GRADUATE SCHOOL OF ECONOMICS

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Risks and Performance in the Supply Chain

- An Empirical Study in Vietnam Construction Sector –

(サプライチェーンにおけるリスクとパフォーマンス

- ベトナム建設業における実証研究 -)

By:

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I am truly grateful and words cannot express my appreciation.

DEDICATION

This thesis is dedicated to my family, especially my wife and my parents, for their love, encouragement and support in all aspects of my life. I am endlessly grateful for their sacrifice and I recognise my good fortune in being part of such a considerate family. Without them, this journey in search of knowledge would have been unbearable. Thank you all for believing in me.

ABSTRACT

Risk can be described as a chance of danger, damage, loss, injury or any other undesired consequences (Harland et al. 2003). It is the fact that risks can exist in virtually all firms, even though the firms did everything very well, risks are still prevalent (Ho et al. 2015). There are so many academicians aim at quantifying the potential degree of risks (Truong Quang and Hara 2015). Some researchers examined the effect of **each risk** on different outputs (Lockamy III and McCormack 2012, Lockamy III 2014). Meanwhile, others aim at a wider picture covering various risks in the SC network (Ho et al. 2015, Wagner and Bode 2008).

Naturally, examining a certain risk will provide an insight into a single dimension, but a picture covering various risks in the supply network is still lacking (Ho et al. 2015, Shenoi et al. 2016), as risks do not take place independently, but typically simultaneously (Truong Quang and Hara 2016a). This can be a reason that leads to solutions of risk prevention not to achieve desired outcomes, since risk mitigation plans only focus on each single risk (Truong Quang and Hara 2017a). More badly, in an adverse situation, numerous risks simultaneously occur, if there are no appropriate contingency plans, it will engender extremely devastating consequences to firms/ their SC (Truong Quang and Hara 2016b). Wagner and Bode (2008) indicated that a risk, when it occurs, can cause a domino effect, for instance, by empirical data at 760 German-based firms, the authors found that risks of information and finance can lead to the emergency of supply-, manufacturing- and demand risks.

The modern-day industry has evolved from the time of its relentless focus on manufacturing process independently to provide a manufacturing and associated service(s) of the highest degree as a bundled offering (Truong Quang and Hara 2017g). Thus, it is difficult to distinguish a service-oriented firm and a manufacturing-oriented firm (Truong Quang and Hara 2017f). In this perspective, tangible goods serve as appliances rather than ends in themselves (Truong Quang and Hara 2017b). Firms may find opportunities to retain ownership of goods and merely charge a user fee (Ohlemacher 1999; Harrington 2002), hence finding a competitive advantage by focusing on the entire process of consumption and use (Truong Quang and Hara 2017c).

This transformation has led to the emergence of unknown risks, the impact of risk on the supply chain also varies and the mismatch of the current risk mitigation strategies (Truong Quang and Hara 2017g).

Dealing with this situation, this research concentrates on four following study objectives:

(1) To propose a conceptual framework of various risks in the supply chain.

(2) To evaluate the push effect of risks on supply chain performance.

(3) To validate the mechanism of the push effect at service-oriented firms.

(4) To compare risk behaviours between service-oriented firms and manufacturing-oriented firms.

As a result, by applying SC mapping - a new approach in the SC risk body of literature, various risks in the supply network were identified. These risks are not independent, as multiple risks occur simultaneously. They have links, creating a "push" effect, thus increasing the severity of each and all risk(s) on supply chain performance (Truong Quang and Hara 2017d). Empirical evidence found at 283 Vietnam construction companies proved that by the push effect, the impact of each and all risk(s) on supply chain performance is greater than each and total of single effects(s), explaining up to 73% variance of supply chain performance. Moreover, the mechanism of the push effect is also confirmed at 192 service-oriented firms, a new trend in the now-a-day industry, as risks can explain up to 65% variance of SC performance compared with 52% of the model without push effect. Also, the differences of risk behaviours between service-oriented firms and manufacturing-oriented firms were distinguished by the theory of Goods Dominant Logic and Service Dominant Logic. Accordingly, risks existing at the manufacturing-oriented group have a greater effect on supply chain performance (92%) than service-oriented firms (61%). Manufacturing-oriented companies should pay much attention on operational and demand risks that adversely affect SC performance and "treat" information risk as an opportunity. Meanwhile, for service-oriented companies, it is necessary to manage supply risk which can explain 58.7% variance of SC performance. In addition, service quality will be improved remarkably if information risk is well managed.

There are some contributions of this research to the supply chain risk management literature, being:

i. By the SC mapping approach, a technique that was recommended for a long time but were not used popularly in the SC risk body, a conceptual framework that covers various dimensions of risks in the SC network is proposed and validated by empirical data at Vietnam construction sector. This can be a premise for the next phase, e.g. risk assessment (the push effect), mitigation and monitoring. Moreover, from practical points, by the proposed supply chain map, firms will have a visible and systematic view, whereby they can highlight critical SC risks in their context, so resources can be allocated appropriately and pertinent strategies implemented to mitigate risks.

ii. Understanding the model of the push effect among SC risks, firms can predict the "real" degree of danger of risks on performance in their SC and mitigate the effect of risks in the entire supply chain network. Practitioners and managers can apply the resultant model as a "road map" in their context to achieve this purpose.

iii. It is worth noting that the application of the Goods Dominant Logic and Service Dominant Logic theory to classify manufacturing-oriented firms and service-oriented firms is also a "novelty of approach" of this study. Different characteristics between two compared groups are identified and explained with respect to resources, value, network, effectiveness vs efficiency and communication, providing an insight into risk management activities in the supply chain network (Truong Quang and Hara 2017f).

iv. Last but not least, another contribution with regard to supply chain performance. In attempting to have a comprehensive performance scale, this study utilized the balance scorecard model to define a set of measures for SC performance, supplier performance, internal business, innovation and learning, customer service and finance that are more contemporary, intangible and strategic-oriented.

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List of Abbreviation

AVE: Average variance extracted

CAIC: Consistent Akaike Information Criterion

C.R: Critical ratio

CFA: Confirmatory factor analysis

CFI: Comparative fit index

CR: Composite reliability

EFA: Exploratory factor analysis

PGFI: Parsimony Goodness-of-Fit Index

KMO: Kaiser Meyer- Olkin

NFI: Normed Fit Index

PNFI: Parsimony Normed Fit Index

R^2: Squared Factor Loading

RMR: Root Mean Square Residual

RMSEA: Root Mean Square Error of Approximation

ROI: Return on Investment

SC: Supply Chain

SCRM: Supply Chain Risk Management

SEM: Structural Equation Modelling

SPSS: Statistical Package for Social Sciences

SRMR: Standardized Root Mean Square Residual

TLI: Tucker Lewis Index

$\chi 2$: Chi-square

CHAPTER 1: INTRODUCTION

This chapter describes problems that the research aims at dealing with and then research objectives, methods, context, theoretical and practical contributions will be discussed before the research structure is introduced.

1.1 BACKGROUND

In recent years, a fairly new research area has become apparent on the supply chain management theme: Supply chain risk management (SCRM) (Trkman et al. 2016). This topic has received numerous attention from both academics and practitioners due to two reasons:

- First, a recent series of crises and natural disasters has attracted public attention, e.g. the Hurricane Irma in the Atlantic (2017), the earthquake, tsunami and the subsequent nuclear crisis in Japan (2011), the flood in Thailand (2011), the terrorist attacks of September 11, etc., are warnings that we live in an unpredictable and increasingly unstable world (Truong Quang and Hara 2017g). Moreover, there are strong signals that such catastrophic events are becoming more recurrent (Natarajarathinam et al. 2009).
- Supply chains have become increasingly vulnerable to disruptions (Truong Quang and Hara 2017c). Systems of the chain seem to be more lengthy and complex, reflecting the dynamic and global marketplace (Truong Quang and Hara 2017g). According to an annual survey of Business Continuity Institute in 2015, organizations face today more than 24 sources of risks, with different levels of impacts and consequences. The most common consequences of these risks are the loss of productivity (58%), customer complaints (40%) and increased cost of working (39%), with cumulative losses of at least €1 million per year due to supply chain disruptions (Truong Quang and Hara 2017g). Although supply chain management initiatives have a great potential to make operations leaner and more proficient in a steady environment, they concurrently increase the fragility and vulnerability of supply chains to disruptions (Wagner and Bode 2008).

Risk can be described as a chance of danger, damage, loss, injury or any other undesired consequences (Harland et al. 2003). It is the fact that risks can exist in virtually all firms, even though the firms did everything very well, risks are still prevalent (Ho et al. 2015). However, the number of risk identification studies are quite limited, especially empirical research. In other words, *it is imperative to have a conceptual framework covering various risks in the supply chain network and validated by empirical data (Truong Quang and Hara 2017).*

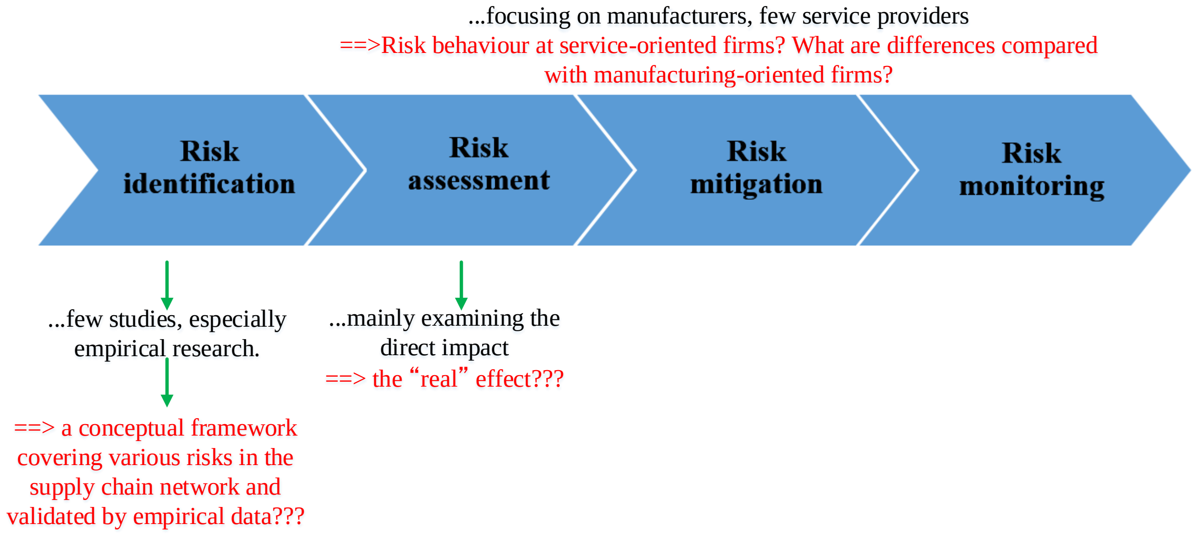

Figure 1.1: Risk management process and research gaps

There are so many academicians aim at quantifying the potential degree of risks (Truong Quang and Hara 2015). Some researchers examined the effect of **each risk** on different outputs (Lockamy III and McCormack 2012, Lockamy III 2014). Meanwhile, others aim at a wider picture covering various risks in the SC network (Ho et al. 2015, Wagner and Bode 2008).

Naturally, examining a certain risk will provide an insight into a single dimension, but a picture covering various risks in the supply network is still lacking (Ho et al. 2015, Shenoi et al. 2016), as risks do not take place independently, but typically simultaneously (Klüppelberg et al. 2014, Truong Quang and Hara 2016a). This can be a reason that leads to solutions of risk prevention not to achieve desired outcomes, since risk mitigation plans only focus on each single risk (Truong Quang and Hara 2017a).

More badly, in an adverse situation, numerous risks simultaneously occur, if there are no appropriate contingency plans, it will engender extremely devastating consequences to firms/ their SC (Truong Quang and Hara 2016b). Wagner and Bode (2008) indicated that a risk, when it occurs, can cause a domino effect, for instance, by empirical data at 760 German-based firms, the authors found that risks of information and finance can lead to the emergency of supply-, manufacturing- and demand risks.

Let take a concrete example, considering a building which is attacked by an earthquake and a flood. If it is situated on the Japanese coast, an earthquake occurring may destroy the building and cause a tsunami arising at the same time, which in turn floods the building (Truong Quang and Hara 2017d). The Tōhoku earthquake and powerful tsunami waves in Miyako, Tōhoku's Iwate Prefecture, Japan on 11/3/2011 is an evidence for this example. Only 6 minutes but cause huge loss of people and wealthy. Estimated economic cost was US$235 billion, making it the costliest natural disaster in history. Hence, it is quite likely that there is a strong positive dependence between these two risks, e.g. the earthquake, when it occurs, not only detrimentally affects the building but the flood is also influenced (Truong Quang and Hara 2017g). Consequently, the degree of danger of the flood will increase as becoming the tsunami, causing a greater effect on output (Truong Quang and Hara 2017d). *This relationship is defined as the "push" effect that still missing in the literature* (Truong Quang and Hara 2017).

Moreover, the modern-day industry has evolved from the time of its relentless focus on manufacturing process independently to provide a manufacturing and associated service(s) of the highest degree as a bundled offering (Truong Quang and Hara 2017g). In this perspective, tangible goods serve as appliances rather than ends in themselves (Truong Quang and Hara 2017b). Firms may find opportunities to retain ownership of goods and merely charge a user fee (Ohlemacher 1999, Harrington 2002), hence finding a competitive advantage by focusing on the entire process of consumption and use (Truong Quang and Hara 2017c). For example, Chauffagistes, an electrical equipment company in France, has realized that buyers do not want to buy furnaces, air conditioners or units of energy, but comfort, therefore their business now contract to keep floor space at an agreed temperature range and an accepted cost. Customers pay for their "warmth service," and the company profits by finding innovative and efficient ways to provide these services rather than sell more products. Similar examples are found in the United States, where Carrier is providing "comfort leasing," or Dow Chemical is offering "dissolving services" while maintaining the responsibility for disposing and recycling toxic chemicals. Therefore, it is said that these firms do not make and sell units of output but to produce customized services to customers, known as service-oriented firms, a new type of company in the modern-day industry (Vargo and Lusch 2008). This transformation has led to the emergence of unknown risks, the impact of risk on the supply chain also varies and the mismatch of the current risk mitigation strategies (Truong Quang and Hara 2017g). Ho et al. (2015) argued that while there are several empirical studies conducting at manufacturing firms, *service-oriented firms have likely received less attention.*

Naldi et al. (2007) stated that risk behaviour depends on organizational context. Firms have different characteristics, e.g. manufacturers and service providers, the impact of risks also varies (Subramaniam et al. 2009, Moses and Savage 1994, Truong Quang and Hara 2016a). Traditionally, Lovelock and Gummesson (2004) identified four following ubiquitous differences between manufacturers and service providers, known as "IHIP."

[1] Intangibility

[2] Heterogeneity

[3] Inseparability

[4] Perishability

As mentioned above, an organization now a day owns the manufacturing division to produce finished products, while its service departments supply the required resources for sales and after sales services, resulting in *a challenging task to distinguish a manufacturer or a service provider* (Cudney and Elrod 2011).

1.2 RESEARCH AIM AND OBJECTIVES

This study aims at investigating the relationship between risks and performance in the supply chain. This main purpose can be broken down into a number of study objectives as follows:

1. To propose a conceptual framework of various risks in the supply chain.

2. To evaluate the push effect of risks on supply chain performance.
3. To validate the mechanism of the push effect at service-oriented firms.
4. To compare risk behaviours between service-oriented firms and manufacturing-oriented firms.

1.3 RESEARCH METHODOLOGY

For the first objective, in the body of risk literature, there are so many approaches with regard to risk identification (Truong Quang and Hara 2017e). Xie et al. (2011) recommended applying SC mapping as a new approach to find out potential risks in the SC network.

> […] supply chain mapping is an approach in which the SC and its flow of goods, information and money is visually depicted, from upstream suppliers, throughout the focal firm, to downstream customers.
>
> […] once every detail of the supply chain has been mapped, potential risks can be identified better.

With regard to the second one, the technique of Structural Equation Modeling is applied. This technique involves the simultaneous evaluation of multiple variables and their relationships, thus it is appropriate to examine the impact of various risks on SC performance, especially the "push" effect (Truong Quang and Hara 2017d). Moreover, the most important strength of SEM is that the relationships among numerous latent constructs can be addressed in a way that reduces the error in the model (Hair et al. 1995). This feature enables assessment and ultimately elimination of variables characterized by weak measurement (Hair et al. 1995). Agreed to this, Hair et al. (2014) stated that:

> […] Concept and theory development require the ability to operationalize hypothesized latent constructs and associated indicators, which is only possible with SEM.

In the third and fourth objectives, the theory of Goods Dominant Logic (GDL) and Service Dominant Logic (SDL) developed by Vargo and Lusch (2004) is utilized to identify two types of business: manufacturing-oriented firms and service-oriented firms. The similarities and differences between manufacturing-oriented firms and service-oriented firms are then compared by the Multiple Group Analysis, a non-parametric significant test for the difference of group-specific results (Henseler et al. 2009). These firms were compared with respect to resources, value, network, effectiveness vs efficiency and communication, being expected to provide an insight into risk management activities at two compared groups (Truong Quang and Hara 2017f).

1.4 RESEARCH CONTEXT

The target population in this study is Vietnam-based companies within the construction industry. This sector is the key in economies throughout the world (Truong Quang and Hara 2015). However, compared to many other industries, it is inherently risky due to its unique characteristics such as the manufacturing facilities or plants must be located at the construction site, long timeframes, complicated processes, unpredictable environments, financial intensity, complex relationships and dynamic organisation structures (Truong Quang and Hara 2016a). As a result, work related accidents are typical and a reputation for being unable to resolve issues develops. Furthermore, many projects fail to meet deadlines, cost and quality targets. Typically, a 10% contingency is added to the total project cost to accommodate for unforeseen circumstances (Truong Quang and Hara 2017c).

In Vietnam, the construction industry has considerably grown and significantly contributed to the national economy (Truong Quang and Hara 2017a). According to a report of World Bank in 2016, the Vietnam's GDP was predicted to stand at 6.21% with growing 7.06% in the industry and construction fields. Despite its contribution, construction projects have been faced with many difficulties and constraints with regard to operational issues. According to an in-depth interview of 11 construction managers, 30% of total construction capital is not used properly for construction purposes during project duration due to poor management (Truong Quang and Hara 2017b). Project delays, cost overruns, labour accidents, low quality and disputes between parties are the consequences often found in projects. Ling and Hoang (2009) found that Vietnamese construction companies are lagging behind foreign enterprises not only in operational capability, but also in financial capacity, experience in complex projects, knowledge in advanced design and construction technology. Other setbacks acting as constraints have focused on the corruption and complications of the legal system for construction companies. Van Thuyet et al. (2007) argued that the lack of a systematic and efficient risk management system is one of the critical factors leading Vietnamese construction projects to failure. Hence, the Vietnam construction sector is selected to validate our conceptual framework.

1.5 RESEARCH CONTRIBUTION

1.5.1 Scientific contributions

- **The theoretical model:** This research aims to build up an extensive picture of relationship between SC risks and SC performance. In this picture, risks do not affect SC performance separately, but simultaneously. By the SC mapping approach, a technique that was recommended for a long time but were not used popularly in the SC risk body, a conceptual framework that covers various dimensions of risks in the SC network is proposed and validated by empirical data at Vietnam construction sector. This can be a premise for the next phase, e.g. risk assessment (push effect), risk mitigation and monitoring. It can be expected that findings explored in this study are able to offer useful guidance for identifying and assessing SC risks, as well as contribute to theory regarding the relationship between risks and performance in the SC. Moreover, the proposed models can be used as a 'guideline' for reducing the impact of risks, especially push effects.
- **The research method:** the technique of SEM is used for testing the research models. It is one of modern and complex methods, however, it gets the highest accurate in the quantitative research.

  Furthermore, it is worth noting that the application of the Goods Dominant Logic and Service Dominant Logic theory to classify manufacturing-oriented firms and service-oriented firms is also a "novelty of approach" of this study. Different characteristics between two compared groups are identified and explained with respect to resources, value, network, effectiveness vs efficiency and communication, providing an insight into risk management activities in the supply chain network (Truong Quang and Hara 2017f).

1.5.2 Practical contributions

There are several conceptual frameworks of the impact of risks on SC performance are planning to develop in this research. Hence, firms will have a visible and systematic view, whereby they can highlight critical SC risks in their context, so resources can be allocated appropriately and pertinent strategies implemented to mitigate risks. Moreover, understanding the model of the push effect among SC risks, firms can predict the "real" degree of danger of risks on performance in their SC and mitigate the effect of risks in the entire supply chain network. Practitioners and managers can apply the resultant model as a "road map" in their context to achieve this purpose.

Moreover, the models of comparison between manufacturing and service-oriented firms provide a thorough view of risk behaviours, thereby proposing appropriate solutions for each type of company.

1.6 RESEARCH STRUCTURE

The thesis is organized in seven following chapters:

Chapter 1 outlines background of the research, aim and objectives, methodology, context as well as research contribution.

Chapter 2 reviews previous studies in the SCRM literature in terms of types of risk, research methodologies and surveyed industries, drawing a general picture in the area before research gaps are identified.

Chapter 3 aims to propose and validate a conceptual framework for linking various dimensions of risk to system performance in the SC. First, risks in the supply network are identified by applying SC mapping, and then the theoretical conceptual framework comprising a holistic set of SC risks will be developed. Empirical data at Vietnam construction industry will be used to validate the model.

Chapter 4 defines and verifies the mechanism of the push effect that is a new definition of the relationship between risks and SC performance. Two models are compared, (1) Model only exists in direct effects, i.e. the competitive model, (2) the other contains relationship between risks that is able to show the mechanism of the push effect, i.e. the hypothesized model. The analysis of Structural Equation Model (SEM) is applied to validate the models, confirming the mechanism of the push effect. Findings achieved from this chapter are utilized as "a guideline" for reducing the impact of this mechanism.

Chapter 5 validates the push effect of risks on SC performance in the context of service-oriented firms. Results will be compared with previous studies conducting at manufacturing firms for an insight into this area.

Chapter 6 applies the theory of Good Dominant Logic and Service Dominant Logic to find differences between manufacturing-oriented firms and service-oriented firms. Practical implications for each type of company are also discussed.

Chapter 7 presents a summary of the major findings, contributions and implications of this research. The direction for future studies is also discussed at the end of this chapter.

The last section of this thesis is a list of references and appendixes.

