative deviations from an expected outcome (Arrow, 1965). However, an empirical investigation by March and Shapira (1987) demonstrated that risk is often reduced to its negative component in practical business, whereas positive deviations are considered 'chances'. Risk can therefore be defined as the product of the probability of occurrence of a (negative) event and the resulting amount of damage (March and Shapira, 1987). The Royal Society (1992) provided a more standard definition of risk:

> '*Risk is the chance, in quantitative terms, of a defined hazard occurring. It therefore combines a probabilistic measure of the occurrence of the primary event(s) with a measure of the consequences of that/those event(s) / a combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of the occurrence.*'

In summary, the various definitions reflect the fact that there are two dimensions of risk: the magnitude of the negative effect and the respective probabilities of occurrence. According to Dowling (1986), the definition of risk can be 'quantified' as a formula to assess the probability of the loss and the magnitude of the loss for an event. Dowling (1986) further quantified risk in a two-dimensional structure that includes uncertainty and adverse consequences. Sitkin and Pablo (1992) also supported this structure in their definition of risk as the extent to which there

is uncertainty about whether potential significant and/or disappointing outcomes of a decision will be realized. In formulaic terms, risk is also equal to the degree of uncertainty multiplied by the degree of loss (Dowling, 1986).

Although risk can be theoretically discussed or quantified by equation, managers did not demonstrate interest in such quantified measures (March and Shapira, 1987). Moreover, March and Shapira (1987) found that uncertainty in business is hard to quantify. For example, an executive interviewee stated, '*You don't quantify the risk, but you have to be able to feel it*.' (March and Shapira 1987, P.1408)

2.2.2. Supply Chain Risks

The modern marketplace is characterized by uncertainty and turbulence (Christopher and Lee, 2004). Companies are facing more tremendous, competing challenges than ever before. Rather than competing as solely autonomous entities, today's individual businesses strive to compete as a supply chain (Lambert and Cooper, 2000). Due to geographic differences and a complex international environment, various types of risk along the supply chain have emerged. The vulnerability of the supply chain to disturbance or disruption has increased because of the greater uncertainties in the supply and demand of the marketplace, globalized manufacturing with complex international distribution networks and shortened product and technology life cycles (Christopher and Lee, 2004). Furthermore, overreactions, unnecessary interventions, second guessing, mistrust and distorted information throughout a supply chain can also lead the supply chain to fall into "chaos". According to Tang (2006), there are many disruptions in recent years, such as terrorist attacks, hurricanes, earthquakes and floods, that make SCR a major factor to consider for the cost reduction in supply chain management. The SCR caused by both factors within supply chains and outside environmental forces is a major concern for

academia and practitioners. Beyond external factors, changes in a company's business strategy can also increase SCR (Christopher and Lee, 2004).

Table 2.1. SCR Classification

Author(s)	SCR Classification
Johnson (2001)	From the perspective of the toy industry, SCR can be divided into supply risks (e.g., capacity limitations, currency fluctuations and supply disruptions) and demand risk (e.g., seasonal imbalances, volatility of fads and new products).
Zsidisin et al. (2000)	SCR can relate to risks of design, quality, cost, availability, manufacturability, supplier, law, environment, health and safety.
Jüttner et al. (2003)	SCR includes sources of risks (e.g., political risk, market risk, financial risk) and consequences of risk (e.g., operational risk, human risk and risk to customer service level).
Chopra and Sodhi (2004)	SCR includes disruptions, delays, systems, forecast, intellectual property, procurement, receivables, inventory and capacity.
Finch (2004)	There are three levels in SCR: application level, organisational level and inter-organisational level
Jüttner (2005)	There are three types of SCR: environmental risk, supply risk and demand risk.
Manuj and Mentzer (2008)	There are three categories of SCR: operational risk, demand risk and security risk.
Tang and Tomlin (2008)	There are six major types of SCR: supply risk, process risk, demand risk, intellectual property risk, behavioural risk and political social risk.

SCR is typically understood to include many different forms (Harland et al., 2003). For example, Chopra and Sodhi (2004) classified SCR in five different forms: delay of materials from suppliers, large forecast errors, system breakdowns, capacity issues, inventory problems and disruptions. According to Tang (2006), SCR includes operational risk (inherent uncertainties such as uncertain customer demand, uncertain supply and uncertain cost) and disruption risks (major disruption caused by natural and man-made disasters), which Tang argued are always associated with greater impact. Tang and Tomlin (2008) later concluded that there are six major types of SCR: supply risks, process risks, demand risks, intellectual property risks, behavioural risks and political-social risks. Finch (2004), meanwhile, classified SCR according to three progressive levels: application level, organisational level and inter-

organisational level. Similarly, Jüttner et al. (2003) found that managers perceive SCR as a multidimensional construct that includes the source and consequences of risk. For example, in SCR, 'political risks' and 'market risks' are sources of risk, while 'operational risks', 'human risks' or 'risk to customer service levels are consequences of risks. Table 2.1 summarises the various classifications of SCR as presented by the literature.

Understanding the nature of SCR is the starting point to managing it. Although there are a number of studies related to SCR, most have focused on the risks associated with supply chain disruptions, which describe those unplanned and unanticipated events disrupting the normal flow of goods and materials within a supply chain network (Zsidisin et al., 2003a; Manuj and Mentzer, 2008). Nevertheless, due to increased product harm scandals, such as melamine milk, dioxin pork and toxic capsules, researchers and practitioners are increasingly interested in the SCQR. According to the literature on SCR, SCQR can be regarded as a sub-category and source of SQR. Furthermore, SCQR can lead to a series of bad consequences within the supply chain. Taking the melamine milk case as example, the SCQR in Sanlu's supply chain resulted in financial loss, reputational loss and even the arrest of managers. Therefore, the SCQR can be understood as an initial point of a supply chain hazard that it is capable of triggering other SCRs.

2.2.2.1. Defining Supply Chain Quality Risk

Quality risk in the manufacturing process is the initial point for scrutinizing the SCQR. Gray et al. (2011) defined the quality risk as: *'the propensity of a manufacturing establishment to fail to comply with good manufacturing practices'*. The melamine milk scandal, Irish dioxin pork and horsemeat scandal are all recent examples of quality risk. These product quality incidents raised public awareness on issues in the global supply chain. Researchers therefore began to extend the study of quality risk to the context of the global supply chain, addressing

'product quality risk in supply chain' (Chavez and Seow, 2012). SCQR is not only the risk related to the manufacturing process; rather, the risk can lead to a chain reaction throughout the network. Tse and Tan (2011, P.141) refined SCQR: *inherent quality problems (i.e., raw materials/ingredients/production/logistics/packaging) in any of the supply members trigger a cascading effect that spread through a multi-tier supply network.* In addition, Chavez and Seow (2012, P.2) defined product quality risk in supply chain as *'a product's quality state in which it is affected by direct and indirect multi-tier suppliers' materials, in which a minor risk incident can have a cumulative effect along the whole network'.* Due to the research scope of dyadic supply chain, the definition of Chavez and Seow (2012) is adopted in this study.

2.3. Review of Risk Perception

2.3.1. Defining Risk Perception

Risk perception is an area of interest across many subjects, from sociology to psychology, management science, economics and preventive medicine (Arrow, 1982, Brewer et al., 2007, Slovic, 2000). The evaluation of the perception of risk usually includes the probability of danger and the consequences of the danger. From the perspective of decision-making theory, risk perception can be defined as a *'decision maker's assessment of the risk inherent in a situation'* (Cooper and Faseruk, 2011). Beyond the probability and consequence of risk, researchers have also studied the emotional components of risk perception, such as worry and insecurity. According to the empirical study by Rundmo (2000), the emotional component of risk perception is the driver of rational judgments of risk. In addition, Fischhoff et al. (1978) used the psychometric paradigm approach to evaluate perceived risk from multiple risk characteristics. From the perspective of health behaviour, Brewer et al. (2007) suggested that there are three dimensions of perceived risk: perceived likelihood, perceived susceptibility and perceived severity of the hazards.

Risk perception is an individual's beliefs about risk, which are based upon the information available, personal experiences, value systems and the social context (WHO, 2002). Different judgmental rules (also called heuristics), such as availability and overconfidence, also come into play when people perceive risks (Tversky and Kahneman, 1974; Slovic et al., 1979). An early approach to studying individuals' perceptions of risk was to make a mass comparison of the estimated numbers of deaths for 40 different hazards – such as smoking, cancer and driving − between known statistical estimation and average people's estimations (Lichtenstein et al., 1978, Fischhoff et al., 1978). Such research demonstrated that people might have biases in risk perception: they sometimes overestimate infrequent risks, and underestimate hazards that frequently occur, such as cancer and diabetes. Nevertheless, risk perception does not only concern the individual; it is also a social and cultural construct reflecting values, symbols, history and ideology (Weinstein, 1989). In particular, the social amplification of the risk framework that was introduced by Kasperson et al. (1988) outlined how public perceptions of risk change (amplifying or attenuating) within the information chain, from risk information senders through intermediates to the final receivers.

2.3.2. Psychology and Sociology Literature

The 'psychometric paradigm' and 'cultural theory' are currently dominating the research field of risk perception by sociologists and psychologists (Sjoberg et al., 2004). However, few attempts of these topics have been made to study the perception of risk in the context of business research, particularly risks that occur in the supply chain.

2.3.2.1. Psychometric Paradigm

The psychometric paradigm is to identify the characteristics influencing people's perception of risk; it assumes risk is multidimensional, that it is not only the probability of harm that affects individual judgments (Mcdaniels et al., 1995, Sjöberg et al., 2004). The psychometric

paradigm addresses the question of why people perceive different risks differently. Through utilizing diverse rating scales (between 9 and 15 dimensions), participants are usually asked to evaluate a set of hazards (e.g., smoking, food colouring, nuclear power, surgery, motor vehicles, home appliances, skiing) (Fischhoff et al., 1978, Sjöberg et al., 2004, Siegrist et al., 2005). The approach then requires calculating the mean ratings for each hazard for obtaining the interrelations in which used to factor analyse. Fischhoff et al. (1978) identified two factors – 'Severity (or Dread)' and 'Technological risk (or Novelty)" through a nine-dimension rating scale (voluntariness, immediacy, knowledge, precision, controllability, newness, catastrophe, dread, and severity) and 30 activities or hazards for scaling.

Subsequent studies of psychometric paradigms extended to cross-cultural or cross-national comparisons of perceived risk. Hayakawa et al. (2000), for example, identified a cross-national difference in automobile risk perceptions between Japan and the US. The difference in risk perception in different countries might be due to the coverage of hazards in the media. Boholm (1998) argued that although people to a large extent acquire information from direct personal experience with regard to many everyday hazards, information about other hazards can only be obtained indirectly from experts, new media public agencies or informal networks of friends and family. According to Englander et al. (1986), the perception of risks differed between Americans and Hungarians to a significant degree because the role of the news media in each country is different. The Hungarian communist government controlled the media and gave very little coverage to domestic hazards, thereby weakening the public's perceptions of risk.

Risk perception according to socio-cultural perspectives considers broader social factors and processes that are based on the empirical findings of psychological studies. According to Bickerstaff's review of the literature (2004), the studies that have emerged from socio-cultural research can be organized in three themes: locality and place, agency and power, and trust and

communication. Several sociology studies have revealed that people with more power and socioeconomic advantages, such as white men, are more likely to perceive the world as safe than are others (Flynn et al., 1994, Finucane et al., 2000). On the other hand, the significant relationship between trust and risk perception has been proved in a number of studies (Peters et al., 1997, Frewer et al., 1996).

2.3.2.2. Risk Communication

The emergence of risk communication as a research theme is closely linked to the issues of inconsistency in risk perception between 'experts' and 'lay people' (Plough and Krimsky, 1987). These issues are also referred to as "Expert-lay discrepancy" (Plough and Krimsky, 1987). In contrast to lay people, the experts on hazards or risks are those who have professional knowledge and experience, such as scientists and government officials. Due to the knowledge difference, lay people perceive risks differently and this can lead to overestimation or underestimation of risks (Sandman, 1988). The need to communicate various risks well is widespread among governments, different authorities and industrial organizations. It is essential for organizations to provide useful information to the public about the risks and benefits of their products, policies and services.

Risk communication is arguably about how experts educate laypeople about risk. At one time, this was the focal communication strategy of risk analysts (Sandman, 1988), because risk experts can identify or quantify risks based on their intelligence and technologies. Nevertheless, it is difficult to prove the effectiveness of expert knowledge and technology in risk analyses (Fischhoff, 1995). In the field of social research, a consensus has been reached that risk communication is a two-way process, rather than a one-way direction, from experts to laypeople.

2.3.3. Consumer Behaviour Research

There has been a long history in marketing research of analysing the consumer's behaviour from the perspective of risk perception (Bettman, 1970, Pras and Summers, 1978, Rao and Farley, 1987). Bettman (1970) underlined that *'understanding perceived risk is of benefit to the marketer.'* More recently, researchers of risk perception have generally concentrated on the consumers' perceived risk, particularly in the food and drug industry (Liu et al., 2014, Bearth et al., 2014, Feng et al., 2014, Lagerkvist et al., 2013). In order to produce an appropriate marketing strategy, it is important to understand how consumers perceive consumption-related risk, particularly with regard to new, high-tech products (Sarin et al., 2003, Phillips and Hallman, 2013). In their study of genetically modified (GM) food, Phillips and Hallman (2013) found that consumers evaluated the product according to how the new technology was framed. Lusk and Coble (2005) also argued that risk perceptions and risk preference are both significant determinants of the consumers' acceptance of GM food (i.e. risky food). Moreover, the product harm crisis is also the entry point of risk perception research, as the increasing product quality crisis – including the horsemeat scandal, mad cow disease and the toxic capsule scandal − has raised wide public concern. On the other hand, if consumer behaviour is driven by their risk attitudes, then eliminating the risk is the appropriate solution. Feng et al. (2010) suggested that when facing product quality risks, people will pay more to purchase better quality products, thus reducing the relative risks. Understanding consumers' risk perception is also significant in establishing pricing strategy. Lowe (2010) asserted that the perceived performance risk can moderate consumers' evaluation of different product promotions, which includes the extra fee for product promotions and price discounts. In particular, the research found that with respect to products with lower performance risk perception, consumers tended to accept the extra amount charged to promote the product instead of opting for discounted prices.

As an emerging concept in the 21st century, risks originating from the internet have also raised researchers' interests. For example, Hassan et al. (2006) developed a method for measuring the degree of consumers' perceived risk regarding online shopping. They posited seven dimensions of perceived risk when consumers shop online: perceived financial risk, perceived performance risk, perceived risk of losing time, perceived social risk, perceived psychological risk, perceived physical risk, perceived source risk and perceived privacy risk. Moreover, taking the online shopping mall of Korea as an example, Kim et al. (2008) argued that customer satisfaction is associated with the consumer's risk perception regarding the security of the transactions, customer support and the interface of the website. Based on a survey of the mangers of UK Small and Medium Enterprises (SMEs), Grant et al. (2014) found that the perception of e-business risk is significantly influenced by the experience of the managers and their work roles. Their findings suggested that IT professionals (head of departments, directors and technicians) in an IT company perceived more reputation risk than did other groups, such as owners or managerial directors (Grant et al., 2014).

2.3.4. Systematic Literature Review of Managerial Risk Perception

The SLR method has been well developed in different fields, such as medical research and education, over the last few decades (Bennett et al., 2005). The UK-based 'Evidence for Policy and Practice Initiative' (EPPI) centre has developed methodologies for scientific reviews and exploiting the results for future research. As presented in Table 2.2, the EPPI centre identified different phases of SLR. Although different researchers might use their own SLR methodologies, all these systematic review methods share a number of common features (Bennett et al., 2005).

Table 2.2. Different stages in Systematic Review

Phase of Review	Key Activities
Identification of review research question	Consultation with review group members to develop and refine the review research question
Developing inclusion/exclusion criteria	Developing inclusion and exclusion criteria to enable decisions on which studies are to be included in the review
Producing the protocol for the review	Producing an overall plan for the review, describing what will happen in each of the phases
Searching	Search of literature for potentially relevant reports or research studies, including electronic searching, hand searching and personal contacts
Screening	Applying inclusion and exclusion criteria to potentially relevant studies
Keywording	Applying EPPI core keywords and review- specific keywords to included studies to characterize their main contents
Producing the systematic map	Using keywords to generate a systematic map of the area that summarizes the work that has been undertaken
Identifying the in-depth review question	Consultation with review group members to identify area(s) of the map to explore in detail, and develop the in-depth research review question
Data extraction	Extracting the key data from studies included in the in-depth review, including reaching judgements about quality
Producing the report	Writing up the research review to a specified format
Dissemination	Publicizing the findings of the review, including the production of summaries by users
Source: Bennett et al. (2005)	

For example, the SLR methodology adopted by the Higher Education Career Service Unit includes four stages: searching and screening, data extraction, synthesis and data analysis, and reporting (Bennett et al., 2005). In the field of SCM, Burgess et al. (2006) conducted a structured literature review that included three phases: the selection of articles, the review process and inter-rater reliability, and the classification framework. The general structure of SLR is similar across different fields. The first step generally focuses on searching and

screening the literature data, with some inclusion and exclusion criteria. The second stage includes data extraction and conducting the synthesis of the data. Finally, the SLR method reports the findings and disseminates them to a wider audience.

The motivation of conducting the SLR on managerial risk perception is threefold. First, given the focus of this study is the perception of SCQR, to ensure the originality of this study, it is vital to systematically check whether this topic has been studied before. Second, although risk perception is an emerging research topic in OM, which is critical to understand manager's decision-making process, there is no article systematically review such important topic. Third, how to measure the managerial risk perception is still an open question to both practitioners and academics. An SLR of the managerial risk perception is helpful for comprehensively reviewing the potential issues of the managerial risk perception measurements and guiding the future directions.

2.3.4.1. SLR Methodology and Preliminary Results

Table 2.3. Keywords Adopted for Searching Literature

<table>
<tr><td colspan="3">AND</td></tr>
<tr><td rowspan="2">Decision-maker in a company</td><td colspan="2">Risk perception</td></tr>
<tr><td colspan="2">AND</td></tr>
<tr><td>`</td><td>Risk*</td><td>Perception*</td></tr>
<tr><td>Buyer*</td><td></td><td>Perceived</td></tr>
<tr><td>Decision-maker*</td><td></td><td></td></tr>
<tr><td>Practitioner*</td><td></td><td></td></tr>
<tr><td colspan="3">* indicates any string of characters</td></tr>
</table>

This SLR focuses on collecting literature and data according to article title, abstract and keywords related to the research topic. The databases utilised as sources of literature data include EBSCO Host & PROQUEST, Scopus and Emerald. The key search terms used were closely related to the research questions. Table 2.3 lists the keywords that were adopted in the

literature searching. In this study, the search terms are classified into two groups: subjective and perceived risk. The '*' sign was added to some search terms because the literature may use slightly different words to describe a same concept. For example, the use of the '*' sign with the term of manager can also capture related words such as 'managers' or 'managerial'.

A preliminary screening was first conducted on the database level. The initial inclusion criterion was the peer-reviewed English journal in prestigious academic journals that listed in CABS[1] journal 2015 including the psychology, marketing, sociology and OM fields. The initial search generated a vast number of articles that include the key words in abstract, title and article keywords, as mentioned in Table 2.3. Six hundred and twenty-four peer review journal articles were filtered in the process of manually checking whether the collected literature was a fit for the review objective of this thesis (i.e., managerial risk perception). The researcher carefully scanned the articles for relevance and thoroughly examined whether the research subject of each article was the decision-maker of the company. Although a combination of keywords (e.g., 'manager' and 'risk perception') was used to collect the literature, this study finds that most of the psychology, sociology and marketing literature is not relevant to the review objective of this study: managerial risk perception. For example, although the keywords of risk perception and managers appear in the research of Liu et al. (2017), their research purpose was to understand the public risk perception in a single urban city within the United States. The researcher found many similar cases in the marketing journal as in the survey of sociology literature; the generated articles were not compatible with the review scope. For example, Bianchi and Andrews (2012), which is focused on investigating the role of customers' perception of risks associated with online shopping, was also captured in the stage of preliminary screening. Therefore, to ensure the accuracy of the literature collection, the scope

[1] Chartered Association of Business Schools 2015 journal list: http://charteredabs.org/academic-journal-guide-2015/

of this SLR was narrowed down to OM articles. This choice is consistent with the focus of this research, because the managerial perception of SCQR is a sup-topic of OM research.

To ensure the review quality and to meet the review objective, this study collected sample articles that are considered at least 'national-recognised' in the field of OM studies. It is important to note that the *Journal of Business Research* and *Industrial Marketing Management* are also included in the literature survey, because abundant articles related to SCM or SCRM were published in these two journals.

2.3.4.2. Descriptive Results

This section presents the descriptive statistics for the topic of 'managerial risk perception' and discusses the distribution by journal, year of publication and article type. There are three categories of article type: empirical research, conceptual paper and experimental research. Given that this thesis adopts an empirical research design, the SLR also included a sub-sample analysis of the empirical research in terms of the analysis method and data collection method.

According to the criteria regarding the scope of journal and searching terms (see Table 2.3), the literature survey initially collected 136 peer-reviewed articles. After removing the duplicated records, a total of 122 articles were retained for further analysis. The retained articles were further screened by manually examining whether the title, keywords and title are relevant to the research context: *managerial risk perception*. The number of retained article was thus further reduced to 56. The full texts of the 36 retained articles were then thoroughly reviewed in order to identify the most relevant studies that fit the research question and research aims of this study. Thirty six articles were ultimately included in this SLR. Table 2.4 summarises the findings of the systematic literature review and all the detailed results for individual article can be found in Appendix A.

As shown in Figure 2.2, in the field of OM, the topic of "managerial risk perception" received the most attention from the Journal of Supply Chain Management (n=5, 13.89%) and the International Journal of Project Management (n=5, 13.89%). Moreover, four related articles were published in the International Journal of Production Research (11.11%) and three in Industrial Marketing Management (8.33%). Managerial risk perception articles can also be found in the top OM journals, such as Management Science and the Journal of Operations Management. Further details on journal distribution are presented in Figure 2.2.

Figure 2.3 reports the distribution of articles by year from 1993 to 2017. In OM literature, research has increasingly investigated managerial risk perception in recent years. Ten articles were published from 2016 to 2017. Managerial risk perception research with an OM focus has grown steadily since 2012. According to the SLR, Henthorne et al. (1993) were the first to conduct research on managerial risk perception in OM. They investigated the effect of experience and locus of control on buyer perception of performance risk, social risk and economic risk.

Figure 2.2. Journals with Managerial Risk Perception in OM

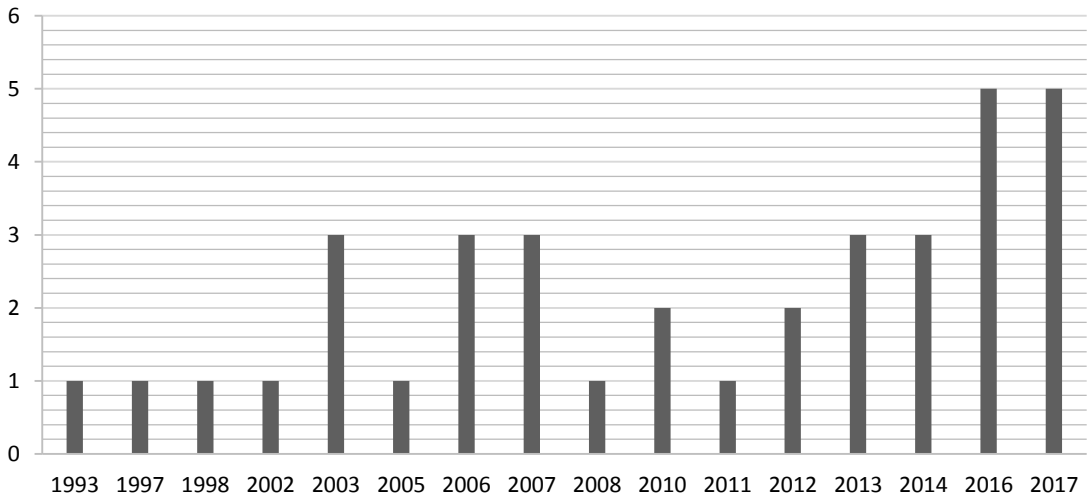

Figure 2.3. Distribution of Articles by Year

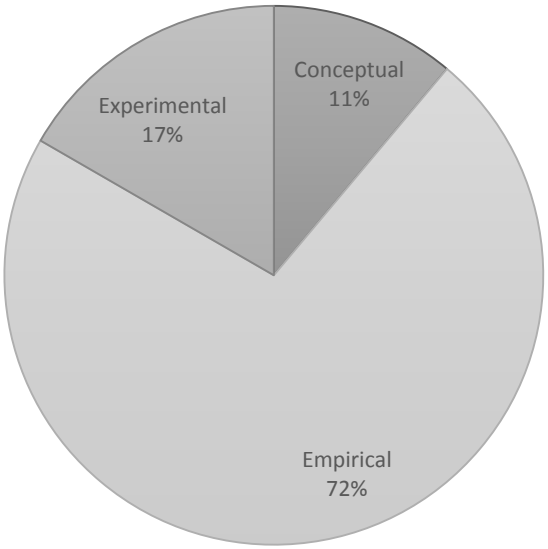

Figure 2.4. Distribution of Articles by Type

This study also categorizes the collected articles by research types: empirical research, conceptual research and experimental studies. As shown in Figure 2.4, most of the OM articles related to managerial risk perception are empirical studies (n=26, 72%). 17% of the collected articles adopted the experimental research design to scrutinize the managerial risk perception, while only four articles were conceptual works. No review articles related to managerial risk

perception have been published in the selected OM journals. This indicates that conceptual research and a systematic literature review are promising research directions for future study of managerial risk perception.

Figure 2.5 presents the distribution of the 26 empirical articles by data analysis method. The data analysis methods used in the empirical studies were diverse. Thirty percent of the empirical papers utilized a statistical model approach, such as SEM in order to test a set of hypothesized relationships. Twenty five percent of the empirical research articles provided only the descriptive statistics of the questionnaire data. The behavioural experiment and case study methods together account for 34% of the empirical research.

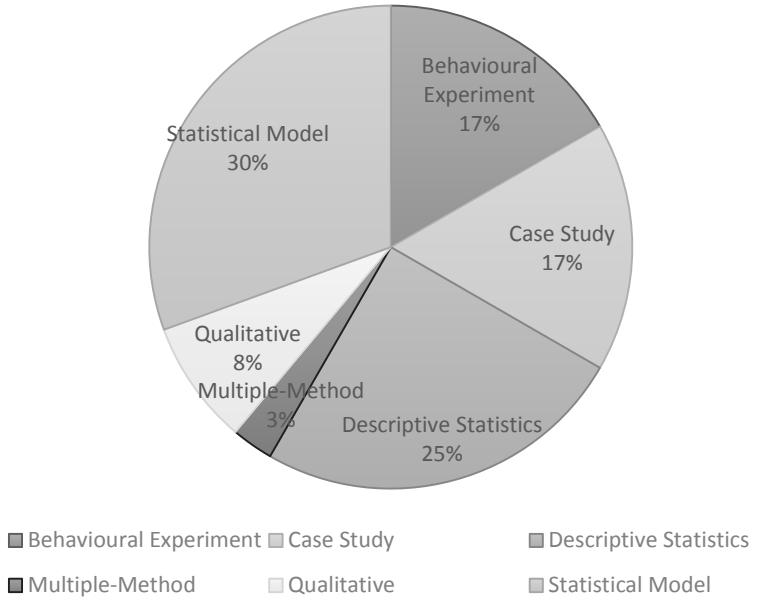

Figure 2.5. Distribution of Empirical Articles by Data Analysis

2.3.4.3. Results of the SLR on managerial risk perception

As reported in the results table, the perceived risk associated with project management and supply management are two major trends in OM articles. The topic of the managerial perception of risk has emerged in several project management papers. For example, by

adopting a risk ranking approach, Lu and Yan (2013) investigated the risk perception behaviour of contractors in China, and revealed that perceived risk is the basis of assessments of construction projects. In addition, de Camprieu et al. (2007) found that cultural differences lead managers to perceive the risk associated with project management differently. Most recently, Wang et al. (2016) conducted empirical research in China to investigate how the personality of construction project managers impacts the perceived risk. They found that personality traits (such as extraversion, agreeableness and conscientiousness) significantly influence risk perception, while risk propensity fully mediates the effects of personalities on the perceived risk (Wang et al., 2016). Technical knowledge and job position were also found to be significant factors that drive the managers to perceive project risk differently (Tiwana and Keil, 2006, Gilkey et al., 2012), The existing literature on perceived project risk has focused on exploring the antecedents of risk perception from a personal level, through examining personalities, technical knowledge, age, knowledge and job position. Only one selected paper on the topic of project risk perception specified the underpinning theory. Furthermore, the project management literature rarely examines the outcome of perceived risk, with the exception of the study of Akintoye and MacLeod (1997). Akintoye and MacLeod (1997) concluded that perceived construction project risk is associated with the potential completion of the project.

The results of the SLR suggest that a second major research stream is the *'buyer perception of risk'*. The research subject of 'buyer perception of risk' is generally the top manager, supply chain manager or purchasing directors of a focal company. Over 50% of the OM risk perception studies in this literature survey are related to this topic (n=21). Figure 2.5 summarises the research topics for the studies on *'buyer perception of risk'*. A major topic in these studies is supply risk. Zsidisin (2003b, P.222) was one of the first pioneers to define perceived supply risk:

Supply risk is defined as the probability of an incident associated with inbound supply from individual supplier failures or the supply market occurring, in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to customer life and safety. (p. 222)

Perceived supply risk is widely viewed as a multi-dimensional concept in terms of the risk sources (Shapira, 1995). However, OM authors have not produced a consistent definition and operationalisation of supply risk. According to Zsidisin (2003a), there are two groups of supply risk sources: individual supplier failure and market characteristics. Building upon the works of Zsidisin, Cheng et al. (2012) operationalised perceived supply risk through a sample of 188 Hong Kong manufacturing companies. Although they applied the perspective of supply risk sources to measure the perceived supply risk, their measurement of perceived supply risk failed to accurately reflect the definition provided by Zsidisin (2003b) regarding the components of risk probability and risk consequences. More recently, Shafiq et al. (2017) extended the original scope of supply risk to include sustainability risk and operations risk as two sub-dimensions. According to their study, supplier capacity, supplier cost competitiveness, supplier lead time and supplier on-time delivery are the four factors for measuring operations risk (Shafiq et al., 2017). Sustainability risk, on the other hand, is defined as the *'potential consequence of an incident associated with social and/or environmental shortcoming or failure by a supplier'* (Shafiq et al., 2017, p.1389). The research of Shafiq et al. (2017) conceptualised perceived supply risk in a single dimension (i.e., risk consequence) and therefore failed to reflect the definition provided by Zsidisin (2003b).

As shown in Appendix A, supply disruption risk (or supply chain disruption) is the second major topic in managerial risk perception studies. Supply disruption risk is one of the dimensions of supply risks (Swierczek, 2016). However, OM researchers use 'supply risk' and

'supply disruption risk' interchangeably to refer to risk related to the upstream disruption (Shafiq et al., 2017). Ellis et al. (2010) shed new light on measuring supply disruption risk in a real multidimensional framework. They conceptualised three components of perceived supply disruption: probability of supply disruption, magnitude of supply disruption and overall risk perception (Ellis et al., 2010). The probability of supply disruption and magnitude of supply disruption were found to significantly and positively affect overall risk perception (Ellis et al., 2010). Ellis et al. (2010) refined the definition provided by Zsidisin (2003b), suggesting that both risk probability and risk magnitude are significant determinants of supply disruption risk. Nevertheless, recent OM empirical research has ignored the caution of Ellis et al. (2010, p.44): '*results from our study serve to caution future researchers from adopting conceptualizations of supply disruption risk that include only the probability or the magnitude of a supply disruption'.* Oliveira and Handfield (2017), for example, measured supply disruption risk only from the view of risk probability. To close this gap, this study provides a more appropriate solution to measure perceived risk in Chapter 4.

Risk perception studies in the supply chain context investigate either the antecedent or outcome of perceived risk. The antecedents of perceived supply risk can be categorised as item characteristics, market characteristics or supplier characteristics (Zsidisin, 2003a). The item characteristics reviewed in this study include item customization, item importance, product modularity and process modularity (Ellis et al., 2010, Gualandris and Kalchschmidt, 2013). Regarding the supplier characteristics, Oliveira and Handfield (2017) suggested that communication with suppliers and supplier financial health are both significant factors that reduce perceived supply disruption risk. Ellis et al. (2010), in their empirical study, found that market thinness drives both the probability and magnitude of supply disruption risk. That is, when the market has fewer alternative suppliers, buyers perceive a greater supply disruption risk (Ellis et al., 2010). Their result is consistent with the experimental findings of Mantel et

al. (2006), who concluded that the number of qualified suppliers is negatively associated with decision-makers' perception of supply risk. However, according to the SLR results, the existing literature has not fully examined the roles of all the factors highlighted by Zsidisin (2003b) in managerial perception of supply risk.

The results of the SLR indicate that there are three types of outcomes of perceived supply risks: response action, implementation of management practices and performance. The theoretical foundation of response action studies is generally based on the argument of behavioural decision-making. Mantel et al. (2006), for example, asserted that a supply manager is more likely to keep production in-house when he or she perceives a high degree of supply risk. Extending the buyer's behavioural decision-making process proposed by Mantel et al. (2006), Ellis et al. (2010) found a significant and positive effect of perceived risk on the decision of switching suppliers. Kull et al. (2014) also applied behavioural decision theory in a supply chain context. They found that perceived risk is negatively associated with supplier selection risk taking, which reflects the *'likelihood of a decision-maker to select a supplier that is associated with more uncertainty'* (Kull et al., 2014, P.471). Response action studies often connect perceived risk with the nature of decision-making, such as risk-taking (Kull and Ellis, 2016, Mantel et al., 2006). In this literature survey, the research on implementation of management practice focuses on risk mitigation practices such as the total quality management, safety stock, supply chain collaboration and supplier involvement (Baker, 2007, Zsidisin and Smith, 2005). Two empirical papers addressed in this survey examined the relationships between perceived risk and performance. Truong Quang and Hara (2017) found that supply chain risks − which include supply risk, operational risk and demand risk − are negatively associated with supply chain performance. Schoenherr (2010) concluded that the relationship between perceived risk and purchase performance is not significant.

Table 2.4 Summaries of Systematic Literature Review Results

Type of Risk	**Research Subject**	**Relevant Variables**		**Adopted Theory**	**Method**	**Data Collection**
		Antecedent	**Outcome**			
Supply Chain Risk (Djeflat, 1998; de Champrieu et al., 2007; Grudinschi et al., 2014; Mantel et al., 2006; Baker, 2007; Kuller et al., 2014; Brusset and Teller, 2017; Truong Quang and Hara, 2017)	Buyer and Top Manager	Sourcing category difficulty; sourcing category importance; proportion of contingent pay; perceived supplier control; risk propensity; Number of suppliers; cost implications; information sufficiency	Trust; governance & administration; communication; Trust; governance & administration; communication; Likelihood to outsource; Tendency toward long-term relationships; removal of trust; element from the relationship; Supply chain performance	Behavioural decision theory; Inventory control theory and Behavioural decision-making theory	Structural Equations Modelling and Partial Least Square-SEM	Mail Survey and Interview
Supply Risk (Zsidisin, 2003a, 2003b; Zsidisin and Ellram, 2003; Zsidisin and Smith, 2005; Delerue-Vidot, 2006; Chen et al., 2012; Gualandris and Kalchschmidt, 2013: Shafiq et al., 2017)	Buyers and General Managers	Item characteristics; market characteristics; supplier characteristics; Product modularity; process modularity and flexibility.	Buffer-oriented techniques; behaviour-based techniques and Guanxi (i.e., informal relationship) development	Agency Theory and Social Capital Theory	Case Study, Regression Analysis and Structural Equations Modelling	Interview and Mail Survey
Supply Disruption Risk (Ellis et al., 2010; Schoenherr, 2010; Ellis et al., 2011; Oliveira and Handfield, 2017; Swierczek, 2016)	Buyers	Buyer-supplier communication; supplier financial health; proactive contract negotiation; Enactment: early supplier involvement; logistics integration	Cognitive cause map and Switching to alternative supplier	Enactment Theory, Resource Dependence Theory	Conceptual and Structural Equations Modelling	Mail Survey

Type of Risk	Research Subject	Relevant Variables		Adopted Theory	Method	Data Collection
		Antecedent	Outcome			
Risk associated with construction projects (Akintoye and MacLeod, 1997; Lu and Yan, 2013; Wang et al., 2016; Tiwana and Keil, 2006; Gillkey et al., 2012)	Project Manager	Personality and risk propensity; Related technical knowledge; customer involvement; requirements volatility; methodological fit; formal project management practices; project complexity; Job position;	Potential completion of the project	Information integration theory	Partial least square-SEM, ANOVA, Descriptive Statistics and Regression	Mail Survey
Risk associated with information (Farahmand et al., 2013 and Tran et al., 2015)	Supply Chain Manager and Top Manager	Not specified	Information security decisions; Frequent communication; partner selection; honest and open transaction; formal contract; ongoing collaboration and personal relationship management	Agency Theory	Case Study	Interview
Financial Risk (Rao et al., 2007 and Koudstaal et al., 2016)	General Managers	Job position; age; gender; education; experience; salary	Not specified	Prospect theory	Structural Equations Modelling	Mail Survey

2.4. Review of Management Practices

2.4.1. Risk Management

This section provides a review of the risk management (RM) literature related to risk in the field of business research, although RM is a cross-discipline subject in the social sciences, such as public risk management. RM focuses on how to reduce both the probability of associated risks and consequences of loss. Hollman and Forrest (1991) argued that RM should be a systematic approach for a company to utilize internal resources − such as physical, financial and human capital − to ensure the integrity of the firm's assets and profits.

RM refers to a trade-off behaviour between risk and benefits. These trade-offs made by individuals or organizations depend on their acceptable level of risk, the size of potential benefit, and their attitude toward 'risk taking' (Adams, 1995, Smallman, 1996). There are two dimensions in managing risk: reducing the bad effect and enhancing the benefit. From the perspective of financial management, to manage risk is to leverage the effect of risk (Hamada, 1972, Saunders et al., 1990, Bouchaud et al., 2001). According to Waring and Glendon (1998), RM is managing hazards and threats in a way that '(a) pure risks are eliminated, reduced or controlled, and (b) speculative risks result in enhanced overall utility or benefit'. Pure risks are typically related to unavoidable hazards, such as health, safety, environment and security (Williams, 1966, Halek and Eisenhauer, 2001). On the other hand, speculative risks are associated with risks made as conscious choices that result in an uncertain degree of gain or loss (Williams, 1966, Halek and Eisenhauer, 2001). In terms of the scope of RM, there are four key dimensions (Waring and Glendon, 1998): hazards or threats (i.e., the objects of risk management), risk context, risk management objectives and risk management methods.

The scope of RM provides the research agenda for this text. With respect to the objects of RM, the pure risks connected to 'hazards' and the speculative risks related to the 'threat'

(Waring and Glendon, 1998). In addition, the leveraging of risk (i.e., trade-off between risk and benefit) is regarded as the objective of RM. Waring and Glendon (1998) stated, 'the context(s) in which risks are perceived to exist and to which risk management responds set the scene for identifying and understanding relevant hazards and threats and analysing the corresponding risks'. The study of risk perception is therefore about understanding the risk contexts of RM. Furthermore, the RM method discusses the process of managing risks. There are generally four steps within the risk management process. Although the labelling of these steps differs, their meanings are similar. The four main steps of RM include: (a) risk identification – measuring the risk; (b) risk assessment – answering how big in a scale of risks; (c) risk decisions (i.e., risk mitigation) and (d) risk control.

The RM method has been widely adopted in different fields of business studies. For example, using stock market information and the joint dynamics of bank investment, Lehar (2005) proposed a new RM method for bank regulators to identify and control risk. In the construction project context, Al-Bahar and Crandall (1990) developed a construction risk management system to help project managers identify project risks and systematically analyse and manage them. In order to assess the project risk, they introduced influence diagramming techniques and the Monte Carlo simulation as the toolbox of RM. Gordon et al. (2009) conducted empirical research to investigate the relation between enterprise risk management and firm performance. They found that the enterprise risk management-firm performance relation is contingent on the proper match between enterprise risk management and five contingency variables (environmental uncertainty, competition within industry, firm complexity, firm size and monitoring by board of directors). In recent years, RM has been extended to the supply chain context in order to refine a new concept of supply chain risk management (SCRM) (Jüttner et al., 2003, Tang, 2006, Norrman and Jansson, 2004).