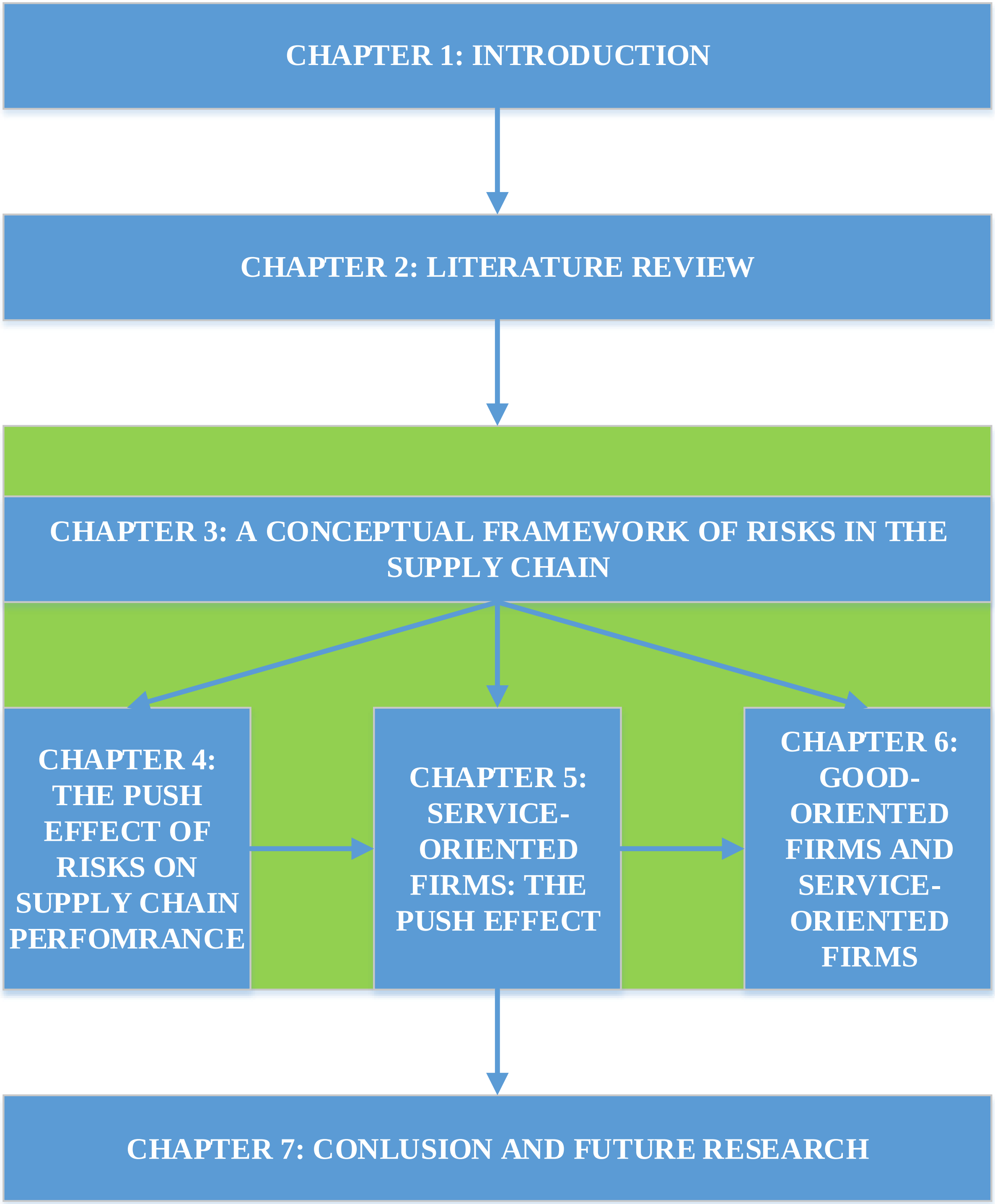

Figure 1.2: Research structure

1.7 SUMMARY OF THE CHAPTER 1

There are four key objectives that this thesis has addressed:

1. To propose a conceptual framework of various risks in the supply chain.
2. To evaluate the push effect of risks on supply chain performance.

3. To validate the mechanism of the push effect at service-oriented firms.
4. To compare risk behaviours between service-oriented firms and manufacturing-oriented firms.

Each objective will be carefully analysed and discussed in the next chapters but beforehand, the chapter 2 will review previous studies in the SCRM literature, drawing a general picture in this area before identifying research gaps.

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CHAPTER 2: LITERATURE REVIEW

In this chapter, previous studies in the SCRM literature are reviewed as some following criteria:

- Types of risk
- Research methodologies
- Surveyed industries

In doing so, a total of 169 journal articles between 2003 and 2016 will be analysed. For a broad view, at first, a process of SCRM is introduced, being a platform to examine three criteria. Subsequently, it is a SCRM literature review that afterwards research gaps are identified.

2.1 SUPPLY CHAIN RISK MANAGEMENT PROCESS

Risk management in supply chains is more of a recent phenomenon (Ho et al. 2015). Current studies explored risk management approaches from a variety of angles (Xie et al. 2011). Building on these studies, a structured risk management process includes the four critical phases: Risk identification, risk assessment, risk mitigation and risk monitoring, developed by Tummala et al. (1994). The risk management process was extensively applied in numerous individual project decisions, it however has not been employed yet to the much broader context of the supply chain (Xie et al. 2011, Kersten et al. 2011).

SC risk-related research has emerged since 2003 (Ho et al. 2015). Xie et al. (2011) proposed that risk management in the supply chain is a process of six critical steps grouped into three following phases.

- *Phase 1: Risk Identification* - *Risk Measurement* - *Risk Assessment*

  This phase begins with identifying risks and determining potential SC risks comprehensively and structurally. Subsequently, an evaluation of consequences and magnitudes of impact of all potential SC risks is conducted before a risk assessment is carried out to estimate the likelihood of each risk factor.

- *Phase 2: Risk Evaluation* - *Risk Mitigation and Contingency Plans*

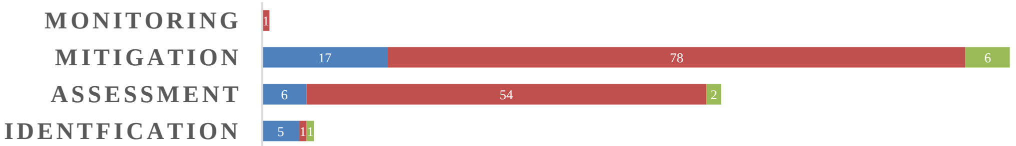
In this phase, risk exposure values are calculated and acceptable levels of risk are established. Risk response action plans then are developed to contain and control risks.

- *Phase 3: Risk Control and Monitoring*

  This final step aims to assess possible preventive measures and providing instructions for further improvement.

Of these three phases, the first one is a premise and has a significant effect on the whole process (Thun and Hoenig 2011). Affected areas need to be clearly identified, and consequences should be understood, whereby risk mitigation strategies can be executed (Xie et al. 2011). Many organizations and supply chains start a risk management program without knowing what threats the organization faces, or what consequence a disruption would have (Truong Quang and Hara 2015). Consequently, they concentrate on protecting against the wrong threats and have ineffective plans against appropriate threats (Truong Quang and Hara 2017e). Worse yet, they fail to anticipate important threats, or fail to recognize the consequence of a minor threat, magnifying its implications (Tang 2006).

In the total of 169 reviewed journal articles published between 2003 and 2016, the number of risk identification studies are quite restrictive, especially empirical research (Figure 2.1). Manuj and Mentzer (2008) indicated that there is a lack of conceptual frameworks and empirical findings to provide clear meaning and normative guidance on the phenomenon of global supply chain risk management. Ho et al. (2015) aims to a model of various risks and suggested more and more empirical research to confirm reliability of the model. Wagner and Bode (2008) concluded that although risks are inherent in supply chains, with both their impact and management under greater scrutiny, current knowledge is still limited as most articles on SC risks are qualitative or case study-based (Figure 2.1).



	IDENTFICATION	ASSESSMENT	MITIGATION	MONITORING
Qualitative studies	5	6	17	0
Analytical studies	1	54	78	1
Empirical studies	1	2	6	0

**There are two journal articles conducting an integrated process that two processes took into account concurrently.*

Figure 2.1: Distribution of research methods over the last 14 years

2.2 SUPPLY CHAIN RISK MANAGEMENT LITERATURE

Risks can appear everywhere at any firms/ supply chains (Truong Quang and Hara 2016a). In the effort to identify and manage SC risks, researchers carried out various works in different perspectives (Truong Quang and Hara 2017b).

Supply risk is the one that received the most attention in the literature (George et al. 2004, Wu et al. 2006, Zsidisin and Ellram 2003, Guo et al. 2016). This risk causes failures to deliver inbound goods or services to the purchasing firm (Zsidisin and Ellram 2003). As a result, it disrupts operating activities of the purchasing firm and subsequently throughout the downstream SC (Guo et al. 2016). An example of the Wilderness AT tire in 2000, the discovered quality problems relating to supply risk resulted in 174 reported deaths and an estimated cost of $2.1billions for their recall (Truett 2001).

Moreover, some common risks were also listed in the SC risk management literature, comprising operational risk, demand risk and finance risk (Table 2.1). These risks have a deteriorating effect on various outputs, being:

- Operational risks disrupt operating activities that result in decrease of expected return (Kim and Chavas 2003). Williams et al. (1995) argued that these types of risk increase in project costs.
- Demand risk, makes firms unable to forecast the real demand of market (Truong Quang and Hara 2017b). George et al. (2004) indicated that fluctuations in customer demands give rise to backlogging or shortages in the orders, planning flaws and

bullwhip effect. Moreover, the author indicated that rapid changes in customer expectations are the main reason of increasing product costs.

- Finance risk exists in any chain of SC network (Truong Quang and Hara 2015). Inflation, fluctuations of currency and interest rate and stakeholder's requests are key factors of this type of risk (Truong Quang and Hara 2017e). For instance, inflation disrupts operations planning, breaks the relationship with customers and suppliers (Parks 1978). Otherwise, fluctuations of currency and interest rate have various effects on output growth and price (Kandil and Mirzaie 2005). Stakeholders' requests, moreover, also affect activities, operational plans of SC (Truong Quang and Hara 2017b).

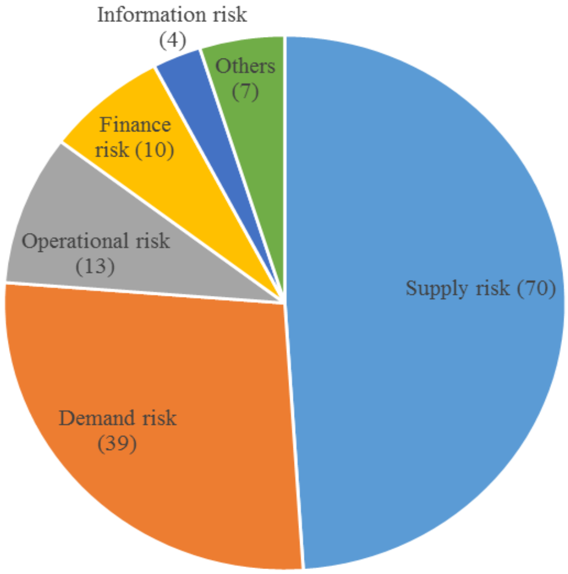
Conversely, there is a lack of studies that examined information-related risks (Truong Quang and Hara 2017b). Lack of information or distorted information passed from one end of the supply chain to the other, causing significant problems, including, but not limited to, excessive inventory investment, poor customer service, lost revenues, misguided capacity plans, ineffective transportation, and missed production schedules (Truong Quang and Hara 2016b). Rather, this type of risk is the main cause of the bullwhip effect (Handfield and Nichols 2008).

Table 2.1: Single supply chain risk types

Authors	Risk types	Methodology	Data	Results	Other authors
Zsidisin (2003)	Supply risk	Case studies	Seven purchasing organizations - five manufacturers in the electronics industry and two firms in the aerospace.	The outcomes of supply risk events can result in the loss of customer business and detrimentally influence on revenues and profits. Threats on integrity, durability, and reliability of products cause serious troubles for customer life and safety.	(George et al. 2004) (Wu et al. 2006) (Zsidisin and Ellram 2003) (Guo et al. 2016) (Ray and Jenamani 2016)
Lewis (2003)	Operational risk	Case studies	Four operational failure case studies: financial services provider, retail chain, industrial components manufacturer and aerospace components manufacturer.	Some functions of internal (operational) and external (customer) losses are main reasons causing negative consequences on operational performance.	(Kim and Chavas 2003). Mas (2004) Williams et al. (1995)
Xu et al. (2010)	Demand uncertainty	Simulation	Simulated data	Demand uncertainty leads to price fluctuations, and a less variable demand will have a higher optimal expected profit.	(Jemaï and Karaesmen 2005) (Ai et al. 2012) (Ray and Jenamani 2016) (Adida and Perakis 2010)
Kestens et al. (2012)	Finance risk	Case studies	Secondary data of Belgian firms from Bureau van Dijk Electronic Publishing	Finance risks cause deteriorating effects on company performance. This effect is particularly higher in case, the firms have an increase in trade payables.	(Kandil and Mirzaie 2005) (Parks 1978)
Johnson (2008)	Information risk	Case studies	A group of large financial institutions using a direct analysis of leaked documents.	There is a statistically significant link firm visibility and information risk. Moreover, firms with higher information risk also experience increased losses.	(Lee et al. 2004b)

We can see that though considering diversified aspects of the supply chain, the common thing among previous studies is that they only focus on a single dimension of SC risks in their own contexts. This approach probably will provide an insight into a particular dimension. However, it is the fact that in reality, at a certain moment, there is not only one risk incurred. Naturally, there will be two risks or more occurring simultaneously. Thus, since considering the relationship between risk and outputs, it is imperative to investigate the simultaneous impact of different risks on various outputs (Truong Quang and Hara 2017f). This, on the one side, will provide a comprehensive picture about the relationship between risks and outputs. On the other side, more importantly, this approach will determine the "real" effect of risks on outputs. Table 2.2 presents the previous studies integrating SC risk types simultaneously.

In this table, supply-, manufacturing- and demand-related risks appeared in all seven studies. Meanwhile, there are few researches drawing attention on the risks of transportation (Tuncel and Alpan 2010, Wagner and Neshat 2010, Chopra and Sodhi 2012, Schoenherr et al. 2008), finance (Manuj and Mentzer 2008, Schoenherr et al. 2008, Chopra and Sodhi 2012, Hahn and Kuhn 2012) and information (Chopra and Sodhi 2012). These statistics are also reflected in the reviewing result of journal articles published between 2003 and 2016 (Figure 2.2).



Notes: Others include transportation risk, political & economical risk and natural disaster.

Figure 2.2: Supply Chain risks

Table 2.2: Integrated SC risk types in the literature

Authors	Risk types	Methodology	Data	Industry	Results
(Manuj and Mentzer 2008)	Demand Manufacturing Supply Finance	Qualitative methods	14 in-depth interviews with senior SC executives across eight companies and a focus group meeting involving seven senior executives of a global manufacturing firm.	-	The study provides insights into the applicability of six risk management strategies with respect to environmental conditions and the role of three moderators.
(Schoenherr et al. 2008)	Macro Micro Manufacturing Supply Transportation Finance	Quantitative methods and Analytic Hierarchy Process	A United States family-owned manufacturer and distributor of commercial tools	-	A comprehensive framework of risk factors to be considered in an international sourcing context was proposed. Moreover, this empirical paper contributed to the research streams of offshoring and risk management in purchasing and supply, as well as to decision-making under uncertainty and AHP.
(Tuncel and Alpan 2010)	Demand Manufacturing Supply Transportation	Quantitative methods. Failure mode, effects and criticality analysis technique; Petri-nets	A medium-size company in Turkey	Producing supplementary-parts for electric, automotive, and home appliance industries.	The results of this case study indicate that the system performance can be improved using risk management actions, and the overall system costs can be reduced by mitigation scenarios.
(Wagner and Neshat 2010)	Demand Manufacturing Supply Transportation	Quantitative methods. Survey, Graph theory; SC vulnerability index	760 top-level logistics and SC management executives at German-based firms	Seven main industries: Food and consumer goods, Engineered products, Automotive, Information and communication technology, Process manufacturing, Wholesale and retail, Logistics.	The authors developed an approach based on graph theory to quantify and hence to reduce SC vulnerability. The empirical results proved that quantification of SC vulnerability is helpful for managers to assess the vulnerability of their SCs and to compare among different risk mitigation strategies.
(Hahn and Kuhn 2012)	Demand Manufacturing Supply Finance	Quantitative methods. Fuzzy analytic hierarchy process; Fuzzy technique for order preference by similarity to the ideal solution	Simulated data	-	This paper presents a holistic framework for value-based performance and risk management in SCs. It is capable of providing real decision support for value-based management as opposed to common explanatory approaches.

(Chopra and Sodhi 2012)	Macro Demand Manufacturing Supply Information Transportation Finance	Qualitative methods	-	-	By understanding the diversity and mutual interaction among SC risks, it is useful for managers to balance and propose effective risk mitigation strategies at their own companies.
(Samvedi et al. 2013)	Macro Demand Manufacturing Supply	Quantitative methods. Survey, Fuzzy analytic hierarchy process; Fuzzy technique for order preference by similarity to the ideal solution	62 respondents in charge of SC management or logistics. Personal interviews were conducted with 18 of these respondents. Simulated data	Indian textile and steel industry	Fuzzy values in this study help in capturing the subjectivity of the situation with a final conversion to a crisp value which is much more comprehensible.

Moreover, the applied research methodologies are very diversified, e.g. in-depth interviews, focus group meetings to define concepts, identify factors and develop frameworks (Chopra and Sodhi 2012, Manuj and Mentzer 2008). Otherwise, many of the previous studies aim at developing/ validating conceptual models by using simulated data (Hahn and Kuhn 2012, Samvedi et al. 2013) or a case study from a specific firm (Kull and Talluri 2008, Schoenherr et al. 2008, Tuncel and Alpan 2010). Only Wagner and Neshat (2010) conducted a large-scale survey to quantify risks at German firms. Thus, it can be said that the use of real data to test models is still restricted. Additionally, the most popular individual approach in empirical studies is the multiple regression models (Zsidisin and Ellram 2003). There is a lack in the application of the Structural Equation Modeling technique (SEM), one of the most modern and complex methods that can receive the highest accuracy in the quantitative research (Hair et al. 1995). For a more comprehensive picture, Table 2.3 depicts research methodologies in the supply chain risk literature.

Table 2.3: Research methodologies in the supply chain risk literature (2003 – 2016)

Empirical quantitative methods		
Individual quantitative methods	Multiple regression models	3
	Partial least squares analysis	1
	Quantitative survey analysis	1
	Real options theory	1
	Statistical analysis	1
Integrated quantitative methods	Analytic hierarchy process; Survey; Wards' and K-mean clustering; Nonparametric Spearman rank correlation test	1
	Survey, Bow-Tie analysis, and fuzzy inference system (FIS)	1
	Cluster analysis; Factor analysis	1
	Exploratory factor analysis; Regression models; Reliability tests	1
	Structural equation modeling technique; Partial least squares analysis	1

Among survey industries in the literature, furthermore, the manufacturing industry, e.g. the automotive (Kull and Talluri 2008, Tuncel and Alpan 2010, Wagner and Neshat 2010), electronics (Zsidisin and Ellram 2003, Tuncel and Alpan 2010) and aerospace (Zsidisin and Ellram 2003) are the most popular application areas. Surveyed industries in the body of SCRM also confirm this data (Figure 2.3). Meanwhile, the service sector has received less attention (Ho et al. 2015) and it is worth noting that the construction sector has not been fully investigated yet from the literature.

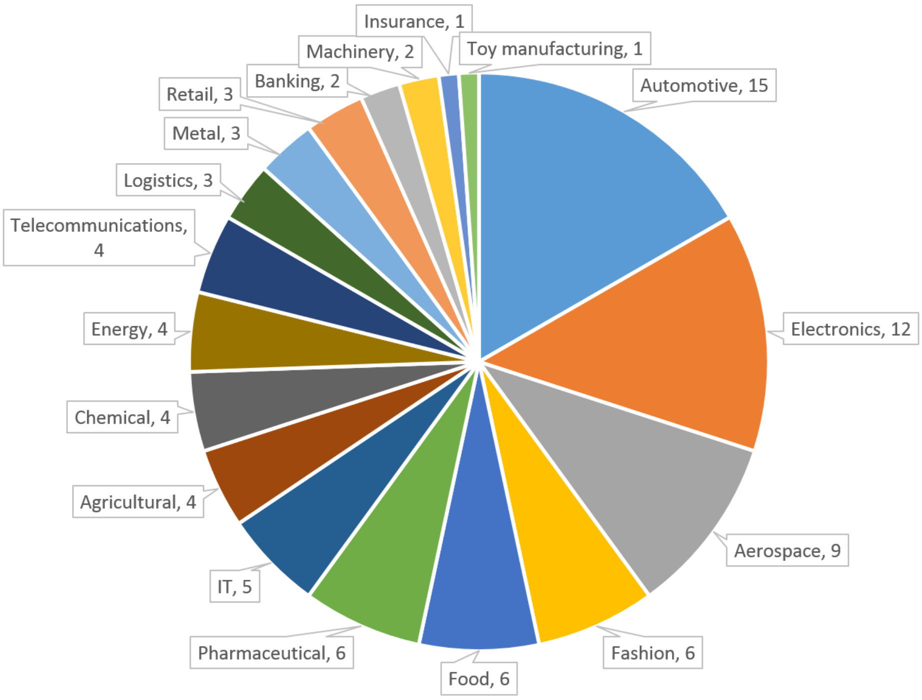


Figure 2.3: Surveyed industries in the supply chain risk literature (2003 – 2016)

2.3 SUMMARY OF THE CHAPTER 2

This chapter reviewed 160 SCRM-related journal articles between 2003 and 2016, identifying some following research gaps:

- The number of risk identification studies are quite limited, especially empirical research. In other words, it is imperative to have a conceptual framework covering various risks in the supply chain network and validated by empirical data.
- There is a lack of the Structural Equation Modeling's application, one of the most modern and complex methods that can receive the highest accuracy in the quantitative research.
- The service and construction sectors has not been fully investigated yet from the literature.

These research gaps will be discussed in details in the next chapters, starting with the chapter 3 - A conceptual framework of risks in the supply chain.

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CHAPTER 3: A CONCEPTUAL FRAMEWORK OF RISKS IN THE SUPPLY CHAIN

Examining a certain risk will provide an insight into a single dimension, but a picture of different risks in the supply chain (SC) is still lacking, as risks do not take place independently, but typically simultaneously (Truong Quang and Hara 2015). This chapter aims to propose and validate a conceptual framework for linking various dimensions of risk to system performance in the SC. To this end, first risks in the supply network were identified by applying SC mapping - a new approach in the SC risk body of literature. Then the theoretical conceptual framework comprising a holistic set of SC risks was proposed. Empirical data at Vietnam construction industry will be used to validate the model.

Using this framework, companies will have a systematic view of risks in the whole SC network whereby they can define risks in their own context and ascertain critical SC risks that cause negative effects on SC performance. Moreover, this framework can be used as a 'guide-map' in an effort to mitigate SC risks.

3.1 SUPPLY CHAIN MAPPING

Risk appears everywhere in any firm, from design activities through operational processes to distribution (Truong Quang and Hara 2015). Generally, since competition moves from firms to supply chains, the scope of risk now is extended – in the whole SC network (Truong Quang and Hara 2017e).

From the literature, there are so many ways to identify potential SC risks (Ryan et al. 2012, Neiger et al. 2009). To this end, Xie et al. (2011) summarized some key approaches, being:

> [...] SC mapping is an approach in which the supply chain and its flow of goods, information and money will be schematically depicted, from upstream (suppliers), throughout the focal firm, to downstream (customers) (Gardner and Cooper 2003).
>
> [...] checklists or checksheets are forms to record how often a failure was attributed to a certain event (Chase et al. 2004).

[...] event tree or fault tree analyses are graphical representations of all possible and subsequent outcomes triggered by an event, e.g. a supply chain failure (Paté-Cornell 1984).

[...] failure mode and effect analysis (FMEA) is a tool to identify "at the design stages potential risks during the manufacture of a product and during its use by the end customer" (Karim et al. 2008).

[...] Ishikawa cause and effect analysis (CEA) involves the brainstorming and exploration of all possible relationships between potential causes and failure events (Chase et al. 2004).

Among these approaches, supply chain mapping was proposed as a new one to identify potential risks in SC network (Xie et al. 2011). A supply chain map aims to align supply chain strategy with corporate strategy, show/ clarify boundary setting, and help firms manage and modify the supply chain (Gardner and Cooper 2003). Once every detail of the SC has been modelled, potential risks can be identified better (Xie et al. 2011). Gardner and Cooper (2003) proposed that geometry, perspective and implementation issues are three critical points in modelling a certain supply chain:

1. Geometry refers to defining the number of tiers that can be described by direction and length (Truong Quang and Hara 2017e). The direction can be up the channel (Supplier-Oriented) from the focal firm, down the channel toward the final consumer (Customer-Oriented), or both. Meanwhile, length is the distance out from the focal firm. For example, our model covers both up and down the channel of distribution, the length of 1/1, meaning that 1 tier up and 1 tier down from the focal firm, i.e. Suppliers – Focal firm – Customers.
2. Perspective refers to focal point and scope that aim to describe the view depicted by the supply chain map (Truong Quang and Hara 2017e). A supply chain map can analyse a perspective from a focal firm, or a perspective covering a competitive set of firms. Hence, firm-centric and industry-centric views are both possible as focal points. With regard to scope, there are different ways to define the scope, in which adapts from definition of SC risk, as the student's point of view, is a comprehensive approach. Jüttner et al. (2003) stated that SC risk is any failures aligning to flows – from original suppliers to delivery of final products for the final user. This definition was shared by many academicians (Ho et al. 2015). Hence, scope of risk in the supply chain will be identified on three main flows, i.e. product – information – finance flows.

3. Implementation issues indicate how the map will provide information and be disseminated, emphasizing the role of information along the chain (Truong Quang and Hara 2017e).

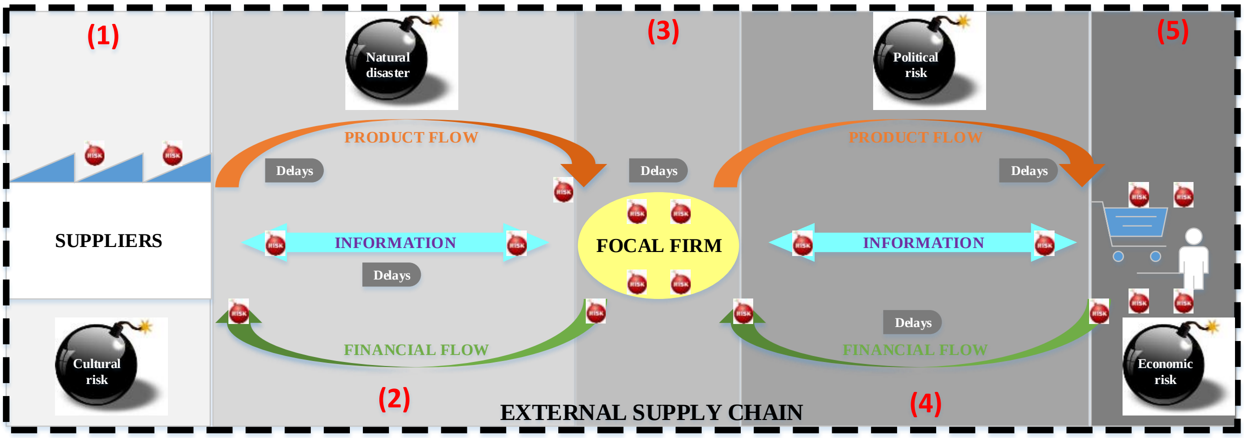

Figure 3.1: Supply chain map

As these instructions, our SC map is visually depicted in the Figure 3.1. Accordingly, this supply chain representation: 1) depicts both directions, one tier down and one up, 2) chooses a firm focal perspective, 3) covers three flows of the supply chain, 4) is low in information density. Moreover, this Figure is separated into five sections that risks can exist, e.g. (1) at suppliers; (2) processes from suppliers to focal firm and vice versa; (3) at the focal firm; (4) from the focal firm to customer and vice versa and (5) at customers. Table 3.1 summarizes potential risks in the literature with respect to these five sections.

The risks in the table 3.1 are then filtered throughout structural interviews of three academicians and five practitioners who have expertise in logistics and SC management. The selected risks are grouped in corresponding types of risk that are discussed in the next section.

Table 3.1: Potential risks in the supply chain

RISKS	SECTIONS 1	2	3	4	5
1*	Natural disaster War and terrorism Fire accidents		Political instability Economic downturns	External legal issues Government regulations Social and cultural grievances	
2	Selection of wrong partner Supplier bankruptcy Lack of integration with suppliers Lack of suppliers' visibility Supplier opportunism Suppliers' dependency Supply responsiveness Global outsourcing Cannot provide competitive pricing	Failures to make delivery requirements Inability to handle volume demand changes Inability to meet quality requirements Transport providers' fragmentation Damages in transport Accidents in transportation Transportation breakdowns Port strikes Port capacity and congestion Custom clearance at ports Higher costs of transportation	Inventory holding cost Design changes Technological change Warehouse and production disruption Operator absence Labour disputes/ strikes Employee accidents Dissatisfaction with work Lack of experience or training Working conditions Product obsolescence Production capabilities/capacity Products quality and safety Shorter life time products Insufficient maintenance	Transport providers' fragmentation Damages in transport Accidents in transportation Transportation breakdowns Port strikes Port capacity and congestion Custom clearance at ports Higher costs of transportation	High competition in the market Inaccurate demand forecasts Demand uncertainty Market changes Customer dependency Customer fragmentation High level of service required by customers Deficient or missing customer relation management function Low in-house production Order fulfilment errors
3*	Exchange rate Currency fluctuations Interest rate level Wage rate shifts Financial strength of customers		Information infrastructure breakdown System integration or extensive systems networking E-commerce Information delays Internet security Bullwhip effect or information distortion		Price fluctuations Insurance issues Market growth Market size Credit risk

**Risks at the row of 1 and 3 are likely to occur at all five sections in the supply chain.*

3.2 CONCEPTUAL FRAMEWORK

As schematically depicted in the figure 3.1, there are three critical flows in the SC map, including:

The product flow typically involves the movement of materials throughout various nodes along the SC from the raw material source to the final consumer (Truong Quang and Hara 2015). Starting with the upstream that supplies input for the main process of the focal firm, supplier bankruptcy and price fluctuations are major concerns (Xie et al. 2011, Chopra and Sodhi 2012, Ketikidis et al. 2006, Shenoi et al. 2016). As finished products of suppliers are transported to the focal firm, issues such as inadequate quality and quantity of inputs cause a domino effect through the SC to the final customer (Zsidisin et al. 2000). Lee and Billington (1993) indicated that capacity shortages and poor logistics performance are outcomes that derive from **supplier-related risks**. Moreover, these risks may have detrimental effects on the customer's costs and competitiveness (Zsidisin and Ellram 2003). Wilderness AT is an example of supply risk, with tire issues in 2000. A quality issue was discovered that related to supply risk, resulting in 174 reported deaths and an estimated cost of $2.1billion due to a recall (Truett 2001). A further case is Robert Bosch, who was concerned as the company delivered its customers with defective high-pressure pumps for diesel fuel injection systems at the beginning of 2005. A sub-supplier of Bosch was accountable for this fault, leading to millions of dollars in costs and affecting the entire supply chain.

In the focal firm, changes in design and technology are likely to occur (Tuncel and Alpan 2010, Samvedi et al. 2013, Xie et al. 2011). These risks increase project costs (Williams et al. 1995) and disrupt operating activities, resulting in a decrease of expected return (Kim and Chavas 2003). Mitsubishi Aircraft Corp. announced that delivery of the new Mitsubishi Regional Jet might be delayed for a fifth time due to technical problems, resulting in shares to decline 2.7% and extending their losses this year to 20%. The jetliner, which seats 70 to 90 passengers, is designed for short- to medium-haul flights and consumes 20% less fuel than similarly sized aircraft. Experts believed that any subsequent design changes could force Mitsubishi Aircraft to review production plans, leading to a substantial delay in the plane's delivery, but manufacturing operations had already started (Truong Quang and Hara 2017e).

Also at operations process of the focal firm, labour accidents and disputes are risks probably existing at any SC (Truong Quang and Hara 2015). The Health and Safety Executive statistics revealed that more than 27 million working days were lost between 2011 and 2012 due to occupational illness or personal injury (Sweeney 2013). In the case study of Caterpillar - the world's largest manufacturer of construction machinery, Mas (2004) documented that during a dispute, the price was discounted by about 4 percent. Product quality declined and the consequential result was a $240 million decrease in revenue. Ho et al. (2015) identified the risks occurring at the focal firm as **operational risks.**

As the physical flow moves to downstream, ***demand-***related risks, such as demand variability, high competition in the market, customer bankruptcy and customer fragmentation, when incurred, make firms unable to forecast real market demands (Shenoi et al. 2016, Vishwakarma et al. 2016). Consequently, operating activities are disordered, costs overrun, resulting in revenues and profits falling (Fleischhacker and Fok 2015). George et al. (2004) indicated that fluctuations in customer demands give rise to backlogging or shortages in the orders, planning flaws, bullwhip effect and have a deteriorating effect to the performance of stochastic inventory systems (Jemaï and Karaesmen 2005). George also argued that rapid changes in customer expectations are a main cause of increasing product costs. Xu et al. (2010) concluded that demand uncertainty is an important factor for optimal decisions and expected profit.

As discussed above, supply, operational and demand risks are ones pertaining to product flow, known as core risks. These risks are ordinary workday problems that might directly affect supply chains (Rice and Caniato 2003). Each risk has different attributes that lead to various impacts on SC performance as illustrated. (Thun and Hoenig 2011) indicated that core risks have a high likelihood to occur but a lower impact on performance than external SC risks. Thus, we propose the following hypotheses:

H1: Core risks are negatively related to SC performance.

The second flow in the chain, ***finance,*** begins with the customers, back through the other nodes in the chain. This flow has an extremely important role that "feeds" activities in the supply network. However, risks associated with finance flow diminish benefits of the chain (Truong Quang and Hara 2017e). Factors of this risk, e.g. inflation, interest rates, currency fluctuations, stakeholder requests, etc., engender price fluctuations in supply activities, operation planning, labour disputes, demand variability and SC disruptions (Shenoi et al. 2016). For instance, inflation leads to continuously increased prices that irritate consumers who place the blame on producers. This is a reason for demand variability (Parks 1978). Firms try to avoid raising prices and in doing so they prefer to lock material costs with long-term contracts, although this hurts their suppliers. Inflation also disrupts operations planning (Truong Quang and Hara 2015). Companies that wish to plan ahead encounter difficulty in the presence of uncertainty. They may have problems with budgeting since they are unsure about costs. Moreover, since the inflation rate is high, employees request higher wages from employers that engender labour disputes.

Regarding interest rates, Mitra et al. (2013) argued that as it increases, banks charge more for business loans, resulting in reducing the ability of customers to buy products and services, thus raising demand risk. This phenomenon can cause price fluctuations in supply activities (Lee et al. 2016).

Two other finance risks are currency fluctuations and stakeholder requests. While the first one has received much attention from academicians, having various effects on output growth and price, it is particularly true for multinational companies or foreign partners (Kandil and Mirzaie 2005), until 2014 stakeholder requests were initially suggested as a finance risk by (Ackermann et al. 2014) Accordingly, stakeholders have influences on particular dimensions and typically have a strong voice in company direction. They participate in the daily operations of the business or vote on critical decisions that affect activities of operation plans. Moreover, these members are able to monitor supplier selection, company's outsourcing activities and globalization initiatives, and may vote against business decisions (Truong Quang and Hara 2017e).

The last flow – ***information***, aligns the relationship between the SC's various stages, allowing them to coordinate their actions and maximize total SC profitability. However, lack of information or incorrect information passed through the SC leads to excessive inventory investment, misguided capacity plans, missed production schedules, ineffective transportation, poor customer service and lost revenues (Lee et al. 2004a). Moreover, distorted information throughout the SC can amplify the bullwhip effect (Handfield and Nichols 2002). A customer information leak at Benesse, a Japanese company which focuses on correspondence education and publishing, by a systems engineer led to second quarter (2015) consolidated revenue down 7% from the same period of the previous fiscal year, with operating profit also decreasing 88% and 280,000 customers being lost (Ishii and Komukai 2016).

In the SC, Ho et al. (2015) argued that there are several "infrastructure" elements which aim to ensure the healthy functioning of the chain, such as finance or information. As discussed above, any disruptions relating to these elements can lead to serious problems for processes in the supply chain – especially supply, manufacturing and downstream activities (Wagner and Bode 2008). Another important infrastructure element is time. Delays in activities cause serious issues that can disrupt firms operations (Shenoi et al. 2016). A firm can expect additional costs as they have to pay for an idle workforce and underutilized equipment during the course of the delay. Sambasivan and Soon (2007) confirmed that time-related risks in projects give rise to the dissatisfaction of all the parties involved. For instance, information delays can breakdown communication among members in project teams and in the SC (Angulo et al. 2004). These delays in the delivery of products to customers can cause bankruptcy of partners (Bernanke 1981), or delays in payment – and are some of the main reasons for disputes (Aibinu and Jagboro 2002). It is worth mentioning that although ***time source***-related risks exist in the SC risk management literature, there is a shortage of accessing these risks as an independent entity (Truong Quang and Hara 2017e). All above, we propose the following hypothesis:

H2: Infrastructure risks are negatively related to core risks.

Wagner and Bode (2008), based on the contingency theory and the strategic management, suggested to extend the scope of risk, stating that high organizational efficiency and performance results when firms consider the context in which strategy is crafted and implemented. As such, firms must match structure to the context and environment, i.e., forces outside the decision-maker's control. If this "fit" is not reached, "opportunities are lost, costs rise, and the maintenance of the organization is threatened" (Child 1972). Agreeing with this discussion, Thun and Hoenig (2011), in a rare empirical study, proved that there is a significant difference between internal and external SC risks in terms of impact on performance.

External risks deal with threats from an external perspective of SC that can be caused by economical, socio-political or geographical reasons (Truong Quang and Hara 2015). Examples are fire accidents, natural catastrophes, economic downturn, external legal issues, corruption, cultural differentiation (Samvedi et al. 2013, Wu et al. 2006, Shenoi et al. 2016, Vishwakarma et al. 2016). These risks rarely occur but can lead indirectly to disturbances within the supply chain. For instance, a fire at a Phillips semiconductor plant in 2000 led to disruptions in operational processes, which eventually engendered a $400 million loss for Ericsson (Chopra and Sodhi 2012). Another example is the earthquake, tsunami and the subsequent nuclear crisis in Japan (2011) which caused Toyota's production to drop by 40,000 vehicles, resulting in a loss of $72 million in profit per day (Pettit et al. 2013). Toyota also decided to stop production in its US-based plants after the terrorist attacks of September 11, which caused significant delays in delivery of parts coming from foreign countries (Sheffi 2001). Thus, we propose the following hypotheses:

H3: External risks are negatively related to core risks and infrastructure risks.

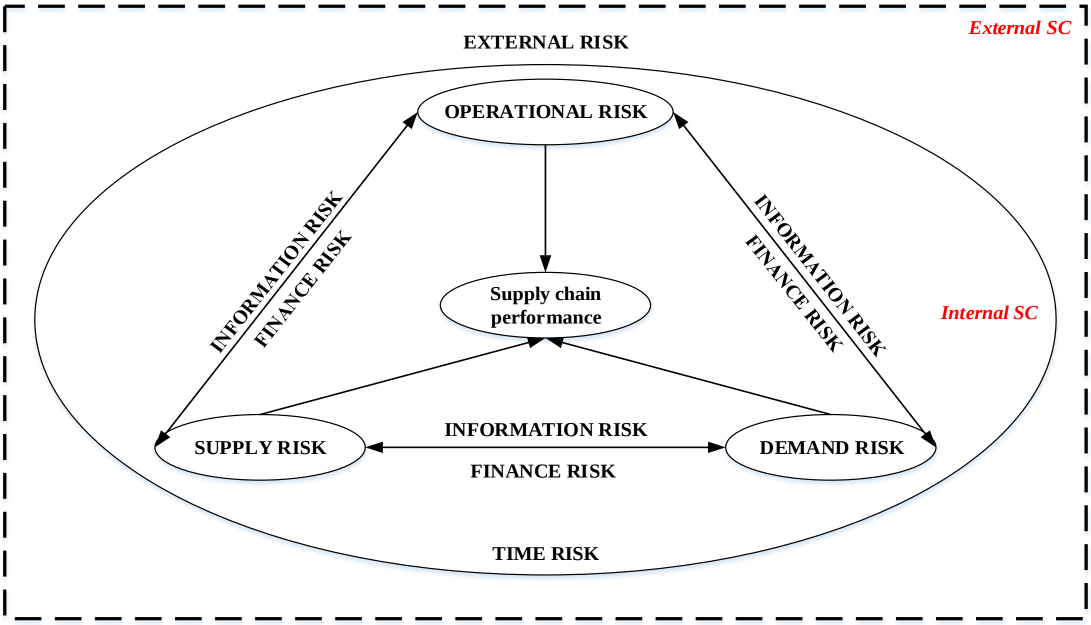

Figure 3.2: Theoretical conceptual framework

Figure 3.2 visually depicts our theoretical framework, in which, as discussed SC risks are separated into three levels, being:

- The first level is core risks that directly affect SC performance. These risk types align with physical flow, including supply-, operational- and demand risks.
- The second level is infrastructure risks, e.g. information and finance risks that cause negative effects on physical activities in the SC, increasing core risk seriousness. Time risk is also known as infrastructure risks, but the scope and the consequence are larger. Thus, time risk influences physical, finance and information flows from an internal perspective of the SC.
- The third level is external risks, e.g. natural catastrophes, economic downturns, etc., having a comprehensive effect on all activities in the SC network.

Supply chain performance

The center of the theoretical model – SC performance – is used to examine the degree of risk in the SC. Traditionally cost is recognized as a key performance indicator (KPI) for assessing the efficiency of a supply chain (Truong et al. 2017). It is a key objective in supply chain management as minimizing cost – and waste – results in a better performing supply chain (Truong et al. 2017). However, this measure tends to be historical and does not demonstrate the current situation of the business environment and future performance (Quang et al. 2016).

Some authors have suggested Return on Investment (ROI) and Growth as a "solution" for SC performance measurements (Fernandes et al. 2017). Quang et al. (2016) argued that ROI fails to provide an objective assessment of smaller companies that may be owner-managed. Moreover, according to Andersen and Jordan (1998), this variable is useful to compare similar firms within their sector, but restricts cross-sector comparisons.

Likewise, Growth measures, e.g. revenue growth, profitability growth, productivity growth, etc., have become meaningless, since comparing enterprises in different sectors – such as an ineffective firm operating in the software industry (a high-growth sector) – will have higher revenue growth/profitability growth, etc., than effective apparel enterprises (Quang et al. 2016).

Naturally, financial measures still have an important role. Nevertheless, in attempting to have a comprehensive performance scale, it is necessary to be balanced with more contemporary, intangible and strategic-oriented measures (Quang et al. 2016).

Kaplan and Norton (1992) argued that the contemporary approach emphasizes on how short- and long-term measures affect firm performance. This disputation led to the development of two concepts:

- Lagging indicators describe what has actually happened in the past, e.g. financial variables.
- Leading indicators provide an early warning of what might happen in the future. An example of such is customer-oriented variables, e.g. customer satisfaction, delivery performance, lead times, flexibility, quality, etc., or human resource-oriented variables, e.g. employee satisfaction and morale, etc.

Developed by Kaplan and Norton (1992), the balanced scorecard model recognizes the limitations of traditional firm performance measurement and translates a firm's strategy into performance objectives, particularly focusing on intangible assets, e.g. innovation, value chain, employee skills and knowledge levels, customer and supplier relationships, etc. This new approach shifts the conventional focus on physical assets to emphasize both physical and intangible resources in a firm for a purpose of corporate long-term development in the future. A scorecard has four balanced perspectives, including financial, customer, internal processes and innovation & learning, which are able to cover leading and lagging indicators. As such, this study defines a set of measures for SC performance based on the balance scorecard model comprising five crucial dimensions as supplier performance, internal business, innovation and learning, customer service and finance (Table 3.2).