2.4.2. Supply Chain Risk Management

As the result of increasing global sourcing, a number of uncertainties have emerged that affect the operations of a long and multi-layered supply chain. These unexpected events can determine the risks of a supply chain, and SCRM is intended to manage those risks (Bak, 2018). The 'Albuquerque accident', a fire in March 2000 on the premises of a sub-supplier of Ericsson, raised widespread concerns about SCRM. Christopher et al. (2002) posited that 'little research has been undertaken into supply chain vulnerability and awareness of the subject is poor'. Furthermore, firms implement organisation-specific risk management; however, few of these risk management practices extend to the supply chain level (Jüttner, 2005). Compared with enterprise risk management, SCRM is a broader concept (Blome and Schoenherr, 2011). In other words, SCRM extends beyond the boundaries of a single company.

In the last several years, SCRM has attracted the interest of both practitioners and researchers. Researchers have strived to define SCRM and outline content for SCRM from different perspectives. For example, Jüttner (2005, P.124) defined SCRM as *'the identification and management of risk for the supply chain, through a coordinated approach amongst supply chain members, to reduce supply chain vulnerability as a whole'.* Tang (2006, P.453) similarly defined SCRM as *'the management of supply chain risks through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity'*. Norrman and Jansson (2004) also underlined that coordination among supply chain members is important in the application of SCRM; they argued that 'SCRM is to collaborate with partners in a supply chain that apply risk management process tools to deal with risks and uncertainties caused by, or impacting on, logistics related activities or resources'. Furthermore, Lavastre et al. (2012) emphasised that effective SCRM is based on supply chain partners'

collaboration through periodic collaborative meetings and timely and relevant information exchanges. According to the above definitions, chain members' coordination is at the core of SCRM.

Ritchie and Brindley (2007) identified five basic components of SCRM: risk drivers, risk management influences, decision-maker characteristics, risk management responses and performance outcomes. Designing the process flow is also a focus of researchers to present the application of SCRM. For example, Harland et al. (2003) proposed the SCRM process as a cycle, which includes six stages: map, identify, assess, manage, form strategy and implement strategy. Although there are many different forms of the SCRM process (Matook et al., 2009, Norrman and Jansson, 2004), the main steps (i.e., identification, assessment, mitigation and control) within the SCRM process cycle are similar. These stages of the SCRM process are also consistent with the traditional RM process as mentioned in Section 2.4.1. According to Colicchia and Strozzi (2012), the ultimate goal of an effective SCRM process is to create robust and resilient supply chains.

In order to mitigate the effect of SCR, various practices and models have been developed by researchers. Jüttner et al. (2003), for example, discussed the conclusions drawn from five strategies for mitigating risk in individual organisations, as approaches of enterprise risk management (Miller, 1992), and indicated that four of them can be adapted to the supply chain context: avoidance, control, co-operation and flexibility. Tang (2006) also generalised four approaches for mitigating SCR: product management, supply management, demand management and information management. Yang et al. (2009) organised the tools for SCRM according to supply disruptions in four categories: multi-sourcing, alternative supply sources and back-up option, flexibility and supplier selection. SCRM is also associated with a firm's performance. According to Thun and Hoenig (2011), companies with a high implementation

SCRM degree show better supply chain performance and higher average value in terms of disruption resilience or reduction of the bullwhip effect.

2.4.3. Quality Management

As mentioned in the introduction, companies' concerns about product quality have been raised in response to the increased number of recall crises. Identifying potential quality problems and addressing these issues have become a priority for practitioners and OM researchers (Huo et al., 2014a). According to Nair (2006), QM is one of the most significant research topics in the OM field. Early QM research strived to provide the definition of quality management concepts and to generalise QM activities and practices. Ross (1993) argued that QM should be an integrated philosophy that requires companies to be *'quality proactive'* in various aspects, such as focusing on customer demand, reducing the likelihood of rework, improving employees' involvement in the production process and maintaining good relationships with suppliers. In their annotated review, Ebrahimi and Sadeghi (2013) concluded that QM has already become a management paradigm that helps companies to improve organisational effectiveness, competitiveness and innovativeness. The authors identified seven key practices in QM: human resource management, customer focus and satisfaction, top management commitment and leadership, process management, supplier quality management, quality information and analysis and strategic quality planning (Ebrahimi and Sadeghi, 2013). According to Flynn et al. (1994, P.339), QM can be defined as:

> *"an integrated approach to achieving and sustaining high quality output, focusing on the maintenance and continuous improvement of processes and defect prevention at all levels and in all functions of the organization, in order to meet or exceed customer expectations".*

The implementation of QM is widely understood as the means to improve firm performance. A large body of research has confirmed the positive relationship between QM and firm performance through questionnaire data and secondary data (Ebrahimi and Sadeghi, 2013). Kaynak (2003) found empirical evidence that QM positively affects financial and market performance through improving operations performance. QM practices are also positively associated with customer satisfaction (Claver et al., 2003, Das et al., 2000). Using a sample of 152 Indian manufacturing companies, Parvadavardini et al. (2016) provided empirical evidence to support the positive effect of QM on quality performance and financial performance. The positive relationship between QM and performance is not only found in the manufacturing industry, but also in the service sector. Most recently, Llach et al. (2016) found that hospitability performance is positively influenced by the implementation of QM. Although substantive research has confirmed the adoption of QM is beneficial to company performance, the existing literature has also emphasised the failure of implementing QM to drive superior firm performance. According to Dooyoung (1998), the existing literature reports that the estimated failure rate of QM implementation is around 60-67%. Some studies have also suggested that total quality management (TQM) companies do not show competitive advantage in comparison with the non-TQM companies (Ebrahimi and Sadeghi, 2013). The literature reveals a consensus that QM needs to move beyond the scope of simply justifying practices to understanding the contextual effects on the implementation of QM practices, such as country, industry and firm size (Jayaram et al., 2010, Zhang et al., 2012).

The empirical study of quality management and related measurement scales have been well developed over the last two decades, providing practitioners and academics with fundamental understanding of the related concepts (Kaynak, 2003, de Sousa Jabbour et al., 2014, Flynn et al., 1995, Nair, 2006). However, scholars widely criticize the measurement of QM as a single construct, which can result in inconclusive results in performance outcomes (Zhang et al., 2014,

Zhang et al., 2012). To address this deficiency, OM researchers advocate the need to customize QM in order to respond to contextual factors and reflect the decision-makers' strategic orientations (Sitkin et al., 1994, Westphal et al., 1997, Zhang et al., 2012). The exploration-exploitation structure provides a conceptual framework to customize and classify QM practices based on decision-makers' strategic orientation (Zhang et al., 2014). According to Herzallah (2016), exploration can be defined as *'search, variation, risk taking, experimentation, play, flexibility, discovery, innovation'*, while exploitation can be defined as *'refinement, choice, production, efficiency, selection, implementation, and execution'*. OM scholars have also recently started to argue that QM practices have these two strategic orientations (i.e., quality exploration and quality exploitation) (Herzallah et al., 2017, Zhang et al., 2012, Zhang et al., 2014). The aim of quality exploration is to *'get new insights about process innovation and explore the unknown technique'* while quality exploitation aims to *'control the existing process to ensure the consistency and efficiency of the outcomes'* (Wu and Zhang, 2013, P.282). Herzallah et al. (2017a) proposed the concept of quality ambidexterity, which refers to the capability of firms to simultaneously apply quality exploration and quality exploitation. Although the literature has begun to operationalise customised quality management (i.e., quality exploration and quality exploitation) and examine effects on firm performance, limited research has attempted to explore the antecedent of these management practices. Moreover, there is no existing research that has investigated the ambidextrous structure of QM practice.

2.5. Research Gap Summary

Due to the complex nature of SCR, the identification of risk in the SCRM process is still a significant challenge for both practitioners and academics. As discussed in Section 2.4.2: Supply Chain Risk Management and Section 2.4.3: Quality Management, much of the OM literature has examined the roles of different management practices in addressing product

quality risk in a supply chain context (Tse and Tan, 2012, Tse and Tan, 2011, Zhu et al., 2007, Zhang et al., 2012). As shown in the results obtained from the SLR on managerial risk perception, although there is an increasing number of OM articles investigating the managerial perception of risk, most of this research focuses on the risks associated with project management and supply disruption. A research gap in managerial risk perception studies is therefore that the topic of SCQR has not been fully investigated.

To understand the role of risk perception in the decision-making process, it is necessary to employ empirical methods to operationalise the concept. As presented in Figure 2.4, although most managerial risk perception studies are conducted with an empirical research design, the conceptualisation and operationalisation of perceived risk are still inconsistent in the literature. For example, Rao et al. (2007) measured perceived risk as a one dimensional construct that focuses on the consequence of the risk, while Ellis et al. (2010) advocated that perceptual risk should be measured according to multiple factors. A possible explanation is that the existing literature is lack of a rigorous scale development process to empirically verify the measurement scales of perceived risk. Moreover, as indicated in Section 2.3.4.3, most of the existing OM literature focuses on measuring the supply disruption risk and project risk. Although measurement instruments for perceived risk can be found in many articles, there is no validated measurement scale for SCQR perception.

OM scholars have started to investigate the decision-making process associated with risk perception. However, a research gap still exists in identifying the determinants of managers' perceived risk and understanding how they are likely to respond after the risks are perceived. Although Ellis et al. (2010) attempted to clarify the perception of disruption risk in the supply chain context, they failed to comprehensively analyse how managers intend to respond to supply risks. Moreover, as shown in Appendix A, many of the existing studies in managerial

risk perception scrutinise either the antecedents or the outcomes of perceived risk (Djeflat, 1998, Wu and Wu, 2014, Cheng et al., 2012, Akintoye and MacLeod, 1997). Very few studies have empirically analysed a comprehensive framework of risk perception, which includes contextual factors, risk perception and decision-making. Furthermore, although there are some OM studies concerning the effect of risk perception on decision-making, QM as a form of decision-making has received very limited consideration in the study of managerial risk perception. As mentioned in Section 2.4.3, QM can be categorised as quality exploration and quality exploitation based on the different strategic orientations and risk attitudes of decision-makers (Zhang et al., 2012). However, the effects of managers' risk perception on the adoption of quality exploration and quality exploitation has not yet been investigated in the literature.

2.6. Chapter Summary

This chapter explores the relevant topics under SCQR (i.e., risk, SCR, SCQR, risk perception, managerial risk perception, RM, SCRM and QM). This study is the first attempt to conduct a SLR on the topic of managerial risk perception in OM studies. The research gaps identified in Section 1.3 are further supported by this comprehensive review. This thesis aims to close the research gaps that identified from the comprehensive literature review. Chapter 4: The Conceptualisation and Operationalisation of SCQR Perception addresses the first research gap. Chapter 5: Scale Development of the Perceptions of SCQR closes the second research gap, which is the lack of a reliable measurement scale for SCQR perception in OM literature. Finally, Chapter 6: The Theoretical Framework and Chapter 7: Assessing the Risky Decision-Making Model bridge the third research gap.

CHAPTER 3. METHODOLOGY

3.1. Introduction

As a research strategy, the methodology includes different conducting rules, such as epistemological and ontological principles (Lather, 1992, Sarantakos, 2005). According to Hofer and Pintrich (1997: P88), epistemology *"is an area of philosophy concerned with the nature and justification of human knowledge".* On the other hand, Slevitch (2011) defined the ontology as *"the study of reality or things that comprise reality"*. As this study investigates both managerial perception of SCQR and adoption of quality management practices, the appropriate ontology for this research should be objectivism (practices adopted in reality). Moreover, this study aims to identify the antecedents of managerial risk perception and investigate how risk perception influence on the adoptions of different quality management practices. Therefore, our research function and purpose should be categorised as *regulatory*[2] in accordance with Bryman and Bell (2015).

Qualitative and *quantitative* research methods are regarded as two distinct research strategies, which have different consideration of ontology, assumptions and research process (Bryman and Bell, 2015). Specifically, the quantitative research uses a language of "variables and hypotheses" and qualitative research adopts a language of "cases and contexts" (Neuman, 2011, P165). Moreover, the quantitative research is based on positivism (Sale et al., 2002) while the qualitative research is based on interpretivism (Altheide and Johnson, 1994, Kuzel and Like, 1991, Secker et al., 1995, Sale et al., 2002). Drawing on the ontology (nature of

[2] *Regulatory – the purpose of this business research is to describe what goes on in organisations, possibly to suggest minor changes to improve them, but not make any judgement (Bryman and Bell, 2015, P35);*

reality), a quantitative approach accepts only one truth, objective and independent reality but apprehensible (Guba and Lincoln, 1994, P109). According to Neuman (2011), there is a distinct "logic" and researching path between the qualitative and quantitative approaches. For instance, the logic of quantitative approach is systematic, and its research path is linear (Neuman, 2011). In contrast, the qualitative approach employs the logic of on-going practice and follows a nonlinear research path (Neuman, 2011).

Due to the differences between qualitative and quantitative approaches, researchers should carefully select the appropriate research strategy based on the research objectives and the research functions (Bryman and Bell, 2015). Each of the research strategies has their distinct data collections and analysis method with its strengths and limitations (Creswell, 2013: P44), in a qualitative approach, *"the collection of data in a natural setting sensitive to the people and place under study, and data analysis that is both inductive and deductive and establishes patterns or themes".* The qualitative approach aims to collect the data with "up-close" information from direct communication with the research target (Creswell , 2013: P45). Nevertheless, the qualitative research should be critiqued that the research results are too subjective, which refers to the lack of transparency and less credible to policymakers (Easterby-Smith et al., 2002, Bryman and Bell, 2015). On the other hand, quantitative research "*tends to be based on numerical measurements of specific aspects of phenomena; it abstracts from particular instances to seek general description or to test causal hypotheses; it seeks measurements and analyses that are easily replicable by other researchers*" (King et al., 1994, P.3-4). However, it is the lack of flexibility in ascertain deeper underlying meanings and explanations of the research results (Amaratunga et al., 2002).

Risk perception is an abstract concept that cannot be simply captured from an individual opinion but needs to be observed in a more generalizable way. According to the literature

review, quantitative research is the mainstream of risk perception studies. In this case, the quantitative approach would be employed as the research methodology in this thesis to identify the antecedents of the perception of SCQR, its impact on the adoption of adopting different QM practices. Also, there are three points to prove the appropriateness for the adoption of quantitative research. First, to understand the drivers of perception of SCQR and identify the management practices impacted by perceived SCQR, it is necessary to adopt a considerable size of the sample to validate the hypothesised model. Second, the ontology of the quantitative method, which is objectivism and focusing on the facts, fits with the research objectives. Third, a quantitative approach can test the hypotheses model holistically and identify some indirect effects using various statistical analysis techniques. For instance, the effect of SCQR perception on quality management practice might be moderated by different variables, such as company size and supply chain location. In summary, to holistically investigate the managerial perception of SCQR and how perceived SCQR impact on the adoption of QM practices, applying quantitative approach can benefit from using large-scale data to validate the hypotheses and generate the reliable results (Flynn et al., 1994).

3.2. Structural Equation Modelling and Factor Analysis

The main purpose of this section is to discuss two main data analysis approaches in which widely adopt in the field of questionnaire-based research and operations management, i.e. SEM and factor analysis. Typically, there are two disciplines of factor analysis, which are Exploratory Factor Analysis (EFA) and Confirmatory Factor analysis (CFA) (O'Rourke et al., 2013). To be noted, these two approaches are not two distinct methods, but a set of analysis tool that generally conduct together. According to Shah and Goldstein (2006), although the OM researchers use SEM as the research method later than the researchers in other subjects, it has become a popular data analysis for empirical researchers in OM area.

3.2.1. Factor Analysis

Factor analysis is usually conducted before the SEM analysis to determine the underlying structure among the variables in the analysis (Hair, 2010). This section discusses two types of factor analysis – EFA and CFA according to the sequence. Specifically, EFA refers to the method *"used to explore the possible underlying factor structure of a set of observed variables without imposing a preconceived structure on the outcome"* (Child , 1990, P.6). In other words, the purpose of conducting EFA is to identify the structure among a set of variables. In the family of EFA, based on the statistical criteria for deriving the factors, there are generally three procedures that include centroid, principal components, and principal (common) factor analysis (Kline, 2011). In order to justify whether the proposed questions (i.e. items) could represent the conceptual construct, the principal components method would be adopted in this study.

For the empirical researchers, who need to verify the hypothesised framework, the factor analysis in a confirmatory approach (i.e. CFA) is also in their "*to-do-list*". CFA is the approach to check whether the collected data fit with the proposed structure. Specifically, through CFA, researchers could assess the fitness of the indicators in the latent variable (i.e. a construct variable represents a concept within the theoretical model).

As illustrated in the Figure 3.1, it is a standard example of CFA model: **a)** a_1, a_2, a_3 stands for the indicators measure the factor X; **b)** similarly, a_4, a_5, a_6 measure the factor Y; **c)** the arrows between the indicators and construct is the factor loadings or pattern coefficients (λ); **d)** (ϕ) represents the factors covary relationship; **e)** the number (1) (i.e. parameter) appear on the factor loadings λ_1 and λ_2 are the constrained number that allow the computer to estimate factor variances and covariance (Kline, 2011); and **f)** (ε) is the error of each item, for instance, $\varepsilon_1, \varepsilon_2, \varepsilon_3$ are respectively the errors of a_1, a_2, a_3. Particularly, the error (ε) term stands for the

unique variance in which is the factor analytic term for indicator variance not explained by the factors (Kline, 2011). In the CFA model, the arrows are all "two-headed curved" that represent the correlational relationship.

Although the factor analysis approaches (i.e. EFA and CFA) are adopted to verify the "representativeness" of the conceptual framework, their starting points are different. EFA is used to primarily determine the number of factors and the pattern of factor loadings from the data (Fabrigar et al., 1999). It is the technique that does not require researcher to priori hypotheses about factor-indicator correspondence (Kline, 2011). On the other hand, CFA is required to specify all the contents, i.e. number of factors, pattern of zero and nonzero loadings of the measured variables on the common factors (Fabrigar et al., 1999, Hoyle, 2000). In the empirical researches of OM, to holistically measure and validate the conceptual model, normally EFA is used to primarily construct and purify the scales and CFA is adopted to validate the scales (O'Leary-Kelly and Vokuraka, 1998, Koufteros, 1999, Hensley, 1999, Chen and Paulraj, 2004). This study will discuss in depth about the adoption of EFA and CFA in the following section – scale development process along with their rules of thumb.

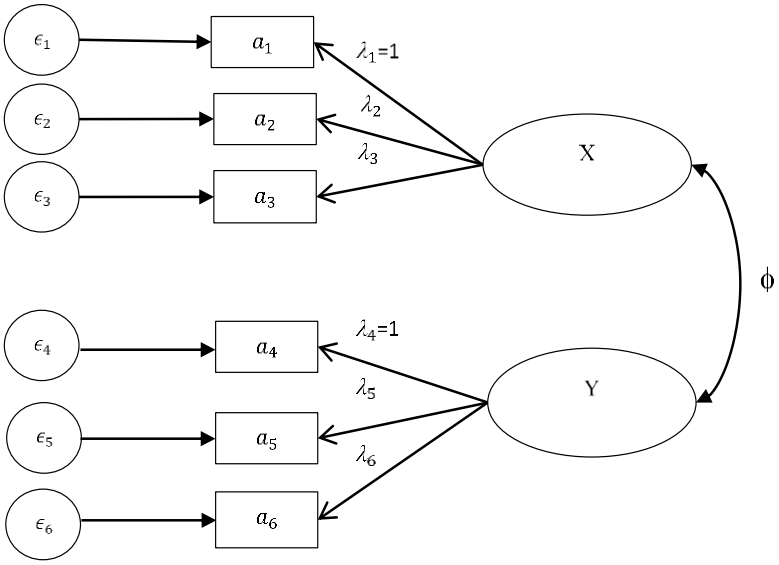

Figure 3.1. Confirmatory Factor Analysis

3.2.2. Structural Equation Modelling

In order to test the causalities among the conceptual constructs, this study will conduct the SEM. According to Byrne (1994), SEM is a research methodology that analysing a structural theory through a confirmatory approach. It is a technique that "*specifying, estimating, and evaluating models of linear relationships among a set of observed variables (i.e. indicators) in terms of a generally smaller number of unobserved variables (i.e. manifest variables or conceptual construct)*" (Shah and Goldstein, 2006, P.149). Particularly, the observed variables are also known as the latent variables, which can be independent (i.e. exogenous) or dependent (i.e. endogenous) (Shah and Goldstein, 2006). To be noted, the main purpose of SEM is to validate the priori model with hypothesised relationships instead of 'found' a suitable model (Gefen et al., 2000).

In comparison with the traditional statistical tools (such as linear regression, logistic regression, ANOVA, and MANOVA), SEM provides a more systematic and comprehensive analysis to the researchers (Gefen et al., 2000). For instance, in a linear regression model, there is only one dependent variable at a time that might limit the researcher's observation. However, SEM differs from these traditional statistical tools in that it tests the relationships among multiple independent and dependent constructs simultaneously (Gerbing and Anderson, 1988). In other words, SEM allows researchers to analyse multiple layer of linkages between exogenous variables and endogenous variables (i.e. dependent variables) at a time. Although it is similar to the multiple regression, SEM has an exclusive ability to scrutinise a series of casualities, where a dependent variable could also act as an independent variable in subsequent relationships within the same analysis (Jöreskog et al., 2001). Therefore, SEM would be an ideal research tool for this study to scrutinise the hypothesised relationships developed in the proposed model.

Two main approaches were widely adopted by the SEM researchers – covariance-based SEM (CBSEM) and Partial Least Squares (PLS) approach, which is also known as latent variable partial least squares. According to Chin (1998b), the difference between the CBSEM and PLS is similar to the disparity between common factor analysis and principle component analysis. In CBSEM, the latent variables are specified by the residual structure. On the other hand, PLS weight the latent variable "*based on the composite scores of the observed variables and lead directly to explicit factor scores*" (Peng and Lai, 2012). Due to the low barriers of PLS, such as a smaller required sample size, there are increased empirical studies in the field of OM adopt the PLS method (Peng and Lai, 2012). However, PLS is critiqued by its predictions. According to Peng and Lai (2012), PLS is not able to achieve the optimal predictions, due to the lack of precision of maximum likelihood (ML) estimation. In this case, the CBSEM[3] would be adopted in this study to obtain the more precise results.

The structure of the latent variables in SEM is similar to that of CFA (as shown in the Figure 3.2). The regression coefficients (λ_1 - λ_3 & λ_4 -λ_6) represent the factor loadings of X and Y respectively. In addition, ε_1 - $\varepsilon_6$represent the errors of the indicator variables. However, differ from the CFA, the arrow in the SEM model should be single-headed, which represents a dependence relationship. According to Byrne (1994), the single headed arrow stands for the regression coefficients, which indicate the influence of the independent variables on the dependent variables.

[3] *In the following contents, SEM stands for the CBSEM.*

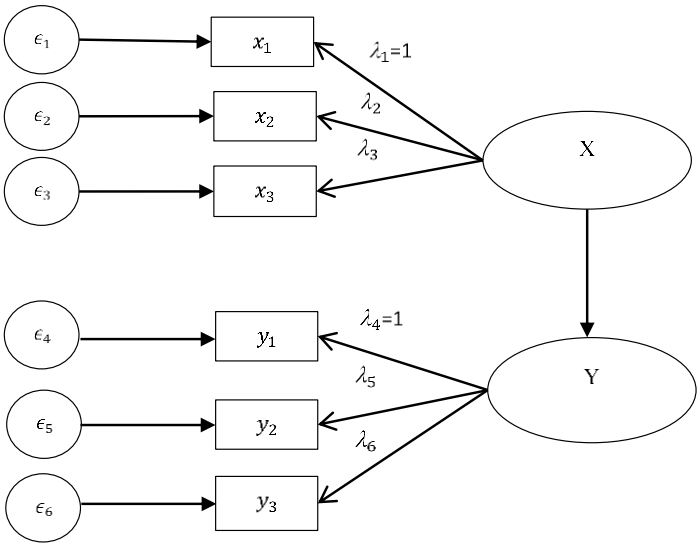

Figure 3.2. A Standard SEM Model

In summary, this study tests the conceptual model using a two-step approach (James et al., 1982) in accordance with the most referenced empirical OM studies (Yeung, 2008, Flynn et al., 2010, Ellis et al., 2010, Narayanan et al., 2011, Wong et al., 2011, Kim et al., 2012). In the first step, this study focuses on analysing the measurement models to assess psychometric properties by conducting the CFA model. Then, the second step is to test the direct or the indirect relationship among the latent variables. According to Maruyama (1997), researcher should analyse the conceptual model separately to ensure model identification, i.e. measurement model (using CFA method) and structural model (using SEM method). Swafford et al. (2006) stressed that the structural model cannot be identified until the measurement model has been scrutinised independently.

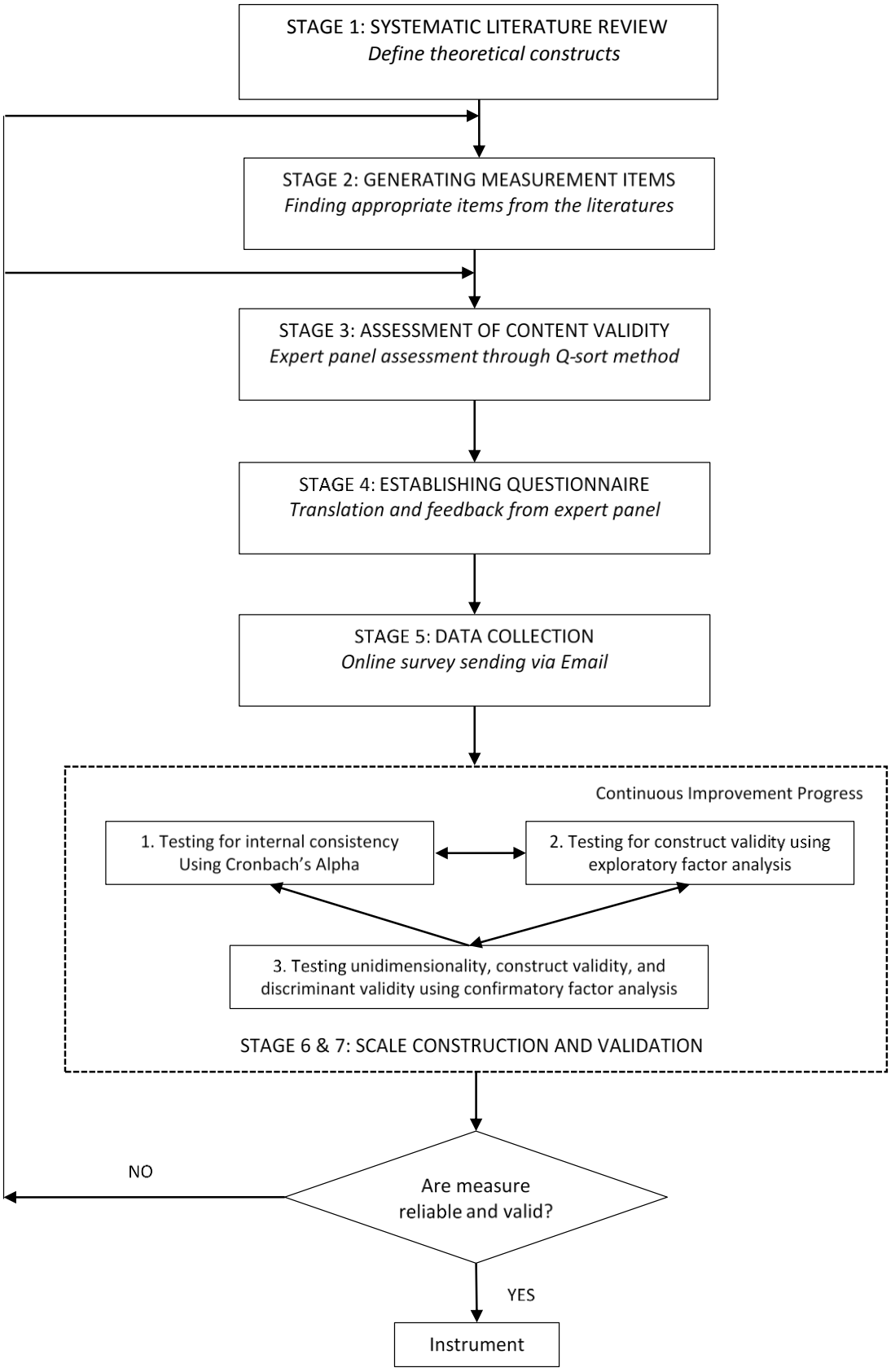

Figure 3.3. Scale development Structure

Developed from the work of Chen and Paulraj (2004)

3.3. Scale Development

The adoption of SEM is a recommended research method for the empirical researcher in the field of OM study. Due to the limitations inherent in single-item measures, the basis of the CFA and SEM should be the multi-item measurement (i.e. two or more measures). Therefore, to establish the reliable scales for measuring the concept is important. In order to identify and validate the measurement scales, a comprehensive scale development process would be conducted in this study. Typically, the main purpose of scale development is to generate a valid measure of an underlying construct (Clark and Watson, 1995). The scale development process for establishing and validating the measurement of the underlined constructs within the theoretical model is illustrated in the Figure 3.3.

3.3.1. Stage 1: Systematic Literature Review and Define Theoretical Constructs

The purpose of this stage is to conceptualise the constructs within the study. According to Netemeyer et al. (2003), a sounded conceptualisation should be building on a comprehensive literature review. Differ with other researches, the starting point in this scale development process is the SLR on managerial risk perception. The SLR provides a strong theoretical support to define the constructs more precisely. Compared with conventional literature reviews, SLR aims to search the literature exhaustively to minimise bias through a replicable, scientific and transparent process (Tranfield et al., 2003).

3.3.2. Stage 2: Generating Measurement Items

In comparison with the first step, the second stage aims to select the appropriate measurement items for representing the concepts. It is important to define the scope of selection, because the scale items will be generated to tap into the specified conceptual domain

(Hinkin, 1995, Netemeyer et al., 2003). Nevertheless, the generation of items should never be too narrow or too broad (Netemeyer et al., 2003). In this study, the new scales are proposed to measure the managerial perception of should be derived from existing measurement instruments or suggested by the literatures (Churchill, 1979). Hinkin (1995, P.971) stressed that *"it would seem that a necessary prerequisite for new measures would be establishing a clear link between items and their theoretical domain".* Moreover, researchers should being aware of the problems, such as "multiple negative", "double barrelled" and "ambiguous pronoun reference" (Hikin, 1995; Netemeyer et al., 2003). Therefore, this study will generate the measurement items for each construct through an extensive review and rigorous conceptualization process.

3.3.3. Stage 3: Assessment of Content Validity

Once the item pool is established, it is necessary to check the content validity. Typically, Rungtusanatham (1998, P.11) defines that *"if the items in the measurement instrument constitute a randomly chosen subset of universe of item that represent the construct's entire domain"*, the content validity would be realised. A general way of conducting the assessment of content validity were though expert panel's review. Normally, the expert panel is consisted of both academia and practitioners. For example, in the study of Cao and Zhang (2011), the item pool of supply chain collaboration practice was reviewed and evaluated by four managers from different manufacturing companies. In accordance with the prior survey based researches, this study will also organise an expert panel, who is familiar with the SCQR to assess the proposed measure scales.

Specifically, to confirm the content validity, this study adopts a three-step assessment procedure adapting from the research of Cao and Zhang (2011). First, a series of structured interviews would be conducted to scrutinise the relevance and clarity of each construct's

definition and wording of question items. As our research focus would be the Chinese market, the accuracy of the translation should also need the opinions from the expert panel. Second, this study would ask the expert panel to make arrangement for the questionnaire items into the corresponding constructs. The problems mentioned in last stage (*i.e.* "multiple negative", "double barrelled" and "ambiguous pronoun reference") could be avoided by the feedback from our expert panel. In this phase, some potential items could be added in our item pool when it is necessary (Cao and Zhang, 2011). Third, the content validity test for evaluating the scales will be conducted through three Q-sort measures as suggested by Rungtusanatham (1998)and Cao and Zhang (2011).

According to Moore and Benbasat (1991), the Q-sort measure "is to have experts act as judges and sort the items into several groups, with each group corresponding to a dimension based on agreement between judges". This study adopts three measure indexes to conduct the content validity test: a) inter-judge agreement percentage, b) item placement ration (i.e. hit ratio) and c) application of Cohen's kappa (k) test. Specifically, the inter-judge agreement percentage is the number of items that expert judges agree to place into a certain category divided by the whole item pool (i.e. the total number of items). According to the review of Hardesty and Bearden (2004), the threshold value for the inter-judge agreement percentage is from **60%** to **75%**. Moreover, the hit ratio is "items that are correctly sorted into the intended theoretical category divided by twice the total number of items" (Cao and Zhang, 2011, P.168). However, there is no established standard to determine a "good" levels of hit ratio (Moore and Benbasat, 1991). Generally speaking, the hit ratio above 70% would be accepted (Stratman and Roth, 2002, Moore and Benbasat, 1991). The last step of the Q-sort measure would be Cohen's kappa (k), which indicate the index of beyond-chance agreement among the judges of expert panel (Cohen, 1960, Stratman and Roth, 2002, Armenakis et al., 2007). The specified equation for the index can be defined as follows:

$$\kappa = \frac{F_a - F_c}{N - F_c} \qquad (3.1)$$

Where in equation (3.1), N = total number of the items, F_a = numbers of sorted items corresponding into the same Risk Perception dimensions by all judges, summed over all dimensions *i for i = [1,…,N]*,

$$F_a = \sum_{i=1}^{N} F_{i(a)} \qquad (3.2)$$

Where in equation (3.2), $F_{i(a)}$ is the number of measurement items sorted into the same category by all judges.

In equation (3.3), F_c = number of measurement items for which agreement, as to their classifications, among all judges is expected by chance, summed over all categories *i for i = [1,…,N]*

$$F_c = \sum_{i=1}^{N} F_{i(c)} \qquad (3.3)$$

Generally, the Cohen's kappa ranges from -1.00 to +1.00. If the value exceeds 0, the observed agreement among judges would be regarded as *beyond chance agreement*. The perfect inter-judge agreement would be achieved, when Conhen's kappa tends to +1.00 (Rungtusanatham, 1998). After two rounds of Q-sort, feedback will be distributed to the expert panel for reviewing the question items again and it will indicate to keep, drop, modify, or add items to the constructs (Cao and Zhang, 2011). Although it is time consuming, further refining the items is necessary.

3.3.4. Stage 4: Establishing Questionnaire

The aim of this stage is to produce a well written and clear questionnaire. As suggested by Hinkin (1998), researcher should take into account of format issues including the *"use of negative wordings"*, *"number of items within a construct"* and *"justification of Likert scale".* In this study, each of the construct would have more than three measurement items. Moreover, the respondents will be asked to measure their level of agreement for each of the construct items by a 7-point Likert scale. As our research target is the Chinese managers, there would be two language version of our questionnaire – Chinese and English. Therefore, the process of translation is critical for our research. According to Brislin (1980), the forward and backward translation process of the questionnaire would be adopted to clarify the appropriated language for target respondent (i.e. Chinese manager).

3.3.5. Stage 5: Questionnaire Administration and Data Collection

In this stage, an electronic questionnaire is administered to the research respondents in the selected data pool. To be noted, the unit of our research respondent would be individual firms. Due to the instable utilization of the foreign questionnaire website (such as Surveymonkey and Qualtrics) in China, this study considers to use the local survey service provider[4] – Sojump. With a covering letter, the hyperlink of the questionnaire will be sent to our potential respondents via email. A whole data collection process would take around two months. Every two weeks, a reminder email will be sent to the potential respondents. Additionally, the author will also take phone call as another manner of reminder. After the completion of data collection,

[4] *The largest online questionnaire service provider in China*

data purification will be proceeded. The purification process generally consists of making a comparison between the "first wave and second wave", identifying outliers, assessing normality and linearity and solving the problems of missing value.

3.3.6. Stage 6: Scale Construction and Purification Using EFA

To mathematically construct the scales, EFA as mentioned in prior section would be applied. The scale purification includes two steps – first EFA served as the assessment of unidimensionality, then Cronbach's alpha to check the construct reliability. Gerbing and Anderson (1988) defined the unidimensionality as *"the existence of a single concept underlying a group of measures and is important to assess before structural model testing is done"*. To be noted, before conducting the EFA, this study will check the correlation analysis of the items within each construct. According to DeVellis (2003), items that are correlated negatively or weakly with each other within a same construct should be removed. Typically, the correlation value below 0.20 would be regarded as weak (Netemeyer et al., 2003, Robinson, 1991).

This study uses the EFA with principal components analysis (PCA) and varimax rotation as suggested by extensive empirical researches (Chen and Paulraj, 2004, Swafford et al., 2006, Zhao et al., 2008). There are three criteria to ensure the unidimensionality in EFA. First, according to Nunnally (1978), item with largest factor loading exceed 0.40 with/or cross-loading difference exceed 0.10 should be held. Second, the percentage of variance of the items extracted by the construct should be larger than 0.50 (Hair, 2010). Third, to confirm the convergent validity, eigenvalue should be greater than 1.0 (Swafford et al., 2006). In order to ensure the construct reliability, the rule of thumb of Cronbach's alpha should be greater than 0.70 (Nunnally, 1978). In this stage, IMB SPSS v22 would be the major statistics tool to check the construct reliability and conduct the EFA analysis.

3.3.7. Stage 7: Empirical Scale Validation

The CFA is the theme of this stage. According to Hatcher (1994), researcher can conduct CFA to further assess the unidimensionality and validity of the construct scales. Peter (1981 , P.134) defines the construct validity as *"the vertical correspondence between a construct which is at an unobservable, conceptual level and a purported measure of it which is at an operational level".* For assessing the validity of the scales, this study adopts three approaches in CFA, which are overall CFA model fit index, convergent validity and discriminant validity.

3.3.7.1. Overall Fit Index

In order to assess the CFA model, this study will use the AMOS 22, which is a powerful statistics software that has been widely used in recent OM empirical studies. The purpose of observing the goodness-of-fit index is to evaluate how well the data fits the proposed model (Cao and Zhang, 2011). The goodness-of-fit criteria were general categorised intro three groups, including model fit (i.e. absolute measures), model comparison (i.e. relative fit measures) and model parsimony (i.e. parsimony fit measures) (Schumacker and Lomax, 1996, P.120). To be noted, the parsimony fit indexes are sensitive to the model size (i.e. complexity) (Schreiber et al., 2006, Shah and Goldstein, 2006). Based on the prior researches, this study provides suggested value for these three groups of goodness-of-fit indices in Table 3.1. Specifically, according to Blunch (2013, P.116):

The absolute fit indexes *"judge the fit of a model per se without reference to other models that could be relevant in the situation*[5]*".*

[5] *In other words, it indicategs how well the specified model reproduces the observed data*

The relative fit measures *"introduce an explicit basis model*[6]*, which serves the purpose of making it possible to judge the fit of different models on a common basis".*

A parsimony fit indexes "introduce a 'punishment' for complicating the model by increasing the number of parameters in order to improve the fit".

Table 3.1. Recommendation Values for Model Fit Indexes

Indexes	Shorthand	Rule of thumb
Absolute		
Chi-square Test	X^2	NA
Root mean square error of approximation	RMSEA	≤ 0.08
Standardised root mean square residual	SRMR	≤ 0.10
Comparative fit		
Normed fit index	NFI	≥ 0.90
Incremental fit index	IFI	≥ 0.90
Tucker-Lewis index	TLI	≥ 0.90
Comparative fit index	CFI	≥ 0.90
Relative noncentrality fit index	RNI	≥ 0.90
Parsimonious fit		
Parsimony-adjusted GFI	PGFI	Closer to 1
Normed Chi-square	$X^2 / d.f.$	≤ 0.10
Parsimony normed fit index	PNFI	≥ 0.70

3.3.7.2. Convergent Validity

If a construct has convergent validity, different measures of the same construct will obtain high correlations (Churchill, 1987). According to Kline (2011, P.71), *"a set of variables presumed to measure the same construct shows convergent validity if their intercorrelations are at least moderate in magnitude"*. This study will apply three approaches including factor

[6] *The explicit basis model is also known as the null model that assuming all the observed variables are uncorrelated*

loading, average variance extracted[7] (AVE) and composite reliability to assess the convergent validity. Three acceptable criteria for the convergent validity are suggested by the literatures (Narasimhan and Das, 2001, Yang et al., 2004, Shah and Goldstein, 2006):

The standardised factor loading should be above **0.5**.