Table 3.2: Supply chain performance indicators

	Supplier performance	Internal business	Innovation and learning	Customer service	Finance
Supply chain performance indicators	Reliability	Amount of production waste	Number of new product developed per year	Delivery timeliness	Market share growth
	Response time	Costs of inventory management	Workforce flexibility	Percentage of "perfect orders" delivered	Return on Investments (ROI)
		Workforce productivity		Product value perceived by the customer	
				Product/ Service quality	
				Response time to customer queries	
Authors	(Gunasekaran et al. 2005, Chung et al. 2007, Bendoly et al. 2007, Cuthbertson and Piotrowicz 2008, Chae 2009, Wang et al. 2009, Taticchi et al. 2010, Papakiriakopoulos and Pramatari 2010, Sarkis et al. 2010)				

3.3 RESEARCH PROCESS

Figure 3.3 schematically depicts the research process used throughout this thesis, each steps will be discussed as follows:

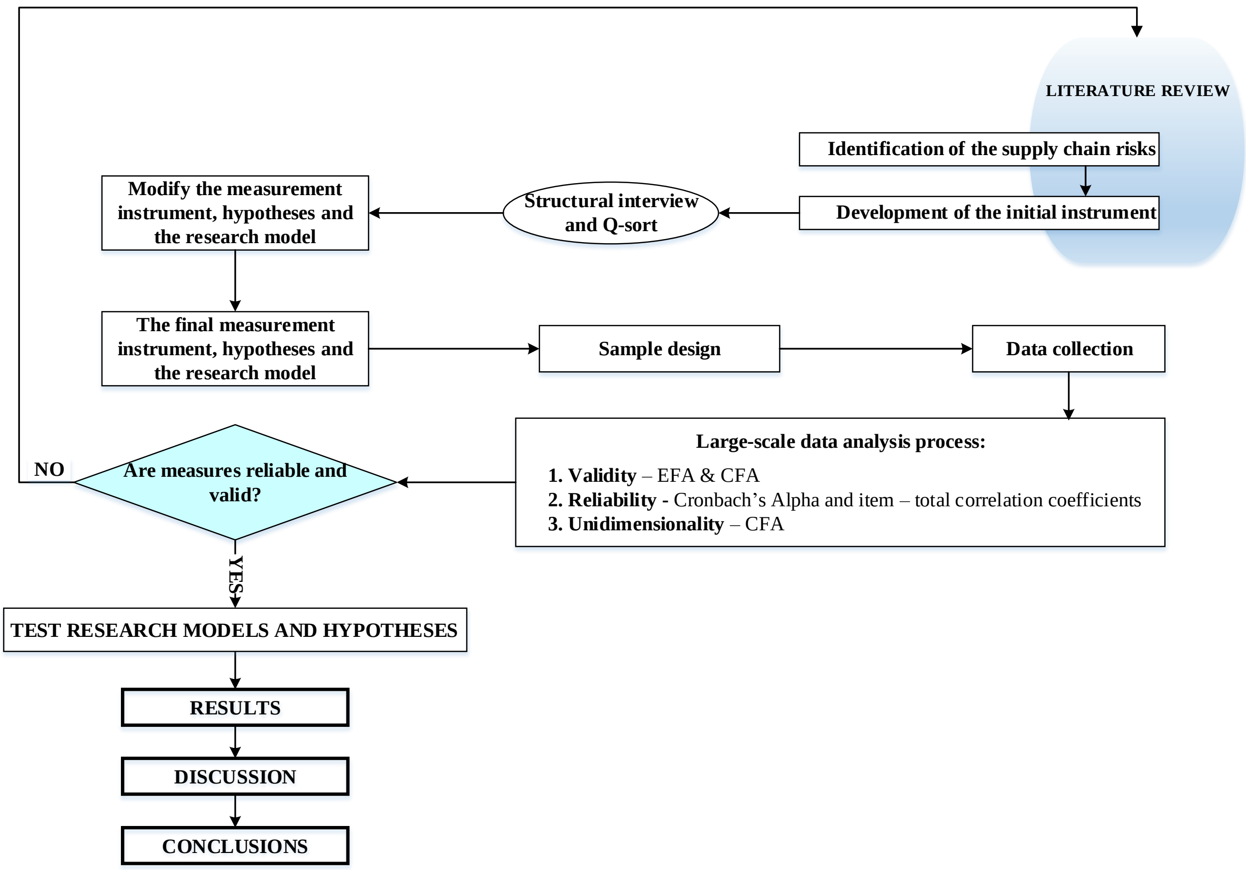

Figure 3.3: Research process

3.3.1 Development of the initial instrument

The effective measurement instrument should cover all content domains of constructs (Parasuraman 1991), measurement items of each construct should converge with other items statistically (Garver and Mentzer 1999). In other words, two constructs which are similar in theory, are also the same in practice and vice versa. Constructs should have high level of reliable, short and easy to use (Li et al. 2005). As the guidelines of Phillips and Bagozzi (1986), the following measurement properties are considered important for assessing the effectiveness of instruments: (1) reliability, (2) construct validity, (3) unidimensionality.

- **Reliability** indicates the degree to which operational measures are free from random error and measure the construct in a consistent manner (Campbell and Fiske 1959).
- ***Construct validity*** *is the extent to which the items in a scale measure the abstract or theoretical construct. It consists of content validity, convergent validity, discriminant validity, and criterion-related validity* (Carmines and McIver 1981, Churchill 1979)
  - *The first step in the construct validation process is to establish content validity (O'Leary-Kelly and J. Vokurka 1998). The* ***content validity*** *of an instrument is the extent to which it provides adequate coverage for the construct domain or essence of the domain being measured (Churchill 1979).*
  - ***Convergent validity*** *is concerning the consistent degree of items in the same construct (Phillips and Bagozzi 1986).*
  - *The concern with* **discriminant validity** *is the ''extent to which a concept differs from other concepts''* (Phillips and Bagozzi 1986, Hoskisson et al. 1993, Venkatraman and Grant 1986).
  - ***Criterion-related validity*** *is a measure of how well the scales representing various constructs, the measures of performance (Venkatraman and Grant 1986).*
- **Unidimensionality:** Assessing unidimensionality means determining whether or not a set of indicators reflect one, as opposed to more than one, underlying factor (Gerbing and Anderson 1988, Droge 1997). There are two implicit conditions for establishing unidimensionality. First, an empirical item must be significantly associated with the empirical representation of a construct and, second, it must be associated with one and only one construct (Anderson and Gerbing 1982, Phillips and Bagozzi 1986); Phillips and Bagozzi, 1986; Hair et al., 1995). A measure must satisfy both of these conditions in order to be considered unidimensionality.

First, based on of risk factors in the Table 3.1, a preliminary questionnaire had been drafted. Respondents from the target firms were asked to evaluate how their firms had been affected in the last five year by SC risks and to estimate their SC performance. Five-point Likert-type items were employed with a score of 1, representing “strongly disagree,” and 5, indicating “strongly agree,” to obtain the different attitudes of respondents.

3.3.2 Personal interview and Q-sort

A structural interview of academicians was carried out. The comments from academicians were recorded and analysed before conducting some improvements in the measurement scales. Subsequently, Q-sort method was applied with the participation of eleven managers to preliminarily assess validity, reliability and unidimensionality of research concepts. Hence, the final version of the questionnaire was developed for the large-scale survey.

3.3.3 The official questionnaire

The structure of the official questionnaire consists of 4 parts as follows:

- Introduction
- Company information
- Main information
- General information

Main contents of each section in the questionnaire are describing below, referring to Appendix 1 for details.

Introduction

Opening words are briefly presented in order to introduce purposes of the survey and convince target respondents to participate.

Company information

Based on the value chain of the construction, in this study, the target population is categorized into five critical groups:

1. Building Material Manufacturing (sand, stone, additive, etc.)
2. Building Material Distribution
3. Concrete production
4. Construction executive
5. Design (architecture and construction)
6. Transportation

In case, the company of target respondents is operating in many fields, they should choose a certain field which brings the greatest value for them.

The next questions aim to classify enterprises:

Type of business:

☐ 100% Locally-owned ☐ 100% Foreign-owned ☐ Joint Venture

Years of business:

☐ Less than 5 years ☐ From 5 - 10 years ☐ From 10 - 20 years

☐ From 20 - 30 years ☐ From 30 - 40 years ☐ From 40 - 50 years

How many full-time employees work for your company?

☐ Less than 10 ☐ 10 - 200

☐ 200 - 300 ☐ More than 300

Authorized capital:

☐ Less than 20 billion VND ☐ From 20 to 100 billion VND

☐ Above 100 billions VND

What is the main target customer of your firm:

☐ Industrial Construction (B2B) ☐ Civil Construction (B2C)

Main information

This section aims to examine the impact of supply chain risks on supply chain performance, including:

- 90 questions related to the occurrence (in the past) and estimate the probability (likelihood in the future) of each supply chain risk as well as to what extend has the firm in the past five years experienced a negative impact in supply chain management.
- 14 questions of evaluating supply chain performance indicators.

Other information

This section contains questions classifying target respondents, being:

1. What is your job title?

☐ Top-level manager ☐ Middle-level manager ☐ First-level manager

☐ Coordinator ☐ Others: …………………

2. What is your working area?

☐ Purchasing ☐ Logistics ☐ Operations/ Projects

☐ Human Resources ☐ Risk Management ☐ Finance

☐ Sales ☐ Marketing ☐ Others: ………………

3.3.4 Sample design

3.3.4.1 Population

Enterprises and individual businesses are operating in the Vietnam construction sector.

3.3.4.2 Sampling method

The convenience sampling, a technique of non-probability sampling, was applied. A major advantage of this technique is that it's very cost- & time-effective and easy to use. This is a popular method used in similar researches (Hair et al. 1998).

3.3.4.3 Sample size

Using the survey method, researchers have to consider the balance among time, budget, human resource, the accuracy of obtained information, etc. (Karataş 2009). Thus, sample design is very important.

Normally, with a smaller sample size, the accuracy of collected information is reduced but it is more convenient in term of time and cost. In contrast, if the sample size is large, the level of representation for population and statistical efficiency will be high but economic efficiency is low. Therefore, we should consider between statistical and economic issues when sampling.

Moreover, the method of data analysis is planning to use in this study is Structural Equation Modeling (SEM), a technique requiring a large sample size as it is dependent on a large sample distribution theory (Raykov and Widaman 1995).

It is the fact that there is no agreement how is large sample size (Karataş 2009). Hair et al. (1998) argued that it is subject to the sample size also depends on the used estimation methods, for instance, if we use maximum likelihood method, minimum sample size is ranged from 100 to 150 (Hair et al. 1998); or a critical sample size should be 200 (Hoelter 1983). Hence, in this research, an estimated sample size over 200 is expected.

3.3.5 Large-scale data collection

The target population is Vietnam-based companies within the construction industry. Managers, coordinators, etc., who have knowledge and experience of logistics and SC management are target respondents in this research. Based on information from the list of General Statistics Office in 2008 and the website of nhungtrangvang.com.vn which provides addresses, email, phone, etc. of companies in Vietnam, a total of 3601 contact information of enterprises were collected. The link of the official questionnaire was sent to these firms via email addresses. In order to increase the response rate, an electrical postcard was sent after the initial mailing to remind non-respondents. Depending on their requirements, a copy of the questionnaire was mailed by post-office or the link of the survey was sent to their email. One month later, the survey link once again was emailed. To encourage the cooperation of respondents, the survey results would be sent to them.

3.3.6 Large-scale data analysis process

The process of large-scale data analysis aims to validate measuring scales and research models in terms of validity, reliability and unidimensionality.

3.3.6.1 Exploratory factor analysis (EFA)

The aim of EFA in the current study was data reduction of the entire sample and to ascertain whether the survey questions loaded on their respective dimensions.

- Necessary conditions for EFA

To be able to apply EFA, observed variables have to correlate each other. Tabachnick and Fidell (2007) suggested an inspection of the correlation matrix for evidence of coefficients greater than 0.3. If few correlations above this level exist, factor analysis may not be suitable. Two statistical methods are also provided by the SPSS package to test the factorability of the data set: Bartlett's test of Sphericity (Bartlett 1954), and the Kaiser Meyer Olkin (KMO) measure of sampling adequacy (Kaiser 1974). Bartlett's test of Sphericity should be significant ($P < 0.05$) for the factor analysis. Meanwhile, the KMO index ranges from 0 to1, particularly 0.6 was suggested as the minimum value for a good factor analysis (Tabachnick and Fidell 2007).

- Criteria of exploratory factor analysis

Variance explained criteria: The total of variance explained is greater than 50% (Gerbing and Anderson 1988).

The correlation coefficient between items and factors, known as factor loadings:

- Convergent validity: factor loadings of items are greater than 0.4 in a certain factor (Hair et al. 1995).
- Discriminant validity: the level of difference between factor loadings of each item in distinct factors is greater than 0.3 (Hair et al. 1998).

3.3.6.2 Cronbach's Alpha

The Cronbach's Alpha coefficient is used for evaluating reliability of each construct (Antony et al. 2002). This coefficient is a statistical test of the consistent degree to which observed items in a construct correlated (Fowler Jr 2013). High alpha scores imply more internal reliability in the measurement scale whereas a low alpha indicates that the items do not capture the construct and some items should be eliminated to improve the reliability level (Santos 1999). According to Hair et al. (2014) and Nunnally (2010), the lower limit for Cronbach's alpha is 0.70. Bryman and Bell (2015) asserted that the figure of 0.80 is typically employed as a rule of thumb to denote an acceptable level of internal reliability.

In the purpose of improving Cronbach's Alpha coefficient, the items which have a small value of the item – total correlation coefficient will be deleted (Santos 1999). The coefficient of item – total correlation expresses the correlation between an item and the average score of other items in the same construct (Hair et al. 1995). Thus, the higher this coefficient is, the stronger the correlation among items achieved and consequently, the reliability of this construct is more significant (Hair et al. 1995, Nunnally 2010). The items having the item – total correlation coefficients less than 0.35 will be deleted from the measuring instrument (Hair et al. 1998).

Subsequently, confirmatory factor analysis (CFA) are conducted to confirm validity and reliability of constructs, including: convergent validity, discriminant validity, reliability, unidimensionality and criterion-related validity.

3.3.6.3 Confirmatory factor analysis (CFA)

- Introduction

The analysis of Cronbach's Alpha coefficient and Explanatory factor analysis are used to refine preliminarily and explore the underlying structure of observed variables (Hair et al. 1998). For a final confirmation of validity, reliability and unidimensionality of measures, it is necessary to apply the technique of CFA (Hurley et al. 1997).

This technique has more advantages than other traditional ones, e.g. correlation coefficient, EFA, etc. (Bagozzi and Yi 2012), for instance, CFA allows us to validate measuring scales as well as the relationship between two concepts without bias due to the consideration of measurement errors in the CFA model (Steenkamp and van Trijp 1991)

- Criteria of Confirmatory factor analysis

The measuring scales are unidimensional if the corresponding measurement models are overall fit (Steenkamp and van Trijp 1991). The indicator of Chi-square is one of criteria to evaluate the goodness of fit of research models (Hair et al. 1998). A well-fitting model will have $p>.05$. However, because Chi-square has a disadvantage that it relies on sample size, the greater sample size is, the higher Chi-square is. It therefore, reduces goodness of model fit (Hair et al. 1998), meaning that Chi-square is not capable to reflect "real" goodness of model fit in case of the large sample size. Hence, some other goodness of fit indicators are used in parallel with Chi-square, e.g. Chi-square /df, p, CFI (Comparative Fit Index), and RMSEA (Root Mean Square Error Approximation). If a research model has Chi-square /df <3.0, $p>0.05$, CFI from 0.90 to 1 and RMSEA<0.08, this model is well-fitting to the data (Arbuckle 1999). These indicators will be discussed in details in the section of "*3.3.6.4 Structural Equation Modelling (SEM).*"

The measuring scales are convergent if the standardize regression weight of observed items is greater than 0.5 and ideally 0.7 or higher at the significant level of $p<0.05$ (Gerbing and Anderson 1988).

Additionally, the composite reliability, a measure of the overall reliability of a set of heterogeneous but similar indicators, should be above 0.7 and ideally 0.8 or higher. While the reliability of individual variables can be tested using Cronbach's Alpha, the composite reliability is concerned with testing the reliability of a construct/ latent variables.

Average variance extracted (AVE) reflecting the overall amount of variance in the manifest variables accounted for by the latent construct, should be greater than the cut-off-value of 0.5 (Hair et al. 2010). Composite reliability (Joreskog and Sorbom 1993) and Variance explained (Fornell and Larcker 1981) is calculated as follows:

Composite reliability – CR:

$$CR = \frac{\left(\sum_{i=1}^{p} \lambda_i\right)^2}{\left(\sum_{i=1}^{p} \lambda_i\right)^2 + \sum_{i=1}^{p}\left(1-\lambda_i^2\right)}$$

(3.1)

Variance explained – VE

$$VE = \frac{\sum_{i=1}^{p} \lambda_I^2}{\sum_{i=1}^{p} \lambda_I^2 + \sum_{i=1}^{p}\left(1-\lambda_i^2\right)}$$

(3.2)

In these equations:

P : Number of observed variables in a certain concept

λ_i : Standardized Regression Weights of the item i

$\left(1-\lambda_i^2\right)$: Variance of measurement error of the item i

Regarding the discriminant validity, two components of a certain construct or two constructs are discriminant since measurement models are well-fitting to the data and the correlation coefficient between them r<1 at the statistical significance (Steenkamp and van Trijp 1991).

All above describe how to validate the measurement instrument, if measurement items are valid, reliable and unidimensional, the analysis of Structural Equation Model (SEM) is carried out to test research hypotheses developed in the research model. Conversely, the process will turn back to literature review to redefine the research concepts as well as the measurement instrument.

3.3.6.4 Structural Equation Modelling (SEM)

- Introduction

Structural Equation Modelling has grown to be one of the main techniques of data analysis that attracted many scholars across different disciplines and progressively in the social sciences (Kelloway 1995, Büchel and Friston 1997, Barrett 2007, Hooper et al. 2008). The term of SEM suggests two main features of the procedure: (1) the causal processes are characterized by a series of structural equations, i.e. regression, and (2) these structural relations can be modelled in a picture to enable a clearer conceptualization of the theory (Tabachnick and Fidell 2007).

Additionally, SEM is a technique to analyse multiple and interrelated relationships among the constructs for model building (Hair et al. 2014, Tabachnick and Fidell 2007, Byrne 1998). It is the unique technique that allows to simultaneously test all relationships for complex and multidimensional phenomenon (Tabachnick and Fidell 2007), pp. 679). In other words, according to Muthen and Kaplan (1985),

> *[...]SEM took factor analysis one step further by relating the constructs to each other and the covariance in the system of linear regressions thereby purging the structural regressions of biasing effects of measurement error.*

Moreover, SEM allows dependent variables in one equation to become independent variables in other equations (Ullman and Bentler 2003).

- Model evaluation

This section is to determine how well the data fit the model; in other words, to what extent is the theoretical model supported by the observed sample data (Schumacker and Lomax 2004). There are two aspects in the model evaluation, (1) an evaluation of measurement models and (2) evaluation of the structural model.

The measurement models describe the relationship between observed variables and the latent variable (Hair et al. 2014). Assessing the measurement models entailed the use of CFA to test factor loadings of observed items on the latent variable (Byrne 1998).

The structural model: There are two ways to think of the goodness of fit of a structure model.

(1) Test the adequacy of each parameter estimate

Schumacker and Lomax (2004) suggested three key features of the adequacy of each parameter. One feature is whether a free parameter is significantly different from zero (Byrne 1998). Once parameter estimates are attained, standard errors of each estimate are also obtained. A ratio of the estimated parameter to the standard error can be calculated as a critical ratio (C.R.), which is assumed normally distributed (Schumacker and Lomax 2004, Byrne 1998). A probability level of .05, the test statistic must exceed the value of ± 1.96 to reject the null hypothesis that the estimate equals zero (Byrne 1998). A second feature is whether the sign (positive/negative) and the direction of the estimate are consistent with what is anticipated from the theoretical model (Schumacker and Lomax 2004). A third feature is that parameter estimates should be logical, that is, they should be within an anticipated range of values, e.g. no negative values obtained and correlations should not exceed the value of 1.00 (Byrne 1998). Thus, all free parameters should be in the expected positive/negative direction, be statistically different from zero, and make practical sense (Schumacker and Lomax 2004).

In doing so, squared multiple correlations (R^2) for each single observed variable will be evaluated separately. These values show how well each observed variable serves as a measure of the latent constructs and range from 0 to 1, where 0.3 expresses an accepted level (Byrne 1998). Squared multiple correlations are also specified for each endogenous variable separately (Schumacker and Lomax 2004).

(2) Assessing the model as a whole

The goodness-of-fit for the entire model describes how well the theoretical model reproduces the covariance matrix between the indictors' items. In other words, the model is first specified (based on a theory) and then the sample data is utilized to test the model to determine the goodness-of-fit between the theoretical model and the sample data (Byrne 1998).

The estimated covariance matrix (∑k) is mathematically compared to the actual observed covariance matrix (S) to supply an estimate of model fit, where the closer the values of these two matrices are to each other, the better the model fit (Hair et al. 2010).

Goodness of fit measures for the whole model can be classified into three groups: basis measures, absolute measures and incremental measures (Arbuckle 1999).

The basics of goodness- of -fit

Chi – square is the fundamental measure of fit as it provides a mathematical result of the difference between the estimated covariance matrix (∑k) and the actual observed covariance matrix (S) by the following equation:

$$\chi 2 = (N-1)\ (S - (\sum k\ ) \quad (3.3)$$

where N is the overall sample size (Hair et al. 2014).

The $\chi 2$ value increases if the sample size increases. Moreover, the SEM estimated covariance matrix (∑k) is also influenced by how many parameters are free to be estimated, therefore the model degree of freedom (df), calculating by subtracting the number of estimated parameters from the number of data points, also affects the $\chi 2$ value (Byrne 1998). In contrast with the other statistical methods which aim to obtain smaller probability values, i.e. P- values-< 0.5, indicating that a relationship is existed; with the Chi-square test in the SEM, the smaller the p- values, the greater the possibility that the estimated covariance matrix (∑k) and the actual observed covariance matrix (S) are not equal. Thus, smaller $\chi 2$ values (and consequently larger P- values) should imply statistically significant difference between the two matrices (S) and (∑k) (Hair et al. 2014, Tabachnick and Fidell 2007).

Harrington (2009) argued that there are several limitations to the Chi-square as it depends on sample size and will always be significant with large samples. Hence, its value cannot be used as a unique indicator. Three alternative goodness of fit measures, including absolute measures, incremental measures and parsimony measures were developed to assess the goodness of fit of a specific model (Raykov and Marcoulides 2006).

Absolute fit measures

An absolute fit measure is a measure of the overall model goodness-of-fit. Root Mean square Residual (RMR), Standardized Root mean square Residual (SRMR) and Root Mean Square Error of Approximation (RMSEA) are three indicators received much attention.

The RMR is the square root of the average squared amount by which the sample variances and co-variances (S) differ from the estimated obtained variances and co-variances (∑) under the assumption that the model is correct (Arbuckle 1999). Good-fitting models have small RMR. However, sometimes it is difficult to interpret an unstandardized residual because the scale of the variables affects the size of the residual (Tabachnick and Fidell 2007, Harrington 2009).

Thus, a standardized root means square residual (SRMR) was recommended. Similar as RMR, small values indicate good-fitting models, that explain why sometimes they are called as badness-of-fit measures (Hair et al. 2014).

The RMSEA value differs from RMR, particularly it has a well-known distribution. Therefore, this value can better characterize how well the model fits a population, not just an estimation sample. Moreover, it attempts to correct for both model complexity and sample size by containing both in each calculation (Byrne 1998). Lower RMSEA value (0.08) indicates a better fit while a higher value indicates a worse fit (Hair et al. 2014). Generally speaking, RMSEA has a range of values between 0 and 1, where values of 0.08 or less are accepted (Hair et al. 2014, Byrne 1998), and values of 0.05 or less are preferred (Schumacker and Lomax 2004).

Another value is the normed Chi-square goodness of fit that is a ratio of chi square to the degree of freedom (df) for the model. Basically, Chi-square: df on the order of 3:1 or less are associated with better fitting (Hair et al. 2014).

Incremental measures

These measures assess how well a particular model fits relative to alternative baselines (null/ independence) model (Hair et al. 2014). The most widely applied incremental measures are the Normed Fit Index (NFI), Comparative Fit Index (CFI), and Tucker Lewis Index (TLI).

- The Normed Fit Index (NFI) evaluates the estimated model by comparing the chi square $\chi 2$ value of the model to the $\chi 2$ value of the independence/ null model. Its value ranges between 0 and 1.00, where high values of NFI (greater than 0.9 and ideally 0.95) are indicative of a good-fitting model (Tabachnick and Fidell 2007).
  The Comparative Fit Index (CFI) is one of the most widely employed indices as

it is considered as an enhanced version of the Normed Fit Index (NFI), which is insensitive to model complexity (Hair et al. 2014).