AVE should be above **0.5**.

The composite reliability should be greater than **0.7**.

3.3.7.3. Discriminant Validity

Discriminant validity is defined as "the extent to which independent assessment methods diverge in their measurement of different traits (ideally, these values should demonstrate minimal convergence)" (Byrne, 2013, P.275). Typically, if the "construct correlates with other constructs in the model is low" and "other measures are supposedly not measuring the same variables or concept", the discriminant validity will be indicated (Heeler and Ray, 1972, P.32). This research will conduct the AVE comparison method (Fornell and Larcker, 1981) approach to assess the discriminant. If the AVE for each construct is greater than the squared correlation between that construct and the other constructs, the test would further confirm the discriminant validity (Fornell and Larcker, 1981, Flynn et al., 2010).

[7] *AVE is calculated as the mean variance extracted for the measurement items loading on a construct.*

3.3.7.4. Validation of Second-order Factor

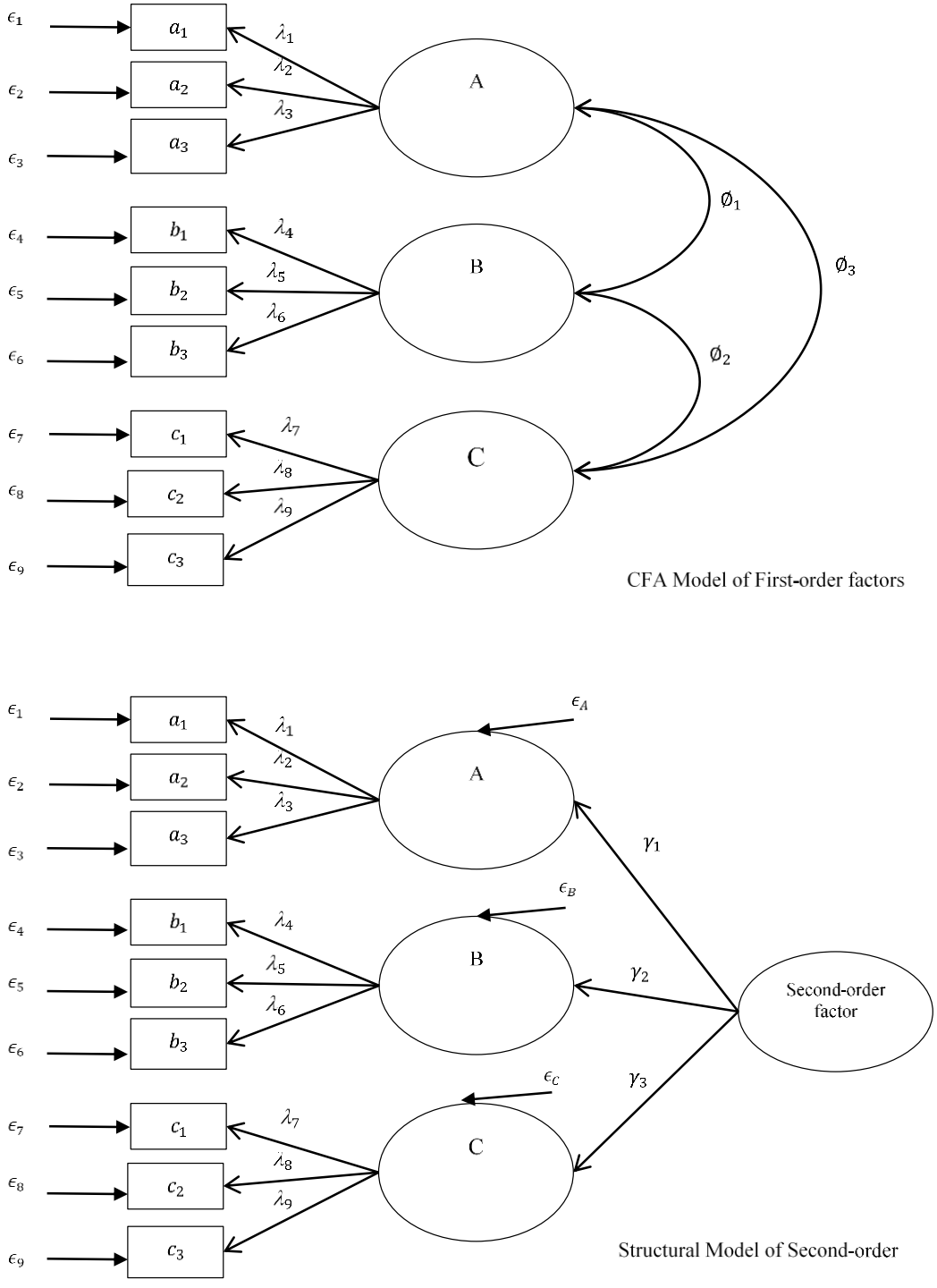

Figure 3.4. Validation of Second-order Model

The quality management practices would be a multidimensional construct that contains various aspects (i.e. quality ambidexterity). Therefore, it is necessary to overview the process of assessing second-order factor (i.e. hierarchical latent factor). Generally, the assessment of a second-order factor would be the final step of scale development (Kaynak and Hartley, 2006).

As shown in the Figure 3.4, the second-order factor is consisted of three first-order (A, B, C). Compared with the normal construct, second-order factor is measured by the first-order factor rather than the measurement indicators. According to Byrne (2013), the second-order factor is the unique independent variable, while first-order factors are dependent variables which are explained by the second order factor. To assess the validity of second order factor, researcher need to establish the hierarchical CFA model. First, there are at least two first-order constructs. Second, the overall fit indices of the first-order latent variables CFA model (as presented in Figure 3.4) should be passed according to the rules of thumps in Section 3.3.7.1. Third, to confirm the proposed structure of second-order factor (as shown in Figure 3.4), the standardised path coefficient between the firs-order constructs and higher-order construct should be significant. Forth, if the target (*T*) coefficient (where *T* = first-order X^2/ second-order X^2) is in the range from 0.80 to 1.00, the efficacy of second-order model would be indicated (Marsh and Hocevar, 1985, Cao and Zhang, 2011, Tse et al., 2016b).

3.4. Data Collection

To collect information about how managers perceived SCQR and related factors in the theoretical framework proposed in Chapter 6, a large scale of questionnaires were sent to the potential respondents. The English and Chinese versions of the questionnaire are provided in Appendix C and D respectively. In particular, managers who were at the decision-making level were the target informants of this study. To facilitate the research purpose, the unit of analysis was the buyer's transaction with the supplier (Ellis et al., 2010). The survey data were collected

through a large online survey platform in China, namely Sojump.com (SJ). The service of the SJ Company is reliable, because many empirical business studies in China that have been published in top-ranked journals have successfully employed this platform (Jin et al., 2013, Ye et al., 2016, Zhou et al., 2013).

To approach the potential respondents, three email contact lists were made, and emails were sent to the contacts that included the information sheet, the covering letter and the Web link to the online survey. A merged contact list containing contact information that was provided by GISTI and obtained from the Zero2IPO database was used as the sample for this study. Zero2IPO is a leading research institute in China that has a large amount of company information (Gu and Lu, 2014). Overall, the contact list included 1,384 manufacturing firms that deal with furniture, metal, computer equipment, pharmaceuticals and medical devices. The period of data collection was from 10/2016 to 12/2016. Then a follow-up email was sent to remind the respondents to finish the questionnaire. Excluding the replicated information, 1,021 emails were sent. However, 356 contacts either returned the email or the email address was no longer valid. A total of 483 responses were eventually received, but 127 were incomplete responses. In line with Hair et al. (2009), a complete case approach was adopted for this study, which means that the responses that had missing values on any variables were removed. Therefore, 316 valid responses were received. The effective response rate was thus 30.95% (i.e. 316/1021).

The characteristics of the sample companies are shown in Table 3.2, including company size, industry sector, sales revenue and the company's ownership. Such demographic information questions are widely utilised in top operations management journals (Cao and Zhang, 2011, Cousins et al., 2006, Wong et al., 2011, Zhao et al., 2011). The titles of the respondents included CEO (11.4%), Vice-President/Director (41.8%), Senior Managers

(29.1%) and Junior Managers (17.7%). Most of the senior managers and the junior managers were responsible for their company's purchasing activities. Therefore, it is believed that the informants were knowledgeable enough to understand the questions.

Table 3.2. Profile of respondents

	Number of firms	Percentages (%)
Company Size (Number of employees)		
≤50	10	3.2
51-300	116	36.7
301-2000	144	45.6
>2000	46	14.5
Annual Sales Revenue (CNY ¥)		
≤10 Million	15	4.7
10 Million – 30 Million	44	13.9
30 Million – 50 Million	81	25.6
50 Million – 200 Million	98	31.0
>200 Million	78	24.7
Company's ownership		
Local Enterprise	231	73.1
Sino-Foreign Joint Venture	61	19.3
Foreign-Owned Enterprise	24	7.6
Industry Sectors		
Computing machinery	43	13.6
Radio, television & communication equipment	146	46.2
Automotive	76	24.1
Chemicals and Pharmaceutical	26	8.2
Other manufacturing	25	7.9

3.5. Chapter Summary

A solid methodology plan could ensure the reliability of the data analysis and provide a strong support for the theoretical discussion. According to the research objectives, this study first justifies the research strategy – quantitative research. Based on the review of previous

empirical researches, this chapter has also established a step-by-step plan for developing the measurement scales and validating the theoretical model.

This chapter presents a comprehensive plan of instrument development and data collection. Initially, this research will define the theoretical construct of managerial perceived SCQR and to generate the potential questionnaire. Secondly, an expert panel, including academia and practitioners, will be invited to assess the content validity and translation accuracy of the questionnaire. Thirdly, to ensure the efficacy of data collection, this report has well prepared the data administration plan with reminder procedure. Fourthly, a robust model validation procedure, which includes EFA, CFA and SEM, is proposed. SPSS 22 will be adopted to conduct the EFA and AMOS 22 will be applied to validate the CFA and SEM model. Finally, the details of data collection are provided.

CHAPTER 4. CONCEPTUALISATION AND OPERATIONALISATION OF SUPPLY CHAIN QUALITY RISK PERCEPTION

4.1. Introduction

One of the ultimate goals of SCM is to ensure the quality of supplied materials (Zu and Kaynak, 2012, Tse and Tan, 2012). However, due to the increased dependence on outsourcing activities such as production and logistics service, manufacturers are having more difficulty controlling or monitoring the potential issues in their supply chain regarding product quality (Zu and Kaynak, 2012). Most recently, the large-scale recalls of Samsung Electronic Co.'s Galaxy Note 7 smartphones has put the spotlight on quality management issues in the supply chain. Ranging from electronic products to automobiles to food and drugs, the product recalls have sparked the trend of studying product quality problems over the last two decades (Flynn et al., 1994, Kaynak, 2003, Tse and Tan, 2011, Steven et al., 2014, Zeng et al., 2015). There are several streams of related research in the field of product quality study. For example, regarding the cause of product quality failure, Steven et al. (2014) indicate that offshore outsourcing would lead to more product recalls. Companies with outsourcing domestically experience least product recalls (Steven et al., 2014). Using the event study method, Zhao et al. (2013b) underscore the significant negative consequences of product recalls (i.e., product quality failure). Interestingly, such negative impact of product recalls is more severe for the Chinese company than for the US companies (Zhao et al., 2013b). Last but not least, Tse et al. (2011) propose a conceptual framework for analysing and mitigating the product quality risk.

Although these research streams have shed the light on the root causes, consequences and management of SCQR, to the best of the author's knowledge, no research has analysed the development of the managerial views of SCQR. This gap in the literature leads me to adopt an empirically driven study in this chapter to conceptualise and operationalise the perceptions of SCQR. In particular, this chapter integrates the behavioural risk theory described in Chapter 2. into the conceptualisation of SCQR. Drawing upon the theoretical model of risky decision-making by Yates and Stone (1992) and the initial development of Zsidisin (2003a), this study establishes a conceptual framework of SCQR. In recent years, some scholars have started to apply the risky decision-making model in the area of operations management (Ellis et al., 2010, Tse et al., 2016a). However, their research focuses more on supply disruption risk. To the best of the author's knowledge, no research has scrutinised the representations of SCQR theoretically and empirically. Therefore, this chapter addresses the question related to the conceptual examination: what should SCQR entail? To answer this question, a conceptual model of SCQR is proposed. Four representations of SCQR have been conceptualised: probability of SCQR, magnitude of SCQR, psychological factor and overall perception SCQR.

For the research in decision-making, thoroughly understanding the perceptions of risk is vital (Slovic, 1987, Yates and Stone, 1992) because appraisals of risk are subjective and actions of the decision-maker regarding risk are based on perceptions (Ellis et al., 2010, Yates and Stone, 1992). The conceptual framework should provide a theoretical foundation for future OM research in risk management or quality management that strive to identify the antecedents that drive SCQR and examine management practices to mitigate SCQR. Moreover, the appraisals of SCQR conceptualised in this chapter might also be applied in other risk studies in the area of OM, such as relational risk (Liu et al., 2008) and demand variability risk (Zhao et al., 2013a), *etc*.

The rest of this chapter presents the theoretical basis of risk perception, describes the representations of the SCQR and explains in depth each of the constructs. The items proposed to measure the constructs are also provided.

4.2. How to Conceptualize the Risk?

To address the questions of how to measure the risk, the objective assessment of risk is dominative in the decision-making and OM literature (Ellis et al., 2010). For example, Nigro and Abbate (2011) measured/assessed the risk as variability in the expected results that adopt the classical corporate finance model, i.e., Capital Asset Pricing Model (CAPM). Using the mathematical programming method, Bogataj and Bogataj (2007) measured SCR based on the material requirements planning and distribution requirements planning stochastic model. Moreover, the simulations modelling techniques were commonly used to study supply chain risks, for instance, agent-based simulation or multi-agent-based simulation (Cao and Chen, 2012, Giannakis and Louis, 2011), the Petri net-based simulation (Tuncel and Alpan, 2010) and discrete-event simulation (Carvalho et al., 2012), etc. Although the simulation method is widely adopted, some scholar critique its effectiveness due to the lack of risk data support (Aqlan and Lam, 2015). Heckmann et al. (2015) asserted that because there are limited quantitative measures that capture the more complex realities of supply chains, the traditional measures generally adopted in the context of finance and insurance are applied for supply chain risks.

The risk assessment method is well developed and uses different rigorous models, but a question is, *"Does it really impact on managers' decision-making?"* From the views of behavioural research, March and Shapira (1987) argued that the decision-making behaviour of managers is guided by subjective risk perception rather than objective assessment of risk. According to Sitkin and Pablo (1992 , P.4), perceptual risk is *"a decision-maker's assessment*

of the risk inherent in a situation". Similarly, Mitchell (1999 , P.164) stressed that *"it is not objective risk motivates decision-making, but the consumer's impression of it"*. Unlike professional auditors, accountants or actuaries who may have substantial knowledge, experience and vast amounts of data, the supply chain manager or even the top manager of a firm has limited information or skill to precisely assess the risk. Even the objective risk information is sufficient for the management to make a decision, how the risk information is interpreted may also produce bias to the risk assessment process (Ellis et al., 2010, Stone et al., 1994). Therefore, this study adopts the concept of perceptual risk to measure SCQR instead of the objective risk assessment. The adoption of the perceptual risk measurement also respond to suggestions of Zsidisin (2003) that behavioural theory might be beneficial to understand better the risk constructs.

Table 4.1. Risk Metrics in OM literature

Literature	Measurement	Description	Definition provided in the article
Wang et al. (2016)	One dimension construct	Uses the direct measurement of whole (overall) risk perception in construction project	A decision-maker's assessment of the risk inherent in a situation
Rao et al. (2007)	One dimension construct	The question items only emphasise the consequence of the risk.	Risk associated with initial development investments and recurring operating expenses
Liu et al. (2008)	One dimension construct	Of the six items in the construct, five of them measure the impact of the risk, while only one measures the likelihood of risk.	The probability and consequences of not having satisfactory cooperation
Zhao et al. (2013a)	One dimension construct	The items only describe the impact of the risk, but the component of probability is missing.	The variation in the distribution of possible outcomes, their likelihood, and their subjective values
Mantel et al. (2006)	One dimension construct	Three different facets are adopted to measure only the consequence of the risk.	The research does not define the risk clearly.
Liu (2015)	One dimension construct	The measurements mostly describe about the difficulties of the project instead of the traditional meaning of "risk".	The uncertainty inherent in system complexity in terms of project difficulties
Tse et al. (2016a)	Two constructs structure	The research measures accurately the concepts of both probability and magnitude factors in perceived risk.	An individual's perception of the total potential loss associated with the disruption of

			supply of a particular purchased item from a particular supplier.

An increasing number of studies in OM adopts the perceptual risk constructs in the theoretical model and test it with large-scale empirical data (Table 4.1). While these studies improve our understanding of the perceptual risk in the OM domain, most of them studies treat risks in a unitary manner. Specifically, to measure the perception of risk, previous research mostly adopt the single construct or even single item measurement. While some literature emphasised the risk composed by probability (i.e., likelihood) and magnitude (i.e., impact), most neglect such nature when establishing the measurement construct and question items. Ellis et al. (2010) indicated that perceptual risk should be measured and evaluated by multiple factors.

According to the comprehensive literature review of this study (Chapter 2), research in the fields of marketing and sociology widely adopt this view. For example, Dash et al. (1976) measured the perceived risk in two components, uncertainty of product satisfaction and consequence of unsatisfactory product performance. For measuring the perceived risk of terrorism, Lee and Lemyre (2009) employed four cognitive factors: perceived probability, perceived seriousness, perceived personal impact and perceived coping efficiency. Most recently, Tse et al. (2016a) categorised perceptual supply disruption risk as magnitude and probability. In particular, Mitchell (1999) remarked that abundant literature in consumer research measures perceptual risk based on the subjective assessment of probability and magnitude. This is basically in line with Yates and Stone (1992) risk perception structure. Specifically, Yates and Stone (1992) claimed that before evaluating the perception of overall risk, decision-makers initially judge the probability of loss (i.e., likelihood of risk), magnitude of loss (i.e., significance of risk) and other relevant considerations. Interestingly, most of the recent studies adopt a binary setting of risk (i.e., magnitude and probability) and ignore the

other relevant considerations as emphasised in Yate and Stone's risk perception model. As a result, questions persist regarding what the relevant consideration factor is in the risk appraisal structure.

After reviewing and consolidating the previous research, this chapter provides the answer to this question by proposing a ternary setting, including risk magnitude, risk probability and psychological factor. In the next sub-sections, this study will discuss in depth the operational definition of each risk construct, and this study will provide the initial question items used to measure the respective construct. It is important to remember that to limit the scope of the investigation of SCQR, this chapter refines the context of perceptual SCQR definition to a key supply material/products sourcing from the key supplier rather than the general product. Specifically, the perception of risk for different supply materials or from different suppliers can be confusing when measuring the SCQR context. Therefore, it is reasonable to narrow the conceptualisation of SCQR.

4.3. The Probability of Risk

Traditional risk management literature posits that after identifying the risk, managers should carefully assess risks based on their probability of emergence. Numerous researchers have investigated the probability of risk (Visschers et al., 2009). From the view of business decision buying, Hunter et al. (2004 , P.147) defined risk probability as *"the manager's perceived probability of making a poor product choice"* and classify the problem of "difficult to assess supplier capabilities" as the industrial buying issue with high probability. In the SCRM domain, Thun and Hoenig (2011) categorised sixteen different supply chain risks and find that the supplier quality problem is one of the high probability risk events. Therefore, it is expected that the probability of SCQR occurrence should lead to higher overall risk perception.

Although prior literature has defined the probability of risk in different contexts, there is no concrete guidance for operationalising the concept of SCQR probability. In this chapter, the probability of SCQR is defined as the *perceived likelihood that the key supply material/product from a key supplier will have quality problems*. In terms of risk probability measurements, some literature adopts objective ways to interpret likelihood, such as the percentage of occurrence or the exact frequency number of risk occurrence (Slovic, 2000, Slovic, 1987). However, for assessing risk probability, Aven (2013, P.118) argued that *"there is no striving to be objective. The fundamental idea is to present the judgement of the analysts/experts, while not the knowledge in a neutral way"*. Indeed, in the context of this study, i.e., SCQR, it is difficult for managers to accurately describe or report the exact frequency numbers of quality problem occurrence. This chapter incorporates the empirical works of Zsidisin (2003a), Ellis et al. (2010) and Tse et al. (2016a) and develops a new set of items to measure SCQR probability.

Table 4.2. Measurement Items for Probability of Quality Risk

Measurement Items		Supporting Literature
PR 1	There is a high probability that the key supply material from the key supplier cannot meet the quality standards.	(Kannan and Tan, 2005, Zsidisin, 2003b)
PR 2	There is a high probability that the key supplier will be unable to commit to quality improvement of the key supply material.	(Kannan and Tan, 2005, Lai et al., 2005)
PR 3	There is a high probability that the key supplier will not supply the major raw material as specified within our purchase agreement.	(Chan and Kumar, 2007, Kannan and Tan, 2002)
PR 4	We never experience that the key supplier cannot maintain the quality of the key material. (Reverse Coded)	(Ellis et al., 2010, Kannan and Tan, 2005, Tse et al., 2016a)
PR 5	There is a high probability that the key supplier will supply us the key supply material with poor quality packaging.	(Aung and Chang, 2014, Tse and Tan, 2011)
PR 6	There are always unforeseen issues in logistics that will have an impact on the key supplier's ability to supply the key material with good quality.	(Ellis et al., 2010, Tse et al., 2011)
PR 7	We are always not confident in the key supplier's ability to maintain the quality of its production.	(Ellis et al., 2010, Tse et al., 2011)

4.4. The Magnitude of Risk

In this section, another important component in risk perceptions will be operationalised—the severity of loss, also known as the magnitude of risk. According to the State Office of Risk Management (2004), the severity of risk indicates the size or cost of the loss to the organisation or individual. Similarly, the International Organisation for Standardisation (ISO 2002) marks the magnitude of risk as the losses along with the related amounts. In other words, the severity of loss is used to capture the significance of a particular negative outcome (Yates and Stone, 1992). If the loss of the risk events or personal actions are more severe, greater riskiness is perceived by the individual. In the case of SCRM, the magnitude of risk is considered an important factor that need to be interpreted (Narasimhan and Talluri, 2009). In particular, Hunter et al. (2004, P.147) defined the magnitude of risk in industrial buying as the "perceived importance in the buyer's mind of potential negative consequences of a poor product choice".

While the literature attempts to operationalise the magnitude of risk in different contexts, to the best of the author's knowledge, no studies have defined or conceptualised the "magnitude of SCQR". By extending the previous studies, the "magnitude of SCQR" is defined as the perceived severity/significance of the impact that the key supply material/product from a key supplier has quality problems. In terms of operationalising the measurements, there still exists a need to explain the argument of "subjective or objective". Indeed, it cannot be denied that there is some objectivity to the loss significance. For instance, every manager will agree that disrupting the supply chain for a month is worse than disrupting it for a couple of days. According to the feedback from our expert panel, some managers might feel that having a minor quality problem in product packaging will damage their company's reputation. Other managers perceive quite differently. Accordingly, these managers would perceive the riskiness of product quality differently. Thus, the subjective judgement of magnitude of SCQR is chosen

for establishing the question items. The seven-point Likert scale of agreement is also adopted. Moreover, this chapter establishes a seven-item scale for the magnitude of SCQR that incorporates the theoretical work of Yates and Stone (1992), Ellis et al. (2010) and Tse et al. (2016a).

Just like the items developed to investigate the probability of SCQR, the measurement scales for capturing the magnitude of SCQR are based on the characteristics of SCQQ: general negative consequences of SCQR and the negative consequence of the specific quality problem in logistics, packaging and production of the key supplier.

Table 4.3. Measurement Items for Magnitude of Quality Risk

Measurement Items		Supporting Literature
MA 1	A lack of awareness of the usage of defective purchased material in our product would have severe negative financial consequences for our business.	(Zhao et al., 2013b, Ni et al., 2014)
MA 2	We would incur significant costs and/or losses in revenue if we were unaware of the usage of defective purchased material in our product.	(Sroufe and Curkovic, 2008, Tse and Tan, 2011)
MA 3	Key suppliers' inability to supply qualified material that conforms to agreed specifications would seriously jeopardize our business performance.	(Zhao et al., 2013b, Ni et al., 2014)
MA 4	The quality problem of the key material supply from our key supplier will significantly and negatively impact our production.	(Ellis et al., 2010, Tse et al., 2016a)
MA 5	The quality problems that occur in the logistics process will cause significant customer loss.	(Ellis et al., 2010)
MA 6	The supply of major raw materials with poor quality is NOT a big deal to our company. (Reversed Code)	(Tse and Tan, 2011, Zhang et al., 2011b)
MA 7	The quality risks are of concern as a huge factor that could interrupt the company's supply chain.	(Zhao et al., 2013b, Ni et al., 2014)

4.5. The Psychological Factor

From this discussion, it is clear that a significant body of evidence supports the binary structure of the perceptual risk, including two stable components—risk probability and risk magnitude. Yet, based on the views of risk analysts in sociological and psychometric domains,

many other potential factors can also facilitate the constructions of risk perception (Slovic, 1987, Jia et al., 2015). For example, Loewenstein et al. (2001) revealed that changes in affective factors (or mood) will influence the perception of riskiness. Most recently, Jia et al. (2015) indicated that except for risk probability and risk magnitude, the self-control factor facilitates the construction of perceived risk. These studies are consistent with the risk appraisal model of Yates and Stone (1992), who proposed there are other risk factors for developing risk perception other than risk probability and risk magnitude. In particular, Ellis et al. (2010) acknowledged the limitation of their binary risk factor model and suggested future research should investigate additional psychological factors in the risk appraisal model. To respond to the call of Ellis et al. (2010), this study extended the previous risk management research in OM domain by applying the psychometric paradigm method to operationalise the psychological factor as one of the risk factors. As indicated in Chapter 2, the systematic literature review, the psychometric paradigm has become a widely-accepted scale in measuring risk perception (Slovic et al., 1982, Gaskell et al., 2017). It is surprising that few works in OM or even general business study have looked into applying such recognised instruments. By doing this, this study contributes to the literature the operationalisation of the psychological factor by adopting the Slovic team's method. Some empirical research has started to investigate the psychologic factor for testing the OM theory, such as Hill et al. (2009), but very few studies have examined the psychological factors in assessing risk perception, let alone the investigation of SCQR.

Some early staged research argues that experts only have the simple judgement of the risk (Yates and Stone, 1992). However, this study questions whether a supply chain manager or even a CEO of a company is really an "expert" in risk assessment. The recent risk perception research overthrows the assertion of experts' simple judgement of risk. Dobbie and Brown (2014) indicated the cognitive structure of the risk perception is the same for both experts and

laypeople. Hence, the adoption of psychometric paradigm for measuring the managerial risk perception should be reasonable.

According to Slovic (2000), the psychometric paradigm is used to capture the roles of affect or emotions that impact individual risk perception. It is a method for identifying the characteristics that influence individual perceptions of risk and assumes risk is multidimensional and that not just the individual judgment of probability of harm has an effect (McDaniels et al., 1997, Sjöberg et al., 2004). The psychometric paradigm was originally developed to measure different man-made hazards or natural disasters on various risk characteristics. For instance, Feng et al. (2010, P.1578) measured the individual perceived risk by *"a seven-rating scales of controllability, dread, severity of consequences, voluntariness, known to those exposed, immediacy of effect and risk newness".* It is important to note that the nature of SCQR is different from a normal public hazard/risk, such as smoking or aviation risk. Therefore, some risk characteristics might be not applicable in the context of SCQR. For instance, the characteristic of "voluntariness" might not fit with the measurement of SCQR. Specifically, the scale is, "To what extent does the individual face the risk voluntarily?" It might be not reasonable to adopt such a factor in this study, because most managers will regard the SCQR as involuntary. Nevertheless, to avoid unforeseen bias in understanding the concepts, this chapter retains these original risk characteristics factors for the validation tests in the next-step scale development process.

Based on the psychometric paradigm research, I adopt eight measurements that managers could apply to evaluate the SCQR psychologically: immediacy of the effect, knowledge of exposure, level of control, risk newness, perceived dread, severity of consequence and chronic-catastrophic risk. Consistent with the items of risk probability and risk magnitude, these risk

characteristics are measured by a seven-point Likert scale. Table 4.4 presents the details of each question item.

Table 4.4. Measurement Items for Psychological Factor of SCQR

Measurement Items		Supporting Literature
PSY1	Please rate to what extent you can avoid the negative impact of the supply chain quality problems happening to your company through your personal knowledge and experience, if exposed to this risk. (1=Controllable; 7=Uncontrollable)	Slovic (2000), Slovic (1987)
PSY2	Do you think the supply chain quality problems can be easily reduced or are they hard to reduce? Please rate the difficulty of this risk. (1=Easily; 7=Difficult)	Slovic (2000), Slovic (1987)
PSY3	Are the supply chain quality problems ones that you can think about reasonably calmly or are they the risks that you truly dread? Please rate the level of dread potential. (1=Low dread; 7=High dread)	Slovic (2000), Slovic (1987)
PSY4	Do you think the company will go bankrupt if you have serious product quality problems? Please rate how likely it is that the consequences will be fatal, if the risk is realised in the form of a mishap. (1=Not fatal; 7=Fatal)	Slovic (2000), Slovic (1987)
PSY5	Overall, are supply chain quality problems preventable or non-preventable? (1=Preventable; 7=Non-preventable)	Slovic (2000), Slovic (1987)
PSY6	Are supply chain quality problems the ones that you worry will threaten you personally (e.g. job position, salary etc.) or it does it not matter to you? (1= No Impact; 7 = Great Impact)	Slovic (2000), Slovic (1987)
PSY7	Do you think the negative effects of the supply chain quality problem are likely to occur immediately or at some later time? Please rate the immediacy of the effect of this risk. (1=Immediate, 7=Delayed)	Slovic (2000), Slovic (1987)
PSY8	Do you think the supply chain quality problems are known precisely by the managers who are exposed to these risks? Please rate the extent to which you think the risk is known to those who are exposed to it. (1=Known Precisely; 7=Not Knowns)	Slovic (2000), Slovic (1987)

4.6. The Representation of Risk—*Synthesis*

The purpose of this chapter is to conceptualise and operationalise the SCQR framework to deepen understanding of the decision-making of the practitioners. But it is worth asking if the decision-making is directly impacted by the various risk elements discussed in the last several sections. Figure 4.1 illustrates how various risk factors influence decision-making. Therefore, it is a decentralised risk perception framework. Nevertheless, Shapira (1995) argued that the executive decision is based on the perception of "overall risk". Adapting from the risky decision model of Yates and Stone (1992), Ellis et al. (2010) and Tse et al. (2016a) remarkably developed a risk appraisal model that shows that the risk factors, i.e., risk probability and risk magnitude, are synthesised into an overall risk appraisal. The model emphasises that the risk factors play a formative role in the perception of the overall risk. In the context of supply disruption risk, Ellis et al. (2010) and Tse et al. (2016a) empirically tested the overall risk perception framework. Specifically, they find significant and positive linkages between risk probability, risk magnitude and overall risk.

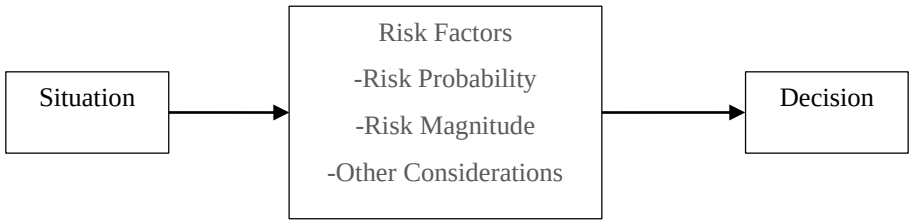

Figure 4.1. Risk Perception Scenario 1

Based on the previous works, this study conceptualised the risk perception framework that consists of two representations, the risk factors (including risk probability, risk magnitude and psychological factor) and the overall SCQR perception. Ellis et al. (2010, P.37) stated, *"a key difference between these successive stages of assessment is the distinction between judgement*

and decisions". The "decisions" in Ellis' statement are not the decision-making, but rather the result/evaluation of the judgement. Given the findings of Thun and Hoenig (2011), managers view the supplier quality problem as a high probability event with great negative impact. Then, managers might evaluate the judgement of the risk constructs and perceive the greater level of supplier quality risk. The prescription of Yates and Stone (1992) is also helpful to overcome the issue in traditional risk assessment. For instance, it is hard to simply equate the risks with high probability but low impact and the risks with high magnitude with low probability (Kaplan and Garrick, 1981). Therefore, this chapter argued that the perception of SCQR is a process of managers' evaluating (Stage 2 in Figure 4.2) the judgement of various risk elements (Stage 1 in Figure 4.2).

In this chapter, the perceived overall SCQR is defined as *"individual's perception of the overall level of the riskiness due to the inherent quality problems in the supply of key materials from the key supplier"* (Tse and Tan, 2012, Tse et al., 2011, Ellis et al., 2010). To develop a formative risk perception model, this chapter employs a single item for measuring overall SCQR. This measurement is based on Tse et al. (2016a) operationalisation of overall disruption risk. Using a seven-point Likert scale, the respondents will be asked to evaluate their agreement of the statement, "Overall, the quality problems in supply of the key material from the key supplier are characterised by a high level of risk".

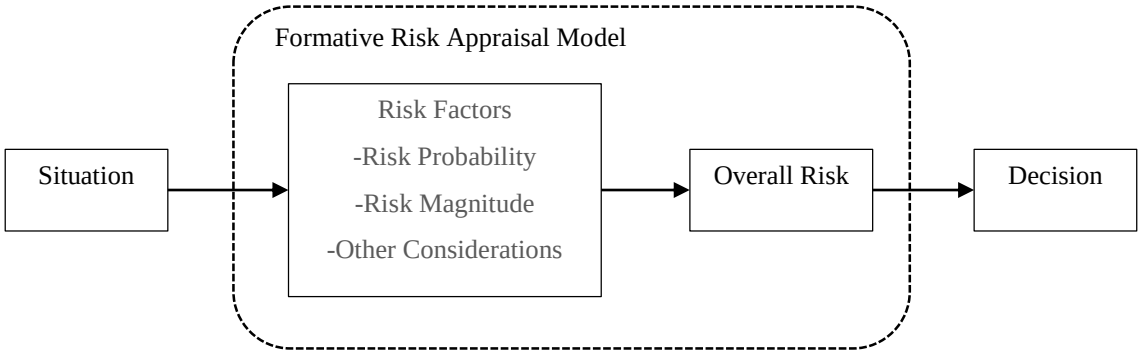

Figure 4.2. Risk Perception Scenario 2

4.7. Chapter Summary

This chapter proposes a comprehensive framework of the perception of SCQR and operationalises the risk factors that make up the framework. In particular, this study advances the current knowledge of risk perception in the domains of OM and SCM. Specifically, the conceptualisation of the risk factors has integrated the perspective of other disciplines, such as psychology and sociology (Slovic, 2000). While previous research investigates various management practices that can be adopted to mitigate quality risk in a supply chain, an existing gap about the managerial view of SCQR still needs to be filled. Although a few OM studies have started to empirically test the development of risk perception in the context of SCM, the authors of these studies mostly focus on the supply disruption risk (Ellis et al., 2010, Tse et al., 2016a). Furthermore, this chapter argues that the binary model of the risk perception in OM study, only entailing the risk probability and risk magnitude, might not obtain a comprehensive picture of the risk perception. To address this research gap, this chapter conceptualises a risk perception framework comprised of three factors: risk probability, risk magnitude and psychological factor.

Initially, risk probability is widely regarded as a vital element in the development of risk perception (Hunter et al., 2004, Tse et al., 2016a, Visschers et al., 2009). Therefore, this chapter conceptualises the factor of risk probability in SCQR context. In our study, the factor of SCQR

probability strives to capture the perceived level of the likelihood that the manager will face an unforeseen quality problem in the supply material from a key supplier. The impact (or magnitude) of SCQR is the second factor in the representation of risk perception. According to March and Shapira (1987), executives usually view the significance of loss as greatly impacting their risk perception. Consistently with the previous research, this chapter develops a factor of SCQR magnitude, "the perceived severity of the negative impact that the key supplier supply the material with poor quality". Last but not least, this chapter extends the traditional view of risk perception by incorporating the psychological factor. Although there has been a long history of using the psychometric paradigm to measure perceived risk, few OM studies have adopted the well-developed method to measure risk perception. The final piece of our proposed framework, psychometric factor, is conceptualised to capture the emotion of a manager when facing a supply chain quality problem. Because our study attempts to investigate a topic that has never been explored, i.e., perception of SCQR, most of the measurement items are newly developed. However, the items are operationalised based on the existing literature. For example, the development of the items in probability and magnitude are based on the study of Ellis et al. (2010). Moreover, the items in psychological factor are based on Slovic's (2000) psychometric paradigm.

Another contribution of this chapter is establishment of a formative structure of the overall SCQR perception. This study hypothesises that the overall SCQR is directly impacted by the three risk factors. In Chapter 7, this study tests the synthesis effects of risk factors on overall SCQR and further discusses the empirical results. To rigorously examine the validity and reliability of the items that have been operationalised, Chapter 6 presents the seven-step scale development process.

Chapter 5. SCALE DEVELOPMENT OF THE PERCEPTIONS OF SUPPLY CHAIN QUALITY RISK

5.1. Introduction

According to the proposed scale development process presented in the Methodology Chapter, the final item that was used to measure the perceptions of SCQR is described in this chapter. In the last few chapters, risk perception studies in the context of OM were extensively reviewed and it was found that the existing literature was confined to supply disruption risk (Ellis et al., 2010, Tse et al., 2016a) or the relational risk between buyer and supplier (Liu et al., 2008). While these emerging studies provide some information towards developing a psychometrically sound metric for evaluating how practitioners perceive risks in the supply chain, the incompleteness of the data means that limited research has been done to investigate SCQR. The lack of a thorough understanding of SCQR is undesirable to the development of SCRM and the implementation of QM and supply chain quality management (SCQM). Therefore, the aim of this chapter is to develop and validate the perception of SCQR from the Chinese senior manager's perspective. A validated measurement scale of SCQR perception can advance behavioural theory in the domain of empirical OM and offer holistic metrics for future research on related topics, such as SCQR and SCQM. Regarding the practical contributions, the verified measures for assessing perceptions of SCQR can help to guide manager's supplier segmentation and portfolio approach to supply base management (Ellis et al., 2010).

In this chapter it is shown that using various data collected from the manufacturing industry in China and opinions from a group of international experts in the field of OM contributes to the development of the scales of SCQR perceptions. In particular, the scale development process from various OM articles, such as Shah and Ward (2007), Oliveira and Roth (2012)

and Zhang et al. (2018) was adapted. In accordance with the widely-adopted scale development process, in Section 5.2, it is briefly reported how the content validity was assessed in this study with the help of an expert panel. Then Section 5.3 is a discussion of the back-translation of the question items and Section 5.4 further confirms the content validity through the well-known Q-sort method. Section 5.5 comprises a discussion of the reports of the data analysis of various statistical tests and the corresponding results, such as common method bias, non-response bias, CFA and EFA, etc. Section 5.6 is the conclusion of the chapter.

5.2. Assessing the Content Validity – Initial Expert Judgment

Table 5.1 Background information for expert panel

Expert	Job Title	Year of experience in their field	Area of expertise
Practitioner 1	CEO	25	Antilock brake system manufacturing in China.
Practitioner 2	CEO	23	Dialysis manufacturing in Guangdong China.
Practitioner 3	Purchasing Director	13	Pharmaceutical companies in China.
Academic 1	Professor	20	Operations and Marketing.
Academic 2	Assistant Professor	10	Quality management and quality risk.
Academic 3	Assistant Professor	7	Supply chain risk management.

In the Conceptualisation and Operationalization Chapter, the theoretical constructs were defined and the question items based on the existing literature, i.e. Stage 1 and Stage 2 in our scale development process, were formulated (see Figure 3.3. in Methodology Chapter). However, understanding these concepts only from the perspective of the author could have been limited. The wording of the items might also have been somewhat ambiguous. Therefore, an expert panel comprising three practitioners and three academics were asked to review the theoretical domains and the wording of our question items.

First the initial question items with the corresponding construct definitions, as presented in the previous chapter, were sent out for a first-round expert review. Several items of feedback

regarding the construct definitions and wording of the question items were received from the expert panel. Following this, the question items and construct definitions were revised on the basis of the comments from the expert panel. Again, in order to ensure the validity of the revised items, Stage 3 of the scale development process was repeated. The expert panel was invited to review the revised items and indicated that no further improvements were needed. The background information for the expert panel is provided in Table 5.1.

5.3. Translation of the Question Items

Because our research targets were senior managers in China, it was important to carefully refine and translate all the question items and definitions into Chinese. According to Brislin (1970) and Prince and Mombour (1967), a back-translation approach is conducted to ensure conceptual equivalence. Thus an *a priori* Chinese version of the questionnaire was first translated. Then two bilingual researchers were employed to do the translation. Translator A was asked to translate the first half of the Chinese questionnaire and second half of the questions into English. For translator B, the task order was reversed. Prince and Mombour (1967 , P.236) state, *"The translation of items eliciting discrepant response should be held suspect and further attempts at translation should be made"*. The results indicated that the works of the two translators were basically consistent with the *a priori* version of this study. After discarding the question items that yielded discrepant responses, the translators reviewed the final version of the Chinese and English questionnaires and agreed that the translation of the question items and construct definitions were satisfactory and would not be misunderstood by the respondents.

5.4. Establishing the Content Validity of the Instrument

The aim of this section is to further confirm content validity, which refers to *"the degree to which a measure's items are a proper sample of the theoretical content domain of a construct"* (Flores et al., 2012, Schriesheim et al., 1993). In contrast with Section 2 – the initial expert judgment, this section is focused more on examining the degree of linkage between the measurement items and the definition of their corresponding construct. It is crucial for a questionnaire-based study to determine whether a question item properly measures the phenomenon of interest (Ambulkar et al., 2015, Cao and Zhang, 2011, Chan et al., 2016, Hensley, 1999, Schriesheim et al., 1993, Yang et al., 2004). Because the research targets of this study were senior managers in China, the Chinese version of the initial questions formulated in Section 5.3 were used to form a common pool of items (Cao and Zhang, 2011). In accordance with Flores et al. (2012), two methods were employed to assess the content validity, namely Lawshe's (1975) content validity ratio and Schriesheim et al.'s (1993) Q-sort method.

5.4.1. Judge panel method

Table 5.2. Example of Judge Panel Method

Perceived Probability of SCQR						
Measurement Items	Definition	Item adequacy capture the definition				
		1	2	3	4	5
There is a high probability that the key supplier will supply us the key supply material with poor quality packaging.	The perceived likelihood that the key supply material/product from the key supplier will cause quality problems.					✓
There are always unforeseen issues in logistics that will have an impact on the key supplier's ability to supply the key material with good quality.					✓	
Perceived Magnitude of SCQR						
The quality problem of the key material supply from our key supplier will significantly and negatively impact our production.	The perceived severity/significance of the impact that the key supply of material/products from the key supplier causes quality problems.				✓	
The quality problems that occur in the logistics process will cause significant customer loss.				✓		
Psychological Factor of SCQR						
Are the supply chain quality problems ones that you can think about reasonably calmly or are they the risks that you truly dread? Please rate the level of dread potential. (1=Low dread; 7=High dread)	The subjective feeling when facing the situation that the key supply material/product from the key supplier will cause quality problems.					✓

Following Lawshe (1975) and Flores et al. (2012), the judge panel method was adopted to determine whether the proposed question items were consistent with the theoretical content domain of the three-factor SCQR structure. Notably, for this study the members of the judging panel were a different group of practitioners who were not involved in the initial expert judgment. Twenty-four senior directors from Chinese manufacturing firms endorsed by the Guangdong Institute of Science & Technical Information (GISTI) were invited to be the judges for the content validity test.

As shown in Table 5.2, an instrument was created that contains a definition for each risk factor, i.e. risk probability, risk magnitude and psychological factor, along with the items sorted according to their proposed corresponding constructs. The judging panel was asked to use the definitions provided to rate the adequacy of each item in terms of capturing the theoretical domain. The response scale ranged from 1 to 5. The higher value of the response rate indicated that the question items more adequately captured the sorted definition. The content validity ratio (CVR) was calculated (Lawshe, 1975) as follows:

$$CVR_e = \frac{n_e - \frac{N}{2}}{\frac{N}{2}} \qquad (5.1)$$

N is the total number of judges (i.e. 24) and *n* denotes the number of judges who indicated that the item *e* was "essential" or "good". In particular, only those items with an adequacy value above 4 were judged as "good indicators" (Flores et al., 2012). The CVR for each question item is presented in Table 5.3. According to Lawshe (1975), for a group that consists of 25 panellists, the item should have a CVR of 0.37 to satisfy the criterion of significant content validity (p<0.05). Overall, 19 of the 22 items in the common pool had significant content validity. The three items with insignificant content validity (CVR<0.37), i.e. MA7, PSY7 and PSY8, were removed from the item pool.

Table 5.3. Results of Judge Panel Method

		1st Round - Judge Panel Method		Inter-sorting Method
Constructs	Proposed indicators	CVR	Significant? (Y/N)	% of judges assign the item to the desired dimension
Probability of SCQR	PR1	91.67%	Y	100%
	PR2	83.33%	Y	100%
	PR3	41.67%	Y	100%
	PR4	66.67%	Y	100%
	PR5	91.67%	Y	100%
	PR6	58.33%	Y	100%
	PR7	50.00%	Y	40%
Magnitude of SCQR	MA1	66.67%	Y	80%
	MA2	83.33%	Y	100%
	MA3	100.00%	Y	100%
	MA4	91.67%	Y	100%
	MA5	83.33%	Y	100%
	MA6	50.00%	Y	40%
	MA7	25.00%	N	Removed in first round
Psychological Factor	PSY1	91.67%	Y	100%
	PSY2	91.67%	Y	80%
	PSY3	100.00%	Y	100%
	PSY4	100.00%	Y	100%
	PSY5	41.67%	Y	100%
	PSY6	50.00%	Y	100%
	PSY7	8.33%	N	Removed in first round
	PSY8	16.67%	N	Removed in first round

5.4.2. Q-sort Method

Although the CVR method is widely used, the lack of a data reduction component is one of its major limitations (Flores et al., 2012). In other words, the CVR is subject to its inability to determine the dimensionality of the question items. Following Schriesheim et al. (1993), the Q-sort method was adopted for this study as a supplementary method to further assess the

content validity. Five Chinese academics were invited to participate in the Q-sort test. According to Flores et al. (2012), sourcing a variety of respondents who have differing backgrounds could further ensure content validity.

The Q-sort questionnaire was designed by taking the following steps: a) the definitions for three risk factors were provided at the top of the questionnaire; b) the 19 items that remained from Section 5.4.1 were organised in a random order; c) a combo box with the three factor options were provided for each of the indicators. The respondents were asked to utilise the definitions provided to categorise the item into no more than one dimension (or construct). As expected, the Q-sort analysis generated three distinctive factors, which were mostly in line with our proposed structure. As mentioned in the Methodology Chapter, the Kappa was computed to indicate the inter-rater agreement of the proposed items (Fleiss, 1971). As shown in Table 5.3, all the items met the minimum criterion for the correct sorting, i.e. 60%, except for PR7 and MA6, which had only 40% of the correct judgment. Therefore, PR7 and MA6 were removed in this round. The Kappa value was 81.59%, which can be regarded as excellent inter-judge agreement (Landis and Koch, 1977). Moreover, the standard deviation for Fleiss's Kappa value, i.e. $\sigma_{\kappa,}$ was 0.049, yielding a 95% confidence interval for Cohen's Kappa in [0.72, 0.83].

In summary, the Q-sort test yielded three factors that corresponded with the three proposed theoretical dimensions. For each theoretical dimension, 5 to 6 indicators were captured. The remaining 17 items were all grouped into the expected factor, indicating an excellent factor structure.

5.5. Establishing the Questionnaire

5.5.1. The Web/Email Questionnaire

Having decided to rely on the questionnaire method to collect the research data, it was essential to find an appropriate approach to administering the data collection. In a business study, there are several ways to gather data. These include face-to-face structured interviews, telephone surveys, mail-delivered questionnaires and online questionnaires. Considering the feasibility, in this section the reasons for rejecting the first three approaches is explained and the choice to disseminate the questionnaire by email is justified.

Firstly, it would have been hard to approach the potential respondents from all around China directly, because of the high financial cost. Secondly, collecting the answers to the questionnaire by telephone was considered inappropriate because conducting hundreds of telephonic interviews to collect the responses to more than 20 questions per respondent would have been too time consuming and labour intensive. Indeed, most researchers who conduct questionnaire-based research would use the telephone only to ask or remind respondents to complete the questionnaire. Few researchers use only the telephone to directly collect questionnaire data (Cao and Zhang, 2011, Tse et al., 2016b, Zhao et al., 2008, Zhao et al., 2011). Thirdly, although using a surface mail survey for questionnaire data collection has been widely adopted in many empirical OM studies in the last two decades (Cousins and Menguc, 2006, Johnston et al., 2004), this method was not chosen for several reasons, such as slow turnaround time, limited screening capability, that it is not environmentally friendly and it is difficult to follow up.

Given the above limitations associated with survey data collection, Web-based (or email) dissemination was chosen as the ideal method to collect the data for this thesis. In particular, the Web-based questionnaire has been widely used in recent research in the field of empirical

OM, such as by Ambulkar et al. (2015). According to Kaplowitz et al. (2004), in comparison with a hard copy, mailed questionnaire, a Web survey would achieve a higher response rate. A possible advantage of using a Web survey is cost saving associated with printing the hard copy of the questionnaire and distributing it (Cobanoglu et al., 2001, Kaplowitz et al., 2004). Moreover, due to the increased use of mobile internet services, people are currently relying on the internet more than ever before. Checking one's emails on one's mobile phone has become the daily routine of many people. Email has become an essential tool, especially for managers who need to exchange massive amounts of information daily. Moreover, a Web questionnaire made it convenient to prepare the data for further analysis, because the data collected through an online method was already in electronic format. Last but not least, the online method is helpful to monitor the bias in responses to the questionnaire, such as unreasonable answering time and extreme responses.

5.5.2. Online Questionnaire Format and Layout

After finalising the question items, there were five indicators for SCQR probability, six indicators for SCQR magnitude and six indicators for psychological factor in the main questionnaire. Designing the questionnaire well is important to reducing measurement error. In particular, the length of scale may affect the response quality (Hinkin, 1995). If a construct has too many items, it may raise the problem of response bias or respondent fatigue (Anastasi, 1976). Nevertheless, if there are too few indicators in the construct, the data will fail to pass the various validity tests, such as those pertaining to discriminant validity, convergent validity, unidimensionality, and construct reliability. Therefore, it is critical to determine how many items should be included in a construct. According to Netemeyer et al. (2003), a recommended criterion is that the number of indicators in a construct should range from five to 10. However, Hinkin (1995) indicates that, in order to ensure the reliability of the measurement, a construct

should have at least three items. This is consistent with the findings of related studies in the OM area. For the research of Ellis et al. (2010), the risk magnitude was measured by three items and the risk probability was measured by three indicators. Therefore, the number of proposed items per factor was appropriate in this study.

Regarding the response format, various question formats can be found in the existing literature. According to Churchill and Lacobucci (2013), the response formats of the questionnaire include open-ended questions, closed-ended questions, dichotomous questions and multi-dichotomous questions. However, researchers in the business arena generally use open-ended and closed-ended questions. In this study, all the questions were in the closed-ended format. With this format, several fixed options are provided for each question. The reasons for using the closed-ended format are threefold. Initially, the closed-ended questions enabled the respondent to save more time when answering the questions. In addition to this, according to Gilbert (2002), closed-ended question can help the respondents to interpret the question correctly. Last but not least, in comparison with open-ended questions, the use of closed-ended questions can greatly reduce the amount of missing data in a Web-based questionnaire, which is self-administrative (Reja et al., 2003). Therefore, closed-ended questions were the most appropriate format for this study.

Furthermore, the layout of the questionnaire is critical to improving the completion rates. DeVellis (2003) indicates that a researcher should control the length of the questionnaire well. As suggested by Lumsden (2006), in order to attract respondents, only a few questions (less than five) were listed per page, along with a progress bar to clearly show the preceding and succeeding pages of the questionnaire. Moreover, each respondent was provided with a unique Web link so that he or she was able to interrupt and re-open the questionnaire whenever he or she wished to continue.

The final questionnaire consisted of three main sections. There were a total of six questions in Section 1, with questions relating to demographic information, such as the position of the respondents, type of industry, ownership of the company, the size of the company (the total number of fulltime employees) and annual sales In Section 2, the 16 questions relating to the factors of perception of SCQR were proposed. The aim of the final section of the questionnaire was to identify the antecedents of the perception of SCQR and related behaviour responses, which will be further discussed in Chapter 6 and Chapter 7.

5.5.3. Pilot Testing

Two managers and two academics who were invited to the first-round expert review were asked to check the online questionnaire for wording, layout and format etc. To accurately obtain the responses and suggestions from the experts, face-to-face discussions were held. Because the questionnaire had to be administrated on the website, the pilot test was conducted on different devices, such as personal computer, mobile phone and tablet. One of the experts suggested that it was difficult to read the questionnaire on a mobile phone, because of the resolution problems. To address the concerns raised by the expert, a mobile version of the questionnaire that was fitted with the resolution of a general mobile phone monitor was developed. Then the questionnaire was sent for review and the expert panel was satisfied with the new mobile phone version. Overall, no significant change was made to the questionnaire (Chinese version).

5.6. Administrating the Questionnaire

5.6.1. Non-response bias and detection of outliers

The received data needed to be purified before conducting the multivariate data analysis. Hair et al. (2009) suggest that the researcher needs to consider the estimation of non-response

bias and to identify the outlier(s). Specifically, the test for non-response bias is to determine whether the uncollected data will impact the research outcome. It is critical to understand the difference between the participants and non-participants (McNutt and Lee, 2000). This researcher first compared the sample of non-respondents that were randomly selected from the contact list and the sample of the valid responses. In accordance with the method suggested by Armstrong and Overton (1977), a *t*-test was conducted to assess whether the respondents and non-respondents were significantly different ($p<0.05$) in the related demographic information. No significant results were identified in the *t*-test of respondent and non-respondent difference on number of employees (p=0.283) and annual sales revenue (p=0.764). According to Swafford et al. (2006), the non-response bias can also be used to assess the significance of the difference between the early and late returned surveys. Regarding the company size (i.e. annual sales revenue and number of employees), the results of the *t*-test indicated that the difference between early respondents (n=212, received within the first four weeks) and late respondents (n=104, received within the fifth week and later) was insignificant. Therefore, it was concluded that non-response bias did not threaten the research outcome (Armstrong and Overton, 1977).

Outliers are potential problems. The results of the validity test and the estimation of the statistical model could be significantly influenced by the outliers. Therefore, it is also important to carefully purify the raw data by examining the outliers before continuing with any calculation (Blunch, 2013). A univariate approach was adopted to examine the outliers. Firstly, the values of each construct, i.e. risk probability, risk magnitude and psychology factor, were transferred as standard scores with standard deviation equal to 1 and mean equal to 0. Then the z-scores were calculated for all the variables. According to Tabachnick and Fidell (1996), if the observations have z-scores that are greater than "the absolute value of 3.29 (p<.001, two-tailed test)", they would be classified as univariate outliers. No significant outliers were found in this research, because all the z-scores were lower than the threshold value (See Table 5.4).

The test for Kurtosis further confirmed that there were no significant outlier problems in this research, because the values of Kurtosis were between +1 and -1. Moreover, the absolute values of the Kurtosis were all less than three times the standard error, which means that the data had no Kurtosis issue. Therefore, the data had no significant outliers.

Table 5.4. Kurtosis Test

Factor	Minimum	Maximum	Kurtosis	
	Statistic	Statistic	Statistic	Std. Error
SCQR Probability	-2.4341	3.0861	0.448	0.273
SCQR Magnitude	-2.8668	1.7834	0.574	0.276
Psychological Factor	-2.3587	2.0601	-0.818	0.273

5.6.2. Sample Size

As an advanced technique for the multivariate data analysis, SEM requires a large sample (Kine, 2015). In comparison with a simple model, a more complex model will require a larger sample size. Although there is no absolute threshold in the literature in terms of the sample size, the item-to-response ratios is widely used as an index to determine whether the sample size is sufficient to explain the model (Jackson, 2003). Jackson (2003) suggests that the minimum sample size for the estimation model can be calculated by the ratio of case (N) to the number of perimeters that require statistical estimates (q), i.e. the indicators. A threshold value of the item-to-response ratio is 1:4, but 1:10 is ideal (Rummel, 1970, Schwab, 1980). For the model of this study, with 17 indicators, the minimum sample size was 68 and the ideal sample size was 170. Therefore, with 316 samples, the model should be adequately estimated in this study.

5.7. Scale Construction and Purification

Because multiple items were used to measure each theoretical construct, a rigorous process was conducted to assess the unidimensionality, construct reliability, discriminant validity and convergent validity, etc. Firstly, the dimensionality of the constructs was established through EFA and CFA, which are widely accepted in empirical OM research (O'Leary-Kelly and Vokuraka, 1998, Devaraj et al., 2007, Vaidyanathan and Devaraj, 2008). In addition, according to Huo et al. (2014b), the construct reliability was checked by means of different indexes, such as Cronbach's alpha and composite reliability. Moreover, the discriminant validity was assessed by the X^2 difference test and the test of AVE comparison (Sekaran, 1992). The *t*-value of factor loading and AVE were used as the means to examine the convergent validity.

5.7.1. Pearson Correlation Coefficient of the Question Items

As mentioned in Chapter 3, before conducting the unidimensionality tests, it is important to examine the correlation coefficient for the items in their corresponding constructs. As shown in Table 5.5-5.7, three Pearson Correlation Coefficient tests were performed. For the construct of SCQR probability, the non-significant correlation with RP1, RP2 and the negative correlation with RP5, RP3 should have been problematic (DeVellis, 2003). The items in SCQR magnitude were significantly correlated with each other; therefore all five items could be retained for the following analysis. Regarding the psychological factor, PSY4 had a negative Pearson Correlation Coefficient with all the other items; the item thus needed to be removed. In the next sections, EFA and CFA were carried out to further confirm the deletion of these items.

Table 5.5. Pearson Correlation Coefficient – SCQR Probability

	RP1	RP2	RP3	RP4	RP5	RP6
RP1	1					
RP2	0.680**	1				
RP3	0.047 (n.s.)	-0.039 (n.s.)	1			
RP4	0.443**	0.314**	0.212**	1		
RP5	0.398**	0.554**	-0.133*	0.230**	1	
RP6	0.422**	0.294**	0.240**	0.506**	0.234**	1
** Correlation is significant at the 0.01 level (2-tailed) * Correlation is significant at the 0.05 level (2 tailed) n.s. indicates the correlation is not significant						

Table 5.6. Pearson Correlation Coefficient – SCQR Magnitude

	MA1	MA2	MA3	MA4	MA5
MA1	1				
MA2	0.479**	1			
MA3	0.592**	0.501**	1		
MA4	0.654**	0.600**	0.615**	1	
MA5	0.623**	0.487**	0.619*	0.579**	1
** Correlation is significant at the 0.01 level (2-tailed) * Correlation is significant at the 0.05 level (2 tailed) n.s. indicates the correlation is not significant					

Table 5.7. Pearson Correlation Coefficient – Psychological Factor

	PSY1	PSY2	PSY3	PSY4	PSY5	PSY6
PSY1	1					
PSY2	0.446**	1				
PSY3	0.507**	0.460**	1			
PSY4	-0.349**	-0.198**	-0.366**	1		
PSY5	0.430**	0.421**	0.556**	-0.503**	1	
PSY6	0.537**	0.546**	0.681**	-0.374**	0.571**	1
** Correlation is significant at the 0.01 level (2-tailed) * Correlation is significant at the 0.05 level (2 tailed) n.s. indicates the correlation is not significant						

5.7.2. Exploratory Factor Analysis (EFA)

In order to obtain an overall picture of the factor structure of the retained items, an EFA was performed before assessing the measurement model (Zhang et al., 2018). There are two steps for conducting the EFA. Firstly, the factors with their proposed corresponding items are separately analysed by the PCA, which have been utilised consistently in previous research (Zhao et al., 2008). The results of the first-step EFA are reported in Table 5.8. As expected in the Correlation Analysis (Section 5.7.1), PR3 was removed, because of the low factor loading (0.136) that was not satisfied with the criterion ≥ 0.40 (Netemeyer et al., 2003). Although RP5 and RP6 were loaded on two different factors, both of them were retained, since the cross-loading difference between two factors was greater than 1.0. The cross-loading for RP5 was 0.174 and the cross-loading for RP6 was 0.243. After removing the unqualified items, the retained items of SCQR probability all met the suggested criteria and loaded on a single construct. In terms of the SCQR magnitude, all five items were loaded on a single factor and the factor loadings were all above 0.745. Due to the low factor loading, PSY4 was removed, which was consistent with the result of the correlation test. The deletion of PSY4 results in five retained indicators.

After removing the problematic items, i.e. RP5, RP6 and PSY4, 15 items were retained. The second step of the EFA was to aggregate all the indicators and rerun the PCA with the VARIMAX rotation method. The result of the Kaiser-Meyer-Olkin (KMO) test was 0.822, that is, greater than the recommended value of 0.60 (Worthington and Whittaker, 2006). The number indicated that the sample of this study was adequate for running the EFA. As specified in Table 5.9, the three-factor solution was retained with an all factor loading of >0.50. However, RP4 and RP6 were dropped due to the significant cross-loading problem. Therefore, the EFA was rerun and the unidimensionality was confirmed in the 13-item structure.

Table 5.8. Exploratory Factor Analysis at Individual Construct Level

	Factor loadings [% of factor variance explained]		
	First Round		Second Round
SCQR Probability	Factor 1 [44.42%]	Factor 2 [21.99%]	Retaining One Factor [53.083]
PR1	0.832	0.100	0.835
PR2	0.796	0.346	0.807
PR3	0.136 (<0.40)	0.800	Removed
PR4	0.680	0.389	0.668
PR5	0.641	0.467	0.657
PR6	0.669	0.425	0.654
SCQR Magnitude	Retaining One Factor [66.11%]		All items were retained in the first round.
MA1	0.828		
MA2	0.745		
MA3	0.821		
MA4	0.852		
MA5	0.816		
Psychological Factor	Retaining One Factor [55.85%]		Retaining One Factor [61.484%]
PSY1	0.730		0.738
PSY2	0.685		0.723
PSY3	0.815		0.828
PSY4	-0.596 (<0.40)		Removed
PSY5	0.782		0.759
PSY6	0.847		0.863

Table 5.9. Exploratory Factor Analysis at all items level

	First Round			Second Round		
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
MA1	.818	.073	.018	.828	.062	-.011
MA2	.741	-.051	.054	.741	-.059	-.001
MA3	.803	.089	.061	.822	.074	.047
MA4	.851	-.009	-.050	.849	-.015	-.101
MA5	.806	.086	-.015	.812	.077	-.047
PSY1	.000	.703	-.197	-.028	.719	-.215
PSY2	.102	.720	-.047	.108	.721	-.016
PSY3	.045	.824	-.071	.053	.824	-.029
PSY5	-.069	.767	.035	-.073	.770	.042
PSY6	.063	.857	-.122	.069	.860	-.076
PR1	.056	-.171	.818	.113	-.211	.817
PR2	-.099	.016	.849	-.021	-.030	.902
PR4	.389	.225	.576	The item was removed due to the significant cross-load in Round 1.		
PR5	-.221	.047	.724	-.162	.012	.764
PR6	.317	.216	.569	The item was removed due to the significant cross-load in Round 1.		
Eigen Value	3.550	2.160	3.668	3.068	1.980	3.552
Total Variance Explained	62.525%			66.154		

5.7.3. Confirmatory Factor Analysis (CFA)

According to Hausman et al. (2002) and Shah and Ward (2007), the "split-sample" approach is conducted to examine the measurement model. Specifically, the original data was randomly divided into two datasets for the various tests of the measurement model. The sub-datasets were named the calibration sample, with 165 observations, and the validation sample, with 151 observations. For both of the datasets, the sample size met with the minimum requirement of the item-to-response ratio. Shah and Ward (2007) suggest, that the convergent validity and unidimensionality should be examined in all three datasets, i.e. calibration (n=165), validation

(n=151) and whole sample (n=316). The construct reliability and the discriminant validity were evaluated only in the whole sample set.

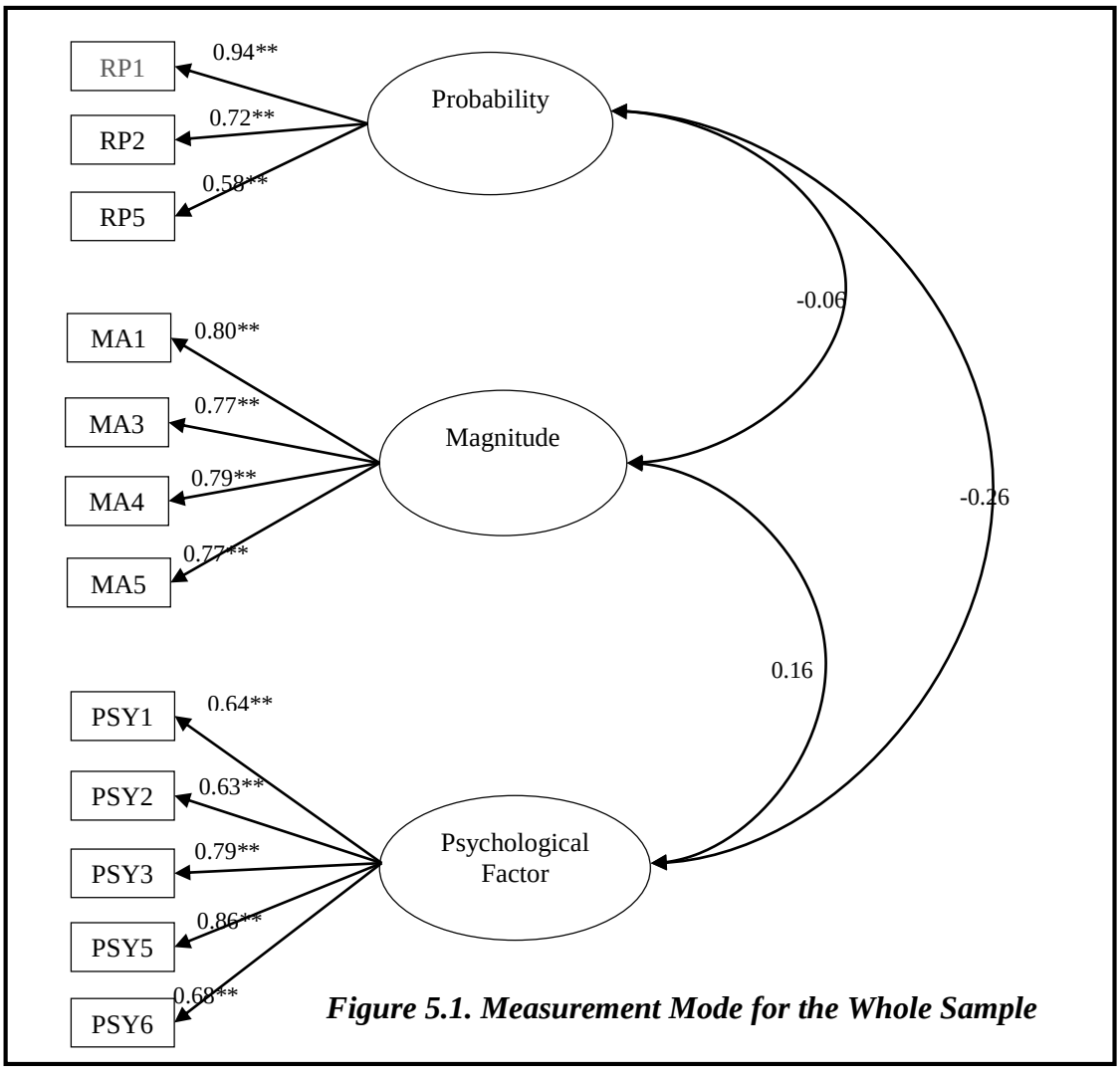

Figure 5.1. Measurement Mode for the Whole Sample

5.7.3.1. CFA analysis for the calibration sample

Firstly, to examine the fitness of the measurement model, a model comparison method was adopted (Hair, 1998). Three models were developed, i.e. the null model (Model 1), one-factor model (Model 2) and measurement model (Model 3). Model 3 assessed whether the three proposed constructs were freely correlated with each other. In Model 1, the correlations of all the constructs were constrained to zero. Moreover, Model 3 forced all the indicators loaded into one single factor. As listed in Table 5.11, the model fitness of all three models in the

calibration sample was assessed. According to Hair (1998), in order to accept the measurement model, the model fitness of the null model and one-factor model should not provide a better model fitness. Otherwise, the proposed model should be rejected. In particular, the X^2 difference test was conducted to compare the three models. For the calibration sample, Model 3, i.e. the proposed model, showed the best model fitness in comparison with two estimated models in terms of the CFI with 0.963, NNFI with 0.964 and RMSEA with 0.061 Moreover, the results of X^2 difference test indicated that Mode 3 was significantly different to the other two models. The unidimensionality of the proposed model was further confirmed.

Furthermore, the convergent validity was confirmed by the fact that all the factor loadings were above the recommended value of 0.50. Except for MA2, all the standardised path coefficients were greater than their standard error. In this case, MA2 was deleted. In addition, no absolute standardised residuals in the calibration sample were greater than |2.58| and all the modification indices were below 0.10.

5.7.3.2. CFA analysis for the validation sample

Using the same procedure applied in the calibration sample, the proposed model was again assessed. As for the results for the calibration sample, the proposed model showed the best model fitness in three estimated models. The model fit index of the proposed model, including the normed X^2 (1.312), RMSEA (0.046), CFI (0.978) and NNFI (0.978), all exceeded the "rules of thumb" for a good model fit. As expected, the results of the X^2 difference test also indicated that the proposed model was significantly different to the one factor model and the null model. Moreover, the standardised factor loadings with their corresponding *t*-values all exceeded the cut-off value. The convergent validity was thus obtained in the validation sample. In summary, the CFA results for the calibration sample and the validation sample successfully approved the

"invariance of form", which means that *"using the mapping of manifest variables to latent variables in two sub-samples is appropriate in this research"* (Shah and Ward, 2007, P.798).

5.7.3.3. CFA analysis for the whole sample

The tests for convergent validity and the unidimensionality were again conducted for the whole sample set. Furthermore, following Shah and Ward (2007) and Zhang et al. (2018), the discriminant validity and construct reliability were examined in the entire sample. Firstly, the convergent validity was confirmed. As shown in the Table 5.12, the standardised factor loading between the indicators and latent variables ranged from 0.583 to 0.944 and their respective *t*-values were all significant at the level of 0.01. Secondly, the measurement model for the entire dataset also had good unidimensionality. The model fit indexes of the proposed model were all above the recommended value. In comparison with the two competing models – the null model and the one-factor model, the proposed model (Model 3) showed the best model fitness (See Table 5.11).

Table 5.10. Discriminant Validity and Construct Reliability Test

		$\boldsymbol{p_c}$[a]	α[b]	Items	AVE	PR	MA	PSY
1	PR	0.801	0.782	3	0.583	0.724	590.091[d]	287.836
2	MA	0.845	0.840	4	0.614	0.114[c]	0.784	299.353
3	PSY	0.864	0.842	5	0.525	-0.135	-0.048	0.764

Note: a. Composite reliability for the latent variable is denoted as $\boldsymbol{p_c}$.

b. The Cronbach's alpha is denoted as α.

c. The lower triangle shows the correlation.

d. The upper triangle shows the X^2 difference between the pairwise factor model and single factor model. All X^2 difference test with 1-degree freedom, so if X^2>11, the p-value is significant at 0.001 level.

e. PSY=Psychological Factor; MA=Risk Magnitude; PR=Risk Probability

Because the Cronbach's alpha and composite reliability of all the latent variables were greater than the cut-off value of 0.70, the construct reliability was confirmed in this study. The composite reliability and AVE results also confirmed the construct reliability. As shown in Table 5.12, all composite reliabilities and AVEs of the latent constructs were greater or recommended values of 0.70 and 0.50 respectively. Regarding the discriminant validity, as mentioned in Chapter 3 – Methodology, two methods were adopted, namely the AVE comparison approach and the pairwise CFA approach. Table 5.10 shows that the correlations between the three proposed constructs (off-diagonal values) were less than the square roots of AVE (bold numbers in diagonal). Moreover, according to Zhu et al. (2008), the pairwise CFA models for every latent variable were built and compared with a single factor model[8]. The significant results of all three pairwise X^2 difference tests demonstrate the discriminant validity (Zhang et al., 2018, Zhu et al., 2008).

[8] The indicators from each pairwise model are forced to be measured in a single latent variable.

Table 5.11. Model Fit Performances for Calibration, Validation and Whole Sample

	RMSEA [90% confidence interval]	NFI	NNFI	TLI	CFI	Normed X^2	GFI	X^2(df)
Calibration Sample (N=165)								
Model 1	0.070	0.891	0.948	0.936	0.948	1.804	0.917	97.434(54)
Model 2	0.235	0.393	0.418	0.278	0.409	10.080	0.590	544.324(54)
Model 3	0.061	0.909	0.964	0.952	0.963	1.603	0.927	81.757(51)
Validation Sample (N=151)								
Model 1	0.063	0.889	0.955	0.945	0.955	1.599	0.921	86.333(54)
Model 2	0.225	0.403	0.433	0.295	0.423	8.615	0.609	465.186(54)
Model 3	0.046	0.914	0.978	0.971	0.978	1.312	0.936	66.927(51)
Whole Sample (N=316)								
Model 1	0.066	0.921	0.952	0.941	0.952	2.372	0.941	129.098(54)
Model 2	0.238	0.372	0.385	0.242	0.380	18.774	0.595	1013.771(54)
Model 3	0.066	0.925	0.955	0.942	0.955	2.366	0.943	120.676(51)

Table 5.12. Factor Loadings for the Calibration, Validation and Whole Sample

Indicator	Latent Variable	Calibration Sample (n=173)	Validation Sample (n=120)	Whole Sample (n=293)
		$\beta(C.R.)$[a]	$\beta(C.R.)$[a]	$\beta(C.R.)$[a]
RP1	Risk Probability	0.734(-)	0.837(-)	0.944(-)
RP2	Risk Probability	0.962(8.356)	0.898(9.433)	0.720(10.235)
RP5	Risk Probability	0.615(7.795)	0.612(7.614)	0.583(9.891)
MA1	Risk Magnitude	0.767(-)[b]	0.784(-)[b]	0.804(-)[b]
MA3	Risk Magnitude	0.775(9.698)	0.763(9.212)	0.771(13.922)
MA4	Risk Magnitude	0.757(9.460)	0.721(8.681)	0.789(14.258)
MA5	Risk Magnitude	0.858(10.290)	0.818(9.815)	0.771(13.917)
PSY1	Psychological Factor	0.619(-)	0.587(-)	0.644(-)
PSY2	Psychological Factor	0.593(6.385)	0.627(6.072)	0.628(9.473)
PSY3	Psychological Factor	0.823(8.095)	0.788(7.033)	0.791(11.310)
PSY5	Psychological Factor	0.664(6.980)	0.555(5.542)	0.855(10.056)
PSY6	Psychological Factor	0.868(8.294)	0.873(7.311)	0.676(11.800)

Note: a. Standardised factor loading is denoted as β and t-value is denoted as C.R.

b. This regression weight was fixed as 1.0

5.8. The Risk Appraisal Model

According to the risk perception model suggested by Stone et al. (1994), a formative model was tested by means of the SEM approach. Specifically, this research establishes three structural linkages between three risk factors and an evaluation of overall risk. Following Shapira (1995) and Ellis et al. (2010), a single-item measurement that captures managers' overall evaluation of SCQR was developed. Figure 5.2 shows the results of the structural equations model. The fit indexes of the risk perception model satisfy the recommended values for an excellent model fit (please refer to the Methodology chapter). With an X^2 of 141.450 and degree of freedom of 61, the normed X^2 is 2.319, thus lower than 5. Moreover, the RMSEA with 0.065 was lower than 0.08. The IFI of 0.950, NNFI of 0.936 and GFI of 0.937 also indicate a good model fit. Therefore, the structural model was considered to be acceptable (Browne and Cudeck, 2003).

Firstly, the standardised path coefficient between risk probability and the overall risk perception is 0.347 and statistically significant at the 0.01 level with *t*-value of 5.841. Secondly, as can be seen from Figure 5.2, the standardised path coefficient between risk magnitude and overall risk perception was 0.172, with a *t*-value of 3.032 ($p<0.01$). Thirdly, the psychological factor significantly and positively impacted on overall risk perception, with a standardised path coefficient of 0.223 and *t*-value of 3.508 ($p<0.01$). The three risk factors jointly explain 18% of variance in overall risk perception ($R^2=0.18$). Thus, the proposed risk perception model was supported. Finally, following Zhao et al. (2011) and Ellis et al. (2010), the structural model also controlled two company size variables, i.e. annual sales and number of employees. The structural relationships did not appear to be affected by the control variables (see Figure 5.2).

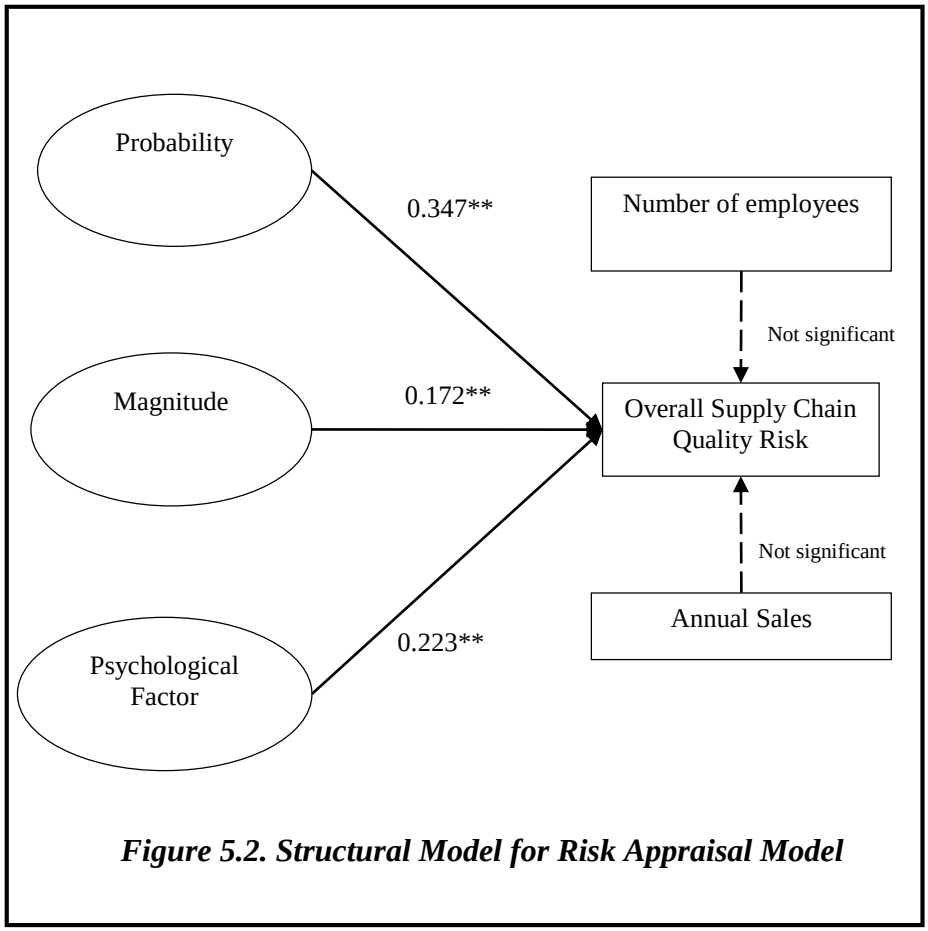

Figure 5.2. Structural Model for Risk Appraisal Model

5.9. Discussion

Three important contributions to the OM literature were made in this chapter. Firstly, this study shed light on how managers' perceptions of SCQR are formed. The overall evaluation of SCQR is positively influenced by three individual factors, namely risk probability, risk magnitude and the psychological factor. Secondly, except for two well-known risk factors (i.e. magnitude and probability) that have been analysed in previous studies (Ellis et al., 2010, Tse et al., 2016a), a psychological factor underlying risk perception research was identified and validated. Thirdly, through a rigorous process of scale purification, 12 items to measure the theoretical constructs were contributed. However, 10 items were deleted to ensure the validity and the reliability of their corresponding constructs. Although almost half of the items were removed, the operationalized constructs of this study were measured by at least three indicators.