- Similar as NFI, the value of the CFI is normed so it ranges between 0 and 1.00, where the larger, the CFI the better the fit and CFI values above 0.9 and ideally greater than 0.95 are often indicative of a good-fitting model (Tabachnick and Fidell 2007).
- The Tucker Lewis Index (TLI) provides very similar values to CFI by comparing a specified theoretical measurement model with the baseline null model, but it is not normed. Thus its value can be below 0 or above 1.00, where a higher value of TLI suggests a better fit than a model with a lower value (Hair et al. 2014).

It is worth noting that no single value can be employed to differentiate a good model from a bad model (Hair et al. 2014). It is imperative that at least one incremental index and one absolute index should be reported. Table 3.3 summarizes selected goodness of fit indices and the recommended cut -off values.

Table 3.3: The recommended cut -off values for SEM fit indices

Fit index	**Cut-off values from literature**	**References**
Basic measures:		(Bollen 1989, Byrne 1998, Carmines and McIver 1981, Hair et al. 1995, Jaccard and Wan 1996, Joreskog and Sorbom 1993)
Chi-square	As smaller as possible	
p	>0.05	
Absolute fit measures:		(Bollen 1989, Byrne 1998, Carmines and McIver 1981, Hair et al. 1995, Jaccard and Wan 1996, Joreskog and Sorbom 1993)
Chi-square/df	<3.0	
RMSEA	<0.08	
Incremental measures:		
CFI	>.90	

- Model modification and validation

The final step in SEM is to conduct model modification in order to obtain a better data-to-model fit. If the model fit indices in the structural model are not satisfied, a researcher usually performs a specification search to gain a better fitting of the theoretical model to the observed sample variance-covariance matrix (Kline 1998). One may remove parameters that are insignificantly different from zero and/or insert extra parameters to attain at a modified mode (Tabachnick and Fidell 2007).

As removing parameters, the popular techniques are to (1) to compare the t statistic for each single parameter to the tabulated t-value (i.e. t > 1.96) of statistical significance and (2) to utilize the Wald (W) statistic in the same way as the t-statistic (Schumacker and Lomax 2004). For adding additional parameters, the common procedures are (a) to choose the highest value of modification index (MI). This index is the likely value that describes a decrease of Chi-square if a specific parameter was added, (2) to select the highest value of the expected parameter change statistic (EPC) (the new parameter approximate value), and (3) to apply the Lagrange multiplier (LM) statistic (Tabachnick and Fidell 2007).

We could also use the standardized residual matrix as clues which observed variances and co-variances are not well accounted for by the theoretical model. A great value of the standardized residuals (above 1.96 or 2.58) indicates that this relationship is not well explained in the hypothesized model (Schumacker and Lomax 2004).

After obtaining a satisfactory model fit, the research hypotheses were tested. Each path in the structural model represents a specific hypothesis. The null hypothesis raised here is that there is no relationship exist between two latent variables. If the P value is less than the significance level (i.e. t > 1.96), the null hypothesis was rejected and vice versa (Pallant 2007). The key determinant for accepting or rejecting hypothesis is the significance of standardised coefficients of research parameters. The level of significance employed in this thesis was less than 0.1 (an acceptable significance), 0.05 (strong significance) and 0.01 (a high significant level); where the lower the significance level, the more the data must deviate from the null hypothesis to be significant (Tabachnick and Fidell 2007).

3.4 RESULTS

3.4.1 Data refinement process

A total of 324 answers were received. These answers were filtered before using in the large-scale analysis process in order to minimize errors in the interview and data entry stages.

The data refinement process was conducted in two main steps:

Step 1: Deleting the answers that target respondents replied "perfunctory," e.g. there are some answers only choosing one option throughout the questionnaire or ones having the shape of "zigzag."

Step 2: Applying statistical tools of SPSS 15.0 software to filter errors in the data entry process. In particular, frequency of all observed variables was described to find missing and strange values. The missing ones were then assigned "mean" values due to difficulty in re-contacting to target respondents.

After the data refinement process, there are 202 valid answers that were described in the Table 3.4.

Table 3.4: Survey sample

Firm profile			Firm profile			Respondent profile		
Operation fields	Building Material Manufacturing (sand, stone, additive, etc.)	32	Years of business	< 5 years	16	Job title	Top-level manager	15
	Building Material Distribution	47		5 - 10 years	73		Middle-level manager	47
	Concrete production	36		10 - 20 years	88		First-level manager	102
	Construction executive	72		20 - 30 years	22		Coordinator	22
	Design (architecture and construction)	15		30 - 40 years	2		Others	16
Full-time employees	Less than 10	5		40 - 50 years	1	Working area	Purchasing	10
	10 - 200	71	Authorized capital	<20 billion VND	11		Logistics	9
	200 - 300	52		20 - 100 billion VND	34		Operations/ Projects	120
	More than 300	74		> 100 billion VND	157		Human Resources	17
							Risk Management	11
							Finance	3
							Sales	26
							Marketing	6

Calculation unit: %

VND: Vietnamese Dong

3.4.2 T-test and Common Method Variance (CMV)

An estimate of non-response bias with T-test procedures was conducted in order to test the difference in items between early and late respondents (Armstrong and Overton 1977). Results showed no significant differences in the average scores of all observed items (internal confidence of 99%). This shows that non-response bias exists between early and late respondents.

In addition, independent and dependent variables were obtained from the same respondent in each firm. This could lead to the presence of common method variance (CMV). Harman's single-factor test was calculated to test this existence (Podsakoff et al. 2003). Un-rotated factor analysis was performed with all observed items. If only one factor emerges – if a general factor can explain covariance in all variables – it is rational to conclude that a significant CMV exists. Results indicated that 11 factors appeared. However, when the number of items are too much, this way of testing is not exact (Podsakoff et al. 2003). Therefore, items in each of the independent construct (SC risk) were factor analysed with items in the dependent construct's scale (SC performance).

For each case, the results of factor analysis showed that two, and more than two, factors emerged, showing there is no significant CMV.

3.4.3 EFA and Cronbach's Alpha coefficient

As mentioned above, Exploratory Factor Analysis (EFA) is conducted to explore the structure of the data. The proposed extraction method is Principal component with the rotation technique of Varimax (Hair et al. 1995). The breakpoint is at Eigenvalue ≥ 1 for all constructs in the theoretical model. The results of EFA and Cronbach's Alpha coefficient for each measuring scale were discussed in the following sections.

3.4.3.1 The scale of supply risk

Supply risk is measured by four observed items as illustrated in Table 3.5. EFA extracted one factor at eigenvalue = 2.652 with the total of Variance explained = 66.288 (>50%). Factor loadings range from 0.739 to 0.888 (>0.4). Cronbach's Alpha coefficient is 0.824 (>0.7). Item-total correlation coefficients range from 0.559 to 0.77 (>0.35). Hence, we can conclude that all observed items of this measuring scale are satisfactory and continue testing by CFA.

Table 3.5: Test results of the supply risk scale

Construct	Observed items	Factor loadings	Eigenvalue	Variance extracted	Item – total correlation	Cronbach's alpha
SUPPLY RISK	Supplier bankruptcy	0.888	2.652	66.288	0.77	0.824
	Price fluctuations	0.79			0.611	
	Unstable quality of inputs	0.739			0.559	
	Unstable quantity of inputs	0.832			0.679	

3.4.3.2 The scale of operational risk

Operational risk is measured by four observed items as illustrated in Table 3.6. EFA extracted two factors at eigenvalue = 1.642 with the total of Variance explained = 87.137 (>50%). Factor loadings are greater than 0.9. Cronbach's Alpha coefficients are 0.875 and 0.821, respectively (>0.7). Item-total correlation coefficients range from 0.696 to 0.778 (>0.35). Hence, we can conclude that all observed items of this measuring scale are satisfactory and continue testing by CFA.

Table 3.6: Test results of the operational risk scale

Construct	Observed items	Factor loadings		Eigenvalue	Variance extracted	Item – total correlation	Cronbach's alpha
OPERATIONAL RISK	Design changes	**0.94**	-0.097	1.642	87.137	0.778	0.875
	Technological changes	**0.945**	0.045			0.778	
	Accidents	0.011	**0.921**			0.696	0.821
	Labour disputes	-0.06	**0.92**			0.696	

3.4.3.3 The scale of demand risk

Demand risk is measured by four observed items as illustrated in Table 3.7. EFA extracted one factor at eigenvalue = 2.562 with the total of Variance explained = 64.056 (>50%). Factor loadings range from 0.733 to 0.848 (>0.4). Cronbach's Alpha coefficient is 0.812 (>0.7). Item-total correlation coefficients range from 0.551 to 0.696 (>0.35). Hence, we can conclude that all observed items of this measuring scale are satisfactory and continue testing by CFA.

Table 3.7: Test results of the demand risk scale

Construct	Observed items	Factor loadings	Eigenvalue	Variance extracted	Item – total correlation	Cronbach's alpha
DEMAND RISK	Demand variability	0.796	2.562	64.056	0.625	0.812
	High competition in the market	0.733			0.551	
	Customer bankruptcy	0.82			0.658	
	Customer fragmentation	0.848			0.696	

3.4.3.4 The scale of finance risk

Finance risk is measured by four observed items as illustrated in Table 3.8. After deleting the item of "Stakeholders" due to unable to achieve the threshold values, EFA extracted one factor at eigenvalue = 2.048 with the total of Variance explained = 68.279 (>50%). Factor loadings range from 0.78 to 0.871 (>0.4). Cronbach's Alpha coefficient is 0.767 (>0.7). Item-total correlation coefficients range from 0.538 to 0.671 (>0.35). Hence, we can conclude that all observed items of this measuring scale are satisfactory and continue testing by CFA.

Table 3.8: Test results of the finance risk scale

Construct	Observed items	Factor loadings	Eigenvalue	Variance extracted	Item – total correlation	Cronbach's alpha
FINANCE RISK	Currency fluctuations	0.871	2.048	68.279	0.671	0.767
	Inflation	0.78			0.538	
	Interest rate level	0.825			0.596	
	Stakeholders (request late changes, new stakeholders, etc.)	Deleted				

3.4.3.5 The scale of information risk

Information risk is measured by three observed items as illustrated in Table 3.9. EFA extracted one factor at eigenvalue = 2.472 with the total of Variance explained = 82.388 (>50%). Factor loadings range from 0.892 to 0.916 (>0.4). Cronbach's Alpha coefficient is 0.883 (>0.7). Item-total correlation coefficients range from 0.762 to 0.803 (>0.35). Hence, we can conclude that all observed items of this measuring scale are satisfactory and continue testing by CFA.

Table 3.9: Test results of the information risk scale

Construct	Observed items	Factor loadings	Eigenvalue	Variance extracted	Item – total correlation	Cronbach's alpha
INFORMATION RISK	Communication breakdown with project team	0.916	2.472	82.388	0.803	0.883
	Information infrastructure breakdown	0.915			0.796	
	Distorted information	0.892			0.762	

3.4.3.6 The scale of time risk

Time risk is measured by five observed items as illustrated in Table 3.10. EFA extracted one factor at eigenvalue = 3.138 with the total of Variance explained = 62.761 (>50%). Factor loadings range from 0.774 to 0.818 (>0.4). Cronbach's Alpha coefficient is 0.849 (>0.7). Item-total correlation coefficients range from 0.634 to 0.692 (>0.35). Hence, we can conclude that all observed items of this measuring scale are satisfactory and continue testing by CFA.

Table 3.10: Test results of the time risk scale

Construct	Observed items	Factor loadings	Eigenvalue	Variance extracted	Item – total correlation	Cronbach's alpha
TIME RISK	Delays in supply activities	0.79	3.138	62.761	0.667	0.849
	Delays in operating activities	0.782			0.651	
	Delays in distribution activities	0.818			0.692	
	Delayed payment	0.774			0.634	
	Information delays	0.797			0.668	

3.4.3.7 The scale of external risk

External risk is measured by six observed items as illustrated in Table 3.11. After deleting the item of "Cultural differentiation" due to unable to achieve the threshold values, EFA extracted two factors at eigenvalue = 1.681 with the total of Variance explained = 74.35 (>50%). Factor loadings are greater than 0.795. Cronbach's Alpha coefficients are 0.728 and 0.865, respectively (>0.7). Item-total correlation coefficients range from 0.541 to 0.762 (>0.35). Hence, we can conclude that all observed items of this measuring scale are satisfactory and continue testing by CFA.

Table 3.11: Test results of the external risk scale

Construct		Observed items	Factor loadings	Factor loadings	Eigenvalue	Variance extracted	Item – total correlation	Cronbach's alpha
EXTERNAL RISK	M1	Economic downturns	**0.816**	0.011	1.681	74.35	0.568	0.728
		External legal issues	**0.795**	0.072			0.541	
		Corruption	**0.806**	0.015			0.551	
	M2	Fire accidents	0.015	**0.938**			0.762	0.865
		Natural catastrophes	0.061	**0.937**			0.762	
		Cultural differentiation	Deleted					

3.4.3.8 Discriminant validity test

The results of discriminant validity are presented in the Table 3.12. We can see that the level of difference between factor loadings of each item in distinct factors is greater than 0.3 implying the discriminant between research concepts. Moreover, operational and external risks were also separated into specific constructs. Accordingly, two new concepts establishing from operational risk, being:

(1) OP1 that includes the risk factors of design changes and technological changes;

(2) OP2 comprising accidents and labour disputes.

External risk was also split into two new constructs:

(1) ER1 that encompasses economic downturns, external legal issues and corruption;

(2) ER2 consisting of fire accidents and natural catastrophes.

Table 3.12: Discriminant validity results

		SR	OR		DR	FR	IR	TR	ER		Threshold values
Constructs	**Observed items**		**OR1**	**OR2**					**ER1**	**ER2**	
SR*	Supplier bankruptcy	**.865**	-.050	.030	.014	-.011	.179	.133	-.013	.123	**1. Factor loadings > 0.4.** **2. Item – total correlation >0.35**
	Price fluctuations	**.788**	-.079	-.277	-.046	-.011	.002	.175	-.075	.111	
	Unstable quality of inputs	**.667**	.193	.348	.077	.008	-.047	.116	.215	.297	
	Unstable quantity of inputs	**.737**	.030	.042	.221	.106	.165	.302	.017	.066	
OR*	Design changes	-.024	**.878**	.078	-.055	.088	.185	-.025	.124	-.121	
	Technological changes	.015	**.873**	-.030	.055	.059	.118	-.027	.248	.006	
	Accidents	.196	.095	**.839**	.039	.051	-.015	.047	-.032	-.085	
	Labour disputes	.234	.038	**.825**	.107	-.036	-.174	-.035	.050	-.062	
DR*	Demand variability	.147	-.073	-.378	**.763**	.086	.062	.123	-.027	.020	
	High competition in the market	.024	.129	.013	**.717**	.036	.235	.135	-.002	-.117	
	Customer bankruptcy	.034	-.001	.081	**.819**	.078	-.191	.000	.029	.173	
	Customer fragmentation	.016	-.052	.129	**.842**	-.074	-.057	.137	.017	.022	
FR*	Currency fluctuations	-.013	.134	-.056	.051	**.861**	-.026	-.105	.089	.020	
	Inflation	.021	.045	.386	.042	**.733**	.074	-.001	.214	.021	
	Interest rate level	.056	-.051	-.162	.006	**.825**	.072	.209	-.020	.143	
	Stakeholders (request late changes, new stakeholders, etc.)										
IR*	Communication breakdown with project team	.102	.090	.040	.066	.060	**.876**	.188	.045	-.074	
	Information infrastructure breakdown	.011	.196	.080	.000	.035	**.885**	.112	.173	-.024	
	Distorted information	.209	.023	-.170	-.081	-.001	**.805**	.329	.047	-.010	
TR*	Delays in supply activities	.293	-.220	.043	.239	-.143	.076	**.683**	.016	.073	
	Delays in operating activities	.012	-.236	.186	.098	-.048	.218	**.726**	.022	.186	
	Delays in distribution activities	.285	-.084	-.249	.091	.022	.160	**.740**	.111	.044	
	Delayed payment	.189	.111	.113	.137	.145	.291	**.686**	-.050	.017	
	Information delays	.107	.211	-.115	.015	.096	.064	**.823**	.093	.121	
ER*	Economic downturns	.054	.114	.130	.081	.153	.162	-.007	**.762**	.012	
	External legal issues	.025	.176	-.246	-.094	.098	.051	.101	**.760**	.085	
	Corruption	-.035	.057	.099	.019	-.011	.019	.051	**.828**	-.001	

	Fire accidents	-.021	-.298	.189	-.006	.111	.114	.323	.039	**.712**	
	Natural catastrophes	.019	-.409	.108	-.110	.230	-.005	.337	.110	**.633**	
	Cultural differentiation										
Total variance extracted		**76.034**									**> 50%**

**SR: Supply risk; OR: Operational risk; DR: Demand risk; FR: Finance risk; IR: Information risk; TR: Time risk; ER: External risk.*

3.4.3.9 The scale of supply chain performance

Supply chain performance is measured by five components including 14 observed items as illustrated in Table 3.13. EFA extracted five factors at eigenvalue = 1.067 with the total of Variance explained = 69.823 (>50%). As the results in the Table 3.13, these five factors are convergent, discriminant and unidimensional, e.g. factor loadings range from 0.500 to 0.878 (>0.4), Cronbach's Alpha coefficient is greater than 0.65, item-total correlation coefficients range from 0.408 to 0.657 (>0.35). Moreover, the concept of supply chain performance is widespreadly tested in previous studies, thus the CFA step will be skipped (Beamon 1999, Gunasekaran and Ngai 2004, Shepherd and Günter 2006).

Table 3.13: Test results of the supply chain performance

	Observed items	**Supplier_ performance**	**Internal_ business**	**Innovation & learning**	**Customer service**	**Financial indicators**	**Item – total correlation**	**Threshold values**
Supplier performance	Reliability	.141	.060	.025	**.878**	.122	0.629	**1. Factor loadings > 0.4. 2. Item – total correlation >0.35**
	Response time	.090	.102	.143	**.849**	.113	0.629	
Internal business	Amount of production waste	.104	**.622**	.435	.209	.068	0.553	
	Costs of inventory management	.100	**.820**	.165	.081	.125	0.642	
	Workforce productivity	.175	**.867**	.034	-.021	-.002	0.601	
Innovation and learning	Number of new product developed per year	.125	.092	**.850**	-.032	.100	0.641	
	Workforce flexibility	.050	.209	**.849**	.129	.128	0.641	
Customer service	Delivery timeliness	**.500**	.116	.496	.172	-.108	0.408	
	Percentage of "perfect orders" delivered	**.638**	.291	.045	.101	.035	0.461	
	Product value perceived by the customer	**.837**	.033	.123	.010	.095	0.608	
	Product/ Service quality	**.717**	.131	.136	.112	.386	0.657	
	Response time to customer queries	**.514**	-.014	-.020	.381	.363	0.465	
Finance	Market share growth	.127	-.033	.042	.207	**.819**	0.491	
	Return on Investments (ROI)	.157	.186	.136	.034	**.799**	0.491	
Cronbach's alpha		0.771	0.765	0.749	0.751	0.658		**> 0.7**
Eigenvalue		1.067						**> 1**
Variance extracted		69.823						**> 50%**

3.4.4 Test results of CFA

Table 3.14 shows the CFA results that all Standardized Regression Coefficients of the remaining items are greater than twice standard error, $R^2 > 0.3$, Composite reliability > 0.7 and Variance extracted > 0.5. This confirms that the measuring items have convergent validity.

Table 3.14: CFA results

	Constructs	**Standardized Regression Weights**	**Standard errors**	**R^2**	**Composite reliability**	**Variance extracted**
SR	Supplier bankruptcy	0.939	0.044	0.881	0.825	0.549
	Price fluctuations	0.721	0.058	0.519		
	Unstable quality of inputs	0.565	0.06	0.319		
	Unstable quantity of inputs	0.689	0.06	0.475		
OR	Design changes	0.863	0.058	0.746	0.918	0.737
	Technological changes	0.901	0.054	0.812		
	Accidents	0.848	0.055	0.72		
	Labour disputes	0.82	0.059	0.672		
DR	Demand variability	0.641	0.045	0.41	0.804	0.513
	High competition in the market	0.549	0.034	0.301		
	Customer bankruptcy	0.786	0.035	0.618		
	Customer fragmentation	0.85	0.042	0.723		
FR	Currency fluctuations	0.864	0.068	0.747	0.959	0.917
	Inflation	0.645	0.056	0.417		
	Interest rate level	0.674	0.051	0.454		
	Stakeholders (request late changes, new stakeholders, etc.)	Deleted				
IR	Communication breakdown with project team	0.879	0.033	0.773	0.892	0.735
	Information infrastructure breakdown	0.883	0.047	0.78		
	Distorted information	0.807	0.064	0.651		
TR	Delays in supply activities	0.784	0.051	0.615	0.881	0.533
	Delays in operating activities	0.686	0.053	0.471		
	Delays in distribution activities	0.759	0.052	0.576		

	Delayed payment	0.685	0.044	0.469		
	Information delays	0.797	0.033	0.635		
ER	Economic downturns	0.713	5.855	0.509	0.889	0.543
	External legal issues	0.672	6.735	0.451		
	Corruption	0.686	6.446	0.47		
	Fire accidents	0.862	5.008	0.743		
	Natural catastrophes	0.884	4.241	0.782		
	Cultural differentiation	Deleted				
Threshold values		*1. Standardized Regression Coefficients > 0.5.*			*>0.7*	*>0.5*
		2. Standardized Regression Coefficient > 2 x standard error.				
		3. $R^2 > 0.3$.				

Regarding unidimensionality, seven measurement models of research concepts are evaluated. Table 3.15 presents the goodness of fit of measurement models. The results show all models fit to the data proving all seven concepts are unidimensional.

Table 3.15: Goodness of fit of measurement models

	SR	OR	DR	FR	IR	TR	ER	Threshold values
p	0.258	0.304	.602	0.303	0.560	0.142	0.360	**>0.05**
χ2/df	1.280	1.190	.272	1.061	0.340	1.721	1.097	**<3.0**
CFI	0.999	0.999	1.000	1.000	1.000	0.993	0.998	**>0.9**
RMSEA	0.037	0.031	0.000	0.017	0.000	0.060	0.022	**<0.08**

Table 3.16 describes the Chi-square difference among research concepts, which is used to test discriminant validity. 21 pairs coupled from the seven research concepts are compared through two models for each pair. The first model is to allow free correlation between the two constructs, and the other is to fix the correlation between the two constructs at 1.0. The research results indicated that all differences among research concepts are significant at P<0.001. Thus, we can conclude that all research concepts are discriminant.