According to Hinkin (1995), the number of items per construct in this study is appropriate. Moreover, the number of items per construct is comparable with similar research, such as that of Ellis et al. (2010) and Tse et al. (2016a).

Table 5.13. Measurement Items for Probability of SCQR

Measurement Items		Scale Development Result
RP 1	There is a high probability that the key supply material from the key supplier cannot meet the quality standards.	Keep
RP 2	There is a high probability that the key supplier will be unable to commit to quality improvement of the key supply material.	Keep
RP 3	There is a high probability that the key supplier will not supply the major raw material as specified within our purchase agreement.	E
RP 4	We never experience that the key supplier cannot maintain the quality of the key material. (Reverse Coded)	E
RP 5	There is a high probability that the key supplier will supply us the key supply material with poor quality packaging.	Keep
RP 6	There are always unforeseen issues in logistics that will have an impact on the key supplier's ability to supply the key material with good quality.	E
RP 7	We are always not confident in the key supplier's ability to maintain the quality of its production.	Q
Note: E: the item was deleted in EFA; Q: the item was deleted in Q-sort analysis		

The three retained indicators (RP1, RP2 and RP3) significantly reflect the theoretical domain of SCQR probability, although four items (RP3, RP4, RP6 and RP7) were removed during the data purification process. Initially, RP7 was removed at the stage of judge panel assessment. In the first round content validity test, RP7 obtained a satisfactory CVR that was greater than the threshold of 0.37 (p<0.05). However, RP7 seemed to lack content validity in the inter-judge agreement of five Chinese academics. The academic panel pointed out that RP7 was ambiguous because the questions contained the term "confident", which could be viewed as a psychological factor. Moreover, RP3, RP4 and RP6 were eliminated in the EFA. Specifically, RP3 was deleted from the first round EFA due to the low factor loading. A possible explanation is that RP3 captured only a broad concept of a supply product problem that was not specific to the supply chain quality problem. RP4 and RP6 were deleted because

of the significant cross-loading issue. The remaining items showed excellent discriminant validity and convergent validation in various CFA tests. Therefore, no item was further filtered and a three-item construct was confirmed. Table 5.13 shows the evaluation results of the proposed items from the Chapter 4 – Conceptualisation Chapter.

Table 5.14. Measurement Items for Magnitude of SCQR

Measurement Items		Scale Development Result
MA 1	A lack of awareness of the usage of defective purchased material in our product would have severe negative financial consequences for our business.	Keep
MA 2	We would incur significant costs and/or losses in revenue if we were unaware of the usage of defective purchased material in our product.	C
MA 3	Key suppliers' inability to supply qualified material that conforms to agreed specifications would seriously jeopardize our business performance.	Keep
MA 4	The quality problem of the key material supply from our key supplier will significantly and negatively impact our production.	Keep
MA 5	The quality problems that occur in the logistics process will cause significant customer loss.	Keep
MA 6	The supply of major raw materials with poor quality is NOT a big deal to our company. (Reversed Code)	Q
MA 7	The quality risks are of concern as a huge factor that could interrupt the company's supply chain.	Q
Note: E: the item was deleted in EFA; Q: the item was deleted in Q-sort analysis; C: the item was deleted in CFA		

In this study the magnitude of quality risk is defined as *"the perceived severity/significance of the impact that the key supply material/product from key supplier has in terms of quality problems"*. As shown in Table 5.14, the four retained question items can correctly reflect the theoretical domain of the SCQR magnitude. However, in the first phase of the data purification process, MA6 and MA7 were deleted. The deletion of MA7 might be due to the ambiguous statement, because it seemed to focus more on the problem of "supply chain interruption". Regarding MA6, the results of Q-sort analysis show that three of the academics classified it as an indicator of a psychological factorMoreover, to ensure the convergent validity of the construct, MA2 was deleted because of the low factor loading in the measurement model.

Although MA2 was removed, it did not affect the theoretical domain of the construct significantly. The results of the scale development of "Magnitude of SCQR" can be found in Table 5.14 above.

Table 5.15. Measurement Items for Psychological Factor of SCQR

Measurement Items		Scale Development Result
PSY1	Please rate to what extent you can avoid the negative impact of the supply chain quality problems happening to your company through your personal knowledge and experience, if exposed to this risk. (1=Controllable; 7=Uncontrollable)	Keep
PSY2	Do you think the supply chain quality problems can be easily reduced or are they hard to reduce? Please rate the difficulty of this risk. (1=Easily; 7=Difficult)	Keep
PSY3	Are the supply chain quality problems ones that you can think about reasonably calmly or are they the risks that you truly dread? Please rate the level of dread potential. (1=Low dread; 7=High dread)	Keep
PSY4	Do you think the company will go bankrupt if you have serious product quality problems? Please rate how likely it is that the consequences will be fatal, if the risk is realised in the form of a mishap. (1=Not fatal; 7=Fatal)	E
PSY5	Overall, are supply chain quality problems preventable or non-preventable? (1=Preventable; 7=Non-preventable)	Keep
PSY6	Are supply chain quality problems the ones that you worry will threaten you personally (e.g. job position, salary etc.) or it does it not matter to you? (1= No Impact; 7 = Great Impact)	Keep
PSY7	Do you think the negative effects of the supply chain quality problem are likely to occur immediately or at some later time? Please rate the immediacy of the effect of this risk. (1=Immediate, 7=Delayed)	Q
PSY8	Do you think the supply chain quality problems are known precisely by the managers who are exposed to these risks? Please rate the extent to which you think the risk is known to those who are exposed to it. (1=Known Precisely; 7=Not Knowns)	Q
Note: E: the item was deleted in EFA; Q: the items were deleted in Q-sort analysis		

As mentioned in the previous chapters, no OM researcher has used the psychometric paradigm to measure risk perception, which is multi-dimensional. In this study the scales that might be relevant to the SCQR context were first selected. It is widely accepted that the psychometric paradigm method (i.e. cognition map) of risk perception will generate two risk factors, namely "unknown risk" and "dread risk" (Feng et al., 2010). Surprisingly, only the indicators underlying "Dread" in previous research (Slovic et al., 2004) were retained from the

data purification process. The components that belong to the "Dread" factor are sometime called *"risk as a feeling",* which is basically matched with the theoretical domain of the psychological factor. For the indicators PSY7 and PSY8, which measure the "Immediacy" and "Known to the Risk Exposed", were filtered in the first round of expert judgment. A possible explanation is that these two items cannot capture the meaning of "subjective feeling" in SCQR perception. One of the experts in the review panel commented that the deleted items were more related to the view of evaluation than personal feelings or thoughts. Moreover, PSY4 was removed in the EFA. This can be explained by the fact that PSY4, measuring the severity, can also reflect the nature of SCQR magnitude, which is another factor in the proposed model. Therefore, in order to ensure the unidimensionality of the construct, PSY4 was eliminated. Table 5.15 shows the results of scale development. The psychological factor of SCQR perception captures the feelings and thoughts of the manager regarding "controllability", "dread", "preventability", "whether the risk can be reduced" and "personal impact".

Furthermore, the representations of the SCQR appraisal were validated. In Chapter 4 a formative model drawn from previous research (such as Ellis et al. (2010) and Tse et al. (2016a) was conceptualised. In the context of supply disruption, Ellis et al. (2010) and Tse et al. (2016a) have taken the lead in developing the risky decision-making model (Yates and Stone, 1992). However, they all focused on the two-construct structure, i.e. risk magnitude and risk probability. By extending their work, using the scale from the psychometric paradigm, a psychological factor that derived from the psychology and sociology field was incorporated as the third component. The proposed linkages between the risk factors and the overall risk perception were positive and significant. The results are in line with our expectation and the previous research (Ellis et al., 2010).

Regarding the effect size of the standard coefficient, it was found in this study that risk probability (β=0.347) has the highest effect on overall risk perception rather than the psychological factor or the risk magnitude. The result implies that the managers are affected most significantly by risk probability when forming their overall perception of SCQR. A possible explanation is that any defective supply material will have negative financial implications for the buying firms. Indeed, preventing the occurrence of a supply chain quality problem is one of the most important dimensions of QM (Tse and Tan, 2012, Tse, 2012). The main point of this study is that the SCQR is the subjective judgment that managers make about the characteristics of the supply chain quality problem. In responding the call of Ellis et al. (2011), a behavioural perspective was incorporated in this study, in which a perceptual view of risk was explored and in which the psychological factors (β=0.223) that affect the formation of risk perceptions were considered. Although the effect of the psychological factor was smaller than the effect of risk probability, this study provides empirical evidence that SCQR is a multidimensional concept and lends insight into how the perceptual bias of risks is formed (Ellis et al., 2011). The literature in psychology and sociology widely accepts that there are multiple risk characteristics that form individual risk perception, which is not limited to risk probability and risk magnitude (Sjöberg et al., 2004). From the perspective of behavioural OM, this researcher argues that the formation SCQR includes not only risk probability and risk magnitude, but also a psychological factor that captures the various characteristics of perceptual SCQR, such as uncontrollability, preventability, and personal impact and dread, etc. This result is also consistent with a recent study in which an additional factor (i.e. self-control) in forming overall risk perception on the basis of probability and magnitude structure was investigated (Jia et al., 2015).

5.10. Chapter Summary

In this chapter, a rigorous process of developing a measurement scale for perceptual SCQR was presented. Through the various tests for assessing unidimensionality, reliability and validity, three latent variables, namely risk probability, risk magnitude and psychological factors were empirically verified. The structural model of the construction of perceptual SCQR was tested and the three components had a positive and significant impact on the overall perception of SCQR. Therefore, the theoretical structure of risk perceptions in the field of behavioural OM was reinforced (Ellis et al., 2011, Ellis et al., 2010, Tse et al., 2016a). To conclude, a set of 22 question items were operationalized to measure the perceptual SCQR, yet only 11 of them were retained after the scale purification process.

This chapter contributes to the body of knowledge of SCRM in three important ways. Firstly, it provides new insight into how senior managers' perceptions of SCQR are formed, in particular in the context of China. In the field of SCRM, most of the research focuses on the examination of various management practices (Tse et al., 2016a). This study, however, advances new insight into the understanding of perceptual SCQR, which can be regarded as the root of understanding the adoption of different management practices (Yates and Stone, 1992, Ellis et al., 2011, Ellis et al., 2010). Secondly, according to the review by Mitchell (1999), in the context of business management there is a long history of modelling risk perceptions as a function of two components, i.e. probability and magnitude. However, this study advances the insights contained in the previous business literature by adding the psychological factor as an additional factor in forming risk perception. Thirdly, the validated measurement scales of perceptual SCQR can contribute to further understanding of the decision-making process in QM or SCRM. It is essential to understand the risk perceptions well, because actions or decision regarding risks are based on perceptions (Yates and Stone, 1992, Ellis et al., 2010).

CHAPTER 6. THE THEORETICAL FRAMEWORK OF SUPPLY CHAIN QUALITY RISK

6.1. Introduction

Responding to the call to incorporate behavioural theory into the OM empirical model (Bendoly, 2006), this study extends the original model for supply disruption risk into the context of SCQR, which has not been investigated thoroughly in existing literature. In the previous chapters, this study has verified the risk perception structure of SCQR and developed the scales to measure how practitioners perceive the SCQR. However, the factors that could influence managers' perception of SCQR, and what decision making can be influenced by those managers' perceptions, have not yet been revealed.

Empirical researchers have noticed the potential value of studying the relationship between perceived risk and the adoption of management practices, and its implications. Among recent studies that examine this relationship, Ellis et al. (2010) investigate how the overall perception of supply chain disruption risk influences the decision making in searching for alternative sources of supply, and find that the perception of supply chain disruption significantly and positively influences the decision to search for such alternative sources; Kull et al. (2014) empirically confirm a negative relationship between perceived risk in a supplier selection situation and selection risk taking; adopting a clustering analysis method, Revilla et al. (2017) empirically find that the firms with inter-organizational orientation (collaborative and integral) perceive the lowest level of supply chain disruption risk. As mentioned in the Literature Review chapter, managers' perceptions of SCR and the behavioural responses to these perceptions remain largely unexplored. To the best of the author's knowledge, this study is also the first attempt to examine the effect of the perception of SCQR on the adoption of quality

management. This chapter contributes to the SCRM and SCQM literature by proposing that the adoption of QM is not driven by the quality risk event per se; rather it is influenced by how the managers internalize and process the SCQR, i.e. risk perception.

Although there are many promising theories have been investigated in the field of OM, such as resource-based view (RBV), dynamic capabilities and resource orchestration theory, this study will develop the theoretical model through the lens of resource dependency theory (RDT) and agency theory. There are many well-known theories that been applied in the field of OM, such as RBV, dynamic capabilities and resource orchestration theory. However, those theories are concerned with identifying and examining success factors to help companies achieve competitive advantage, which is not the focus of this study. As argued by Tse et al. (2011), the supply chain quality risk is related to the issues of inter-relationship between buyer and supplier. Therefore, the theories applied in this thesis are RDT and agency theory as they are better suited to explore the potential antecedents of SCQR perception.

In this chapter, a conceptual model for identifying the antecedents of perceived SCQR and intention to adopt two different quality management practices is developed. In particular, the chapter presents the hypothesized relationships between the contextual factors and the risk factors and between the overall risk perception and decision making in adopting QM practices.

6.2. Supply Chain Dependencies

6.2.1. Theoretical Background: Resource Dependency Theory

This section discusses the theoretical development for the relationships between two supply chain relational factors and three components of SCQR perception. Taking a RDT perspective, this study investigates the factors of supply chain dependencies (SCD). Emerson (1962) defines dependence in the organizational context as the need to rely on a partner's contribution in

pursuing one's goal. According to Zhang and Huo (2013 , P.546), "*the dependence in SCM can be defined as a firm's need to maintain its business relationship with supply chain partners to achieve its goals"* (p. 546). Here, the RDT is a relevant lens to investigate the mechanism of supply chain dependence, i.e. BD and SD. According to Pfeffer and Salancik (1978), organizations are resource driven in that firms need to rely on both tangible (for example, raw materials, labour, manufacturing equipment) and intangible resources (for example, copyright and human resources) to sustain their business. Nevertheless, firms might not always depend solely on internal resources. According to the RDT, firms cannot be self-sufficient, and must therefore be dependent to some extent on other related organizations (Heide, 1994). Moreover, the nature of task interdependence also determines that companies need to acquire resources from the external environmental to sustain themselves (McCarter and Northcraft, 2007, Zhang and Huo, 2013). Through the lens of RDT, Crook and Combs (2007) investigate the role of bargaining power in the improvement of terms and conditions of exchange within inter-organizational relationships. Bae and Gargiulo (2004) used RDT to study the ability of firms to use a network of inter-organizational relationships to obtain organizational resources and enhance their powers over other organizations. In the context of SCM, inter-dependency among SC partners can be created by the establishment of a long-term cooperative contract and informal SC relationship (Narasimhan et al., 2009). Petersen et al. (2008) indicate that SC parties' dependence can facilitate the socialization process in the SC relationship, such as team-building, organizing social events and holding joint-workshops. Indeed, it has been widely argued that a high level of inter-organizational dependency can positively influence the organizational commitment, manifested in, for example, the dedicated capabilities of chain partners, large purchase volume, and/or relationship-specific investment; hence, the relational capital (such as trust and joint action) can be aggregated (Kim and Henderson, 2015, Kim and Wemmerlov, 2015).

Although the positive effects of SCD are widely acknowledged by existing research, the truth is that a buyer-supplier relationship is not always interdependent. Recently, researchers have argued that when the SCD is imbalanced, SCD should be a multi-dimensional concept that includes supplier dependency (SD) and buyer dependency (BD). Specifically, SD refers to the extent to which the supplier is dependent upon the buyer for resources (such as sales volume and technology), while BD refers to the extent to which the buyer (or focal company) is dependent upon the supplier for resources (Carr et al., 2008). Carr et al. (2008) indicate that SD is a significant contributor to the supplier involvement in product development and participation in buyer supported training. The conceptualizations of these two forms of dependencies are essential, because in a buyer-supplier relationship the SCD is not always symmetric, where buying firms and suppliers are equally dependent on each other. Buchanan (1992) indicates that there is another situation, called asymmetric dependence, where either the buying firm or the supplier is more dependent on their partner. If such asymmetric dependence is serious, it will lead to a "lock-in situation" (Narasimhan et al., 2009). According to Harrison et al. (2012), the "lock-in situation" describes the heaviest level of dependence, where a company cannot change its partners as it has no alternative. There is evidence that the lock-in effect can benefit the relationship between the partners, through increased information exchange, mutual adaptations or higher relational satisfaction. However, some studies also argue that the "lock-in situation" could lead to negative consequences such as the loss of strategic flexibility and the risk of opportunism (Harrison et al., 2012, Schmitz et al., 2016).

From the perspective of RDT, the bargaining power of a focal company in an exchange relationship, such as a buyer-supplier relationship or strategic alliance, is greatly reliant on the resource held by the focal company (Elking et al., 2017). Hillman et al. (2009) suggest that the power relations formed from the resource exchange will create dependency from the weaker party. Hence, RDT suggests that when a firm can minimize its dependence on its external

parties (such as its supplier) and maximize the dependence of other parties on itself, it will be more successful (Pfeffer and Salancik, 1978). In the context of SD, typical techniques of buying firms, such as multi-sourcing and promise of large purchase volume, will be more effective, because they have more power over their suppliers (Kull and Ellis, 2016, Berger and Zeng, 2006). Conversely, if the level of BD is higher, buying firms' ability to effectively capture value in the exchange relationship will be reduced (Kull and Ellis, 2016). According to Provan and Gassenheimer (1994), higher dependencies on external parties will result in decreased resource security and increased vulnerability and uncertainty.

6.2.2. The Association between Dependency and SCQR Factors

This chapter hypothesizes that SD and BD have different effects on three SCQR components, namely psychological factor, probability and magnitude.

If a buyer-supplier relationship is characterized as *"high BD"*, the situation whereby the *"supplier is more powerful"* might be perceived by purchasing decision makers as a worrying signal with regard to quality problems. This is because where there is supplier dominance (i.e. high BD), the supplier has high information asymmetry advantages over the buyer (Cox, 2001). According to Webster Jr and Wind (1972), purchasing decision makers have similar psychological responses to those of consumers, because of the combined effect of information filtered through the external environment. Marketing studies into consumer decisions explain that lack of information pre-processing might increase the risk perception (Ha, 2002). Accordingly, this study suggests that the presence of high BD will positively affect the psychological factor in the perceived SCQR of purchasing decision makers, for example with regard to non-preventability and non-controllability, due to the information asymmetry disadvantage. In a setting of SD, the situation will be completely reversed. In order to improve the activities and ability of suppliers to satisfy the organization's quality requirements, a

company will usually implement process-oriented quality management programs (Choi and Liker, 1995). However, such SCQM programs might be determined by the commitments of the business partners. If the supplier is highly dependent on the buyer (i.e. high SD), a high supplier commitment can be expected (Carr et al., 2008). In this case, the purchasing decision maker should find the QM programs are easier to implement and the quality problems are perceived as more controllable. Consequently, the present study suggests that managers' perceptions of SCQR may be negatively affected by SD.

H1: BD is positively associated with the psychological factor of SCQR.

H2: SD is negatively associated with the psychological factor of SCQR.

A key argument in RDT is that the success of an organization is determined by its ability to access resources (Pfeffer and Salancik, 2003). The accessibility of quality information could be regarded as a kind of intangible resource. Imbalance between the information required and the information actually processed within the organization is a key reason why a company seeks information beyond the intra-organization boundary, moving instead to an inter-organization model (Sander de Leeuw et al., 2015, Pfeffer and Salancik, 1978).The product quality improvement programs of the buyer may be dependent on suppliers for their technical expertise. In the context of QM, collecting quality information outside rather than inside the organization would be more difficult and costly. According to Sousa and Voss (2002), quality information comprises two aspects, namely product quality and process quality. Product quality information is usually available for the purchasing decision makers, while process quality information related to suppliers' process variability is not always obtainable, especially when there are no explicit agreements between the business partners (Sousa and Voss, 2002, Zu and Kaynak, 2012). This study argues that BD makes it more difficult for buyers to assess the quality information from suppliers, especially the process quality information. The RDT

supports the argument that reliance on external parties can raise uncertainties in obtaining external information (Kulangara et al., 2016). By reducing purchasing decision makers' ability to process the quality information, BD increases the likelihood of SCQR. Conversely, when the supplier is dependent on the buyer, there is less likelihood of quality problems being raised in the supply chain, because of the greater commitment to the buyer-supplier relationship, and closer collaboration. According to Hallen et al. (1991), suppliers that are highly dependent on other companies are more likely to satisfy the buyer's needs in terms of product processes, product specification and inventory. It can be expected that buyers' requirements with regard to quality improvement will receive more positive responses and results from dependent suppliers.

H3: BD is positively associated with the probability of SCQR.

H4: SD is negatively associated with the probability of SCQR.

"Substitutability" is a key economic concept that describes the resource dependence (Jacobs, 1974). Specifically, this concept views a party as dependent when other sources are not available (Caniels and Gelderman, 2005). From the perspective of RDT, substitutability can be determined by two elements, namely the *"availability of alternative sources"* and the *"costs that are associated with switching suppliers"* (Caniels and Gelderman, 2005). Accordingly, high SD means that there are fewer alternative sources for the buyers to obtain the resources, and the costs of switching suppliers are high. The negative effects of supply chain quality problems can be magnified by a lack of alternative suppliers. For example, if there are few alternative suppliers, buyers are only able to ask their original supplier to remake or resupply the materials or components. Moreover, the high switching costs mean that the buyers will bear a more serious brunt of the costs related to the supply quality problems. For example, the investments in the supply relationship and in tangible resources such as dedicated equipment

might turn out to be sunk costs (i.e. costs that cannot be recovered) when switching suppliers. Therefore, this study argues that the magnitude of SCQR will be enlarged with increased BD. According to Casciaro and Piskorski (2005), power imbalance in an inter-organizational relationship is due to resource dependence. Specifically, power in the context of the buyer-supplier relationship can be regarded as the function of *"(1) dependence on the other party, and (2) the use of dependence to leverage change in accord with the intentions of the less dependent firm"* (Hart and Saunders, 1997, P.26). With increased SD, buyers have greater power in the transactions with their suppliers, which enables them to influence the suppliers to act in the desired ways. When SCQR occurs, the more powerful buyers ensure that the suppliers help to solve the problems by exerting *coercive power* through threats of various punishments that are detrimental to the suppliers, such as reduced order volume or withdrawal of business (Zhao et al., 2008). Moreover, with SD, the high proportion of sales volume makes the suppliers keen to continue the relationship with their existing customers. To secure future transactions, suppliers should be more willing to share the loss of SCQR. Therefore, from a power relationship perspective, when buyers have more power over their suppliers (i.e. SD), those buyers will suffer less impact of SCQR:

H5: BD is positively associated with the magnitude of SCQR.

H6: SD is negatively associated with the magnitude of SCQR.

6.3. Supply Chain Traceability and Testability

6.3.1. Theoretical Background: Agency Theory

Agency theory is selected to ground the theoretical background of the quality capabilities factors (i.e. traceability and testability) that are supposed to impact the perception of SCQR, i.e. risk probability, risk magnitude and the psychological factor. Agency theory focuses on the

problems that happen in a relationship where one party (the principal) delegates authority, such as the control of and decision making about certain tasks, to another party (the agent) (Eisenhardt, 1989, Wilding et al., 2012). As Zsidisin and Ellram (2003, P.16) suggest,

> *Because the context for managing supply risk involves a principal (purchasing organization) and agents (suppliers), an appropriate theoretical perspective for studying supply risk management is agency theory.*

A key assumption underlying the agency theory is that there is potential goal conflict between principals and agent, as all the parties are supposed to be self-interested (Zu and Kaynak, 2012). In managing the supply chain quality, buyers will expect the suppliers to provide the best product quality and to constantly improve the quality of the manufacturing process at a certain level of cost. However, suppliers might not make continuous investment in quality improvement, especially when they perceive that buyers are acquiring all the transaction benefits (Zu and Kaynak, 2012). Under this assumption, agency theorists discuss two situations, namely complete information and incomplete information (Eisenhardt, 1989). Because, in a real-world situation, "complete information" rarely occurs, organizational researchers focus more on the "incomplete information" scenario, where there is information asymmetry in the agency relationship. Due to the principal's incomplete information on the agent's capability, behaviour and task performance, agents may tend to engage in opportunistic behaviour to maximize their benefits (Eisenhardt and Tabrizi, 1995).

Adverse selection and *moral hazard* are two typical problems related to an agent's opportunistic behaviour in the situation of "incomplete information". Few people will deny that it is expensive and difficult for buyers to constantly monitor the manufacturing process of suppliers. In the context of SCQM, adverse selection arises when the suppliers conceal their difficulties in delivering the quality demanded by the buyers (i.e. misrepresentation of ability

by the agent), while moral hazard arises when the suppliers do not keep promises in product quality improvement and even cheat in supply product quality (i.e. a lack of effort on the part of agent) (Zu and Kaynak, 2012, Eisenhardt, 1989). In accordance with Eisenhardt (1989) classic propositions, SCQM and SCRM researchers have paid considerable attention to proposing and verifying solution methods for the agency problems, which are generally summarized as behavioural-based mechanisms and outcome-based mechanisms. Zsidisin and Ellram (2003) categorize SCRM as buffer-based management practices and behaviour-based practices. Specifically, the buffer-oriented practices aim at reducing the negative impact of the SCRs, while the outcome-oriented practices aim at controlling supplier process (Zsidisin and Ellram, 2003). Regarding SCQM, Zu and Kaynak (2012) view the outcome-based approach as managing or controlling the *"quality of the delivered products/services"*, and the behaviour-based approach as managing or assessing *"the suppliers' efforts in QM and improvement"*.

In contrast to the research on designing and validating a set of detailed "agency-based" practices, SCM researchers have viewed the roots of agency problems in a more generic way. By selecting two agency-based constructs, namely *inability to test* and *inability to trace*, this study advances the application of the agency theory in the field of SCM research. According to Crumbly and Carter (2015), testability is one of the critical challenges in supply chain quality management. This study defines the inability to test as *"the difficulty for the buyers to accurately inspect the problems from supply materials"*. In addition, traceability is seen as a key instrument in SCQM (Viaene and Verbeke, 1998). Investigating the traceability in an opposite direction, this study defines the inability to trace as *"the difficulty to trace the materials to the origins and identify the source from the upstream supply chain*". The concepts of inability to trace and inability to test are highly relevant to the context of agency theory. Both constructs are essentially used to measure the level of information asymmetry between buyer and supplier regarding the supply chain quality. However, while the inability to test

focuses on the uncertainties raised in the final product, the inability to trace focuses on the uncertainties raised in the supply process. In accordance with the proposition of Zu and Kaynak (2012), the inability to test is relevant to the outcome-based context and the inability to trace is relevant to the behaviour-based context.

6.3.2. The Association between Inability to Test & Trace and SCQR Factors

This section hypothesizes both inability to test and inability to trace as positively associated with the SCQR factors.

According to the psychometric theory, people perceive risk in two fundamental ways in parallel: the "analytic / rule-based" system requires conscious control and works by algorithms and rules, while the "emotional / experiential" system works automatically and links experience to emotion and affect (Slovic et al., 2004, Kung and Chen, 2012). The psychological factor, which measures the subjective feelings and emotions of the decision makers, is related to the rationale of the *"risk as feeling"* system, such as concerns, fears and dread. As Guo and Li (2018, P.5) suggest, increased information availability *"should be able to alleviate people's uncertainty about the risk situation"* (p.5). In the context of Business to Consumer (B2C), if consumers are provided with more information about a brand, this can reduce consumer concerns and increase confidence about purchasing products from that brand (Mitchell, 1999, Ha, 2002). Mitchell and Boustani (1994) indicate that the richness of information in the pre-purchase context can significantly help to reduce perceived risk or uncertainty. The aforementioned arguments can be applied to explain the situation of the buyer-supplier relationship. Due to unavailability and/or lack of clarity of the supply material information, i.e. inability to trace, the purchasing decision maker in a buying company may experience concern and worry when sourcing the components or raw materials.

H7: The inability to trace is positively associated with the psychological factor of SCQR.

If a manufacturing company does not possess good traceability toward the upstream supply chain, it might experience a business nightmare like that of Aston Martin in 2014, when an untraceable counterfeit material used by a sub-tier supplier in the production of a pedal arm led to the company recalling over 17,000 cars. Moreover, when a supply quality problem occurs, whether or not the company can trace back to the origin of the problem will determine the success of that company's resilience and responsiveness to the crisis. If the product quality problem spreads to the downstream customer, the first step of the recovery process is to provide a qualitative description of the quality flaw and identify the failed (batch of) product (or part) (Zhang et al., 2011a). Therefore, the tracing ability of a company refers to the extent to which the company can mark, retrieve and analyse the quality data in their supply chain to identify the root causes of the product failure (Zhang et al., 2011a). Moe (1998) indicates that if a company that is involved in a product quality crisis can have more tracing information regarding the production time, batch number or product conditions, they will be able to perform a more efficient and focused product recall to minimize the financial loss and harm to company reputation. Conversely, it is to be expected that when a company has only limited traceability in the upstream supply chain, it will struggle in a product quality crisis. For example, the inability to trace will lead to an increase in liability claims because the responsibilities along the supply chain cannot be identified (Bosona and Gebresenbet, 2013, McEntire et al., 2010). When the buyer cannot trace the origins of the quality flaw and the division of responsibilities between supplier and buyer is unclear, the buyer might bear the full cost of a quality failure that would have been the responsibility of the supplier. This supports a positive relationship between the inability to trace and perceived magnitude of the SCQR:

H8: The inability to trace is positively associated with the magnitude of SCQR.

From the perspective of agency theory, the inability to trace means that the supplier holds an information advantage, and this situation may provide room for their opportunistic behaviour. This study argues that the inability to trace would lead to two consequent agency problems, i.e. moral hazard and reverse selection. In the context of SCQR, the reverse selection problem may arise during the supplier selection process, due to the buyer's lack of full knowledge about the capability of a supplier (Steven et al., 2014). The inability to trace could encourage suppliers to conceal their quality ability during the selection process, because they might expect that the buyer will not have the ability to monitor their behaviour, so even when a quality issue occurs, the buyer cannot claim their responsibility. In this case, the problem of adverse selection can increase the probability of SCQR, due to the higher possibility of selecting unqualified suppliers. Moral hazard, on the other hand, arises when it is difficult and costly for the buyer (i.e. principal) to observe the supplier's (i.e. agent) effort (Steven et al., 2014). According to Tse and Tan (2012), where there is low traceability of materials, it is hard for the company to manage the product quality. This study argues that the inability to trace should lead to the problem of moral hazard. Specifically, if the supplier's behaviour and efforts made towards product quality are untraceable, which means that their behaviour is not highly visible, the suppliers could be motivated to under-invest in the quality improvement (Mishra et al., 1998, Steven et al., 2014). As a result, the probability of SCQR will increase. Therefore, this study proposes:

H9: The inability to trace is positively associated with the probability of SCQR.

The inability to test is related to one of the agency concepts in the SCQM context, namely outcome measurability. This concept is concerned with investigation of the difficulty of measuring a particular task outcome (Eisenhardt, 1989). According to Zu and Kaynak (2012), a fundamental element of achieving high product quality is *"measurement of quality"*.

However, it is not always possible for the buyer to inspect and test the quality of every single supply material, as this would risk potentially destructive testing and high production volume (Chen et al., 2014, Schilling, 1982, Stephens, 2001). In other words, the supply material quality is not always *measurable*. For a company with limited human and technological resources, the testing of delivered supply materials could be too costly. According to Chen et al. (2014a), in developing countries such as China, companies still adopt rather simple basic means of testing, instead of the more advanced testing methods (e.g. continuous sampling and Taguchi methods). Even for a large company with sufficient resources, product testing could be a tremendous challenge, because of the large production volume and high product complexity. Due to the uncertainty in testing procedures, the measurement of quality could be perceived as unreliable. A significant challenge is that most purchasing strategies are based on the evaluation of outcomes. Therefore, if the measurement of outcome (i.e. product testing) is unreliable, decision makers should experience concern and worry about the appropriateness of their purchasing decision and about the potential quality problems that might be incurred due to their wrong decision. The following hypothesis will be tested:

H10: The inability to test is positively associated with the psychological factor of SCQR.

The accuracy of testing depends on the technical level of the quality assurance team, and on the availability of straightforward test procedures and testing facilities (Roth et al., 2008). Moreover, counterfeiting or substitution of lower grade components may be difficult to discover, as the product testing could be destructive to the product (e.g. long hours' reliability test). As long as a lower grade component does not affect the quality performance during the testing period, the defective product can pass along the supply chain. However, although the defective component may not immediately affect the product quality, a minor quality issue could be a hidden danger that accumulates over a long period. Therefore, once the quality

problem has happened, a large amount of product could be affected. Moreover, from the perspective of agency theory, the inability to test could lead to supplier's moral hazard when the focal company faces a crisis such as product recall. Specifically, the supplier might shirk responsibility and shift the blame onto the focal company if the original testing could not detect the problem. In this case, the focal company is likely to bear the full cost of the product failure, as the supplier might insist their product quality is good, as they satisfied the testing. Therefore, the following hypothesis is proposed:

H11: The inability to test is positively associated with the magnitude of SCQR.

Lack of testing ability on the part of the focal company also means that they have limited capacity to assess the supplier quality improvement efforts. This may encourage the supplier to work to satisfy only the minimum requirements of product quality, while putting little effort into quality improvement. Also, given that it is impossible for the buyer to fully monitor the supplier's activities (Steven et al., 2014), the inability to test (high measurement uncertainty) may magnify the impact of supplier moral hazard. Specifically, if the supplier knows the buyer will face difficulties in inspecting a relevant quality issue, the supplier may abuse its powers to capture profit through opportunism, such as by supplying lower grade components. Agency theory, through the lens of adverse selection, suggests that if the principal (i.e. buyer) finds it difficult or costly to verify that the agent (i.e. supplier) has the expertise to perform delegated work, the focal company is likely to select an inappropriate or unqualified supplier (Steven et al., 2014). For example, in the supplier selection process, some component tests are usually performed by the focal company as an important part of the selection standards (Zeydan et al., 2011). Therefore, the focal company's inability to test may hinder the accuracy of supplier selection. According to Steven et al. (2014), compromising on quality and safety standards, and even product recall, are all possible results of wrong decisions in the selection of suppliers.

Due to the potential problems of moral hazard and adverse selection, the inability to test increases the likelihood of SCQR, hence:

H12: The inability to test is positively associated with the probability of SCQR.

6.4. Intention to Adopt Quality Management Practice

6.4.1. Theoretical Background

Using the structure of exploration and exploitation to understand the ambidexterity of organization activities has emerged as a popular strand in the areas of strategic management (Rothaermel and Deeds, 2004, Stettner and Lavie, 2014), organizational learning (March, 1991), supply chain management (Kristal et al., 2010), product innovation (Wei et al., 2014) and entrepreneurship (Ireland and Webb, 2009). The notion of exploration and exploitation is developed from the theory of organizational learning. According to March (1991), there are two types of organizational learning goals, namely the exploration of new opportunities and the exploitation of old certainties. In other words, firms may acquire knowledge from the current process and expertise to improve the existing product and technology (i.e. exploitation); alternatively, they may acquire new and unrelated knowledge to create opportunities (i.e. exploration) (Cohen and Levinthal, 1990). More specifically, according to March (1991 , P.71) definitions of exploration and exploitation in organizational learning, *"A. Exploration includes things captured by terms such as search, variation, risk taking, experiment, play, flexibility, discovery and innovation. B. Exploitation includes such things as refinement, choice, production, efficiency, selection, implementation and execution".* As reflected in these definitions, these two concepts have completely different orientations. From the perspective of manufacturing management, the exploitation strategy is oriented to the short term and to internal processes, such as workforce and specific internal functions of a firm, while

exploration focuses on long-term development and aims at acquiring new knowledge to solve the problems the company faces (Tamayo-Torres et al., 2014, March, 1991).

The empirical study of and related measurement scales for quality management have been well developed over the last two decades, thus providing practitioners and academics with fundamental understanding of the related concepts (Kaynak, 2003, de Sousa Jabbour et al., 2014, Flynn et al., 1995, Nair, 2006). However, scholars widely criticize the measurement of QM as a single construct, which could be one of the reasons why there are inconclusive results in the performance outcomes when applying the QM practices (Zhang et al., 2014, Zhang et al., 2012). To fill this gap, OM researchers advocate the need to customize the QM in order to fit with the contextual factors and reflect the decision maker's strategic orientations (Sitkin et al., 1994, Westphal et al., 1997, Zhang et al., 2012). Here, the aforementioned exploration-exploitation concept can provide a conceptual framework to customize and classify the QM practices based on the decision-maker's strategic orientation (Zhang et al., 2014). In this study, the two different forms of QM are classified based on the conceptual framework of exploitation-exploration, i.e. QELM and QERM. QELM refers to the management practices that aim at refining and improving the existing process to improve firms' quality performance. For example, QELM includes activities such as the practices for ISO9000 certification through managing the stable and familiar process (Wu and Zhang, 2013). However, firms can also improve their quality performance through innovating the production process and exploring the unknown. Therefore, reflecting another orientation, QERM refers to the practices that aim to *"explore unknown and to identify and pursue novel solutions"* (Zhang et al., 2014, P.84). More specifically, QERM includes experimenting and searching for innovative process (Sitkin et al., 1994).

This thesis aims to explore the relationships between the perception of SCQR and adoption of QM. In particular, this study measures the adoption of QM by adoption intention (Liu et al., 2010). The reasons for using this measurement are two-fold. First, focusing on the adoption intention allows the researcher to measure both dependent and independent variables at the same point in time, which therefore avoids methodological concerns, such as endogeneity. Second, according to Liu et al. (2010), a critical challenge when making the adoption decision is that many other factors that are unobservable, such as resource constraints, could be playing a role in the process and the results would be unclear. Furthermore, it has been widely accepted that the actual behaviour is highly correlated with the behaviour intention (Liu et al., 2010). Thus, the adoption intention should be reliable to predict the actual behaviour. This notion is supported by Ajzen and Fishbein (1980 , P.41), who argue that, *"intention is the immediate determinant of behavior, and when an appropriate measure of intention is obtained, it will provide the most accurate prediction of behavior"*. In line with this argument, this thesis proposes that the actual adoption of a particular QM orientation (i.e. QELM and QERM), can be predicted by the decision-maker's adoption intention.

While there is substantive research that examines the decision-making process in which a risky decision is determined by the risk perception, empirical OM research to investigate this theoretical framework is limited. In order to address this research gap, this section proposes two sets of hypotheses that the overall perception of SCQR impacts differently on the QELM and QERM.

6.4.2. The Relationship between Overall Perception of Supply Chain Quality Risk and Quality Management

The explorative organizational activities have the characteristics of risk-taking, and can be seen as a form of risky decision (March, 1991, Zhang et al., 2012). According to Geroski et al.

(1993), exploration activities that create novel competencies that motivate the ongoing innovation within an organization can generally promote superior long-term returns. However, such benefits might come with high costs and uncertainties. Gupta et al. (2006) argue that the benefits brought by the exploration activities are balanced by the higher level of risk inherent in the related activities, which require significant investment in opportunities that are characterized as highly uncertain payoffs. This thesis proposes that the QERM, which involves risk-taking activities such as exploring improvement of new products and processes, identifying new customers and exploring new needs for customers (Zhang et al., 2012), might be negatively associated with the overall perception of SCQR. In other words, when decision makers perceive a relatively high level of SCQR, they should be less likely to engage in proactive QM activities.

The previous literature widely considers the risk perception factor as a significant determinant in the decision-making process. According to Sitkin and Weingart (1995), the degree to which individuals make risky decisions will be negatively associated with their level of perceived risk in the situation. In the field of entrepreneurship research, Simon et al. (2000) find that managers' risk perception is negatively associated with the decision to start a venture, which means that individuals start ventures because they do not perceive the risk involved, rather than that they accept a high level of risk. Most recently, using large-scale survey data, Nguyen et al. (2017) empirically show that investors' financial risk perception is negatively associated with their risky-asset allocation decision. However, the prospect theorists hold another view. According to Kahneman and Tversky (1979), when firms are under threat, they are more likely to embrace more risks. Abebe and Angriawan (2014) provide empirical support for this notion that firms that face intensive market uncertainties will be engaged in more exploratory activities.

H13: Overall SCQR is negatively associated with the intention to adopt quality exploration management.

According to Gatignon et al. (2002), successful exploitation provides a buffer from the shocks of exploration and entails less risk than the exploration activities. When firms' resources become scarce and firms' external environment becomes unstable, organizations are more likely to focus on the existing product competencies, adjusting the product quality with minimal improvements and incremental repositioning (Levinthal and March, 1993). Representing the firms' exploitation orientation, the QELM can be regarded as a reactive management practice. This study argues that the intention to adopt QELM will be motivated particularly by a decision maker's perception of greater SCQR. This argument is consistent with Voss et al. (2008 , P.151) assertion that *"in the face of sure losses, decision makers prefer alternatives that curtail losses over those promising further gains"*. The economic psychologist views this situation as a *"reverse sunk cost effect"* (Zeelenberg and Van Dijk, 1997). In such a situation, managers prefer financial options that promise smaller but certain returns rather than those financial options with greater but uncertain financial returns (Thaler and Johnson, 1990).

The proposition of the positive relationship between perceived SCQR and QELM is also supported by the threat-rigidity perspective (Sitkin and Pablo, 1992, Staw et al., 1981). A situation of looming losses and a loss of control over operating decisions and outcomes could promote decision makers' risk aversion and commitment to protect an organization's current status (Dutton and Jackson, 1987). According to Voss et al. (2008), an organization that faces a threatening environment will aim at the tried and tested competencies with more predictable outcomes to limit the potential loss. Extending this logic, this thesis argues that high perception of SCQR leads to risk aversion and intention to adopt QELM, which focuses on controlling the

stable and familiar processes rather than seeking innovative approaches for improving quality performance (Wu and Zhang, 2013).

H14: Overall SCQR is positively associated with the intention to adopt quality exploitation management.

6.5. Chapter Summary

Table 6.1. Hypotheses for The Theoretical Framework

Hypothesis	Description
H1	Buyer dependence is positively associated with the psychological factor of SCQR.
H2	Supplier dependence is negatively associated with the psychological factor of SCQR.
H3	Buyer dependence is positively associated with the probability of SCQR.
H4	Supplier dependence is negatively associated with the probability of SCQR.
H5	Buyer dependence is positively associated with the magnitude of SCQR.
H6	Supplier dependence is negatively associated with the magnitude of SCQR.
H7	The inability to trace is positively associated with the psychological factor of SCQR.
H8	The inability to trace is positively associated with the magnitude of SCQR.
H9	The inability to trace is positively associated with the probability of SCQR.
H10	The inability to test is positively associated with the psychological factor of SCQR
H11	The inability to test is positively associated with the magnitude of SCQR
H12	The inability to test is positively associated with the probability of SCQR
H13	Overall SCQR is negatively associated with the intention to adopt quality exploration management.
H14	Overall SCQR is positively associated with the intention to adopt quality exploitation management.

The above proposed hypotheses are illustrated in Figure 6.1 and Summarized in Table 6.1. Based on the ideas of bargaining power and substitutability, RDT suggests that there are positive associations between buyer dependence and SCQR factors (H1, H3 and H5), while there are negative associations between supplier dependence and SCQR factors (H2, H4 and

H6). Moreover, although substantial research applies the agency perspective to advance the understanding of supply chain risks, most of this research is practice-based and focuses on identifying solution methods rather than on identifying the root cost of SCQR. This chapter extends the previous research by proposing two constructs derived from the agency theory, namely inability to trace (H7, H8 and H9) and inability to test (H10, H11, H12). This section also proposes that firms' intention to adopt QERM will be negatively associated with overall perception of SCQR, and firms' intention to adopt QELM will be positively associated with overall perception of SCQR.

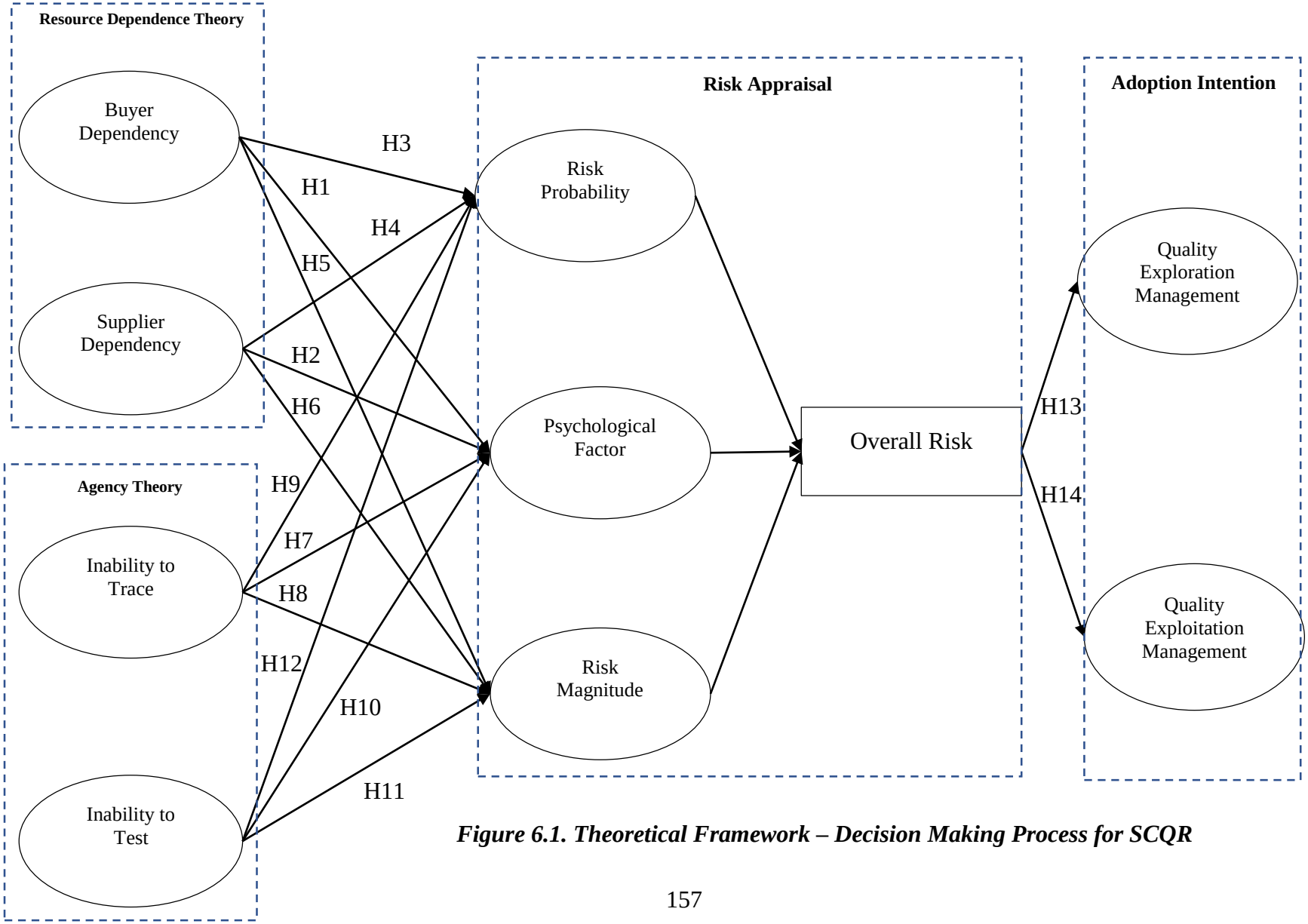

Figure 6.1. Theoretical Framework – Decision Making Process for SCQR

CHAPTER 7. ASSESSING THE RISKY DECISION-MAKING MODEL

7.1. Introduction

In this chapter, the theoretical model is tested by the questionnaire sample that was verified in Chapter 5. The sample consists of 316 Chinese company decision makers for production and purchasing activities. Given that the measurements for the risk situation factors (i.e. inability to trace, inability to test, BD and SD) and two QM practices (i.e. QERM and QELM) have been developed in the literature, the content validity of the instrument is already well established. However, before empirically testing the theoretical model, the scale construction and purification of all the proposed constructs are examined to confirm the unidimensionality, construct reliability, discriminant validity and convergent validity. Empirical studies of managers' risk perception have observed the importance of the antecedents that influence the risk factors and the risk perception that drives the decision making. Nevertheless, a more holistic empirical analysis investigating the whole decision-making process should be of great importance to both academic researchers and practitioners, hence the need for this section in the thesis. To the best of the author's knowledge, this thesis is the first attempt to investigate both the situation factors and the decision making with regard to the perception of SCQR.

The first part of this chapter describes the measurements and examines the reliability of the indicators for measuring the situation factors and adoption intention of the QM practices. The second part examines EFA and CFA for all the latent variables, including risk factors, situation factors and QM practices. The third section tests a structural model through the SEM technique. This is followed by discussion of issues raised in the chapter.

7.2. Measurement

7.2.1. Measurements for Inability to Test and Inability to Trace

Table 7.1. Measurement items for inability to test and inability to trace

Measurement Items	Reference
Inability to Test	
TES1: Some of the testing procedures for our supply materials/components are destructive.	Chen et al. (2014b)
TES2: There is no appropriate guideline to test the supply materials/components.	Roth et al. (2008)
TES3: The supply materials/components should be tested by a complex method.	Roth et al. (2008)
TES4: The tests for our supply materials/components are not straightforward.	Roth et al. (2008)
TES5: We need to allocate more resources (e.g. staff training or purchasing new equipment) than in the past to obtain a reliable test result.	Chen et al. (2014b)
Inability to Trace	
TRA1: The origins of the supply materials/components are hard to trace.	Roth et al. (2008)
TRA2: Tracing the supply materials/components is time consuming.	Roth et al. (2008)
TRA3: The accuracy of the tracing information of the supply materials/components is uncertain (e.g. production time, batch number and product conditions).	Zhang et al. (2011a)
TRA4: It is hard to obtain timely, accurate and complete information from our suppliers and sub-tier suppliers regarding our supply materials/components.	Williams et al. (2013)
TRA5: Establishing the product tracking system (e.g. radio frequency identification devices [RFID]) for our supply materials/components is unaffordable.	Roth et al. (2008)

The inability to test refers to the difficulty for the buyers to accurately test the supply materials/components for problems. The items for this construct were selected and developed from the existing literature, more specifically from Chen et al. (2014b) and Roth et al. (2008). The items measure the buyers' perceived difficulty of product testing in terms of complexity, clarity and expense, where the measurement object of all indicators is the "supply materials/components". In this study, five indicators are adopted to measure the inability to test. The indicators TES1 and TES5 are related to the cost of testing the supply

materials/components (Chen et al., 2014); TES3 and TES4 refer to the complexity of testing (Roth et al., 2008), while TES2, *"There is no appropriate guideline to test the supply materials/components",* refers to the clarity of the testing procedure. Each item was measured according to a 7-point Likert scale, where 1=strongly disagree and 7=strongly agree. The Cronbach's alpha for the latent variable of inability to test is 0.876. Given that the threshold of the Cronbach's alpha is 0.7, this construct is reliable (0.876 > 0.7). A correlation coefficient test for these five question items was also conducted. As shown in Table 7.2, the indicators are positively and significantly correlated with each other.

Table 7.2. Pearson Correlation Coefficient – Inability to Test

	TES1	TES2	TES3	TES4	TES5
TES1	1				
TES2	0.447*	1			
TES3	0.383*	0.662*	1		
TES4	0.359*	0.730*	0.669*	1	
TES5	0.337*	0.763*	0.661*	0.757*	1
* Correlation is significant at the 0.01 level (2-tailed)					

The inability to trace can be measured by the difficulty for the buyer to trace the information of the materials/components to the origin and identify the source from the upstream supply chain. According to Zhang et al. (2011a), the tracing ability of a company refers to whether the company can mark, retrieve and analyse the quality data in the supply chain to identify the root causes of a product failure. This study has selected and developed five items from the literature of QM and SCM, with particular reference to Roth et al. (2008) and Zhang et al. (2011a). The respondents were asked to quantify their perceived difficulty in obtaining the product information from the upstream supply chain and in identifying the source of quality failure. Once again, in each case the measurement objective is the "supply materials/components". As shown in Table 7.3, TRA1 and TRA2 refer to the overall difficulty of tracing the origins of the supplied materials/components (Roth et al., 2008). A particularly important aspect of firms'

ability to trace is the information transparency (or visibility) of the upstream supply chain; therefore, TRA3 and TRA4 were selected to measure the difficulty of obtaining valid tracing information (Zhang et al., 2011a, Williams et al., 2013). Finally, TRA5 was selected to measure the technical barriers to product tracing. Again, all items were assessed according to a 7-point Likert scale, with respondents' indicating their level of agreement from 1=strongly disagree and 7=strongly agree. The Cronbach's alpha of inability to trace = 0.901. As this exceeds the recommended value of 0.7, this study can conclude that the construct is reliable. As expected, all the indicators within the construct are significantly correlated with each other and therefore they are all retained at the next stage, purification.

Table 7.3. Pearson Correlation Coefficient – Inability to Trace

	TRA1	TRA2	TRA3	TRA4	TRA5
TRA1	1				
TRA2	0.410*	1			
TRA3	0.385*	0.787*	1		
TRA4	0.408*	0.756*	0.788*	1	
TRA5	0.385*	0.775*	0.817*	0.764*	1
* Correlation is significant at the 0.01 level (2-tailed)					

7.2.2. Measurements for Supplier Dependence and Buyer Dependence

Table 7.4. Measurement items for buyer dependence and supplier dependence

Measurement Items	Reference
Buyer Dependence	
BD1: Switching to a new supplier for our key supply materials/components would take a lot of effort.	Terpend and Krause (2015)
BD2: We do not have a good alternative to the supplier for our key supply materials/components.	Terpend and Krause (2015)
BD3: We are very dependent on the supplier who supplies us with the key supply materials/components.	Terpend and Krause (2015)
BD4: There are many competitive suppliers for our key supply materials/components (Reverse Coded).	Krause et al. (2007)
BD5: Our production system can be easily adapted to use the key supply materials/components from a new supplier (Reverse Coded).	Krause et al. (2007)
Supplier Dependence	
SD1: Replacing us would require a lot of effort by the supplier who supplies key materials/components to us.	Terpend and Krause (2015)
SD2: The supplier who supplies key materials/components to us does not have a good alternative to replace us.	Terpend and Krause (2015)
SD3: The supplier who supplies key materials/components to us is very dependent on us.	Terpend and Krause (2015)
SD4: The supplier who supplies key materials/components to us will perform poorly if our operations do not perform well.	Awaysheh and Klassen (2010)
SD5: If their relationship with our company were terminated, it would not hurt this key supplier's operations (Reverse Coded).	Krause et al. (2007)

Drawing RDT literature, this study defines the supplier dependence SD as the degree to which a supplier is dependent upon the focal company for resources such as sales volume and technology, while BD can be defined as the degree to which the buyer is dependent upon the supplier for organizational resources (Carr et al., 2008). The indicators of both SD and BD are adapted from Krause et al. (2007) and Terpend and Krause (2015). Regarding buyer dependence, this study uses five indicators to measure and examine how problematic it would be for the buyers to replace their suppliers (BD1, BD2 and BD3), the number of available suppliers (BD4) and technical barriers to adapting the buyers' production system to use new supply materials/components (BD5). It should be noted that BD4 and BD5 are reverse coded

items, which also serve as checks on respondents' attention (Abbey and Meloy, 2017). Specifically, the reverse-coded items are measured by subtracting the response value from 8.

Table 7.5. Pearson Correlation Coefficient – Buyer Dependence

	BD1	BD2	BD3	BD4	BD5
BD1	1				
BD2	0.565*	1			
BD3	0.554*	0.637*	1		
BD4	0.555*	0.539*	0.657*	1	
BD5	0.427*	0.436*	0.521*	0.502*	1
* Correlation is significant at the 0.01 level (2-tailed)					

SD is also measured from the perspective of the buyer, by *"asking the respondents how dependent they perceived the supplier to be on their firm's business"* (Krause et al., 2007, P.537). Drawing on Terpend and Krause (2015), Awaysheh and Klassen (2010) and Krause et al. (2007), this study adopts five indicators, which measure the difficulty for the supplier of replacing the buyer (SD1, SD2 and SD3) and the influence of the buyer on the supplier's operations (SD4 and SD5). For all items of BD and SD, the respondents were asked to use a 7-point Likert scale (1=strongly disagree to 7=strongly agree) to indicate their level of agreement. For both BD and SD the Cronbach's alpha values exceed 0.70 (BD: α=0.855; SD: α=0.870); therefore the construct reliability is confirmed. The fact that all the question items within these two constructs are significantly correlated with each other further confirms the construct reliablity.

Table 7.6. Pearson Correlation Coefficient – Supplier Dependence

	SD1	SD2	SD3	SD4	SD5
SD1	1				
SD2	0.596*	1			
SD3	0.600*	0.666*	1		
SD4	0.588*	0.584*	0.601*	1	
SD5	0.562*	0.505*	0.485*	0.538*	1
* Correlation is significant at the 0.01 level (2-tailed)					

7.2.3. Measurements for Quality Exploration Management and Quality Exploitation Management

Table 7.7. Measurement items for quality exploration and quality exploitation management

Measurement Items	Reference
Quality Exploration Management	
QERM1: Continually improving all aspects of products and processes, rather than taking a static approach.	Zhang et al. (2012)
QERM2: Consulting our customers early in the design efforts for our product.	Zhang et al. (2012)
QERM3: Encouraging the employees of our company to learn how to perform a variety of tasks.	Zhang et al. (2014)
QERM4: Encouraging our manufacturing team members to work interactively with each other for cross-functional cooperation.	Zhang et al. (2014)
Quality Exploitation Management	
QELM1: Monitoring the production processes using statistical process control.	Zhang et al. (2012)
QELM2: Regularly surveying our customers' needs.	Zhang et al. (2012)
QELM3: Holding frequent group meetings where our team members can really discuss things together.	Zhang et al. (2014)
QELM4: Providing training and development in existing workspace skills, on a regular basis.	Zhang et al. (2014)

The measurement scales for QERM and QELM are adopted from the existing literature (Wu and Zhang, 2013, Zhang et al., 2014, Zhang et al., 2012). However, because this study aims to measure the adoption intention rather than the implementation level, the wordings of the original QM practices items were modified. For the items listed in Table 7.7, the respondents were asked to indicate their level of agreement to statements in the form "I am contemplating and likely to adopt the following practices in a year's time" (Teo et al., 2003, Khalifa and Davison, 2006). Consistent with the QM literature, the scales for both QM practices were measured by four dimensions, i.e. customer focus, process management, teamwork and training (Tamayo-Torres et al., 2017, Zhang et al., 2012, Zhang et al., 2014). Specifically, QELM consists of four aspects: improving the process reliability (QELM1), assessing customers'

needs (QELM2), focusing on internal functional problem solving (QELM3) and conducting training on existing skills (QELM4). QERM also comprises four aspects, namely exploring new solutions in improving the production process (QERM1), involving the customer in product design and development (QERM2), offering employees multiple skills training (QERM3), and focusing on cross-functional teamwork (QERM4). A seven-point Likert scale is adopted to measure the relevant indicators. Given that the Cronbach's alpha of QERM=0.875 and the Cronbach's alpha of QELM=0.866, both higher than the threshold value of 0.7, the construct reliability of both constructs is confirmed. As shown in Tables 7.8 and 7.9, the items within the two constructs are significantly and positively correlated with each other. Therefore, all eight items are retained for future analysis.

Table 7.8. Pearson Correlation Coefficient – QERM

	QERM 1	QERM 2	QERM3	QERM 4
QERM1	1			
QERM 2	0.594*	1		
QERM 3	0.626*	0.669*	1	
QERM 4	0.622*	0.676*	0.630*	1
* Correlation is significant at the 0.01 level (2-tailed)				

Table 7.9. Pearson Correlation Coefficient - QELM

	QELM 1	QELM 2	QELM3	QELM 4
QELM1	1			
QELM 2	0.559*	1		
QELM 3	0.532*	0.643*	1	
QELM 4	0.615*	0.675*	0.676*	1
* Correlation is significant at the 0.01 level (2-tailed)				

7.3. Reliability and Validity Tests

Before testing the hypothesized relationships, EFA and CFA are conducted to test the validity and reliability of the items associated with the antecedent factors, risk appraisal factors

and the intention to adopt QM strategies. Because the three risk appraisal factors (i.e. risk probability, risk magnitude and psychological factor) have already been tested in the scale development chapter, the EFA and CFA tests are further extended to all proposed factors. Further, the SEM method is employed to validate the hypothesized relationships proposed in Chapter 6.

Table 7.10. Individual EFA for Supplier Dependence, Buyer Dependence, Inability to Test, Inability to Trace, QERM and QELM

Supplier Dependence		Buyer Dependence		Inability to Test	
Items	Factor Loading	Items	Factor Loading	Items	Factor Loading
SD1	0.827	BD1	0.779	TES1	0.563
SD2	0.829	BD2	0.803	TES2	0.895
SD3	0.830	BD3	0.856	TES3	0.835
SD4	0.817	BD4	0.823	TES4	0.879
SD5	0.752	BD5	0.711	TES5	0.883
Inability to Trace		QERM		QELM	
Items	Factor Loading	Items	Factor Loading	Items	Factor Loading
TRA1	0.556	QERM1	0.940	QELM1	0.892
TRA2	0.901	QERM2	0.933	QELM2	0.887
TRA3	0.916	QERM3	0.932	QELM3	0.875
TRA4	0.898	QERM4	0.922	QELM4	0.865
TRA5	0.907				

As mentioned in the Scale Development chapter, the first step of the EFA is to perform a PCA for each variable with corresponding indicators. As the indicators of the three risk factors have been tested in Section 5.7.2, Table 7.10 only reports the results of the individual EFAs for inability to trace, inability to test, BD, SD, QERM and QELM. As shown in Table 7.10, all factor loadings of the questionnaire items were above the threshold value of *"0.4"* (Netemeyer et al., 2003). Therefore, these question items were all retained for the second-step EFA, which covers all proposed questionnaire indicators, including antecedent factors, risk factors and intention to adopt factors. Due to the significant cross-loading issues, BD5, TRA3 and TES1 were removed. After removing the unqualified items, the result of KMO test, 0.848, indicates

that the sample used in this study is adequate for conducting the PCA with VARIMAX rotation method. Table 7.11 reports the final results of the second-step EFA. Specifically, the nine-factor solution, with all factor loadings greater than the threshold value of 0.5 (Flynn et al., 2010), was retained. Therefore, the unidimensionality was confirmed and thirty-eight question items were retained for CFA.

Table 7.11. Exploratory Factor Analysis for all items

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9
QERM1	.920	.045	.068	-.047	-.093	.030	.144	.014	.050
QERM3	.913	-.012	.075	-.061	-.075	-.035	.139	-.004	.056
QERM4	.910	-.025	.088	-.064	-.045	-.007	.120	.044	.111
QERM2	.904	-.012	.076	-.074	-.059	.010	.096	.092	.067
SD4	-.019	.814	.039	.044	.060	-.020	.083	.087	-.033
SD1	.016	.797	.049	.010	.134	.009	.140	.104	-.071
SD2	-.065	.780	.011	-.098	.147	.113	-.011	.237	-.068
SD3	-.002	.762	-.012	-.083	.116	.041	.066	.247	-.121
SD5	.058	.731	.057	.047	.078	-.097	.176	.115	.010
TRA1	.092	.065	.879	-.005	-.097	-.263	.037	.013	-.051
TRA2	.031	.089	.870	-.046	-.112	-.210	.027	-.017	-.067
TRA3	.125	.001	.860	.004	-.133	-.236	.112	-.021	-.029
TRA4	.087	.006	.859	.008	-.129	-.215	.058	-.058	-.021
QELM2	-.038	-.081	.015	.883	-.087	-.060	.103	-.017	-.027
QELM1	-.042	.040	-.117	.863	-.014	-.043	.020	.018	-.088
QELM4	-.054	-.054	-.009	.862	-.035	-.064	.108	-.112	-.124
QELM3	-.101	.044	.086	.847	-.007	-.075	.068	-.049	-.142
PSY6	-.070	.134	-.135	-.050	.831	.057	-.091	.064	.063
PSY3	-.044	.185	-.180	-.088	.772	.082	-.058	-.035	.012
PSY2	-.089	-.070	-.102	.016	.741	.065	-.096	.061	-.039
PSY5	-.072	.238	.026	.034	.734	.120	.069	-.064	-.002
PSY1	.002	.076	-.064	-.066	.714	.100	.016	-.004	.192

Table 7.11. Exploratory Factor Analysis for all items

TES4	.040	-.015	-.254	-.029	.098	.826	.016	.123	.166
TES2	-.041	.015	-.258	-.113	.157	.817	-.087	.153	.084
TES3	.017	.056	-.229	-.090	.141	.786	.071	.078	.155
TES5	-.022	-.029	-.324	-.064	.100	.778	-.056	.174	.218
MA4	.105	.127	.090	-.009	.021	-.053	.812	.134	-.099
MA1	.064	.160	.032	.098	-.071	-.017	.811	.182	.034
MA3	.168	.047	-.001	.144	-.051	-.016	.802	.130	.046
MA5	.177	.130	.101	.083	-.069	.052	.771	.167	-.061
BD3	.056	.201	-.011	-.164	-.016	.168	.157	.799	.013
BD2	-.009	.116	-.091	-.048	.053	.227	.124	.793	-.021
BD4	.033	.223	.018	.002	-.043	.048	.240	.761	.063
BD1	.085	.286	-.014	.031	.029	.034	.149	.723	.146
RP2	.161	-.176	-.032	-.188	.066	.168	.001	.038	.832
RP1	.081	-.122	-.118	-.050	.226	.178	.121	.107	.782
RP5	.069	.006	-.025	-.203	-.043	.222	-.220	.037	.693
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.									

In this section, the CFA test that was conducted in the Scale Development chapter is extended to all the proposed factors. First of all, the reliability coefficient of the indicators with their corresponding latent variables range from 0.601 to 0.924, which are all greater than 0.50. The t-values of the factor loadings range from 10.509 to 27.491 and are thus all greater than the threshold value of 2.0. Moreover, the composite reliabilities and the AVE are all greater than 0.801 and 0.525 respectively. In addition, as shown in Table 7.12, the model fit indices of the measurement model indicate good model fit: RMSEA=0.045, NNFI=0.942, CFI=0.948 and Normed X^2=1.648. Therefore, the indicators used for measuring the proposed factors have acceptable convergent validity (O'Leary-Kelly and Vokuraka, 1998, Flynn et al., 2010). Our

analysis also supports the discriminant validity, because the values of inter-correlation are all below 0.70 (Mackenzie et al., 2005). The discriminant validity was assessed through comparing the square root of the AVE with the inter-correlation (Hair et al., 2009, Lawson et al., 2008, Swink and Nair, 2007, Tse et al., 2016b, Chin, 1998a). As can be seen from Table 7.14, the square root of the AVE value (diagonal figures with bold face) are all greater than other inter-correlation values. This result provides good evidence that the criteria for discriminant validity have been met. As mentioned in the Scale Development chapter, this study also estimates a two-factor model for each pair of proposed factors. Then, X^2 difference is applied to compare the one-factor model (i.e. combining the items from two latent variables into a single latent variable) with the two-factor model. Given that all the differences in the X^2 test are significant at the 0.05 level, the result provides further support for the discriminant validity (Zhu et al., 2008, Zhang et al., 2018).

Table 7.12. Model Fit Summary for CFA model and SEM model

Model	X^2 (df)	RMSEA	NNFI	NFI	CFI	IFI	Normed X^2
CFA Model	977.409 (593)	0.045	0.942	0.879	0.948	0.948	1.648
CFA Model with CLF	830.302 (556)	0.040	0.956	0.897	0.963	0.963	1.493
SEM Model	1428.027 (646)	0.062	0.877	0.814	0.888	0.889	2.217

Table 7.13. Assesment of Convergent Validity

	Standardized Factor Loading (Error)	t-value	SE	Composite Reliability	AVE	Mean
Inability to Trace				0.935	0.781	4.641
TRA1	0.869	-	-			
TRA2	0.911	22.839	0.048			
TRA3	0.863	20.636	0.051			
TRA4	0.892	21.973	0.049			
Inability to Test				0.907	0.709	3.854
TES2	0.859	-	-			
TES3	0.765	16.101	0.054			
TES4	0.855	19.174	0.053			
TES5	0.885	20.199	0.051			
Buyer Dependence				0.850	0.587	4.829
BD1	0.711	-	-			
BD2	0.748	12.088	0.094			
BD3	0.833	13.217	0.105			
BD4	0.768	12.371	0.095			
Supplier Dependence				0.870	0.574	4.855
SD1	0.769	-	-			
SD2	0.797	14.273	0.083			
SD3	0.803	14.399	0.074			
SD4	0.746	13.288	0.078			
SD5	0.665	11.691	0.076			
Risk Probability				0.801	0.580	3.236
RP1	0.743	-	-			
RP2	0.909	12.934	0.096			
RP5	0.601	10.147	0.089			
Risk Magnitude				0.864	0.614	5.543
MA1	0.802	-	-			
MA3	0.773	14.176	0.071			
MA4	0.779	14.314	0.071			
MA5	0.779	14.306	0.067			

Table 7.13. Assessment of Convergent Validity

Psychological Factor				0.845	0.525	3.905
PSY1	0.644	-	-			
PSY2	0.623	9.446	0.098			
PSY3	0.795	11.4	0.113			
PSY5	0.684	10.183	0.105			
PSY6	0.849	11.841	0.112			
Quality Exploration				0.949	0.824	5.030
QERM1	0.924	-	-			
QERM2	0.887	25.486	0.035			
QERM3	0.912	27.491	0.034			
QERM4	0.908	27.18	0.038			
Quality Exploitation				0.903	0.699	5.373
QELM1	0.804	-	-			
QELM2	0.857	17.04	0.068			
QELM3	0.828	16.326	0.064			
QELM4	0.855	17.001	0.063			

Table 7.14. Assessment of Discriminant Validity

	BD	QERM	SD	ITRA	ITES	QELM	PSYCH	MA	RP
BD	0.766								
QERM	0.127	0.908							
SD	0.505	0.001	0.758						
ITRA	0.010	-0.291	0.006	0.884					
ITES	0.333	-0.024	0.055	-0.018	0.842				
QELM	-0.140	-0.130	-0.059	0.129	-0.197	0.836			
PSYCH	0.075	-0.166	0.310	-0.039	0.313	-0.120	0.724		
MA	0.447	0.313	0.295	-0.020	-0.055	0.184	-0.114	0.783	
RP	0.133	0.234	-0.205	-0.100	0.437	-0.333	0.156	-0.047	0.761

Note: BD=Buyer Dependence; SD=Supplier Dependence; QERM=Quality Exploration Management; QELM=Quality Exploitation Management; ITRA=Inability to Trace; ITES=Inability to Test; MA=Risk Magnitude; RP=Risk Probability

The diagonal figures are the square root of AVE

7.4. Common Method Bias

Table 7.15. Assessment of CMB - Marker Variable

	QERM	QELM	SD	BD	MA	RP	ITRA	ITES	PSY
QERM	1	-.150*	-0.019	0.091	.259**	.163**	-.296**	-0.04	-.171**
QELM	-.125*	1	-0.06	-0.131	.136**	-.327**	.097*	-.202**	-0.119
SD	0.006	-0.035	1	.409**	.239**	-.171**	-0.023	0.017	.231**
BD	.116*	-0.106	.434**	1	.361**	.107*	-0.017	.269**	0.036
MA	.284**	.161**	.264**	.386**	1	-0.095	-0.043	-0.064	-0.113
RP	.188**	-.302**	-.146**	.132*	-0.070	1	-0.099	.398**	.137**
ITRA	-.271**	.122*	0.002	0.008	-0.018	-0.074	1	-0.038	-0.072
ITES	-0.015	-.177**	0.045	.294**	-0.039	.423**	-0.013	1	.26**
PSY	-.146**	-0.094	.256**	0.061	-0.088	.162**	-0.047	.285**	1
SC Position	0.057	0.058	0.067	0.062	0.041	0.054	-0.006	-0.013	***0.025***

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Given the use of single-informant data in this study, the research findings might be subject to common method bias (CMB) (Podsakoff et al., 2003). In order to address this concern, three different tests were adopted, namely Harmon's single-factor test (Podsakoff et al., 2003, Harman, 1967), single-factor CFA (Flynn et al., 2010, Cao and Zhang, 2011) and the "marker-variable" method (Lindell and Whitney, 2001). As advised by Podsakoff et al. (2003), the Harmon's one-factor test was applied first, to examine the CMB. According to Podsakoff et al. (2003), the use of one common method will explain the majority of the total variance, when the CMB is present. The PCA, conducted using SPSS 24, revealed that nine individual factors generated from the selected question items have an eigenvalue greater than one, explaining 74.778% of the total variance. Notably, the factor with the largest explained variance, at

9.474%, does not account for the majority of the total variance. Thus, the Harmon's one-factor test indicates that CMB is not a concern in this study.

To further confirm the result, a CFA approach was adopted to perform the Harmon's one-factor model (Cao and Zhang, 2011, Flynn et al., 2010). Specifically, using SPSS AMOS 24, a latent variable comprising forty selected items was created to assess the uni-dimentionality, i.e. model fitness. As mentioned in the Methodology chapter, the results indicate that the model fit indices, with RMSEA=0.173, NFI=0.189, NNFI=0.154, CFI=0.201 and Normed X^2=10.379, are far worse than the acceptable values. Thus, as the model fit of the single-factor model is not acceptable, the threat of CMB in this study is small (Cao and Zhang, 2011, Flynn et al., 2010, Zhang et al., 2018). Following Paulraj et al. (2008) and Widaman (1985), a two-step CFA comparison method was conducted to reinforce the result. Firstly, a CFA model including nine proposed factors was established. Then, the compared model was created by adding a method factor into the CFA model. The inclusion of the method variable did not make a significant difference to the original measurement model. Specifically, the factor loadings in the compared model and the CFA model were almost the same, and the t-value for the factor loadings all remained significant with the inclusion of a method factor. In addition, the method factor accounted for only 15.1% of the total variance, and only marginally improved the model fit indices of the measurement model (RMSEA by -0.005, NFI by 0.018 NNFI by 0.014, CFI by 0.015 and Normed X^2 by -0.155). Thus, according to Widaman (1985), the CMB is not a serious problem in this study, because the results of the measurement model did not change significantly when including a method factor.

Thirdly, although Harmon's one-factor test and method factor analysis have been widely adopted in the literature for CMB testing, OM empirical studies are paying increasing attention to the "Marker-Variable" method, to provide more rigour (Zhang et al., 2017). In accordance

with Malhotra et al. (2006), this study first selected the firm's supply chain position as a marker variable, that is, a variable that is theoretically unrelated to at least one variable in the measurement model. As reported in Table 7.15, the correlations between the marker variable (i.e. supply chain position) and other factors were small and insignificant, i.e. $p>0.05$. Therefore, the supply chain position could be seen as a good marker variable in the analysis. To conduct the Marker-Variable analysis, the adjusted correlation is computed by subtracting the lowest positive correlation between the marker variable and other variables for each correlation figure. For example, the adjusted correlation between the inability to trace and inability to test is -0.013 - 0.025 = -0.038. Results of the Marker-Variable analysis reveal that after the correlation adjustment, the significant correlations in the zero-order correlation table remain significant. In summary, it is reasonable to suggest that the CMB is unlikely to be a threat in this research.

7.5. Structural Model

Before examining the hypotheses through assessing the path coefficient, it is necessary to evaluate the model fit indices of the structural model (Tse et al., 2016b, Fullerton et al., 2014). The fitness of the structural model is reported in Table 7.12. The goodness-of-fit statistics indicate a good model fit for the structural model. Specifically, the model fit indices, such as NNFI at 0.877, IFI at 0.889 and CFI at 0.888, exceed the threshold value for a reasonable fit of 0.80 (Cao and Zhang, 2011). The RMSEA is below the acceptable maximum level of 0.08 and the SRMR, at 0.072, is also below the acceptable level of 0.10 (Browne and Cudeck, 2003). Although the normed X^2 index of 2.217 is slightly greater than the rule-of thumb of two (Kline, 2011), it is still below the acceptable level of five (Schumacker and Lomax, 2004). In summary, the structural model has a good model fit for the data.

The results of the hypotheses testing are summarized in Table 7.16 and Figure 7.1. First, the risk appraisal structure that was examined in the Scale Development chapter is further confirmed in the full structural model, because the effects of risk probability (β=0.354; t=6.247; p<0.001), risk magnitude (β=0.187; t=3.380; p<0.001) and psychological factor (β=0.195; t=3.508; p<0.001) on overall risk perception are positive and significant. Second, as expected, all antecedent factors significantly impact on the psychological factor. Specifically, the standardized coefficients of paths from BD (β=0.256; t=3.019; p<0.001), inability to trace (β=0.215; t=3.615; p<0.001), and inability to test (β=0.269; t=3.965; p<0.001) to psychological factor are positive and significant. Thus, H1, H7 and H10 are supported. Given that the negative relationship between SD and psychological factor is significant (β=-0.431; t=5.488; p<0.001), H2 is also supported. Regarding the antecedents of risk probability, this study confirms H4, H9 and H12, because the negative relationship between supplier dependence and risk probability (β=-0.276; t=-3.887; p<0.001) and positive relationships between inability to trace (β=0.132; t=2.380; p<0.05) and risk probability are significant. Interestingly, given that the standardized coefficient of path from BD to risk probability (β=0.110; p=0.159>0.05) is not significant, H3 is rejected. Moreover, H12 is not supported, because the relationship between inability to test (β=-0.482; t=-7.370; p<0.001) and risk probability is negative. Three of the four proposed antecedents of magnitude of SCQR drawn from agency theory and resource dependence theory have significant positive effects: BD (β=0.502; t=5.768; p<0.001), inability to trace (β=0.116; t=2.028; p<0.05) and inability to test (β=0.161; t=2.463; p<0.05) show significant relationships with risk magnitude and therefore provide support for H5, H9 and H11. As shown in Figure 7.1, the proposed antecedents explain 27% of the variance in the magnitude of SCQR. However, no relationships are found between supplier dependence and magnitude of SCQR (β=0.053; t=0.746; p=0.460>0.05). Thus, the empirical results fail to support H6. The structural model finds significant relationships between the overall perception of SCQR and the intention

to adopt QERM (β=-0.389; t=-6.703; p<0.001) and QELM (β=0.330; t=5.662; p<0.001). The overall perception of risk accounts for 15% and 11% of the variance in QERM and QELM respectively.