Table 3.16: Chi-square difference among research concepts

	SR	OR	DR	FR	IR	TR	ER
SR	1						
OR	107.322	1					
DR	108.325	148.18	1				
FR	136.53	144.258	147.925	1			
IR	62.497	93.906	106.697	99.725	1		
TR	75.923	150.847	113.673	151.483	62.719	1	
ER	130.613	140.369	161.29	136.295	100.866	126.062	1

**All Chi-square differences were significant at the 0.001 level*

Criterion-related validity is tested through Pearson's correlation coefficient (Table 3.17). There are three critical parts in this test. The first one is the impact of the core risks on SC performance. We can see that while demand risk does not have effect on any indicators of SC performance, operational risk and supply risk have relatively high correlation to dependent variables except financial indicators. The second and third are relationships among external risks, infrastructure risks and core risks that mostly support for our theoretical framework. Hence, research concepts have criterion-related validity.

Table 3.17: Pearson's correlation coefficient

CORE RISKS & SUPPLY CHAIN PERFORMANCE

		SUPPLY CHAIN PERFORMANCE				
		Supplier performance	**Internal business**	**Innovation and learning**	**Customer service**	**Financial indicators**
SR		-.237**	-.432**	.004	-.189**	-.100
	OR	.057	-.287**	-.197**	-.153*	-.102
OR	***OR1***	.070	-.147*	***-.143****	***-.156****	-.034
	OR2	.011	-.259**	***-.135***	***-.061***	-.110
DR		-.120	-.124	-.040	-.065	-.004

INFRASTRUCTURE RISKS & CORE RISKS

	SR	OR	OR1	OR2	DR	FR	IR	TR
FR	.083	.180*	***.151****	.104	.079			
IR	.253**	.127	***.267*****	-.087	.038	.108		
TR	.461**	.092	-.048	***.178****	.271**	.092	.426**	

EXTERNAL RISKS ON INFRASTRUCTURE RISKS & CORE RISKS

		SR	OR	OR1	OR2	DR	FR	IR	TR
	ER	.227**	.290**	.013	***.397*****	.034	.294**	.180*	.367**
ER	***HUMAN_MADE_RISKS***	***.080***	***.288*****	.348**	.058	.019	.214**	.210**	***.114***
	NATURAL_RISKS	***.233*****	***.132***	-.295**	.482**	.030	.204**	.053	***.391*****

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

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

From the above, we can conclude that after removing several items which do not meet the threshold values, a set of various SC risks that are valid, reliable and unidimensional are produced.

3.5 DISCUSSION

This research has identified various risks in the SC network. After a careful testing process of a dataset from Vietnam's construction sector, and comparing with seven original risks, a total of nine SC risks that are valid, reliable and unidimensional were established. First, there are two new concepts formed from operational risk, namely OR1 and OR2. These two risks, though all relate to operational process of the focal firm, are very different in terms of *who* will be responsible. For instance, OR1 comprises design and technological changes, which normally originate from investor decisions. Thus, they will incur any time and cost overruns. In contrast, OR2 is risks that derive from contractors, e.g. accidents that occur if the working conditions are poor or labour disputes due to unfair remuneration and workplace conflict. Hence, with these risks, the contractors are responsible. OR1 and OR2, therefore, are renamed as (1) investor-related operational risks and (2) contractor-related operational risks. Second, external risk is split into two new dimensions: (1) human-made risks (ER1), including economic downturns, external legal issues and corruption and (2) natural risks (ER2), comprising fire accidents and natural catastrophes.

The Pearson's correlation results also confirmed the distinction between OR1 and OR2. Although both OR1 and OR2 belong to the operational risk, their behaviours are very different. While OR1 has positive correlations to Innovation & Learning ***(.143*)*** and Customer Service ***(.156*),*** there is no statistical significance in OR2. Moreover, the impacts of some infrastructure risks on operational risk are only found in OR1, e.g. finance risk ***(.151*)*** and information risk ***(.267**).*** Conversely, time risk and external risk having an effect on OR2 are ***.178**** and ***.397**,*** respectively. Likewise, with external risk, the correlation with other risks is also different between two new concepts. For instance, whilst human-made risks uniquely affect operational risk ***(.288**),*** only natural risks influence on supply risk ***(.233**)*** and time risk ***(.391**)***. These findings support the splitting of the operational and external risks into the specific dimensions.

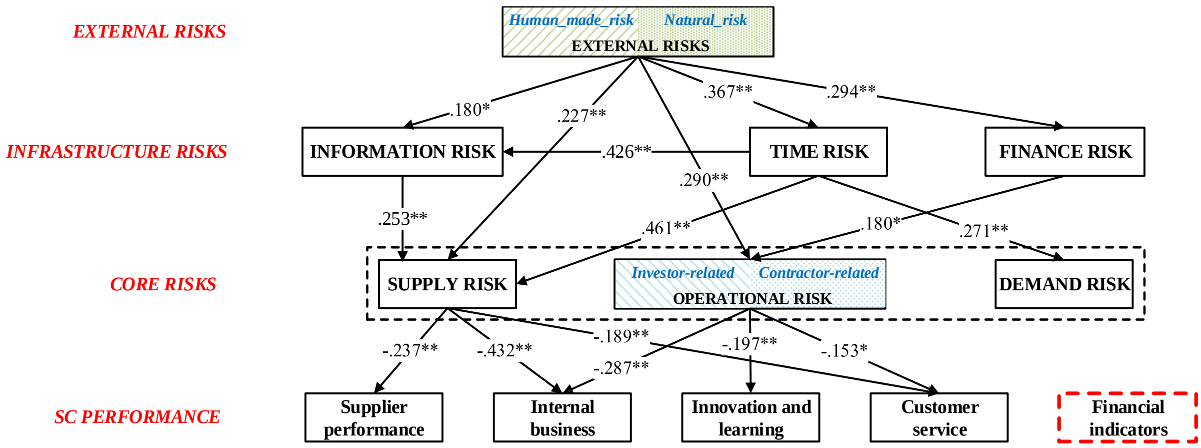

Figure 3.4: Result model

Figure 3.4 schematically depicts the significant relationships between risks and SC performance based on the Pearson's correlation results. As mentioned above, risks in the supply chain are classified into three categories: Core risks, infrastructure risks and external risks.

Core risks, including supply risk and operational risk, have direct effect on SC performance indicators. Particularly, supply risk causes failures to deliver inbound goods or services to the purchasing firm *(-.237**)*. As a result, it not only directly affects performance of suppliers themselves, but disrupts internal business of the purchasing firm *(-.432**)* and subsequently throughout the downstream SC, i.e. reducing quality of customer service *(-.189**)*. Regarding operational risk, when it incurs, also disrupting internal business of the focal firm *(-.287**)* and decreases quality of customer service *(-.153*)*. Moreover, this type of risk affects innovation and learning activities of the focal firm that decrease number of new product developed and workforce flexibility *(-.197**)*.

The research also found the relation of the infrastructure risks to the core risks, being:

- Lack of information or distorted information passed from one end of the SC to the other, causing significant problems for suppliers, e.g., misguided capacity plans, ineffective transportation, and missed production schedules, excessive inventory investment, etc., that increase supply risk *(.253**)* (Costantino et al. 2014).
- Finance risk disrupts operations planning *(.180*)*. Companies that wish to plan ahead may find it difficult in the presence of financial uncertainty. They may have

problems with budgeting since they are unsure about their costs. Moreover, finance risk, e.g. inflation, can lead to a phenomenon that employees require higher wages from employers. This phenomenon can engender labour disputes that are one of operational risk's factors.

- Failure to achieve targeted time can lead to risks of information *(.426**)*, supply *(.461**)* and demand *(.271**)*. Particularly, information delays can break down communication among members in project teams and in the SC (Angulo et al. 2004). More seriously, delays in the delivery of products to customers can cause bankruptcy of partners (Bernanke 1981). Sambasivan and Soon (2007) also confirmed that delays in construction projects give rise to dissatisfaction to all the parties involved.

From external perspective, external risks cause serious troubles for all activities in the chain. For instance, an economic downturn, when it occurs, leads to the changes in financial policies, makes operating business environment highly dynamic and difficult *(.290**)*, or even breaks the relationship between suppliers - buyers *(.227**)* (Krause and Ellram 2014). Likewise, natural disasters raised trading and security costs *(.294**)*, cause delays in activities *(.367**)*, and in some bad conditions, they can break down information infrastructure *(.180*)*. Moreover, the existence of a larger number of procedures engenders delays, difficulties in transactions among members in the SC network (Dreher and Gassebner 2013), and access to capital (Adair 2006), etc.

Meanwhile, there are no relationships that are found between demand risk & any indicators of SC performance as well as SC risks & financial performance. Perhaps, demand risk affects SC performance throughout other risks/ factors, i.e. indirect effect. Likewise, the impact of SC risks on financial indicators will be found if we consider the relation of other SC performance indicators to financial performance, i.e. mediation relationship. Future research should take this statement into consideration to extend the picture of risks and performance in the supply network.

In summary, the proposed conceptual framework aims to have a systematic view of risks in the whole SC network. Using the framework, companies can define risks in their own context and ascertain critical SC risks that cause negative effects on SC performance. Moreover, in an effort to mitigate risks in the SC network, this framework can be used as a ‘guide-map’. Mitigation plans should start with the core risks. Particularly, supply risk and operational risk are ones that directly affect SC performance. Demand risk, though not correlating with SC performance can have indirect effect through operational risk and supply risk. Thus, since operational risk and supply risk are controlled, the impact of demand risk on SC performance will be remarkably decreased.

Additionally, mitigation plans for the core risks also pay attention on the influence of the infrastructure risks on the core risks, e.g. information risk on supply risk and finance risk on operational risk. Restricting this impact, one side is able to reduce the degree of danger of the core risks, moreover, the impact of the infrastructure risks on SC performance will be significantly decreased on the other side. Then the reasons for delays need to be investigated and mitigated against. Finally external risk needs to be considered. Whilst rare, their impacts can be potentially devastating on all activities in the SC network. To this end, it is imperative to have supports from Associations, Governments, etc.

3.6 SUMMARY OF THE CHAPTER 3

There are three main phases in the SC risk management process (Xie et al. 2011). Of them, the first one (Risk Identification - Risk Measurement - Risk Assessment) is a premise and affects the whole process. However, it is worth noting that the number of risk identification studies are quite restrictive, especially empirical studies. This chapter therefore, aims to identify, measure and assess numerous risks in the SC network by empirical data from Vietnamese construction enterprises.

By the SC mapping approach, a technique that was recommended for a long time but were not used popularly in the SC risk body (Gardner and Cooper 2003), every detail of the SC has been modelled, hence potential risks were identified. As a result, there are nine critical risks (four core-, three infrastructure- and two external risks) were found. These risks have interrelationship and various impact on SC performance. The empirical evidence gained from the Vietnam construction industry proved the validity and reliability of the conceptual framework.

Using this framework, firms will have a systematic view of risks in the whole SC network whereby they can distinguish potential risks in their own perspectives and point out critical SC risks that cause negative effects on SC performance. Moreover, this framework can be used as a 'guide-map' in an effort to mitigate SC risks and for the next phase - risk monitoring which received less attention in academic studies.

According to Sampaio et al. (2016), SC risk is an extensive concept. Therefore, despite this research attempting to integrate various dimensions of SC risks in a conceptual framework, it is imperative to validate this framework in a range of contexts in different sectors and supply chains. Each sector/SC will have disparate characteristics that been to be considered. Similar to risk sources and types, the risk factors will be distinct between different industries/SCs, such as the public sector, renewable-energy sector and bioenergy, biomass and service, which were all missing in the literature. These distinct risk factors should be integrated into the framework under the corresponding SC risk types. This reflects the characteristics of industries/SCs but it is still necessary to define a more comprehensive model. It is worthwhile that among four new established concepts, investor- & contractor-related operational risks and natural risk contain only two measurement items that somewhat detract from reliability of constructs. Future research should base on characteristics of survey industries/ research contexts, adding new SC risk factors that aim to increase reliability of these research concepts.

Another approach can be examining and analysing risks in the SC under industry-centric focus. This approach aims to a broader view and can be a platform to suggest implications/solutions for Associations, Governments in the effort of risk mitigation and monitoring. Furthermore, to fully examine SC risks, the next empirical studies should also take into account past risk behaviours and the likelihood of occurrence instead of only looking into the level of impact mentioned in this research.

In the scope of this research, there are some relationships that are not supported. Perhaps, they will be significant if more interactions between risks are examined. This approach, one side, can provide a more comprehensive picture of risks in the supply chain, on the other side, it helps to determine the "real" effect of risks on SC performance.

Hence, a new concept in the SC risk literature was proposed in this research – the "push" effect that will be discussed in the next chapter.

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CHAPTER 4: THE PUSH EFFECT OF RISKS ON SUPPLY CHAIN PERFOMRANCE

A risk, when it occurs, causes negative effects on outputs. Typically, risks are not independent, as multiple risks occur simultaneously. These risks have links, creating a "push" effect, thus increasing the severity of each and all risk(s) on outputs. This chapter aims to define and verify the mechanism of the push effect that is a new approach in the supply chain risk management literature. Two models are compared. (1) Model only exists in direct effects, i.e. the competitive model, (2) the other contains relationship between risks that is able to show the mechanism of the push effect, i.e. the hypothesized model. The analysis of Structural Equation Model (SEM) is utilized to validate the models, confirming the mechanism of the push effect. Findings achieved from this chapter are expected to be used as "a guideline" for reducing the impact of this mechanism.

4.1 THE PUSH EFFECT

Risks exist in all firms. Even if firms operate effectively, risks are still prevalent (Cleland et al. 1981). When they occur, are able to cause serious issues for firms and supply chains (Truong Quang and Hara 2017e). The ability to determine the degree of risk is a desire of any firm (Truong Quang and Hara 2017d).

There are numerous studies conducted that quantify the degree of potential of risks. For instance, Pettit et al. (2013) estimated that the earthquake, tsunami and subsequent nuclear crisis in Japan (2011) caused Toyota's production to drop by 40,000 vehicles, resulting in a loss of $72 million in profit per day. Manavazhi and Adhikari (2002) proved that delays in materials and equipment procurement are often a contributory cause of cost overruns in construction projects, accounting for 0.5% of the total budgeted cost. A customer information leak by a systems engineer at Benesse, a Japanese company which focuses on correspondence education and publishing, led to second quarter (2015) consolidated revenue to fall 7% from the same period of the previous fiscal year, with operating profit also decreasing 88% and 280,000 customers being lost (Ishii and Komukai 2016). In the case of Caterpillar, the world's largest manufacturer of construction machinery, Mas (2004) documented that during the dispute price was discounted by about 4%. Product quality was reduced and $240 million in lost revenue arose from the labour dispute. As the above cases show, whilst different types of risk are analysed they are generally approached through case studies and concentrating on a particular risk.

Examining a certain risk will provide insight into a single dimension, but it does not reveal the full picture (Ho et al. 2015, Shenoi et al. 2016). A risk, when it occurs, causes a negative effect on outputs. Usually, risks do not occur independently, as typically multiple risks occur simultaneously (Truong Quang and Hara 2016b). The question raised here is "in the worst scenario when numerous risks occur at the same time, how can they affect SC performance?" In other words, how can we assess the degree of danger of risks in this scenario?

In this case, the impact of these risks on outputs will be calculated by the sum of effects of each risk (Truong Quang and Hara 2017d). For instance, if there are two risks, A and B, assuming that the impacts of A and B on a certain output are "a" and "b" respectively it is possible to indicate that:

The total effects = a + b

However, this can be queried.

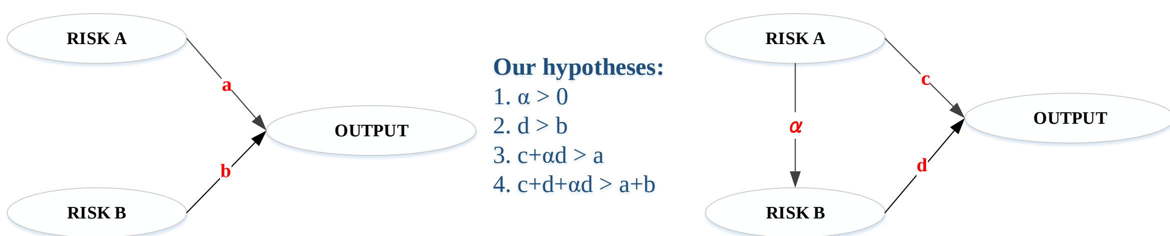

Figure 4.1: The mechanism of the push effect

The typical assumption is that risk A detrimentally affects only the output but Risk B, denoted as "α", is also influenced. Consequently, the degree of danger of risk B will increase, illustrated as “d” (>b) and through the relationship with risk B, and the impact of risk A on performance will enhance “c + αd” (>a) respectively. In general, the total effect of two risks on performance will be “c+d+αd.” The student believes that this total effect is greater than the sum of direct effects (a+b).

For instances, natural disasters such as flooding, hurricanes, and tsunamis show such effects. When they occur, they cause serious losses to outputs of firms and can also affect inputs and processes, which increase damages on firms and their supply chains (Truong Quang and Hara 2017d). An example of such is the severe floods in Thailand (2011) that washed out Western Digital’s offices which supplied one-quarter of the world’s computer hard drives. The total damages after the flood were estimated at roughly US$50 million - this is the direct effect of the flood on SC performance, i.e. “a + b” in the Figure 4.1 respectively. Moreover, the flood also engendered shortages of hard disk drives, leading to prices almost doubling globally – resulting in damages estimated at between US$225–$275 million, i.e. “c+d+αd.” Peter Drucker and many academicians stated that “You cannot manage what you do not measure/assess” (Kleindorfer and Saad 2005). The above consideration aims to a systematic view into the impact of risks on SC performance, thereby evaluating the severity of risks in the SC.

The value of “α” will be estimated based on the relationship between two risks. For example, if risk A makes risk B more dangerous, α will be greater than zero and vice versa. Generally, there are numerous risks occurring simultaneously – there will be β, (,), ∗, etc., creating a “push” effect on outputs. The “push” relationship among risks is described in the Figure 4.2. Accordingly, risks will be classified in hierarchical order according to their characteristics. High-order risks will “push” the lower-order risks, increasing severity of each and all risk(s) on SC performance. As illustrated in the Figure 4.2, in this research risks are categorized into three main groups:

(1) The first-order risks - external risks, e.g. floods, earthquakes, political and economic issues, etc., have influences on all activities of the SC.

(2) The second-order risks - infrastructure risks, e.g. information, finance and time risks, cause disruptions in processes of the SC.

(3) The third-order risks - core risks, e.g. supply, operational and demand risks, are ordinary workday problems that might directly affect supply chain performance.

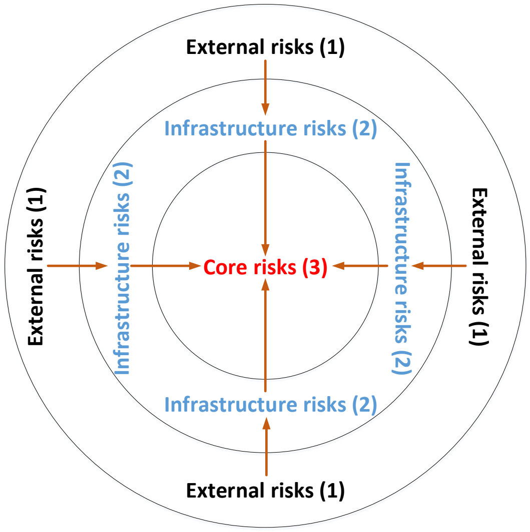

Figure 4.2: Supply chain risks' classification

Within the referenced SC literature, this "push" effect has not yet been considered (Truong Quang and Hara 2017d). This could be a reason that leads to solutions of risk prevention not achieving desired outcomes, as risk mitigation plans only focus on a single risk instead of a complex system that contains numerous risks have links with each other (Truong Quang and Hara 2016b). Considering such, the following research hypotheses are proposed:

H. By the push effect, the impact of each risk on performance is greater than each single effect.*

*H**. By the push effect, the total impacts of all risks on performance are greater than the sum of single effects.*

4.2 SUPPLY CHAIN RISKS AND HYPOTHESIZED MODEL

Risk is an elusive construct that has a variety of meanings, classifications and interpretations (Wagner and Bode 2008). In the general discussion of risk, there is an argument between two different viewpoints with regard to risk definitions.

- *Risk purely as danger*

Researchers sharing this view believe that risk inherits primarily negative consequences corresponding to typical human perception (Truong Quang and Hara 2017d). For instance, Ellis et al. (2010) described SC risk as "an individual's perception of the total potential loss associated with the disruption of supply of a particular purchased item from a particular supplier." March and Shapira (1987) analysed the way that managers perceive and behave to risk. The authors concluded that the majority tends to magnify its "downside." Likewise, Dela Rama (2012) conducted in-depth interviews with 40 board members from business corporations and senior public sector officials with respect to corruption. The study found that a corrupt institutional environment will result in less efficient corporate structures in a predatory business environment.

- *Risk as both danger and opportunity*

In fields such as finance or classical decision theory, risk can be considered as the fluctuations around the expected value of a performance measure (Truong Quang and Hara 2017d). Scholars of this viewpoint argued that risk is equated with variance and consequently has both a potential "upstream" and "downstream." As such, Jüttner (2005), defined SC risk as "a variation in the distribution of possible supply chain outcomes, their likelihood, and their subjective value."

Several scholars in the SCM and supply management fields shared the first notion of risk as purely negative, which corresponds best to supply chain business reality. Following this consideration, Wagner and Bode (2008), based on the contingency theory and the strategic management, suggested to extend the scope of risk, stating that high organizational efficiency and performance results when firms consider the context in which strategy is crafted and implemented. As such, firms must match the structure to the context and environment, i.e., forces outside the decision-maker's control. If this "fit" is not reached, "opportunities are lost, costs rise, and the maintenance of the organization is threatened" (Child 1972). Agreeing with this discussion, Jüttner (2005) examined risk not only at activities/processes of a firm, but at flows of SC from original suppliers to the delivery of the final product for the end user. Thun and Hoenig (2011), in a rare empirical study, proved that there is a significant difference between internal and external SC risks in terms of impact on performance.

Ho et al. (2015) added a unique and more comprehensive idea to this viewpoint since the authors classified risks with regard to various degrees of impact. SC risk was defined as "the likelihood and impact of unexpected macro and/or micro level events or conditions that adversely influence any part of a supply chain leading to operational, tactical, or strategic level failures or irregularities." From this approach, there are two kinds of risk:

(i) **Macro-risks** are adverse and relatively rare external events or phenomenon that may have strong and negative impacts on firms or their SC (e.g. catastrophes such as 9/11, hurricane Katrina, or the Tsunami in 2004).

(ii) **Micro-risks** refer to relatively periodic events, originating directly from internal activities of companies and/or relationships within partners in the supply chain network (e.g. supplier losses or quality problems, delays).

This approach used to be mentioned by Mitchell (1995) as: "the probability of loss and the significance of that loss to the organization or individual." Compared with Ho et al. (2015), the author considers the degree of impact but also emphasizes the indicator of probability and suggests evaluating risk by the following formula:

$$Risk_n = Probability\ (loss_n) \times Degree\ of\ impact\ (loss_n)$$

Considering the above, this study classifies risks as four criteria: Environment, flows of SC, degree of impact and probability, as illustrated in Table 4.1. This classification aims to understand characteristics of each risk in the SC that is a platform to establish relationship (direct and indirect) among risks and SC performance.