Table 7.16. Results of the Structural Model

Hypothesized Relationship	Standardized Path Coefficient (p-value)	t-value	Supported or Not Supported
H1: Buyer Dependence -> Psychological Factor (+)	0.256 (p<0.01)	3.019	Supported
H2: Supplier Dependence -> Psychological Factor (-)	-0.431 (p<0.001)	-5.488	Supported
H3: Buyer Dependence -> Risk Probability (+)	0.110 (p=0.159>0.05)	1.408	Not Supported
H4: Supplier Dependence -> Risk Probability (-)	-0.276 (p<0.001)	-3.887	Supported
H5: Buyer Dependence -> Risk Magnitude (+)	0.502 (p<0.001)	5.768	Supported
H6: Supplier Dependence -> Risk Magnitude (-)	0.053 (p=0.456>0.05)	0.746	Not Supported
H7: Inability to Trace -> Psychological Factor (+)	0.215 (p<0.001)	3.615	Supported
H8: Inability to Trace -> Risk Magnitude (+)	0.116 (p<0.05)	2.028	Supported
H9: Inability to Trace -> Risk Probability (+)	0.132 (p<0.05)	2.380	Supported
H10: Inability to Test -> Psychological Factor (+)	0.269 (p<0.001)	3.965	Supported
H11: Inability to Test -> Risk Magnitude (+)	0.161 (p<0.05)	2.463	Supported
H12: Inability to Test -> Risk Probability (+)	-0.482 (p<0.001)	-7.370	Not Supported
H13: Overall Risk -> Quality Exploration (-)	-0.389 (p<0.001)	-6.703	Supported
H14: Overall Risk -> Quality Exploitation (+)	0.330 (p<0.001)	5.662	Supported

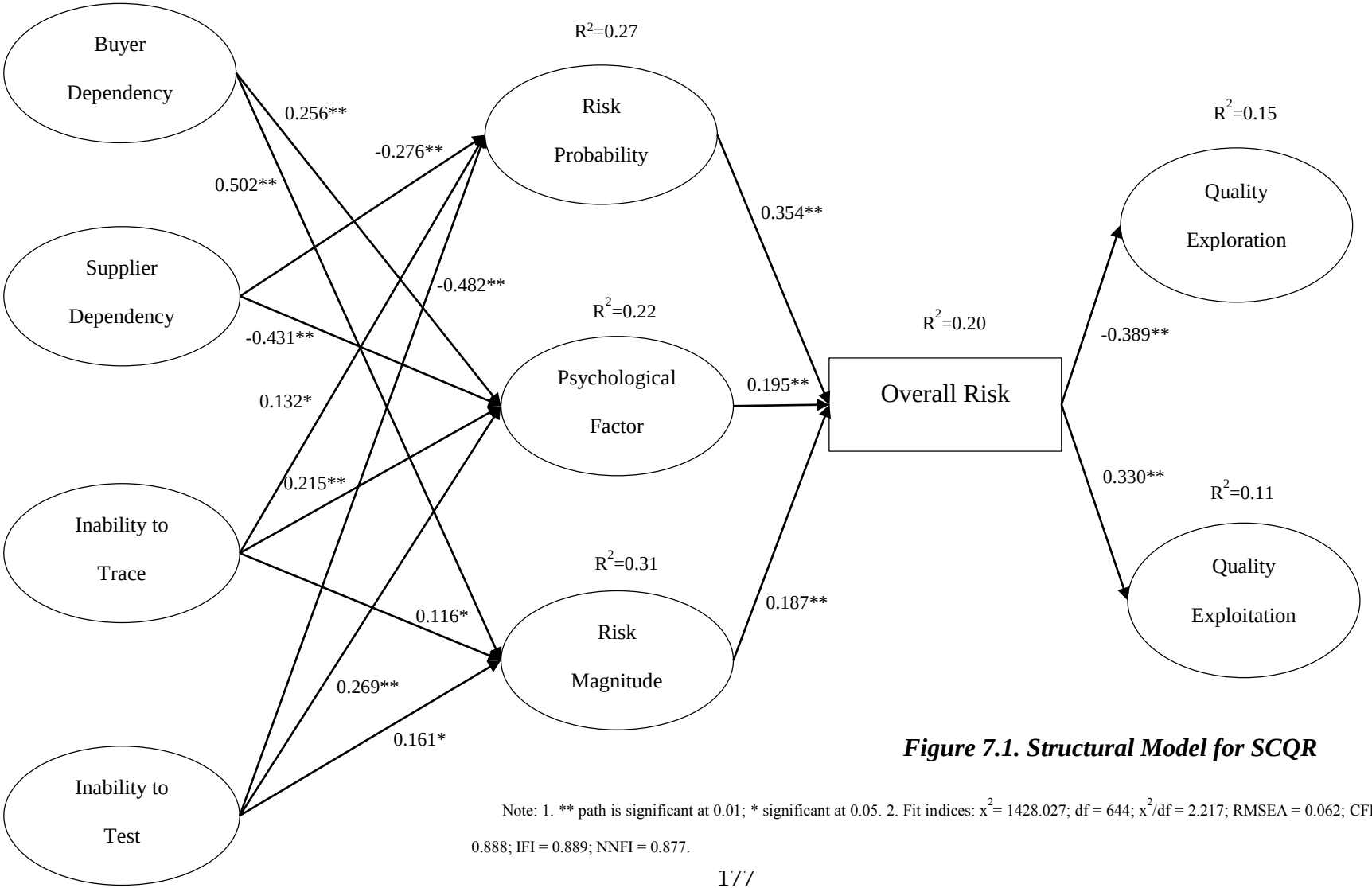

Figure 7.1. Structural Model for SCQR

Note: 1. ** path is significant at 0.01; * significant at 0.05. 2. Fit indices: x^2= 1428.027; df = 644; x^2/df = 2.217; RMSEA = 0.062; CFI = 0.888; IFI = 0.889; NNFI = 0.877.

7.6. Post Hoc Analysis

Table 7.17. Results of Post hoc Analysis

Independent Variables	Dependent Variables – Overall perception of SCQR
Buyer Dependence	0.139
Supplier Dependence	-0.064
Inability to Trace	0.393**
Inability to Test	0.218**
Coefficient of determination (R^2)	14%
ΔR^2 (%) – Percentage decrease in R^2	26.32%

This chapter extends the results from the Scale Development to investigate the central role of the representation of SCQR in the theoretical model based on the risky decision-making process (Yates and Stone, 1992). In order to demonstrate the need to include the formative risk perception model (as presented in the Conceptualization chapter), a post hoc analysis is conducted, in which the risk factors are omitted from the structural model. First, the psychological factor, probability and magnitude of SCQR are removed from the structural model. Then, the direct relationships between four antecedents and overall perception of SCQR are established. Following Ellis et al. (2010), the R^2 is adopted as a key criterion to compare the proposed model with the alternative model in which the overall perception of SCQR is omitted. As reported in Table 7.17, four antecedent factors, i.e. inability to trace, inability to test, supplier dependence and BD, account for only 14% of the variance in overall perception of SCQR. Compared with the theoretical model proposed in this study, the alternative model had a 26.32% of reduction in explaining the variance of overall perception of SCQR. This indicates that the inclusion of the three risk factors enhances the ability to explain the overall perception of SCQR. In summary, the empirical results provide strong support for the inclusion of the formative risk perception model in the risky decision-making process, as suggested by Yates and Stone (1992) and Ellis et al. (2010).

The results of the post hoc analysis provide several important implications. First, as shown in Table 7.17, supplier dependence (-0.064) and BD (0.139) have no significant relationship with the overall perception of SCQR. However, in the structural model, these two factors have different significant effects on the representations of SCQR, i.e. risk probability, risk magnitude and psychological factor. Therefore, if the researcher ignores the representations of SCQR in the decision-making process, they will not obtain a comprehensive picture of how the perception of SCQR is developed. This research finding further confirms the necessity of using a formative model to understand the nature of risk perception in the risky decision-making process (Yates and Stone, 1992). Second, the relationships between all antecedent factors and psychological factors are significant. This research finding indicates the importance of including the psychological factor in the risky decision-making process, and contributes to the literature a more comprehensive structure of risk perception. Third, an added post hoc analysis of the total indirect effect also reveals some hidden information. Specifically, this study finds that the total indirect effects of supplier dependence (-0.308) and BD (0.304) are much greater than those of the inability to trace (0.130) and the inability to test (0.115). A possible implication is that compared with the relational concepts (i.e. supplier dependence and BD), testability and traceability can be improved by direct investment in the relevant technologies, such as radio frequency identification (RFID) and automated quality control (AQC) systems (Patterson et al., 2003, Delen et al., 2007). However, the focal companies need to have a long-term plan to proactively increase the supply chain power so as to increase the supplier dependence and decrease their dependence on the supplier. Compared with direct investment in testing and tracing technologies, it is more difficult and requires more resources to control the relational concept. Therefore, this study finds greater indirect effects of BD and supplier dependence on the overall perception of SCQR.

7.7. Discussion

In the Theoretical Framework chapter, this study developed a theoretical model based on the risky decision-making process (Yates and Stone, 1992). As reported in the results of data analysis, most of the relationships hypothesized in the Theoretical Framework chapter are supported by the results of the structural model. In this section, the results for each hypothesized relationship are discussed.

7.7.1. The effect of buyer depence

BD refers to the dependence of the buying company upon its supplier. According to Kull and Ellis (2016), if the degree of BD is high, the buying company will be limited in its ability to effectively control the business in an exchange relationship. According to Molm (1991) and Emerson (1962), dependence that exists in an inter-organizational relationship determines the perceived value of the outcome that the other party controls. Therefore, in the theoretical framework, this study proposes that BD could positively influence the three risk factors, Narayanan and Narasimhan (2014 , P.725) indicate that high BD can be characterized as *"high importance of the relationship to the buyer and a high degree of information exchange that adds value to the buyer's product by the supplier"*. According to Petersen et al. (2008), when the buying firm has relatively high dependence upon a supplier, it may strive to establish a close collaboration relationship with that supplier and even integrate the supplier to stabilize the uncertain and dynamic supply market. These considerations would explain why a higher degree of BD may not result in higher probability of SCQR. In the situation of high BD the supplier might have information advantages against the buyer, making it hard for the buyer to identify quality problems. Therefore, BD may have an insignificant impact on the probability of SCQR, as quality problems from the upstream supply chain are difficult to detect.

On the other hand, this study finds that BD has significant impact on both the psychological factor and risk magnitude. Where there is high BD, because the buying firm has a limited choice of alternatives in their supply market, their suppliers are likely to become complacent and might even not respond to the buyer's requirements or demands when facing risk (Hajmohammad and Vachon, 2016, Handfield and Bechtel, 2002). This significant relationship between BD and psychological factor confirms the argument of Webster Jr and Wind (1972) that, when facing risk, the psychological responses of decision makers in a buying company are similar to those of consumers. The results indicate that when the supplier dominates the supply chain relationship (i.e. BD), decision makers in buying firms may feel threatened and lacking in control when facing a potential quality problem. For example, in the case of product recall, a focal firm with a high level of BD may receive less support from their supplier. According to Awaysheh and Klassen (2010), an increased level of BD will lower the buyer's ability to enforce the risk mitigation strategy. This situation may enhance managers' concern and anxiety toward the SCQR. In addition, the results in this study provide support for the hypothesized positive association between BD and magnitude of SCQR. A possible implication is that when buying firms are unable to acquire key supply materials from alternative suppliers (i.e. high buyer dependence), the perceived magnitude of SCQR could be amplified. For instance, when SCQR occurs in a situation of supplier dominance, the sourcing organization has limited room to seek alternative suppliers to deal with the SCQR. Drawing lessons from the Kobe steel scandal, the aircraft manufacturers around the world that greatly rely on the supplies from Kobe Steel suffers significant financial loss and raised public concern for their product safety (Cox, 2017). Given that the potential quality problem might have originated with the dominant supplier, to continue sourcing the unqualified supply materials or components should increase the negative impact from SCQR (Hajmohammad and Vachon, 2016). Moreover, as suggested by the insignificant relationship between buyer dependence and the probability of SCQR,

where buyers are highly dependent on their suppliers, it may be difficult for them to identify the SCQR. Therefore, the buying firms may lack experience and be unprepared for potential quality issues. In this regard, the magnitude of SCQR could be increased in the situation of high buyer dependence, as the buying firms may have limited opportunities to cope with the SCQR.

7.7.2. The effect of supplier dependence

In contrast to buyer dependence, supplier dependence is a relatively advantageous situation. According to the RDT, if the dependence occurs in an inter-organizational relationship, the dominant partner could exert greater influence over the weaker partner (Casciaro and Piskorski, 2005, Gulati and Sytch, 2007). A high level of supplier dependence refers to a situation in which the supplier is highly dependent on the resources of buying firms (Hajmohammad and Vachon, 2016). In this situation, buying firms should have more relative power and be able to influence the behaviour and intentions of their supplier (Benton and Maloni, 2005). Therefore, in the Theoretical Framework chapter, this study hypothesized three negative relationships between supplier dependence and the risk factors, i.e. probability of SCQR, magnitude of SCQR and psychological factor. Surprisingly, the data analysis reveals that the relationship between supplier dependence and magnitude of SCQR is insignificant. Consequently, H6 is rejected. The result implies that a dependent supplier may not help to reduce the severity of the SCQR. This might be because where there is a high level of supplier dependence, it is likely that the formal risk sharing contract, which controls the negative impact of supply quality issues, is well defined (Terpend and Krause, 2015). Therefore, as the uncertainty of the loss due to SCQR is already effectively controlled in the formal contract, the severity of the SCQR might not be increased or decreased significantly by the high level of supplier dependence.

H2 proposes a negative relationship between supplier dependence and the psychological factor of SCQR. This hypothesized relationship is supported by the result, indicating that if a supplier is highly dependent on the buying firm, the decision maker of the buying firm may perceive the SCQR as controllable, and not to be feared. This is consistent with the notion of Gao et al. (2005) that where the buyer has relatively high bargaining power over the supplier and the ability to punish the supplier's opportunistic behaviour, decision makers will experience less anxiety regarding the supplier's performance and product. This study suggests that such confidence on the part of the buying firms might be due to high supplier commitment in SCQM programs such as process-oriented quality management programs (Carr et al., 2008). A dependent supplier is more likely to fulfil the buyer's requirements and is more reliant on the collaboration relationship with the dominant partner (Carr et al., 2008, Handley and Benton, 2013, Hajmohammad and Vachon, 2016). This allows the dominant buyer to exercise more control to manage the SCQR, through either monitoring or collaboration practices (Hajmohammad and Vachon, 2016). Given that dominant buyers (i.e. buying firms with highly dependent suppliers) have broad options in managing the SCQR and benefit from greater supplier commitment, it is suggested that supplier dependence is negatively associated with the psychological factor of SCQR.

H4, which proposes a negative relationship between supplier dependence and probability of SCQR, is also supported. This result is consistent with the finding by Gao et al. (2005) that *"supplier dependence does indeed serve to reduce buyer uncertainty"* (P. 402). Supplier dependence is characterized by high proportion of sales volume occupied by the dominant buying firm and high switching cost when seeking alternative customers (Caniels and Gelderman, 2005). Therefore, losing the dominant buyer could be a nightmare for those suppliers in a high dependency relationship. Fear that the buyer could punish them by reducing sales volume or even withdrawing business (Zhao et al., 2008) if they do not comply with the

buyer's requests may motivate the supplier to provide more quality information and to invest more effort into the quality improvement program. The high switching cost will also motivate the supplier to proactively maintain the close collaboration relationship with the dominant buyer (Carr et al., 2008, Zhang and Huo, 2013). Consequently, in a situation of high supply dependence, there is no incentive for opportunistic supplier behaviour regarding product quality.

7.7.3. The effect of inability to trace

As mentioned in the Theoretical Framework chapter, the inability to trace refers to the difficulty to trace the supply materials to their origins and then identify the source from the upstream supply chain. Drawing from the agency theory, this study hypothesizes that the relationships between the inability to trace and the three risk factors are positive. The results obtained from the structural model provide empirical support for a positive association between the inability to trace and psychological factor (H7), magnitude of SCQR (H8) and probability of SCQR (H9).

With regard to H7, the result indicates that with increased difficulty to trace the origins or source of the supply materials, the decision maker in the focal company will be more worried and perceive a lack of control over supply chain quality issues. It is believed that richer information could weaken the negative feelings around the risk situation, such as fear and worry (Guo and Li, 2016). The inability to trace could represent low richness of information for decision makers in the buying firms. Therefore, if there is high inability to trace, the decision maker in a buying firm may feel more concerned and worried regarding the SCQR. As suggested by Tse and Tan (2012), traceability can be understood as a key part of the supply chain visibility. According to Lyles et al. (2008), high supply chain traceability means there must be sufficient documentation that can record and demonstrate whether the upstream

suppliers followed predefined quality control procedures throughout the whole process. This implies that buying firms with high traceability in their upstream supply chain should have high controllability of the SCQR, as they can *"keep track of who, what, when doing to the final quality of the products"* (Tse et al., 2011). In contrast, if the buying firms do not have traceability in the supply chain (i.e. inability to trace), their decision makers may perceive the potential issues related to supply quality as less controllable.

The result obtained from the structural model supports the claim that the inability to trace increases the negative impact of the SCQR (H8). In the last decade, a number of serious global recall events associated with product safety issues, most notably the melamine milk scandal of 2008, have highlighted the need to develop the ability to trace and track materials through the supply chain (Marucheck et al., 2011). There are three critical reasons why inability to trace could increase the magnitude of SCQR: a) increased cost of monitoring the quality problem; b) vague supply chain quality responsibilities; c) slow response to product recall. First, without well-documented tracing and tracking information, companies may need to invest more in monitoring product quality problems. Echoing this interpretation, Regattieri et al. (2007) state that a traceability system enables *"more efficient control of supply chain in terms of improving control of the stock situation, and production monitoring"* (P. 351). Second, the inability to trace may make it extremely difficult to clarify the responsibilities along the supply chain. The documents related to the tracing information should provide straightforward and reasonable evidence to determine the loss sharing between buying firm and supplier. If the buying firm does not have traceability in the supply chain, it might bear the full brunt of the costs due to the quality failure. Third, this study suggests that where there is incomplete tracing information, the companies concerned would not respond efficiently in the recall management process. As a result, the losses related to a product quality crisis could not be efficiently controlled. This is consistent with the argument of Tang (2008) that in a product quality crisis, delay in making

the decision to issue a recall will result in higher losses and more reputational damage to the firm.

With regard to H9, this study confirms the hypothesized relationship between the inability to trace and the probability of SCQR. The result indicates that if the buying firm has greater difficulty in tracing the origin of the supply materials / components, the likelihood of SCQR is increased. This study suggests that where the buying firm has inability to trace, the supplier may be encouraged to engage in opportunistic behaviour, because it will be difficult for the buyer to assess the supplier's performance and to clarify the responsibility for supply chain quality. As argued in the Theoretical Framework chapter, buying firms' inability to trace could be a source of agency problems, i.e. moral hazard and adverse selection (Steven et al., 2014). This research finding is also consistent with the argument of Rábade and Alfaro (2006) that the ability to trace and track a consumer product as it transits though different stages of a supply chain is critical to ensure the product quality and safety and is useful to prevent a variety of consumer hazards.

7.7.4. The effect of inability to test

Drawing from the agency theory, this study investigates the inability to test from the perspective of outcome measurability. Three positive relationships are hypothesized, i.e. H10, H11 and H12. The result of the structural model shows that the effect of inability to test on the psychological factor and risk magnitude are significant and positive. However, the result does not provide full support for the proposed associations. In the case of hypothesis 12, although the relationship between inability to test and probability of SCQR is significant, it is negative, which is opposite to my expectation that the inability to test should have a positive effect on the probability of SCQR. It is worth discussing these research findings in more detail.

First, the postulation that the inability to test is positively associated with the psychological factor is supported. Compared with the other two drivers of the psychological factor, i.e. buyer dependence and inability to trace, the inability to test is found to have a significantly higher impact. Thus, the inability to test is the most crucial antecedent driving managers' dread and perception of uncontrollability regarding supply chain quality issues. This result supports the argument of the agency theory regarding *"outcome measurability"*, that is the degree to which the agent's (i.e. supplier's) performance can be correctly measured (Eisenhardt, 1989). According to Whipple and Roh (2010), the outcome measurability has a highly significant impact on buyer vulnerability, because of the information asymmetry. When buying firms are unable to conduct reliable tests for the supply materials, they may find it difficult to verify the suppliers' actual effort in product quality and could face serious agency problems. Given that the measurement of outcome might be incorrect due to the unreliability of product testing, the decision maker in the buying firm may experience dread and anxiety regarding the correctness of their purchasing decision.

Second, this study finds significant support for the proposed positive relationship between inability to test and the magnitude of SCQR. The construct inability to test draws on the agency theory, which measures the degree of information asymmetry. According to Kirmani and Rao (2000), information asymmetry occurs in an agency relationship where one party has limited ability to detect opportunism of the other party. According to the agency theory, the information asymmetry will lead to moral hazard (Eisenhardt, 1989). As discussed in the prior section, moral hazard in the context of SCQM refers to the situation in which a supplier does not keep their word in ensuring the product quality and engages in fraudulent behaviour to produce unqualified products (Zu and Kaynak, 2012). The result suggests that if the buying firm faces difficulty in testing the quality of the supply materials, this might lead to serious product quality issues (i.e. Risk Magnitude). For example, due to the imperfect product testing

procedure, the famous retailers, such as Tesco, Iceland, Aldi and Lidl, lost not only the sales revenue but also the consumer trust after the exposure of Horsemeat scandal in 2013 (Tse *et al.*, 2016a). Moreover, a buyer's inability to test might also weaken their negotiation power with the suppliers when a product quality problem occurs. If the buying firm cannot test to locate the source of the quality problem, they are likely to bear the full cost of product failure. Therefore, the inability to test is believed to be positively associated with the magnitude of SCQR. This result is also in line with another key argument of agency theory, that information asymmetry, i.e. *increased difficulty of detecting opportunism*, would lead to behaviour contrary to the principles of the contract (Wathne and Heide, 2000).

Contrary to our expectation, the inability to test is found to have a negative effect on the probability of SCQR. In other words, this result suggests that with increased difficulty of testing the quality of supply materials, the decision makers in a buying company may perceive a lower probability of SCQR. The suggested explanation is that as the testability of supply materials decreases (i.e. inability to test increases), the buying firm will find it harder to identify quality issues in the upstream supply chain and this will lead to lower perceived likelihood of SCQR outbreak. The research finding provides an important research implication for future risk research in the OM area. If the researcher captures only the dimension of the risk likelihood, the research findings could be biased. In this study, the inability to test has different effects on the different factors of SCQR. Specifically, inability to test impacts positively on magnitude and the psychological factor, while it has a negative influence on probability of SCQR. As such, this mixed research result informs future researchers into SCQR of the potential bias when conceptualizing the SCQR as comprising only a single dimension of risk.

7.7.5. Intention to Adopt Quality Management Practice

Taking the view of ambidexterity, this study investigates how the overall perception of SCQR influences the intention to adopt two QM practices, namely QERM and QELM. These practices represent different orientations of the decision maker, and thus the associations between the overall perception of SCQR and the two adoption decisions would be different. In H13, this study hypothesizes that the relationship between overall perception of SCQR and QERM will be negative, while in H14 the relationship between overall perception of SCQR and QELM is hypothesized as positive. Both the hypothesized relationships are significant and are in line with the propositions of this study.

First, the relationship between the overall perception of SCQR and QERM is found to be negative and significant, which supports H13. This result reflects the risk averse nature of decision makers in Chinese manufacturing companies. The adoption of QERM is negatively associated with the overall perception of SCQR. In other words, this research suggests that when business decision makers perceive lower levels of quality risk in their supply chain, they are more oriented towards exploration activities of QM. These exploration activities, such as innovating the production process and pursuing novel solutions, can be regarded as proactive management practices (Zhang et al., 2012, Herzallah et al., 2017). However, these proactive activities might involve taking risk, and require extra resources (Zhou et al., 2013). When facing the threat of quality risk in the supply chain, managers tend to avoid these practices, as they might bring more uncertainties to their operations. This empirical result is in line with prior research that highlights the significant role of risk perception in the decision-making process. Specifically, the degree to which decision makers adopt risky decisions will be negatively associated with their perceived risk in the situation (Sitkin and Weingart, 1995, Simon et al., 2000, Nguyen et al., 2017). However, the result is contrary to those of Kahneman and Tversky (1979) and Abebe and Angriawan (2014). A possible explanation is that in some

contexts, risk or uncertainty might represent business opportunities. For example, in the view of Abebe and Angriawan (2014), when firms are facing increased market uncertainty, more business opportunities are available to them and exploratory activities are encouraged. However, this is not the case within the scope of this study, where the perceived SCQR is measured as a relatively negative situation.

Second, for H14, the result indicates that when the decision makers in the buying firms perceive higher SCQR, they are more likely to adopt exploitation-oriented QM. As mentioned in the Theoretical Framework chapter, QELM aims to maintain and refine the familiar practices to improve the consistency, efficiency and stability of the manufacturing process (Zhang et al., 2012, Herzallah et al., 2017). In contrast to the exploration activities, QELM focuses on less risky activities, such as adopting statistical process control to decrease the production variance (Patel et al., 2012) and internal collaboration to increase process efficiency and reduce waste (Ravichandran and Rai, 2000). The result is in line with the proposition of Levinthal and March (1993). When a company is under high threat of SCQR, the QM adoption will be more conservative. According to Voss et al. (2008), when facing increased external risk, companies will normally aim at the existing and tested competencies with more predictable outcomes to limit the potential loss. The empirical results obtained in this study are consistent with their argument.

7.7.6. Effect of SCQR perception on quality ambidexterity

The research findings with regard to H13 and H14 also raise an interesting question for the research topic of ambidexterity, which describes a firm's ability to apply both exploration and exploitation simultaneously (O'Reilly and Tushman, 2004). According to March (1991), carrying out both exploration and exploitation activities in a correct and balanced way is essential for an organization's survival and success. In the field of QM and SCM, the literature

has empirically proved that organizational ambidexterity is a multidimensional, second-order construct reflected by the orientations of exploitation and exploration practices (Herzallah et al., 2017, Kristal et al., 2010). The literature argues that exploration and exploitation practices could coexist and be balanced well by manufacturers (Kristal et al., 2010). Most recently, Herzallah et al. (2017) define quality ambidexterity as a *"firm's ability to simultaneously carry out quality exploration and quality exploitation practices"* (P.1499). In addition, extensive literature suggests that organizational ambidexterity enables companies to achieve superior firm performance (Gupta et al., 2006, March, 1991, Herzallah et al., 2017, Kristal et al., 2010). However, these studies do not incorporate the contingency view understanding of ambidextrous structure. While an ambidextrous structure is ideal for a company to succeed in the long run, there remains a key question as to whether such organizational ambidexterity always exists. As can be seen from the results of this study, the relationships between overall perception of SCQR and two QM practices are different, i.e. positive for QELM and negative for QERM. This study argues that QM ambidexterity might not exist when decision makers perceive high SCQR. To reconfirm this argument, this study proposes an additional analysis.

Table 7.18. Multiple Group Analysis

Models	x^2	df	X^2/df	ΔX^2	ΔDf	X^2 difference test	High Risk Group	Low Risk Group
1. Baseline Model	72.072	38	1.897					
2. Constrained Model	158.438	55	2.881	86.366	17	p<0.01		
3. Constrained Paths (Quality Ambidexterity)								
3. Quality Ambidexterity -> QERM	142.103	47	3.023	70.031	9	p<0.01	0.340	0.947
3. Quality Ambidexterity -> QELM							0.460	0.484

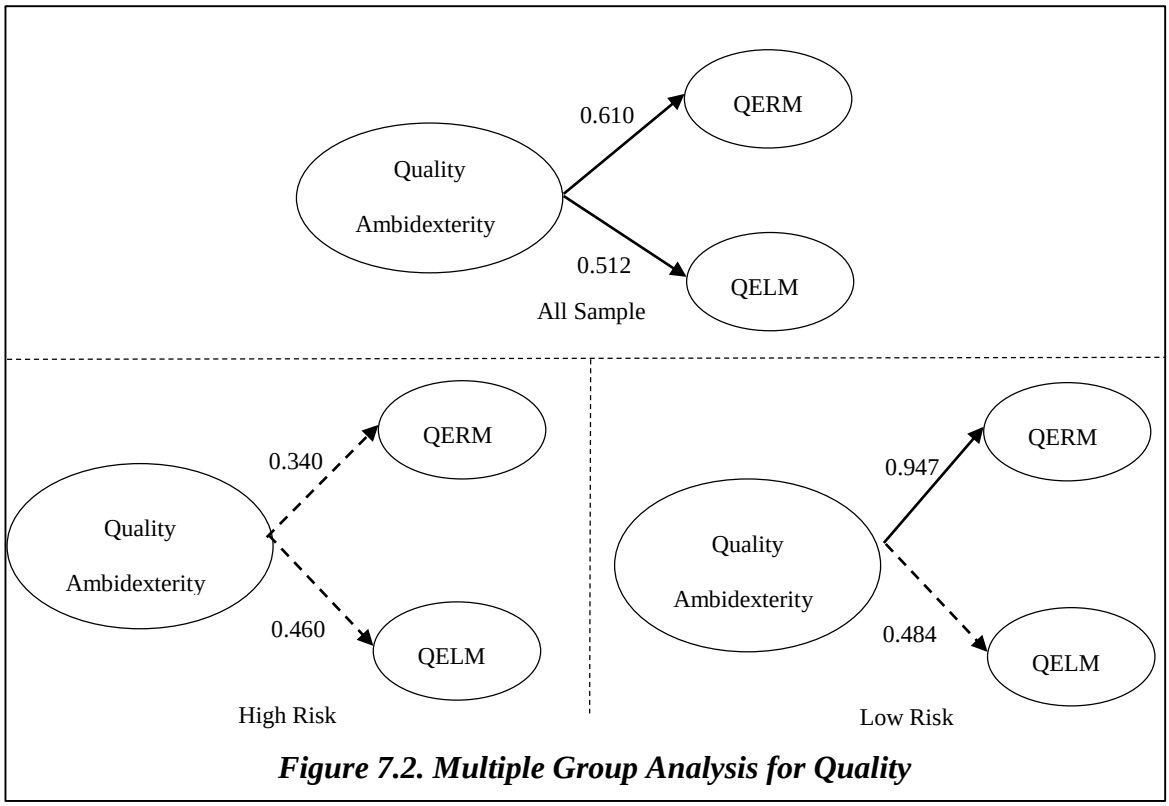

Figure 7.2. Multiple Group Analysis for Quality

Following Kristal et al. (2010), a second-order model is created to verify the ambidexterity in the full data sample (n=316). As shown in Figure 7.2, the quality ambidexterity is operationalized as a higher-order factor with two first-order factors, namely QERM and QELM. As mentioned in the Methodology chapter, there are four steps to examine the existence of a second-order model. First, as the quality ambidexterity consists of QERM and QELM, the minimum number of the first-order factor for a second-order model is satisfied. Second, the model fit indices for the CFA model that includes QERM and QELM are examined. Specifically, the CFA model fit of two first-order factors [RMSEA=0.033, NFI=0.980, NNFI=0.992, CFI=0.995 and Normed X^2=1.349] is far better than the accepted value as mentioned in the Methodology chapter. Third, as indicated in Figure 7.2, the positive and significant path loadings linking quality ambidexterity to QERM (β=0.610; p=<0.001) and to QELM (β=0.512; p=<0.001) lend support for the proposed second-order model. Fourth, as the target (T) coefficient (where T = first-order X^2/ second-order X^2) of 98.2% is within the range

from 0.80 to 1.00, the efficacy of the second-order model is further confirmed (Tse et al., 2016b, Cao and Zhang, 2011). In summary, it appears that quality ambidexterity exists. In accordance with Wong et al. (2011), this study conducts an analysis of multi-group structural invariance to test the moderating effect of overall SCQR perception on the second-order structure of quality ambidexterity. Using AMOS 22, a multiple group analysis is conducted. Table 7.18 reports the results of the multi-group and structural path analyses. In this regard, this study divides the sample into high (n=128) and low (n=188) SCQR perception based on the average scores of the item (i.e. 4.01) (Wong et al., 2011). As shown in Table 7.18, three types of model are tested. In the baseline model, parameters vary freely across different groups (i.e. different overall SCQR perception). The constrained model, in which structural parameters are constrained to be equal across different groups, is used for comparison with the baseline model (Wong et al., 2011). The third model is the equal structural coefficients model (i.e., constrained path) (Cao and Zhang, 2011). The result indicates that the overall perception of SCQR has a significant moderating effect, as there is a significant result in the chi-square statistics between the baseline model and the constrained model (i.e. where all structural parameters across two groups are constrained) (ΔX^2 = 70.031, with 9 *df* difference, p<0.01), which indicates variance of the model under high and low overall perception of SCQR (Wong et al., 2011). As mentioned in the Methodology chapter, the threshold to achieve significant standardized factor loading is 0.5 (Narasimhan and Das, 2001, Zhang et al., 2018). Under both high and low overall perception of SCQR, the second-order factor does not exist. Specifically, in the group of low overall perception of SCQR, only QERM has significant factor loading (i.e. 0.947). In the group of high overall perception of SCQR, neither QERM (i.e. 0.340) nor QELM (i.e. 0.460) show significant factor loading for the quality ambidexterity. This result implies that the perception of SCQR impacts significantly on the structure of quality ambidexterity.

Specifically, with both higher and lower overall perception of SCQR, decision makers might have difficulty in balancing effectively the exploration and exploitation orientations.

7.8. Chapter Summary

This chapter has examined the theoretical framework developed from the risky decision-making process model (Yates and Stone, 1992), RDT (Emerson, 1962, Zhang and Huo, 2013), agency theory (Eisenhardt, 1989) and organizational ambidexterity (Herzallah et al., 2017, March, 1991) with a sample of Chinese manufacturers. First, in terms of theory, the results show that the antecedents influence the different representations of SCQR in different ways, thus emphasizing the need to consider the perceived risk as a multi-dimensional concept. Statistically, the inclusion of representation of risk (risk probability, risk magnitude and psychological factor) enhances the ability to explain the overall perception of SCQR. Second, the risk appraisal structure is empirically confirmed. Three risk factors, i.e. probability of SCQR, magnitude of SCQR and psychological factor, have simultaneous and positive impact on the overall perception of SCQR. Third, the intention to adopt two differently oriented QM practices is significantly impacted by the overall percepton of SCQR. This study argues that the subjective judgement of SCQR significantly affects the quality ambidexterity structure (Herzallah et al., 2017). The empirical findings provide new insights for the risk representation of SCQR from the buyer's perspective. The structural model provides additional perspectives on SCQR, illustrating the relationships among the situational factors and SCQR. The validated theoretical model forms a basis for academics and managers to understand SCQR, and provides direction for managers to identify the drivers of SCQR in their supply chains. Therefore, this study can serve to caution managers establishing a comprehensive risk management strategy to respond to uncertain environments.

CHAPTER 8 CONCLUSION

8.1. Introduction

This chapter summarizes the research findings and draws conclusions. First, the research questions, research aims and research objectives are re-visited. Then, the approaches and research findings of each chapter are summarized. Next, the theoretical implications and managerial contributions of this thesis are discussed. Finally, research limitations are acknowledged and recommendations are made for future research.

8.2. Revisiting Research Questions, Aims and Objectives

Based on a comprehensive review of the literature regarding risk perception, SCRM and QM, three major research gaps are identified. First, although researchers widely acknowledge the important role of risk perception in the decision-making process, to date there has been little research to investigate how the managers of buying firms perceive risk. Some OM studies have empirically examined the role of risk perception (Wang et al., 2016, Rao et al., 2007, Liu et al., 2008, Ellis et al., 2010, Tse et al., 2016a). However, the concept of perceived SCQR is still a missing piece of the jigsaw in the OM literature. To fill this research gap, this study proposes the first research question, *RQ1 - "What would the measurement scales for perceived SCQR entail?"* The associated research aim for this research question is *"Managers' perception of SCQR"*. Three research objectives are established for this research aim: *RO1: Conducting a SLR on the broad area of risk perception studies*; *RO2: Conceptualizing the perceived SCQR to identify the potential instruments,* and *RO3: Using a scale development process to validate the measurement items for measuring the perceived SCQR.*

Second, the empirical SCRM research has already started to explore and examine the antecedents of the representations of risk perception (Ellis et al., 2010, Tse et al., 2016a, Kull

et al., 2014). However, although the existing literature has shed light on the drivers of risk perception, the potential antecedents in the context of a buyer-supplier relationship are still unknown. To close this research gap, this thesis raises the second research question, RQ2 – *"What are the antecedents of perceived SCQR?"*, with the associated research aim of *"The impact of SCD and supply chain quality barriers on the perceived SCQR"*. Two specific research objectives are set to understand this research question: RO5 (a) – *"Developing a theoretical framework that sheds light on the antecedents of perceived SCQR"* and RO6 - *"Empirically testing the hypothesized relationships in the theoretical model".*

Third, although the literature covers the impact of risk perception on decision making in terms of supplier selection (Kull et al., 2014), switching supplier (Ellis et al., 2010) and relational governance (Cheng et al., 2012), to date the question of how the perceived SCQR is associated with QM adoption remains unanswered. To address this research gap, this thesis proposes the third research question, RQ3 – *"What are the relationships between perceived SCQR and managers' intention to adopt QELM and QERM practices?"* The research aim specified for this research question is *"The impact of perceived SCQR on managers' intention to adopt QELM and QERM practices"*. This thesis aims to answer this research question by achieving two research objectives: RO5 (b) – *"Developing a theoretical framework that sheds light on the outcome of perceived SCQR"* and RO6, already stated above.

8.3. Addressing the Research Questions

8.3.1. What would the measurement scales for perceived SCQR entail?

To answer the first research question, this study conceptualizes and operationalizes the perception of SCQR. This research adopts the view of Yates and Stone (1992), to propose SCQR as a multi-dimensional concept. According to Yates and Stone (1992), before evaluating the overall perception of SCQR, the decision makers initially judge the probability of loss (i.e.,

likelihood of risk), magnitude of loss (i.e., significance of risk) and other relevant considerations. Nevertheless, most of the recent studies adopt a binary setting of risk (i.e. risk probability and risk magnitude), or a unitary setting to measure the perceived SCQR, but ignore the other relevant considerations as emphasized in Yates and Stone's risk perception model. Through reviewing and consolidating the relevant literature, the thesis provides the answer to this question by establishing a ternary setting, comprising risk magnitude, risk probability and psychological factor. Specifically, the probability of SCQR probability measures the perceived level of likelihood that the manager will face an unforeseen quality problem in the supply material from a key supplier; the magnitude of SCQR is conceptualized as "the perceived severity of the negative impact if the key supplier supplies material with poor quality", while the psychological factor is conceptualized to capture the emotion of a manager when facing a supply chain quality problem. The result for the formative risk appraisal model suggests that these three risk factors positively and significantly influence the overall perception of SCQR.

8.3.2. What are the antecedents of perceived SCQR?

The second research question aims to identify and examine the antecedents of perceived SCQR. In line with the RDT, this study hypothesizes that the impact of buyer dependence on three SCQR factors (i.e. probability of SCQR, magnitude of SCQR and psychological factor) is positive, while the impact of supplier dependence is negative. Drawing upon the agency theory, inability to test and inability to trace are selected to measure the agency problem regarding the supply chain quality, i.e. information asymmetry between buyer and supplier. Therefore, these two constructs are also proposed as the drivers of the three SCQR factors. By means of the SEM approach, this study has obtained mixed research findings, where the proposed hypotheses are either supported or rejected. The results suggest that buyer dependence, inability to trace and inability to test have positive and significant effect on the

psychological factor. The negative relationship between supplier dependence and psychological factor is significant. Moreover, inability to trace significantly drives the probability of SCQR, while supplier dependence and inability to test hinder the probability of SCQR. Surprisingly, buyer dependence does not affect the probability of SCQR. Regarding magnitude of SCQR, buyer dependence, inability to trace and inability to test show significant and positive effects. However, supplier dependence does not affect magnitude of SCQR.

8.3.3. What are the relationships between perceived SCQR and managers' intention to adopt QELM and QERM practices?

In this study, the two different forms of QM are classified based on the conceptual framework of exploitation-exploration, i.e. QELM and QERM. While there is substantial research that examines the decision-making process in which a risky decision is determined by the risk perception, empirical OM research to investigate this theoretical framework is limited. In order to address this research gap, this study proposes two sets of hypotheses, in which the overall perception of SCQR impacts differently on the QELM and QERM. The relationship between overall perception of SCQR and QERM is hypothesized as negative, as the nature of QERM is risk-taking. Conversely, this study proposes that the intention to adopt QELM is motivated by a decision maker's perception of greater SCQR. The results obtained from the structural equation model support these two hypotheses. Furthermore, the post hoc analysis presented in section 7.7.6 indicates that the QM ambidexterity, which refers to a firm's ability to simultaneously carry out quality exploration and quality exploitation practices, does not exist when decision makers perceive relatively high SCQR.

8.4. Summary of Theoretical Contributions

This study adopts the risky decision-making model (Yates and Stone, 1992) to understand the nature of perceived SCQR. A three-layer theoretical model, which consists of (1) situation, (2) risk appraisal and (3) intention to adopt QM, is examined by a set of rigorous analyses. Sample data from 316 Chinese companies was applied to test the theoretical model. Drawing on the agency theory and RDT, the relationships between two sets of antecedent factors and three risk factors are empirically validated. In addition, the risk appraisal model is empirically verified in a formative factor structure. That is to say, the overall perception of SCQR (i.e. a single item construct) is significantly and simultaneously influenced by three proposed risk factors, namely probability of SCQR, magnitude of SCQR and psychological factor. This study also examines the effect of overall perception of SCQR on the behavioural intention to adopt differently oriented QM practices, i.e. QERM and QELM.

Although some initial research has started to scrutinize the risk decision model in the area of OM, the nature of SCQR is still unknown. Moreover, while SCRM has become a popular topic in OM study, the majority of researches have focused on supply chain disruption (Baiman et al., 2000, Tomlin, 2006, Yang et al., 2009). The examination of the proposed theoretical model successfully responds to the suggestion by Ellis et al. (2010) that:

"To establish the generalizability of Yates and Stone's model of risky decision-making, future research may consider the role of magnitude of loss, probability of loss, and overall risk in other contexts." (Ellis et al. 2010: P. 44)

Specifically, this study extends this risky decision-making model from the context of SCDR to the SCQR. The thesis provides important insights regarding how the decision makers in buying firms internalize the SCQR, in particular in the Chinese manufacturing context. Moreover, this study refines the behavioural model from prior research by incorporating the

psychological factor to form the overall perception of SCQR. The result suggests that the psychological factor is key in the representation of risk. Drawing from the sociological literature, the result extends the boundary of previous risk management literature, which investigates only the probability of risk and magnitude of risk, by considering an additional psychological factor. This contributes to the literature by providing a more holistic picture of how managers process and internalize the SCQR.

Based on the risky decision-making process model, this study contributes to the body of SCRM by enhancing the investigation of the situational factors that might impact on the supply chain risks. OM researchers pay considerable attention to identifying and verifying the practices or capabilities to deal with the SCR. Although studies among the existing literature have attempted to offer insights on how to manage product quality risk in a supply chain context (Tse and Tan, 2011, 2012; Zhu et al., 2007), the mechanism whereby the factors impact on SCQR has received limited attention. By examining the effects of buyer dependence and supplier dependence, this study contributes to the SCRM study from the perspective of RDT. Although Ellis et al. (2010) also adopt the RDT to propose and examine the antecedents of the risk representation factors, the literature is limited to the perspective of environmental factors of supply markets. In line with the RDT, this study adds to the SCRM literature by directly observing how the dependency between buyer and supplier could impact on the managerial internalization of SCQR. Ketchen and Hult (2007) argue that interdependency between supplier and buyer might be helpful to establish a stable supply chain relationship and therefore help to manage the uncertainties in the supply chain. Given the inconsistent discussion of RDT in previous researches, the investigation of the roles of buyer dependence and supplier dependence in influencing the representation of SCQR can offer valuable insights for the development of RDT in OM research.

Moreover, drawing from the perspectives of agency theory, this study examined the roles of inability to test and inability to trace in the representations of SCQR, which responds to the call of Ellis et al. (2010) and Tse et al. (2016a) for scrutiny of additional antecedent factors. To the best of the author's knowledge, there is no research that identifies the situational factor in the risky decision-making process model through the lens of agency theory. While the agency problem has been researched extensively, the existing OM literature on this issue tends to focus on discussing its antecedents (Steinle et al., 2014), or on identifying the practices to manage the agency problem (Zu and Kaynak, 2012, Zsidisin and Ellram, 2003). Given that limited research has sought to understand the consequences of the agency problem, this study also contributes to the development agency theory in OM by scrutinizing how the inability to test and inability to trace could develop the perception of SCQR. According to the literature review, the operationalization of risk perception in the broad area of OM is short of comprehensiveness. In particular, the mixed results for the relationship between inability to test and representations of SCQR emphasize the necessity of investigating the risk perception from a multi-dimensional viewpoint. Specifically, if the researcher investigates only the magnitude of SCQR, the negative relationship between the inability to test and the probability of SCQR might be overlooked.

Furthermore, the associations between SCQR and customized QM practices (i.e. QELM and QERM) as studied in this research are not investigated in the existing literature. Drawing on the view of ambidexterity, Zhang et al. (2012) categorize the QM as two differently oriented practices. This study extends their research by linking the perception of SCQR with the intention to adopt QERM or QELM. This is also one of the few OM studies to understand the QM practices from a behavioural viewpoint. A key research implication is that managers' preference with regard to the QM strategies could be significantly driven by the risk perception. Specifically, the QERM with risk-taking orientation (Zhang et al., 2012) is negatively

associated with the risk perception, while the QELM with risk aversion orientation (Zhang et al., 2014) is positively associated with the risk perception. This study fills the research gap by identifying the drivers of (or barriers to) adopting the QM practices in the decision-making process. In addition, this study offers a contingency view of the organizational ambidexterity regarding the QM practices. Using a sample of Palestinian companies, Herzallah et al. (2017) propose and empirically verify the concept of quality ambidexterity, which describes a firm's ability to simultaneously pursue both QERM and QELM. Through examining the second-order model, this study also finds support for the existence of quality ambidexterity in the context of Chinese manufacturing. However, this study argues that if the decision makers perceive high SCQR, it may be hard for the company to achieve quality ambidexterity. To the best of the author's knowledge, this study is also one of very few attempts to scrutinize the role of risk perception in organizational ambidexterity.

Understanding the association between risk perception and adoption intention can overcome some of the methodological weaknesses in previous research of risk perception. For example, the methodological issue of *simultaneity*, which is one of the major concerns in endogeneity (Ketokivi and McIntosh, 2017, Zhang et al., 2017), exists when the independent variable and dependent variable simultaneously impact on each other, so that there might be a reciprocal feedback loop in the relationship between the two. Cheng et al. (2012) study the effect of the perceived supply risk on the strength of *Guanxi* (a form of informal relational governance mechanism). Although the significant effect of the perceived risk on the strength of *Guanxi* is empirically confirmed by the authors, there might be many reasons to believe that the strength of *Guanxi* could also easily impact on the perceived supply risk. Therefore, it could be problematic to assume the perceived risk as exogenous to the strength of *Guanxi*. A number of empirical and theoretical studies in the field of applied psychology and consumer research have underlined that risk perception is linked with the behavioural intention (Udo et al., 2010,

Nicolaou and McKnight, 2006, Yang et al., 2016, Thakur and Srivastava, 2014). Therefore, this study theoretically addresses the simultaneity problem through understanding the role of perceived risk in managers' intention to adopt the management practices.

8.5. Summary of Managerial Implications

This study provides several practical suggestions for managers to improve their decision making in managing the SCQR. Managers can directly apply the constructs in the model presented here (i.e. buyer dependence, supplier dependence, inability to trace and inability to test) to identify potential problems. For example, if the decision maker perceives great dependency in their upstream supply chain, they should be aware that SCQR might pose a threat to their company. The questionnaire items used in this research can act as a check list of the situational factors for companies' risk management planning. Through the lens of RDT, this study examines the relationships between the supply chain dependency and representations of SCQR. In order to increase the controllability and managers' confidence in dealing with the SCQR, the suggestion of this study is in line with the classic argument in RDT that buying firms should maximize the dependency of the supplier and, at the same time, minimize their own dependency upon the supplier. However, there are mixed results with regard to the risk probability and risk magnitude. To reduce the likelihood of SCQR occurrence, managers should focus on increasing the dependency of their supplier. Second, practitioners should be aware that supplier dependency is not a significant antecedent to the magnitude of SCQR. Therefore, increasing the supplier dependency may not be helpful for practitioners to manage the negative impact of SCQR. To minimize the magnitude of SCQR, this study suggests that practitioners prioritize the activities or actions that reduce their own dependence upon the suppliers.

The research findings also suggest the importance of enhancing traceability, to reduce all the risk factors of SCQR. However, the inability to test may affect the representations of SCQR in different ways. Next, given that the decision maker's intention to adopt particular QM practices is directly influenced by the overall perception of SCQR, This study suggests that managers should also consider incorporating other objective monitoring process and policies to assist in their decision making. For example, companies could adopt a benchmarking standard, such as the Malcolm Baldrige National Quality Award (MBNQA), to assess the quality risk from the upstream supply chain (Zsidisin et al., 2004). Specifically, according to Zsidisin et al. (2004), the pre-defined criteria in MBNQ can be examined in the following aspects: *"a. knowing the process of how to support suppliers' daily operations, b. identifying the key requirements for the support process, c. analysing the performance measures for improving and controlling the suppliers' processes"* (p.405). The findings of this study also have important implications for Chinese manufacturers that wish to achieve organizational ambidexterity. It has been widely accepted that a well-balanced combination of exploration and exploitation activities could enable an organization to be *"innovative, flexible, and effective without losing the benefits of stability, routinization, and efficiency"* (Simsek, 2009) (p. 603). However, the research findings show that imbalance of exploration and exploitation might be directly driven by the decision maker's perception of overall SCQR. Thus, a possible way to avoid the situation of imbalance in exploration and exploitation is to weaken the role of managers' subjective judgement and facilitate objective risk assessment in the decision-making process.

Finally, the model development and the empirical findings presented in this study provide a comprehensive picture of the risk perception mechanism, which can be applied to other areas, such as Finance and Investment Decision. The definition and valid measurement of the presentation of risk (i.e. probability, magnitude and psychological factor) can be applied to

study the risk perception of financial investors. Given the risk perception plays a critical role in the decision-making process, the comprehensive and rigour scales of risk perception that developed in this study provide a solid tool for the future research. The measurement scales verified in this study can also be adapted to the investor's risk appetite questionnaire (i.e. assessing the investor's attitude to investment risk) for the financial institutions.

8.6. Limitations and Future Research Recommendations

Although this research provides practical insights for understanding the SCQR, it does have some limitations, which need to be addressed by future research. Drawing from the agency theory and RDT, this study investigates only the factors related to supply chain dependency and supply chain visibility. In order to refine the current research model, more antecedent factors that may impact on probability of SCQR, magnitude of SCQR and overall perception of SCQR could be considered. For example, future research could investigate how environmental dynamism could affect the view of probability and magnitude of SCQR (Zhang et al., 2017).

Another limitation is that the model is observed from the perspective of a single nation, China. Although China is a global manufacturing hub, the results are not necessarily generalizable, and it is therefore suggested that future research could extend the current model to different country contexts. This study also suggests that future research could compare the risk perception of managers from developed and developing countries. Moreover, although questionnaire based research is widely adopted in the OM literature, this research method suffers some limitations with regard to understanding risk perception, such as common method bias and the endogeneity problem. Future research could adopt an experimental research design, such as functional magnetic resonance imaging (fMRI), to more accurately capture the risk perception.

As with other empirical research in the area of SCRM, this study is limited by a relatively small sample size. Although the power analysis conducted in a previous section indicated that the sample size of 316 has sufficient statistical power to explain the structural model, this study suggests that future research should consider a larger sample size to re-examine the theoretical model. Also, this study observes the cross-sectional data, which reflects only the current situation. Future research could design a longitudinal study to comprehensively analyse the dynamic relationships between the concepts of this thesis.

The use of single respondents is not without limitations, as it might cause the common method bias. However, several well-established statistical tests indicate that the threat of this potential bias is minimal. In addition, further studies could compare the objective assessment of SCQR with the perceived SCQR to understand whether the risk is overestimated or underestimated. It would also be stimulating to scrutinize in what situation the overestimation (or underestimation) of SCQR occurs.

Because of the research scope and the complexity of the theoretical framework, this study only considers the antecedents and perception of SCQR in a dyadic relationship between the focal company and its key supplier. Future study may consider extending the scope of investigation from upstream supply chain to downstream supply chain. For example, a potential research question would be *"How does the SCQR propagate from upstream supplier to downstream customer?"* With regard to adoption intention, this study scrutinizes the role of risk perception in the decision-making process. Nevertheless, if the researcher wishes to identify the appropriate management strategies to mitigate the SCQR, the concepts should be operationalized as the antecedents that could impact on the perceived probability of SCQR, perceived magnitude of SCQR, psychological factor and overall perception of SCQR. To avoid the issue of simultaneity, as mentioned previously, future research will need to consider a longitudinal research design. A possible research design is one in which the researcher can

collect the first round data for the actual adoption of different QM practices, such as employee quality training, supplier quality management and supplier involvement (Ahire and O'shaughnessy, 1998, Nair, 2006); then, the second round data can be collected for measuring the perceived SCQR.

As suggested by Ellis et al. (2011), by incorporating individual factors into SCRM research, a psychological factor that captures the characteristics of SCQR other than probability and magnitude is posited. Due to the context of SCQR, there are many other risk characteristics that were not investigated in this study, such as "voluntary" and "immediacy". (Slovic, 2000). Future researchers could further explore other risk characteristics within the psychological category in other risks contexts, such as supply disruption risk. Moreover, this research only investigates the direct effects of the theoretical factors. An interesting direction of the future research is investigating the interaction effect between the risk factors. For example, scholars may interest in examining the moderating effect of psychological factor on the effects of risk probability and magnitude on the overall perception of SCQR.

Last but not least, due to data availability, the objective data reporting the product quality, such as the qualification rate, was not available for this study. Thus alternative data from other sources, such as from insurance companies, could be compared with the perceptual measures of SCQR.

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APPENDIX A – SLR RESULTS ON MANAGERIAL RISK PERCEPTION

	Paper	Research Subject	Type of Risk	Relevant Variables		Adopted Theory	Method	Data Collection
				Antecedent	Outcome			
1	Ziaee Bigdeli et al. (2017)	CEO	Implementing advanced services	Knowledge and information regarding the service	Expected return	Not specified	Payment card method	14 interviews with managers from 7 companies
2	Wang et al. (2016)	Project manager	Risks associated with a construction project	Personality and risk propensity	Not specified	Not specified	Partial least square-SEM	Mail survey with 246 companies
3	Hajmohammad and Vachon (2016)	Supply manager	Sustainability risk	Not specified	Risk management strategies: a. risk avoidance; b. monitoring-based risk mitigation c. collaboration-based risk mitigation d. risk acceptance	Agency theory & resource dependence theory	Conceptual	Not specified
4	Kull et al. (2014)	Buyer	Risks associated with supplier selection situation	Sourcing category difficulty; sourcing category importance; proportion of contingent pay; percived supplier control; risk propensity	Selection risk-taking	Behavioural decision theory	Behavioural experiment	Mail survey with 119 supply chain professionals
5	Grudinschi et al. (2014)	Top manager	Relationship risks	Not specified	Trust; governance & administration; communication	Not specified	Partial least square-SEM	Mail survey with 216 companies
6	Lu and Yan (2013)	Project manager	15 risk factors associated with construction projects	Not specified	Not specified	Not specified	Spearman rank correlation coefficient	Mail survey with 76 project managers

								employed by contractors
7	Farahmand et al. (2013)	Top manager	Information security risks	Not specified	Information security decisions	Agency theory	Case study	42 interviews with information security executives
8	Rao et al. (2007)	Buyer	Financial risks	Not specified	Electronic marketplace usage	Not specified	Structural equations modeling	Mail survey with 359 professional buyers
9	de Camprieu et al. (2007)	Project Manager	Technical risk; market risk; environmental risk	Nationality; sex; age; occupation	Not specified	Not specified	Correlation coefficient	Mail survey with 138 project managers
10	Akintoye and MacLeod (1997)	Project manager	Risks associated with construction projects	Not specified	Potential completion of the project	Not specified	Descriptive statistics	Mail survey with 100 contractors and project managers
11	Oliveira and Handfield (2017)	Supply manager	Supply disruption risk	Buyer-supplier communication; supplier financial health; proactive contract negotiation	Not specified	Enactment theory	Structural equations modeling	Online survey with 216 companies
12	Shafiq et al. (2017)	Top manager	Supply risk: sustainability risk and operations risk	Not specified	Environmental monitoring, social monitoring and supplier involvement	Agency theory	Structural equations modeling	Mail survey with 623 companies
13	Ellis et al. (2011)	Buyer	Supply disruption risk	Enactment: early supplier involvement; logistics integration; supplier development; contingency planning	Cognitive cause map	Enactment Theory	Conceptual	Not specified

14	Ellis et al. (2010)	Purchasing manager	Supply disruption risk	Technological uncertainty; market thinness; item customization; item importance	Switching to alternative supplier	Resource dependence theory and economic transaction cost	Structural equations modeling	Mail survey with 223 companies
15	Dillon and Tinsley (2008)	Contractors	Not specified	Near-miss information	Not specified	Not specified	Experiment	Mail survey with 236 respondents
16	Baker (2007)	Supply chain manager	Supply chain risks	Not specified	Risk mitigation strategies: total quality management; safety stock; collaboration with customer and third party logistics companies	Inventory control theory	Case study	Interview and questionnaire survey with six companies
17	Mantel et al. (2006)	Supply manager	Strategic vulnerability	Number of suppliers; cost implications; information sufficiency	Likelihood to outsource	Behavioural decision-making theory	Behavioural experiment	Mail survey with 302 respondents
18	Tiwana and Keil (2006)	Management informaton directors	Project functionality risk	Related technical knowledge; customer involvement; requirements volatility; methodological fit; formal project management practices; project complexiity	Not specified	Information integration theory	Multiple regression	Online survey with 60 managers in 60 companies
19	Delerue-Vidot (2006)	Managers	Opportunistic behavior of business partner	Unilateral commitments; relational capital	Not specified	Social campital theory	Multiple regression	Mail survey with 344 managers
20	Koudstaal et al. (2016)	Entreprenurs, managers and employees	Financial risk	Job position; age; gender; education; experience; salary	Not specified	Prospect theory	Experiment and multiple regression	1,607 entrepreneurs, 662 managers and 1,950 employees

21	Swierczek (2016)	Manager	Supply disruption risks	Span of supply chain integration	Transmission of disruptions	Network theory, contagion theory and system thinking	Cluster analysis	Mail survey with 190 companies
22	Tran et al. (2016)	Supply chain manager	Risk associated with information sharing	Not specified	Frequent communication; partner selection; honest and open transaction; formal contract; ongoing collaboration and personal relationship management	Not specified	Case study	Interviews with 11 companies in New Zealand
23	Wu and Wu (2014)	Manager	Risk associated with implementing green management	Not specified	Attitudes toward green management strategies	Theory of planned behaviour	Structural equation modelling	Mail survey with 333 companies
24	Gilkey et al. (2012)	Manager and worker	Risks associated with construction project	Job position	Not specified	Not specified	ANOVA	Survey with 42 managers and 183 frontline construction workders
25	Djeflat (1998)	Manager in focal company	Supply side risks and demand side risks	Not specified	Tendency toward long-term relationships; removal of trust element from the relationship	Not specified	Conceptual	Not specfied
26	Henthorne et al. (1993)	Buyer	Performance, social and economic risks	Locus of control; years of experience	Not specified	Not specified	Multivariate analysis of variance	Mail survey with 329 buyers
27	Cheng et al. (2012)	Manager	Supply risk	Not specified	Guanxi (i.e., informal relationship) development	Social capital theory	Structural equation modeling	Mail survey with 188 companies

28	Schoenherr (2010)	Manager	Purchase risk	Not specified	Purchase performance	Agency theory	Chi-squared contingency	Mail survey with 806 companies
29	Gualandris and Kalchschmidt (2013)	Supply chain manager	Supplier failure	Product modularity; process modularity and flexibility	Not specified	Normal accident theory	Payment card method	Mail survey with 54 companies
30	Truong Quang and Hara (2017)	Managers	Supply chain risks: external risk, time risk, information risk, financial risk, supply risk, operational risk, demand risk	Not specified	Supply chain performance	Not specified	Structural equation modeling	Mail survey with 283 compaines
31	Brusset and Teller (2017)	Supply chain members	Supply chain risks: external risks, supplier risks and customer risks	The authors tested the moderating effect of supply chain risk on the relationship between resilience in supply chains and three capabilities: external capabilities, integration capabilities and flexibility capabilities		Not specified	Partial least square-SEM	Web-based survey with 171 companies
32	Zsidisin (2003a)	Managers	Supply risks	Not specified	Not specified	Not specified	Case study – grounded theory	Interview with seven purchasing organisations
33	Zsidisin (2003b)	Buyer	Supply risk	Item characteristics; market characteristics; supplier characteristics	Not specified	Not specified	Case study	Interview with seven companies
34	Zsidisin and Ellram (2003)	Purchasing professionals	Supply risks	Not specified	Buffer-oriented techniques and behaviour-based techniques	Agency theory	Multiple regression	Mail survey with 261 companies
35	Zsidisin and Smith (2005)	Managers	Supply risks	Not specified	Early supplier involvement	Agency theory	Case study	Interview with six managers

36	Zarkada-Fraser and Fraser (2002)	Marketing manager	Political risk	Not specified	Market entry decisions	International marketing theory	Descriptive statistics	Mail survey with 37 UK firms

APPENDIX B - INFORMATION SHEET

Managerial Perception of Supply Chain Quality Risk

Information Sheet

Can you help us?

We would like to invite you to take part in a research project. This information sheet is to introduce the background of the research project and to ask you if would like to complete the questionnaire.

The aim of the project

In recent years, consumers have become increasingly concern about a series of product harm scandals and doubt to the ability of industries to assure the production safety and supply chain quality. The aim of the study is to understand how top manager perceive the supply chain quality risk (SCQR) and how they make decision after they perceive the SCQR. Particularly, we are interested in identifying your successful risk management practice to reduce SCQR.

Who is doing the study?

The study is based at the The York Management School at the University of York and is being conducted by Minhao ZHANG, who is completing his PhD research.

What would you have to do if you take part?

We would like to send you an online questionnaire hyperlink via email once you accept our invitation. After reading this information sheet you can accept the question "do you consent to this questionnaire?" at the beginning of the questionnaire and continue to complete it.

You just need to take 15 – 20 minutes to finish the online questionnaire. The questionnaire is about your perception of SCQR and how you deal with the SCQR. The aim of the questionnaire is to collect information on managerial views of the SCQR and the winning risk management practices.

It's private and confidential

All questionnaires will be completed anonymously; the researcher will not know who has completed each questionnaire. The research will only be seen by the researcher and his project tutors.

The responses you provide will be used in the researcher's dissertation; direct quotes may be taken from the material but will remain completely anonymous. All information collected from you will be destroyed within 18 months of the research taking place, with the exception of the facts printed.

At the end of the questionnaire there is a question that asks whether you would to receive the feedback of this study. This would be done by sending a short report to you by email three months after the research finished. If you don't mind me doing this, please tick the box and add your name and email address. Otherwise, just leave it blank.

If I agree to complete a questionnaire now, can I change my mind?

Yes, indeed, you can withdraw from the questionnaire at any time throughout completion. Simply do not submit the questionnaire and close your browser. You are free to return and complete the online questionnaire at any time.

Any questions?

If you would like to talk to us more about the project, or if you have any questions about it, please do telephone or write to us.

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Date: 1 October 2016

Thank you for reading this leaflet!

APPENDIX C – QUESTIONNAIRE (ENGLISH)

UNIVERSITY of York

Managerial Perception of Supply Chain Quality Risk

Many thanks for your participation of this survey. Your information will be valuable to our research project about managerial perception of supply chain quality risk (SCQR). The aim of this survey is to identify how the decision-maker of a manufacturing company perceive SCQR and how will the decision-maker adopt quality management practice when facing SCQR. All questionnaires will be completed anonymously. The responses you provide will be used in the researcher's dissertation; direct quotes may be taken from the material but will remain completely anonymous.

Have you read, or has someone read to you, the Information Sheet about the project?	Yes ❒ No ❒
Do you understand what the project is about and what taking part involves?	Yes ❒ No ❒
Do you understand that the project is strictly private?	Yes ❒ No ❒
Do you understand that the information you provide may be used in future research?	Yes ❒ No ❒
Do you know that, if you decide to take part and later change your mind, you can leave the project any time without giving a reason before publication?	Yes ❒ No ❒
Would you like to take part in the 'Managerial perception of supply chain quality risk' project?	Yes ❒ No ❒
If yes – is it OK to take the online questionnaire?	Yes ❒ No ❒

Once you answer the above questions, you can start to answer our questionnaire in next page.

Part A Background Information

A1. Your Position in your firm：_____

A2. Which industry sector your company belong to：

1. Computing Machinery
2. Radio, television & communication equipment
3. Automotive
4. Chemicals and Pharmaceutical
5. Rubber and miscellaneous plastics products
6. Furniture and fixtures

A3. What is your company's ownership?

1. Local Enterprises
2. Sino-Foreign Joint Venture
3. Foreign-Owned Enterprise

A4. How many full-time employees work for your company?

1. ≤50
2. 51-300
3. 301-2000
4. >2000

A5. What is the annual sales of your company (CNY ¥)?

1. ≤10 Million
2. 10 Million – 30 Million
3. 30 Million – 50 Million
4. 50 Million – 200 Million
5. >200 Million

Part B: Please indicate your level of agreement to the following statement:								
		Strongly Disagree	←				→	Strongly Agree
PR1	There is a high probability that the key supply material from the key supplier cannot meet the quality standards.	1	2	3	4	5	6	7
PR2	There is a high probability that the key supplier will be unable to commit to quality improvement of the key supply material.	1	2	3	4	5	6	7
PR3	There is a high probability that the key supplier will not supply the major raw material as specified within our purchase agreement.	1	2	3	4	5	6	7
PR4	We never experience that the key supplier cannot maintain the quality of the key material.	1	2	3	4	5	6	7
PR5	There is a high probability that the key supplier will supply us the key supply material with poor quality packaging.	1	2	3	4	5	6	7
PR6	There are always unforeseen issues in logistics that will have an impact on the key supplier's ability to supply the key material with good quality.	1	2	3	4	5	6	7
PR7	We are always not confident in the key supplier's ability to maintain the quality of its production.	1	2	3	4	5	6	7
MA1	A lack of awareness of the usage of defective purchased material in our product would have severe negative financial consequences for our business.	1	2	3	4	5	6	7
MA2	We would incur significant costs and/or losses in revenue if we were unaware of the usage of defective purchased material in our product.	1	2	3	4	5	6	7
MA3	Key suppliers' inability to supply qualified material that conforms to agreed specifications would seriously jeopardize our business performance.	1	2	3	4	5	6	7
MA4	The quality problem of the key material supply from our key supplier will significantly and negatively impact our production.	1	2	3	4	5	6	7
MA5	The quality problems that occur in the logistics process will cause significant customer loss.	1	2	3	4	5	6	7

MA6	The supply of major raw materials with poor quality is NOT a big deal to our company.	1	2	3	4	5	6	7
MA7	The quality risks are of concern as a huge factor that could interrupt the company's supply chain.	1	2	3	4	5	6	7
PSY1	Please rate to what extent you can avoid the negative impact of the supply chain quality problems happening to your company through your personal knowledge and experience, if exposed to this risk. (1=Controllable; 7=Uncontrollable)	1	2	3	4	5	6	7
PSY2	Do you think the supply chain quality problems can be easily reduced or are they hard to reduce? Please rate the difficulty of this risk. (1=Easily; 7=Difficult)	1	2	3	4	5	6	7
PSY3	Are the supply chain quality problems ones that you can think about reasonably calmly or are they the risks that you truly dread? Please rate the level of dread potential. (1=Low dread; 7=High dread)	1	2	3	4	5	6	7
PSY4	Do you think the company will go bankrupt if you have serious product quality problems? Please rate how likely it is that the consequences will be fatal, if the risk is realised in the form of a mishap. (1=Not fatal; 7=Fatal)	1	2	3	4	5	6	7
PSY5	Overall, are supply chain quality problems preventable or non-preventable? (1=Preventable; 7=Non-preventable)	1	2	3	4	5	6	7
PSY6	Are supply chain quality problems the ones that you worry will threaten you personally (e.g. job position, salary etc.) or it does it not matter to you? (1= No Impact; 7 = Great Impact)	1	2	3	4	5	6	7
PSY7	Do you think the negative effects of the supply chain quality problem are likely to occur immediately or at some later time? Please rate the immediacy of the effect of this risk. (1=Immediate, 7=Delayed)	1	2	3	4	5	6	7
PSY8	Do you think the supply chain quality problems are known precisely by the managers who are exposed to these risks? Please rate the extent to which you think the risk is known to those who are exposed to it. (1=Known Precisely; 7=Not Knowns)	1	2	3	4	5	6	7

TES1	Some of the testing procedures for our supply materials/components are destructive.	1	2	3	4	5	6	7
TES2	There is no appropriate guideline to test the supply materials/components.	1	2	3	4	5	6	7
TES3	The supply materials/components should be tested by a complex method.	1	2	3	4	5	6	7
TES4	The tests for our supply materials/components are not straightforward.	1	2	3	4	5	6	7
TES5	We need to allocate more resources (e.g. staff training or purchasing new equipment) than in the past to obtain a reliable test result.	1	2	3	4	5	6	7
TRA1	The origins of the supply materials/components are hard to trace.	1	2	3	4	5	6	7
TRA2	Tracing the supply materials/components is time consuming.	1	2	3	4	5	6	7
TRA3	The accuracy of the tracing information of the supply materials/components is uncertain (e.g. production time, batch number and product conditions).	1	2	3	4	5	6	7
TRA4	It is hard to obtain timely, accurate and complete information from our suppliers and sub-tier suppliers regarding our supply materials/components.	1	2	3	4	5	6	7
TRA5	Establishing the product tracking system (e.g. radio frequency identification devices [RFID]) for our supply materials/components is unaffordable.	1	2	3	4	5	6	7
BD1	Switching to a new supplier for our key supply materials/components would take a lot of effort.	1	2	3	4	5	6	7
BD2	We do not have a good alternative to the supplier for our key supply materials/components.	1	2	3	4	5	6	7
BD3	We are very dependent on the supplier who supplies us with the key supply materials/components.	1	2	3	4	5	6	7
BD4	There are many competitive suppliers for our key supply materials/components.	1	2	3	4	5	6	7

BD5	Our production system can be easily adapted to use the key supply materials/components from a new supplier.	1	2	3	4	5	6	7
SD1	Replacing us would require a lot of effort by the supplier who supplies key materials/components to us.	1	2	3	4	5	6	7
SD2	The supplier who supplies key materials/components to us does not have a good alternative to replace us.	1	2	3	4	5	6	7
SD3	The supplier who supplies key materials/components to us is very dependent on us.	1	2	3	4	5	6	7
SD4	The supplier who supplies key materials/components to us will perform poorly if our operations do not perform well.	1	2	3	4	5	6	7
SD5	If their relationship with our company were terminated, it would *not* hurt this key supplier's operations.	1	2	3	4	5	6	7
QERM1	Continually improving all aspects of products and processes, rather than taking a static approach.	1	2	3	4	5	6	7
QERM2	Consulting our customers early in the design efforts for our product.	1	2	3	4	5	6	7
QERM3	Encouraging the employees of our company to learn how to perform a variety of tasks.	1	2	3	4	5	6	7
QERM4	Encouraging our manufacturing team members to work interactively with each other for cross-functional cooperation.	1	2	3	4	5	6	7
QELM1	Monitoring the production processes using statistical process control.	1	2	3	4	5	6	7
QELM2	Regularly surveying our customers' needs.	1	2	3	4	5	6	7
QELM3	Holding frequent group meetings where our team members can really discuss things together.	1	2	3	4	5	6	7
QELM4	Providing training and development in existing workspace skills, on a regular basis.	1	2	3	4	5	6	7

APPENDIX D – QUESTIONNAIRE (CHINESE)

管理者的供应链质量风险感知

非常感谢您对这次博士论文调研（英国约克大学）的支持。您所提供的信息将对管理者的供应链质量风险感知这个项目起着深远的作用。本次调研有两个主要目标：第一个目标是找出中国管理者如何感知供应链质量风险研究；第二个目标是观察中国管理者是如何利用不同的质量管理方案去应对这些风险的。本问卷采用匿名调查的方式，我们将保证您的信息严格保密。您在本问卷上的信息将仅供研究者的学术之用，不作其他用途。

您是否阅读（或者他人告知您）关于本次研究的信息表？	是❒ 否 ❒
您是否明白本次研究的意义以及本次研究的相关内容？	是❒ 否 ❒
您是否明白本次研究将会严格保密？	是❒ 否 ❒
您是否明白您所提供的信息将有可能用在将来的研究上？	是❒ 否 ❒
您是否知晓在本研究被发表前，您可以不用提供任何理由退出这个项目？	是❒ 否 ❒
最后您是否愿意参与到“管理者的供应链质量风险感知”这个项目中？	是❒ 否 ❒
如果您愿意参与，我们是否可以开始本次在线问卷调研？	是❒ 否 ❒

当您回答完以上所有问题，您将在本问卷的下一页中开始作答我们的问题。

Part A 背景信息

A1. 您在贵公司的职位是：_____

A2. 贵公司属于以下哪一个行业：

1. 计算机及机械设备
2. 通讯设备
3. 汽车制造业
4. 化学原料及化学制品
5. 塑料制品
6. 家具制品

A3. 贵公司的所有权？

1. 本地企业
2. 中外合营企业
3. 外资企业

A4. 贵公司有多少全职员工?

1. ≤50
2. 51-300
3. 301-2000
4. >2000

A5. 贵公司的年销售额 (CNY ¥)?

1. ≤10 Million 少于一千万
2. 10 Million – 30 Million 一千万至三千万
3. 30 Million – 50 Million 三千万至五千万
4. 50 Million – 200 Million 五千万至两亿
5. >200 Million 多于两千万

Part B: 请指出您对以下论述的同意程度： 1=非常不认同；7=非常认同								
		非常不认同	⟷					非常认同
PR1	有很大几率我们会遇到主供应商不能保证关键供应品质量的情况。	1	2	3	4	5	6	7
PR2	有很大几率我们的主供应商无法承担对关键供应品的质量提高责任。	1	2	3	4	5	6	7
PR3	有很大几率我们的主供应商无法根据我们购货协议上的质量要求来提供主要原材料。	1	2	3	4	5	6	7
PR4	我们从未遇到过主供应商向我们提供不符合质量要求的原材料的情况。（反向问题）	1	2	3	4	5	6	7
PR5	很大几率我们会遇到主供应商的供应品有包装质量问题。	1	2	3	4	5	6	7
PR6	在货物运输过程中，我们很可能遇到由于运输不慎引起的产品包装损坏。	1	2	3	4	5	6	7
PR7	我们总是对主供应商的生产质量提出质疑。	1	2	3	4	5	6	7
MA1	关键原材料的质量问题会造成我们公司重大的商业损失。	1	2	3	4	5	6	7
MA2	关键原材料的质量问题会让我们产生巨额的成本和收入损失。	1	2	3	4	5	6	7
MA3	如果主供应商的供应品出现质量问题会严重危害公司的商业表现。	1	2	3	4	5	6	7
MA4	如果主供应商的供应品出现质量问题会严重耽延公司的生产流程。	1	2	3	4	5	6	7
MA5	在运输过程中出现的质量问题会造成严重的客源流失。	1	2	3	4	5	6	7
MA6	原材料的质量问题对我们公司并不重要。（反向问题）	1	2	3	4	5	6	7
MA7	原材料中的质量风险是导致供应链的中断的一个重大因素。	1	2	3	4	5	6	7
PSY1	作为管理者，您个人认为通过您的个人知识和经验，能多大程度下避免质量风险给公司	1	2	3	4	5	6	7

	带来得的负面影响？请打分。（1=可控的，7=不可控的）							
PSY2	作为管理者，您个人认为供应链质量风险是可以容易地还是困难地处理的？请打分。（1=容易地，7=困难地）	1	2	3	4	5	6	7
PSY3	作为管理者，如果您的产品遇到严重的质量问题，您个人认为您是否可以沉着冷静地去思考的还是会让您感到比较恐慌？请打分。（1=低恐慌程度，7=高恐慌程度）	1	2	3	4	5	6	7
PSY4	作为管理者，您个人会担心公司因为严重的产品质量问题而破产吗？如果这些风险不幸地发生了，您觉得这些后果会有多致命？请打分。（1=不致命的，7=致命的）	1	2	3	4	5	6	7
PSY5	总体而言，供应链质量风险是可以预防还是不可预防的？ (1=可预防的，7=不可预防的)	1	2	3	4	5	6	7
PSY6	您认为供应链质量风险会影响到您个人吗（例如对职位及薪水的影响）？（1=没有影响，7=很大影响）	1	2	3	4	5	6	7
PSY7	你认为这些风险会慢慢地拖垮损害公司（慢性风险）还是会导致公司的立即破产？请打分。（1=慢性的，7=急性的）	1	2	3	4	5	6	7
PSY8	作为管理者，您个人认为供应链质量风险是旧和熟悉的还是完全陌生的？请打分。（1=完全旧的、很熟，7=完全陌生的）	1	2	3	4	5	6	7
TES1	我们一些测试程序会对我们的供应品造成损害。	1	2	3	4	5	6	7
TES2	我们没有合适的指引去测试供应品的质量。	1	2	3	4	5	6	7
TES3	我们需要用很复杂的方法来检测供应品的质量。	1	2	3	4	5	6	7
TES4	我们对供应品的检测程序并不直观。	1	2	3	4	5	6	7
TES5	我们需要比以前需要分配更多的资源（例如员工培训和购买新的设备）去获得可靠的测试结果。	1	2	3	4	5	6	7
TRA1	有些材料的来源是追查不到的，例如二级供应商。	1	2	3	4	5	6	7

TRA2	我们需要花费很多时间去追查供应品组件的来源地。	1	2	3	4	5	6	7
TRA3	追查材料来源的准确性是不确定的（例如生产时间，生产批次以及产品状况）。	1	2	3	4	5	6	7
TRA4	我们很难获得及时，准确及完整的一级及二级供应商信息。	1	2	3	4	5	6	7
TRA5	我们支付不起建立产品追溯系统（例如RFDI）的费用。	1	2	3	4	5	6	7
BD1	我们很难做到随时更换我们的主供应商。	1	2	3	4	5	6	7
BD2	在我们的主供应品上，我们很难找到可以替代我们现有主供应商的公司。	1	2	3	4	5	6	7
BD3	我们很大程度上依赖我们的供应商提供我们的主供应品。	1	2	3	4	5	6	7
BD4	在我们的主供应品上，外面有很多有竞争力的供应商。（反向问题）	1	2	3	4	5	6	7
BD5	我们的生产系统能很容易就适应新供应商的部件。（反向问题）	1	2	3	4	5	6	7
SD1	我们的主供应商很难找到新的买家替代我们公司。	1	2	3	4	5	6	7
SD2	除了我们，我们的主供应商并没有其他很好的买家。	1	2	3	4	5	6	7
SD3	我们的主供应商非常依赖于我们公司。	1	2	3	4	5	6	7
SD4	如果我们公司的营运表现不好的话，我们主供应商的绩效也会受到负面影响。	1	2	3	4	5	6	7
SD5	如果我们和供应商终止合作，他们的经营不会受到很大影响。（反向问题）	1	2	3	4	5	6	7
QERM1	我们努力持续地提升产品和生产流程的所有方面，而不是采取一成不变的方法。	1	2	3	4	5	6	7
QERM2	我们在产品设计早期有进行向顾客的咨询。	1	2	3	4	5	6	7
QERM3	我们公司会鼓励员工学习怎样处理各种各样的任务。	1	2	3	4	5	6	7

QERM4	我们会鼓励我们生产团队的成员和其他部门的员工进行跨部门合作。	1	2	3	4	5	6	7
QELM1	为了避免产品质量缺陷，我们用精密的统计管理来监测我们的生产过程。	1	2	3	4	5	6	7
QELM2	我们会定期调查客户的需求。	1	2	3	4	5	6	7
QELM3	举行频繁的生产小组会议让我们的成员可以讨论在生产中遇到的问题。	1	2	3	4	5	6	7
QELM4	我们会定期地训练和巩固员工的现有技能。	1	2	3	4	5	6	7