SUPPLY CHAIN FLOWS / ***DEGREE OF IMPACT***		**Product flow**		**Financial flow**	**Information flow**		**PROBABILITY**
Micro	Supply risk						High
		Operational risk					High
			Demand risk				High
				Finance risk			Average
					Information risk		Average
	Time risk						High
Macro						Economic risk Political risk Cultural risk Natural disaster	Low
SCOPE / ENVIRONMENT	**Internal**					**External**	

Table 4.1: Risk classification

Risks that are shown in Table 4.1 have received numerous attention in the SC risk literature as an extensive result of documenting 169 journal articles published between 2003 and 2016 (Figure 4.3). Each risk has different attributes that lead to various impacts on SC performance. For instance, risks pertaining to product flow are ordinary workday problems that might directly affect supply chains, i.e. core risks (Rice and Caniato 2003). These risks have a high likelihood to occur but a lower impact on performance than external SC risks (Thun and Hoenig 2011). Conversely, external SC risks rarely occur but can lead directly or indirectly to disturbances within supply chain activities (e.g. the flood in Thailand (2011), catastrophes such as 9/11, the Tsunami in 2004 or hurricane Katrina 2005).

In the SC, there are several "infrastructure" elements that aim to ensure the healthy functioning of the chain, such as information, finance and time (Ho et al. 2015). Any disruptions relating to these elements can lead to serious problems for processes in the supply chain – especially supply, manufacturing and downstream activities (Ho et al. 2015).

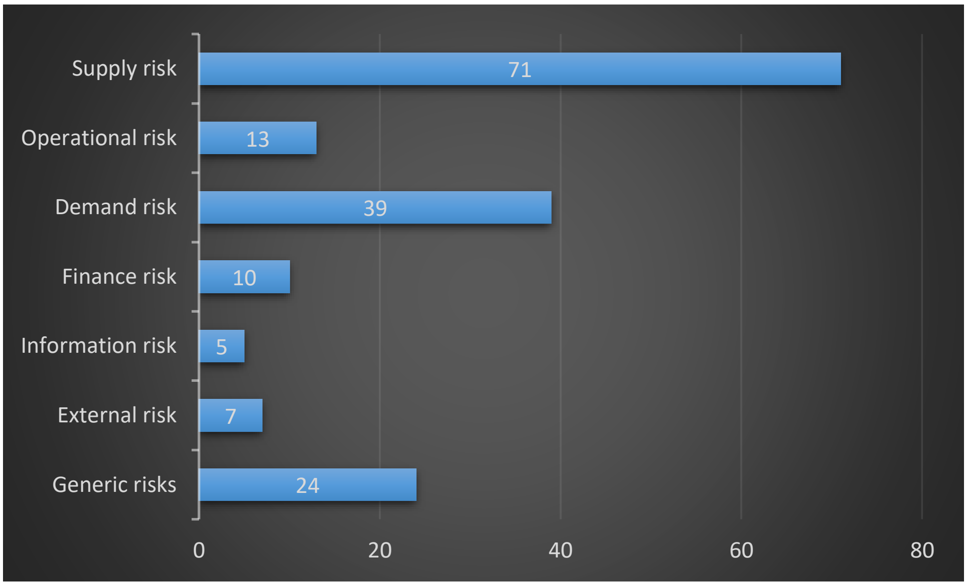

Figure 4.3: Supply Chain risks

Considering the above, the hypothesized model representing the relationship among risks and SC performance is schematically depicted in Figure 4.4. In the center of the model are three core risks pertaining to the product flow; Supply risk – Operational risk – Demand risk. These three risks have a direct effect on SC performance, which is measured by five crucial dimensions, including: supplier performance, internal business, innovation and learning, customer service and finance. The rest of the model describes the push effect among SC risks.

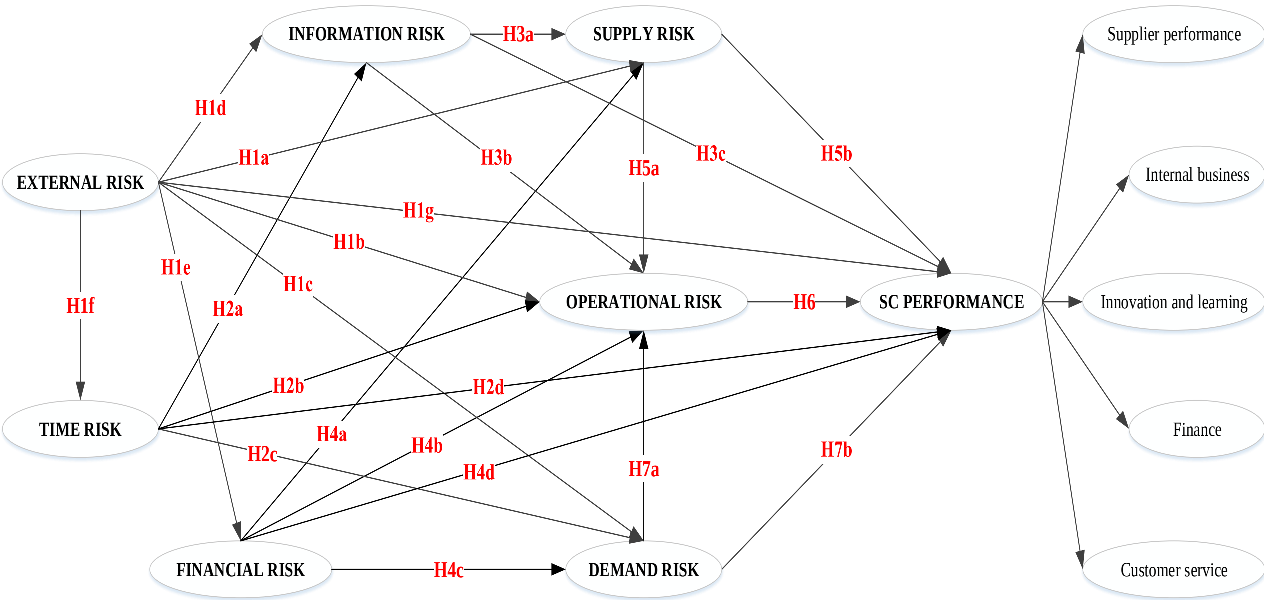

Figure 4.4: Hypothesized model

External risk

External risk deals with threats from an external perspective of SC that can be caused by economical-, political-, socio- or geographical reasons (Rogers et al. 2016). Examples are fire accidents, natural hazards, social and political instability, corruption, cultural differentiation (Samvedi et al. 2013, Wu et al. 2006) (Lockamy III 2014). These risks can have a severe impact and lead directly or indirectly to disturbances within the supply chain. For instance, a fire at a Phillips semiconductor plant in 2000 led to disruptions in operational processes, which eventually engendered a $400 million loss for Ericsson (Chopra and Sodhi 2012). Nikon, a Japanese camera and lens manufacturer undergone supply shortages that resulted from a flood in 2011, damaging a subsidiary located in the Rojana Industrial Park, Thailand. Nikon estimated a loss of net sales by 65 billion Yen and 25 billion Yen of operational income. In the same year, moreover, the earthquake, tsunami and the subsequent nuclear crisis in Japan led to Toyota's production to drop by 40,000 vehicles, resulting in a loss of $72 million in profit per day

(Pettit et al. 2013). Toyota also decided to stop production in its North-American assembly plants within a few days after the terrorist attacks of September 11, which caused massive disruptions to the flow of materials coming from foreign countries (Sheffi 2001).

Hansen et al. (2013) found that economic downturn resulted in changes in market demand and financial policies, and creates a highly dynamic and difficult operating business environment that can even break supplier – buyer relationships (Krause and Ellram 2014). Furthermore, the existence of a larger number of procedures engenders delays, difficulties in transactions among members in the SC network (Dreher and Gassebner 2013), and access to capital (Zhi 1995), etc. Hence we propose the following hypotheses:

H1a, b, c, d, e, f, g: External risk detrimentally affects supply-, operational-, demand-, information-, financial-, time risks and SC performance.

Time risk

Time risk refers to delays in SC activities (Ketikidis et al. 2006). Failure to achieve targeted timeframes can lead to risks of information, operations, demand and SC performance (Truong Quang and Hara 2017d). Manavazhi and Adhikari (2002) proved that delays in materials and equipment procurement are often a contributory cause to cost overruns in construction projects. The author estimated that these issues accounts for 0.5% of the total budgeted cost of projects. When projects are delayed, firms are either extended or accelerated. Consequently, some changes in design, technology, etc., are required, resulting in operational activity disruptions (Truong Quang and Hara 2017d).

Sambasivan and Soon (2007) confirmed that time-related risks in projects give rise to the dissatisfaction of all the parties involved. For instance, information delays can breakdown communication among members in project teams and in the SC (Angulo et al. 2004). These delays in the delivery of products to customers can cause bankruptcy of partners (Bernanke 1981), or delays in payment – and are some of the main reasons for disputes (Aibinu and Jagboro 2002). Hence, we propose the following hypotheses:

H2a, b, c, d: Time risk detrimentally affects information-, operational-, demand risk and SC performance.

Information risk

Information risk refers to communication breakdown within the project team, information infrastructure complications, distorted information and information leaks (Xie et al. 2011, Chopra and Sodhi 2012, Handfield and Nichols 2008). Lack of information or distorted information passed through the SC can cause significant issues, including, but not limited to, excessive inventory investment, poor customer service, lost revenues, misguided capacity plans, ineffective transportation, and missed production schedules (Lee et al. 2004b). These are not deliberate attempts to sabotage the performance of fellow SC members, rather, distorted information throughout the SC having a bullwhip effect (Handfield and Nichols 2008). A customer information leak at Benesse, a Japanese company which focuses on correspondence education and publishing, by a systems engineer led to second quarter (2015) consolidated revenue down 7% from the same period of the previous fiscal year, with operating profit also decreasing 88% and 280,000 customers being lost (Ishii and Komukai 2016). As such, we propose the following hypotheses:

H3a, b, c: Information risk detrimentally affects supply and operational risks and SC performance.

Finance risk

Finance risk deals with changes in financial markets, e.g. inflation, interest rate level, currency fluctuations and stakeholder requests, causing potential losses in the supply chain (Manuj and Mentzer 2008, Trkman and McCormack 2009, Hahn and Kuhn 2012). These kinds of risk engender price fluctuations in supply activities, operation planning, labour disputes, demand variability and SC disruptions. For instance, inflation leads to continuously increased prices that irritate consumers who place the blame on producers. This is a reason for demand variability (Parks 1978). Firms try to avoid raising prices and in doing so they prefer to lock material costs with long-term contracts, although this hurts the supplier. Inflation also disrupts operations planning. Companies that wish to plan ahead encounter difficulty in the presence of uncertainty. They may have problems with budgeting since they are unsure about costs (Truong Quang and Hara 2017e). Moreover, since the inflation rate is high, employees request higher wages from employers that engender labour disputes (Truong Quang and Hara 2017d).

Regarding interest rates, Zhi (1995) argued that as it increases, banks charge more for business loans, resulting in reducing the ability of customers to buy products and services, thus raising demand risk. This phenomenon can cause price fluctuations in supply activities (Zhi 1995).

Furthermore, while currency fluctuations have various effects on output growth and price, it is particularly true for multinational companies or foreign partners (Kandil and Mirzaie 2005). Yeo and Tiong (2000) suggested examining stakeholder requests as a finance risk. Stakeholders have influences on particular dimensions and typically have a strong voice in company direction. They participate in the daily operations of the business or vote on critical decisions that affect activities of operation plans. They monitor supplier selection, company's outsourcing activities and globalization initiatives, and may vote against business decisions (Truong Quang and Hara 2017e). Therefore, we propose the following hypotheses:

H4a, b, c, d: Finance risk detrimentally affects supply-, operational-, demand risks and SC performance.

Supply risk

Supply risk is concerned with "upstream" activities in the SC (Ali et al. 2014). Here, the firm is faced with the risks related to suppliers, e.g. supplier bankruptcy, price fluctuations, unstable quality and quantity of inputs (Tse and Tan 2012, Lockamy III and McCormack 2012, Kei Tse et al. 2011, Tse and Tan 2011). These risks engender failures in delivering inbound goods or services to the purchasing firm and subsequently throughout the downstream SC (Wu and Olson 2010). For instance, in December 2001, UPF-Thompson - a supplier of Land Rover filed for bankruptcy. This company supplied the chassis of a key Land Rover model - the Discovery sport-utility. This abrupt situation created the possibility of a nine-month disruption of production as well as the loss of 1500 jobs for Land Rover. Only after a high expense of goodwill, Land Rover was able to avert the situation.

A quality issue of tires in 2000 was discovered at Wilderness AT resulting in 174 reported deaths and an estimated cost of $2.1billion due to a recall (Truett 2001). Likewise, Mattel suffered for an estimated $30million worth of damage in 2007 for a recall of 18 million toys due to a supplier ignored Mattel's guidelines not to deploy toxic chemicals for the toy production. Two years later, moreover, the Corporation was imposed by the US American Consumer Product Safety Commission a record fine of $2.3milion.

A further case is Robert Bosch, variations in quality of high-pressure pumps for diesel fuel injection systems at the beginning of 2005 resulted in significant losses of production at nearly all German automotive suppliers, e.g. Audi, BMW AG, Daimler Chrysler AG, etc. A sub-supplier of Bosch was attributed to this fault, leading to millions of dollars in costs and affecting the entire supply chain. Furthermore, in 1997, Boeing experienced a supplier delivery failure of two critical parts with an estimated loss to the company of $2.6 billion. Therefore, we propose the following hypotheses:

H5a,b: Supply risk adversely affects operational risk and SC performance.

Operational risk

Operational risk refers to disruptions engendered by problems within the organizational boundaries of a firm, affecting a firm's ability to produce and supply goods/services, e.g. accidents, labour disputes, changes in design and technology (Xie et al. 2011, Tuncel and Alpan 2010, Samvedi et al. 2013, Wu et al. 2006). Williams et al. (1995) found that design changes trigger an increase in project cost. Meanwhile, technological changes disrupt operating activities, resulting in a decrease in expected return on investments (Kim and Chavas 2003). Mitsubishi Aircraft Corp. announced that the launch of the new Mitsubishi Regional Jet might be delayed for a fifth time due to technical problems, pushing down shares by 2.7% and extending their losses this year to 20%. The jetliner with capacity of 70 to 90 passengers, is designed for short- to medium-haul flights and expected to consume 20% less fuel than similarly sized aircraft. Experts believed that any subsequent design changes could force Mitsubishi Aircraft to review production plans, leading to a substantial delay in the plane’s delivery, but manufacturing operations had already started (Truong Quang and Hara 2017d).

According to Sweeney (2013), the majority of labour accidents that resulted from employees taking more than three days off work – or affected their ability to perform their usual duties over this period – were caused by handling accidents. Although some accidents at work can have minor effects, the HSE statistics revealed that more than 27 million working days were lost between 2011 and 2012 due to occupational illness or personal injury – proving that these incidents can have serious repercussions. In the case of Caterpillar - the world's largest manufacturer of construction machinery - Mas (2004) documented that during a dispute, price was discounted by about 4%. Product quality was reduced, and $240 million in lost revenue occurred due to the labour dispute. In 2002, an amount of 100 workers in a longshoreman union strike disrupted operating activities at West Coast port. As a consequence, it took six months for some containers to be delivered and schedules to return to normal. Hence, we propose the following hypotheses:

H6: Operational risk adversely affects SC performance.

Demand risk

Demand risk results from disruptions emerging from “downstream” activities in the SC (Svensson 2000). This type of risk originates from the uncertainty surrounding the random demands of the customers, e.g. demand variability, high market competition, customer bankruptcy and customer fragmentation (Tse et al. 2016).

These risks, when incurred, make firms unable to forecast real market demands. Consequence of which are costly shortages, obsolescence, inefficient capacity utilisation and operating activities are disordered (Wagner and Bode 2008). Moreover, costs overrun, resulting in revenues and profits falling (Grimsey and Lewis 2002).

George et al. (2004) argued that demand uncertainty gives rise to backlogging or shortages in the orders, planning flaws and bullwhip effect. George also found that rapid changes in customer expectations increase product costs. Fluctuations in customer demands, on the other hand, has an adverse effect on the performance of stochastic inventory systems (Jemaï and Karaesmen 2005). For example, Cisco Systems Inc. reported US$ 2.5 billion of inventory due to a lack of communication among its downstream SC partners in 2001. Gurnani and Tang (1999) asserted that demand uncertainty is an important factor for optimal decisions and expected profit. Therefore, we propose the following hypotheses:

H7a,b: Demand risk adversely affects operational risk and SC performance.

4.3 METHODOLOGY

4.3.1 Data collection

For a larger sample, the link to the questionnaire was re-sent to 3601 Vietnamese construction enterprises via their email addresses. In order to increase the response rate, an electric postcard was sent after the initial mailing to remind non-respondents. Depending on their requirements, a copy of the questionnaire was mailed to them or a link to the survey was sent in an email. To encourage the cooperation of respondents, results were provided to them afterwards. Consequently, a total of 283 responses (202 from the old survey and 81 new ones in this survey) were gained. Table 4.2 describes the survey sample.

Table 4.2: Survey sample description

Firm profile		Freq.
Operation fields	Building Material Manufacturing (sand, stone, additive, etc.)	42
	Building Material Distribution	53
	Concrete production	49
	Construction executive	99
	Design (architecture and construction)	37
	Transportation	3
Full-time employees	Less than 10	9
	10 – 200	122
	200 – 300	69
	More than 300	83

VND: Vietnamese Dong

Firm profile		Freq.
Years of business	< 5 years	41
	5 - 10 years	94
	10 - 20 years	103
	20 - 30 years	35
	30 - 40 years	7
	40 - 50 years	3
Authorized capital	<20 billion VND	48
	20 - 100 billion VND	69
	> 100 billion VND	166

Respondent profile		Freq.
Job title	Top-level manager	15
	Middle-level manager	62
	First-level manager	132
	Coordinator	45
	Others	29
Working area	Purchasing	12
	Logistics	12
	Operations/ Projects	156
	Human Resources	26
	Risk Management	11
	Finance	7
	Sales	42
	Marketing	9
	Others	8

4.3.2 Data analysis process

An estimate of non-response bias with T-test procedures was conducted in order to test the difference in items between early and late respondents (Armstrong and Overton 1977). Results showed no significant differences in the average scores of all observed items (internal confidence of 99%). This shows that non-response bias exists between early and late respondents.

In the next step, the research concepts were evaluated for validity and reliability before validating the mechanism of the push effect. According to the results of EFA and Cronbach's Alpha described in the Appendix 2, the minimum factor loadings of observed items onto the underlying constructs is 0.604. The number of factors to extract is specified at eigenvalue ≥ 1. Variance extracted ≥ 59.087 means that latent constructs can explain over 59.087% variance in the observed items. Standardized Regression Weights of all observed items are > 0.587 – twice the standard error. The coefficient of all observed items – the final column is $R^2 \geq 0.344$. Hence, we can assert that all research concepts achieved convergent validity (Hair et al. 1995). Moreover, all coefficients of the item – total correlation ≥ 0.504 and Cronbach's alpha ≥ 0.769 indicate that these concepts are reliable (Hair et al. 1995).

Appendix 3 shows the evaluation of discriminant validity. We can see that the square roots of average variances extracted (AVEs) for each research concept located in diagonal are greater than any correlation relating to each latent variable. The results indicate that the discriminant validity of the research concepts was satisfactory (Fornell and Larcker 1981).

However, it is worth noting that the concept of external risk is split into two new constructs, M1 and M2. Temporarily, M1 is named "Human-made risks" including the observed items of economic downturns, external legal issues and corruption. Meanwhile, M2 is called "Natural risks" comprising fire accidents and natural catastrophes.

Finally, the analysis of Structural Equation Model (SEM) is carried out to test the mechanism of the push effect. This method was utilized because it can simultaneously calculate the impact of different SC risks on SC performance that can show the push effect (Truong Quang and Hara 2017d). The outcome of this step is a platform to quantify the degree of danger of risks on SC performance, and more importantly answer the research question: "in the worst scenario when numerous risks occur at the same time, how can they affect SC performance?"

With regards to test the hypotheses of H* and H**, a competitive model is developed (Figure 4.5). This model only presents the direct effect of SC risks on SC performance and has no relationship among SC risks. The test results of this model are compared with the SEM results. Firstly, the impacts of each risk on SC performance in both models are evaluated and compared. Following this the goodness of fit statistics and R^2 for SC performance explained by the models are calculated. In this case, the parameters of SEM model are greater than those in the competitive model, which means that the mechanism of the push effect is proved and vice versa.

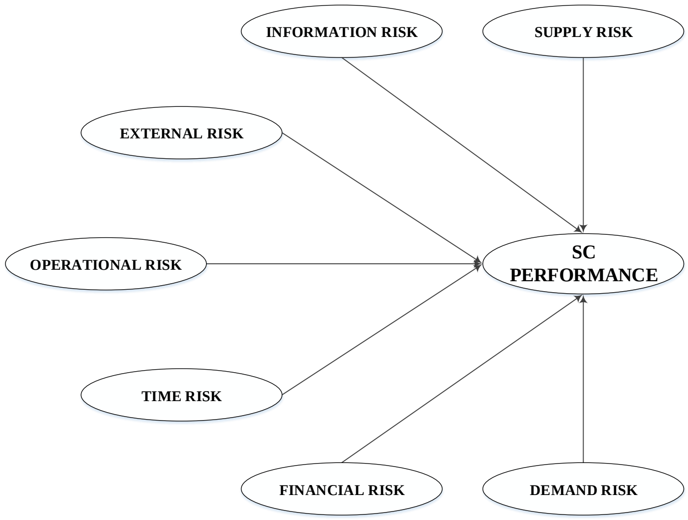

Figure 4.5: Competitive model

4.4 RESULTS

SEM results are schematically depicted in the Figure 4.6. χ2/df = 1.806, CFI = .904, RMSEA = .053 indicated that the model suits the data. Except the research hypotheses pertaining to the dashed lines in the figure, the remaining hypotheses are supported with path loadings being significant at the p < 0.1 level. Appendix 4 and 5 presents in details indexes of model fit and all path coefficients.

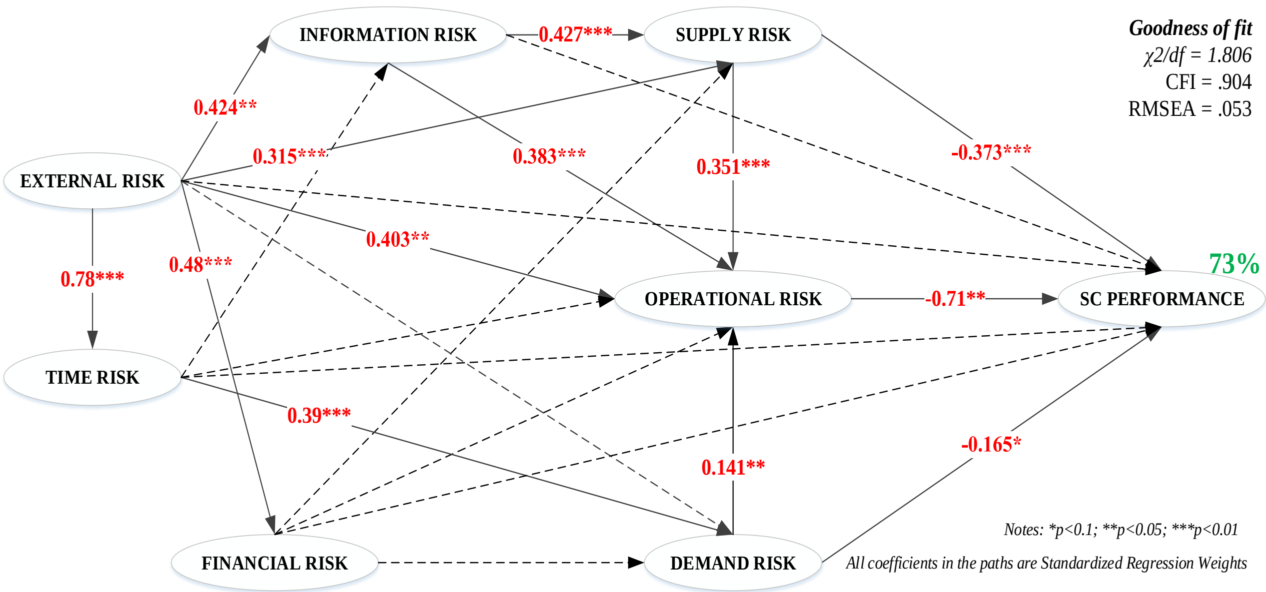

Figure 4.6: SEM results

The coefficient of R^2 is 73%, meaning that by the push effect as shown in Figure 4.6, the proposed risks can explain 73% variance observed in SC performance. This result partially answers the research question. However, it is worth noting that the values in Figure 4.6 only describe the direct relationship between each pair of research concepts. Excluding supply-, operational- and demand risks, the relationships between other risks and SC performance are not visible. Thus, the push effect of each risk on SC performance is not displayed.

Table 4.3: Comparison between the SEM model and the competitive model

				SEM MODEL	COMPETITIVE MODEL	DIFFERENCE (PUSH EFFECT)
RELATIONSHIPS	SR	--->	SCP	-0.622	-0.481	-0.141
	OR	--->	SCP	-0.71	-0.476	-0.234
	DR	--->	SCP	-0.264	-0.244	-0.02
	FR	--->	SCP	-0.031	NONE	-0.031
	IR	--->	SCP	-0.53	-0.166	-0.364
	TR	--->	SCP	-0.22	NONE	-0.22
	ER	--->	SCP	-0.411	NONE	-0.411
GOODNESS OF FIT	*Chi-square/df*			1.806	2.786	
	CFI			0.904	0.804	
	RMSEA			0.053	0.08	
R^2				73%	55%	

Table 4.3 presents the standardized total effects of each risk on SC performance and comparison between the SEM model and competitive model. We can see that the impact of each risk on the SC performance in the SEM model is greater than in the competitive model. The last column (Difference) shows the greater amount of the SEM model to the competitive model, implying the push effect. For example, with regard to supply risk, the difference is "-0.141". As in the SEM model, supply risk is affected by external risk and information risk. By these effects, it leads to an increase (0.141) in the effect of supply risk on SC performance, i.e. the increase of "0.141" is the push effect of external risk, information risk and time risk on supply risk. These results support our first hypothesis: "By the push effect, the impact of each risk on performance is greater than each single effect."

Regarding goodness of fit, the results in the Table 4.3 also showed that the SEM model is more suited to the data than the competitive model. The coefficient of R^2 in the

SEM model is also higher than in the competitive model. These empirical evidence supported the second hypothesis, confirming the mechanism of the push effect.

With respect to predicting the push effect of risks on SC performance, the technique of Partial Least Squares – SEM is applied (Hair et al. 2011). The equation (1) describes a decrease in SC performance with predictors are seven SC risks:

$$\mathbf{SCP = -0.408*SR - 0.322*OR - 0.192*DR - 0.054*FR - 0.35*IR - 0.209*TR - 0.318*ER + r \quad (1)}$$

According to the predictive equation, supply risk causes the biggest loss of SC performance. Since it increases 1, SC performance will reduce 0.408. Generally, in the case of seven risks simultaneously occur and go up 1, they can decrease SC performance by an amount 1.853.

4.5 DISCUSSION

This empirical study aims to verify the mechanism of the push effect. In doing so, the relations of each and all risks to SC performance in both models are analysed. Accordingly, the risks of supply, operations and demand detrimentally affect SC performance in both models – known as core risks. In the SEM model, these risks have a greater effect on SC performance than in the competitive model because the push effect of other risks makes them more dangerous, resulting in increased impact on SC performance.

This statement is also confirmed by the information risk result. The competitive model implies that information risk has a direct effect on SC performance (-0.166). Whilst no direct impact is found at the hypothesized model – but due to the push effect of external risk and time risk – the risk can explain 53% variance of SC performance, more than three times in the competitive model.

Further evidence of the push effect relates to time and external risks. They do not directly affect SC performance in both models. However, these relationships are significant in the SEM model. As with information risk, the push effect of external risk on time risk increases its severity, resulting in a significant impact on SC performance (0.22). We can see that external risk causes “push” effect on all six other risks, i.e. a “push” factor that affects all activities of SC. The loss of this risk will be difficult to fully evaluate if only assessing it as a single one. It is imperative to examine external risk in a system that contains a variety of SC activities instead. According to the result, 41.1% variance of SC performance can be explained by this "push" factor. These findings are in accordance with the hypotheses of the push effect.

Regarding the impact of all risks on SC performance, we can see that the SEM model is more suited to the data and explains variance of SC performance more effectively than the competitive model. These results again confirm the mechanism of the push effect. Through the push effect, the proposed risks can explain 73% variance of SC performance compared with 55% of the competitive model as SC performance is not only influenced by SC risks, but also by other factors; e.g. innovation, SC management practices, etc. Therefore, if a company can manage the mechanism of the push effect, they can mitigate the impact of risks on SC performance.

With respect to quantifying the degree of the push effect, according to the results, we propose the following formula:

$$\mathbf{SCP = -0.408*SR - 0.322*OR - 0.192*DR - 0.054*FR - 0.35*IR - 0.209*TR - 0.318*ER + r \quad (1)}$$

From this formula, we can identify critical risks and assess the "real" effect of each and all risk(s) on SC performance. Especially, it is useful to answer our research question - in the worst scenario, when seven proposed risks simultaneously occur and go up 1, they can decrease SC performance by an amount of 1.853.

As illustrated in Figure 4.1, the notion to reduce the mechanism of the push effect will concentrate on minimizing the coefficient of "α." In other words, it is necessary to restrict / eliminate the relationship between risks. This notion can explain, based on the case of Thailand's flooding, the floods cause a small direct effect on SC performance, but seriously on activities of supply, operations, etc., that subsequently, cause disruptions in the whole chain. Thus, if risk mitigation strategies are able to reduce the impact of the flood on supply and operational risks, the loss will remarkably decrease.

With respect to implementing this idea effectively and efficiently, the SEM model proposed can be "a road map" to achieve this purpose. First and foremost, efforts should start with core risks; i.e. supply, operations and demand, as they are ones that cause direct effects on SC performance. According to the results, supply and operational risks are pushed by external and information risks, meanwhile time risk causes a push effect on demand risk. Turning back to the flood in Thailand (2011), computer makers can reduce losses by owning multiple sources of supply, both domestic and global (Berger et al. 2004). In this case, since a natural disaster occurs, supply activities will not be adversely affected and shortages of inputs or price fluctuations are remarkably decreased (Berger et al. 2004).

Otherwise, Hahn et al. (2000) stated that effective communications among all elements in the supply chain are essential to its success. The more visibility of information across the supply chain, the higher ability in reducing supply and operational risks (Chopra and Sodhi 2013). Information sharing as a prerequisite for trust, binding supply chains together from end-to-end (Yu et al. 2001). Cachon and Fisher (2000) and Lee and Whang (2000) found some benefits of sharing real-time information on supply and operational activities and/or inventory levels between suppliers and customers. Moreover, information sharing can significantly reduce the consequences of the bullwhip effect (Handfield and Nichols 2008).

Regarding the push effect of time risk on demand risk, Diabat et al. (2012) suggested to adding capacity/ inventory or increasing responsiveness/ flexibility/ capability as the best practices to copy with this push effect. However, effectiveness and expense are a "trade-off" that need to be considered.

Moreover, time and information risks are pushed by external risks, causing significant delays in SC activities and difficulties in communication among members. Though we cannot eliminate floods, earthquakes, political and economical issues, an active identification of SC vulnerability points and contingency plans are very necessary (Diabat et al. 2012). Firms should plan and co-ordinate supply and demand activities or manage flexible capacity (Diabat et al. 2012). Alongside efforts from companies, reduction of these risks necessitates support from government and cooperation of actors throughout the SC network.

On the other hand, the SEM model only focuses on validating the mechanism of the push effect based on the proposed hypotheses of relationships among concepts, with the optimal "push" models still missing. With seven proposed risks, relationships among them maximizes their impact on SC performance. Hence, firms are able to predict the worst scenarios in their own businesses, since seven risks occur simultaneously. Conversely, firms are able to create appropriate strategies for mitigation if a model minimizes the push effect of risks on outputs is found. Whilst we cannot eliminate risks we can minimize their impact (Rao Tummala and Leung 1996) – which is where a new model is required.

In this research, time risk refers to delays in SC activities. It is imperative to consider this risk in terms of time series, which is useful in forecasting how many risks are incurred and likely to occur, and quantifying them within a specific period of time. Moreover, SC risks could be classified into long-term risks and short-term risks (Cupples et al. 1992). This approach should be addressed in upcoming researches that will help the prediction of impact of risks on performance more accurately (Mitchell 1995). Furthermore, this study examined SC performance as a second-order latent construct that is measured by five first-order latent constructs comprising supplier performance, internal business, innovation and learning, customer service and finance. Future studies should investigate the push effect of SC risks on each dimension of SC performance to gain an insight into the relationship between these two concepts.

The results also showed that finance risk does not have a relationship with any concepts. This result might be relevant in the short-term for the Vietnam construction sector, where most enterprises have high capital (Table 4.2). However, in the long-term or in other contexts, it may be different. Forthcoming studies could extend the sample scope in other industries / countries to consolidate this statement.

Lastly, this research only analyses supply chain in the simple context of Suppliers – Company – Customers. Ultimate suppliers / customers are yet to be considered (Figure 4.7). It is essential to examine the push effect from the viewpoint an industrial/governmental point of view etc., which contains a multitude of different chains instead of a firm's supply chain as in this research. These discussions imply new directions for future research.

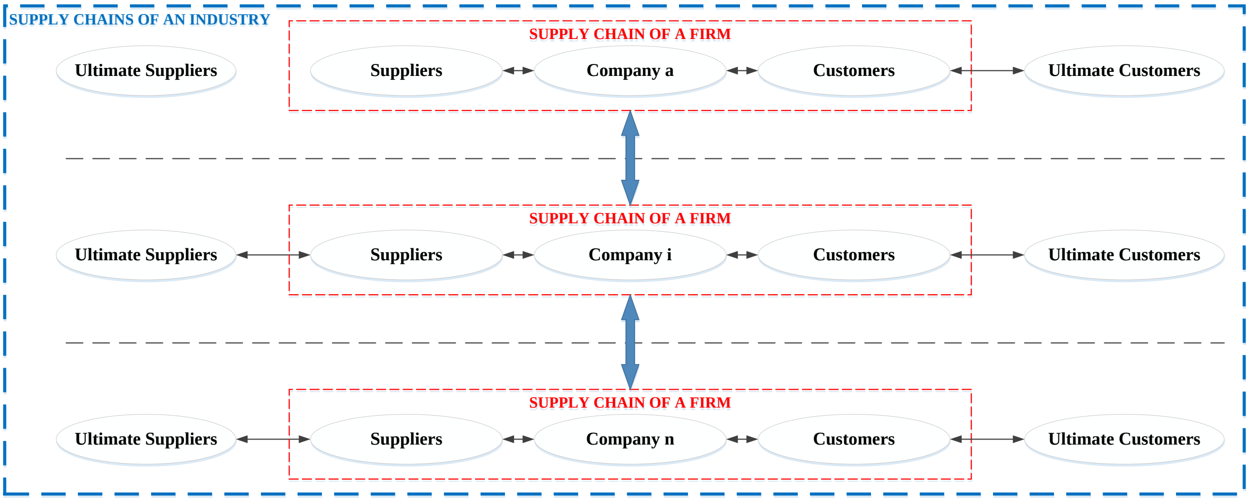

Figure 4.7: SC structure

4.6 SUMMARY OF THE CHAPTER 4

This chapter proposes a new definition of the relationship between risks and SC performance – the push effect. The mechanism of this concept can increase the degree of impact of each and all risks on outputs. With the purpose of verifying this mechanism, two models were compared. (1) Model only exists in direct effects, i.e. the competitive model, (2) the other contains relationship between risks that is able to show the mechanism of the push effect, i.e. the hypothesized model. Empirical evidence found in the Vietnamese construction sector proved that the hypothesized model is better suited and has a greater effect on SC performance in terms of each and all risks.

According to the results, the hypothesized model can explain up to 73% variance of SC performance. Practitioners and managers can utilize this model as a "road map" to reduce SC risks and act as the mechanism of the push effect in such a context as well. Furthermore, a formula that aims to quantify the level of the push effect of risks on SC performance was proposed. To pave the way for developing the mechanism of the push effect, as mentioned above, there are several suggestions for future studies:

- To find out the model in which the push effect of risks on SC performance is highest/ lowest.
- To take time series into consideration and classify long-term and short-term risks.

- To examine the push effect of SC risks on each dimension of SC performance, e.g. supplier performance, internal business, innovation and learning, customer service and finance.
- Moreover, there are numerous factors impacting on SC performance that are not considered in this study. While risks adversely affect SC performance, other factors, e.g. innovation, SC management practices, etc., have positive effects. A new approach can be validating the mechanism of the push effect in terms of applying innovation, SC risk management practices, etc. This approach, i.e. integrating SC risks and these factors in a model, is able to examine how innovation, SC risk management practice, etc., mitigate SC risks, but showing an extensive picture of risk management activities in the SC network.
- Finally, it is necessary to extend the sample scope in other industries / multiple countries and in a wider context of SC. It is worth noting that service-oriented firms will be a new trend since the modern-day industry tends to more focus on customer demand (Vargo and Lusch 2008).

In the next chapter, the push effect of risks on SC performance will be validated at service-oriented firms. Results will be compared with previous studies conducting at manufacturing firms for an insight into this area.

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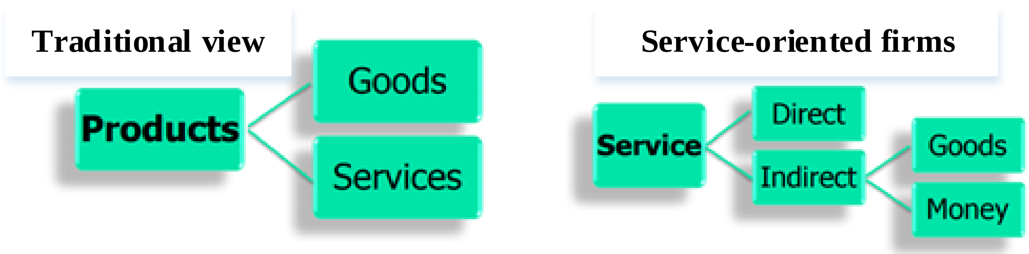
CHAPTER 5: SERVICE-ORIENTED FIRMS: THE PUSH EFFECT

Service-oriented firms will be a new trend since the modern-day industry tends to more focus on customer demand (Vargo and Lusch 2008). Supply chain management gradually shifted towards demand chain management that organizations will not make and sell units of output but producing customized services to customers (Walters 2008). This transformation has led to the emergence of new risks, the push effect of risk on the supply chain therefore also varies and the mismatch of the current risk mitigation strategies (Truong Quang and Hara 2017g). Dealing with these changes is the purpose of this chapter.

5.1 SERVICE-ORIENTED FIRMS

Traditionally, people exchange for goods, fundamentally concerning with units of outputs (tangibility) which are embedded with value during the manufacturing process (Capon and Glazer 1987). The efforts of firms aim to convert theirs natural resources into outputs at a low cost. Thus, standardization, traits of manufactured outputs, the separation of production and consumption, nonperishability are normative qualities (Zeithaml et al. 1985). Services are treated as "an immaterial product/ residual/ add-on" that is a kind of intangible goods and address to enhance the value of goods (Figure 5.1) (Converse 1921, p. vi; see (Fisk et al. 1993)).



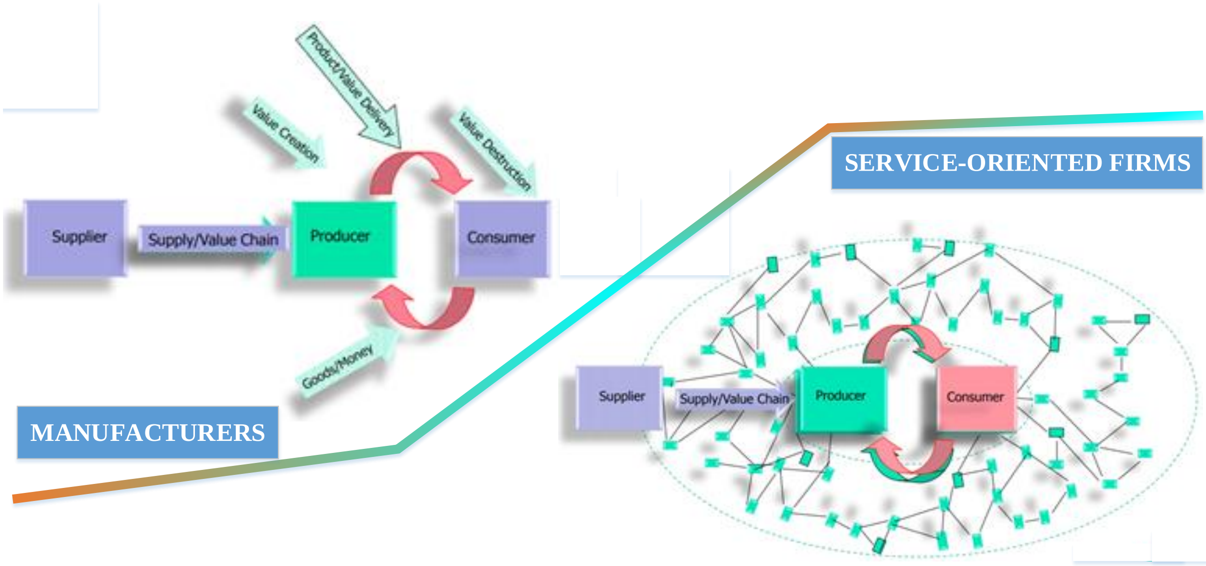
Source: Adapted from the presentation of Stephen Vargo and Robert Lusch "Service-Dominant Logic: An Evolution or Revolution in Marketing Theory and Practice?"John Molson School of Business, Concordia University Montreal, October 20, 2011.

Figure 5.1: Products and Service

The modern-day industry has evolved from the time of its relentless focus on manufacturing process independently to provide a manufacturing and associated service(s) of the highest degree as a bundled offering. In this perspective, a new type of company has emerged, known as service-oriented firms. At the first sight, these companies seem to be manufacturers, have the factor of productions and focus on units of outputs, but rather they concentrate on the service capabilities of these outputs. (Phillips et al. 1999). For example, in case of Hitachi, the corporation is moving from selling products to “selling solutions/services.”

According to Vargo and Lusch (2004), the traditional orientation that production is a process of embedded value and destruction of value will occur when consumption, now was changed. This is a value co-creation process, in which each party bringing its own resource accessibility and integrability into that process (Figure 5.2). Resources mentioned here are not natural resources that are limited. With continued geometric population growth, in the near future, these natural resources, known as “static stuffs” would be soon run out of (Malthus 1888). Vargo and Lusch (2004) argued that resources should be considered not only as “static stuffs” but also as intangible and dynamic functions of human ingenuity and appraisal, e.g. skills and knowledge, employed to act upon natural resources.

In the value co-creation process, the customer is primarily a co-producer of service (Truong Quang and Hara 2017g). Value results from the beneficial application of skills and knowledge and determined by the consumer on the basis of “value in use” (Truong Quang and Hara 2017c). Vargo and Lusch (2004) argued that in either case – service provided directly or through goods – the knowledge and skills of service-oriented firms are essential sources of value creation, instead of the goods, which are only sometimes used to convey them. Hence, service is considered as a process rather than an add-on of output (Vargo and Lusch 2004). All economic exchange represents both collaborative value creation and partially derived demand, i.e. demand chain management (Truong Quang and Hara 2017g).



Source: Adapted from the presentation of Stephen Vargo "Transforming Business Models with Technology and Innovations." Frontiers in Service Conference, Bergen, Norway. June 26, 2016.

Figure 5.2: Manufacturers and Service-oriented firms

5.2 SUPPLY CHAIN RISKS

The attitude of risk treatment will vary dependent on the strategy of each firm (Wagner and Bode 2008). A classical approach of strategic management research in supply chain risk management is to divide the concept of strategy into two discrete dimensions: process and content (Truong Quang and Hara 2017g). Several researchers examined either process and/or content to identify risks in the organizational boundaries (Lockamy III and McCormack 2012, Tse et al. 2016). Although numerous risks have been extensively defined, the inquiry of Ho et al. (2015) indicated that, in addition to content and process, the internal and external perspectives of the organization also play an important role for risk identification and should therefore be incorporated in this framework.

This view-point is supported by the contingency theory whose the key assumption is that high organizational efficiency and business results when organizations consider the context in which strategy is crafted and implemented (Wagner and Bode 2008). As such, organizations must match the structure to the context and environment, i.e., forces outside the organizational boundaries (Truong Quang and Hara 2017g). If this "fit" is not reached, "opportunities are lost, costs rise, and the maintenance of the organization is threatened" (Child 1972).

The environment here is defined as "the totality of physical and social factors that cause effects on organizational performance” (Duncan 1972). This definition encompasses risk factors that are internal and external to the firm (Truong Quang and Hara 2017d). Extending the scope of risks, Wagner and Bode (2008) argued that:

> *[…] SC risk sources are critical contextual variables that can be internal and external to supply chains and to the acting firms in a supply chain network.*

Agreeing with this discussion, Jüttner (2005) analysed risk not only at processes of a firm, but at flows of SC from original suppliers to the delivery of the final product for the end user. Thun and Hoenig (2011), in an empirical study at 67 German automotive companies, proved that there is a significant difference between internal and external SC risks in terms of impact on performance.

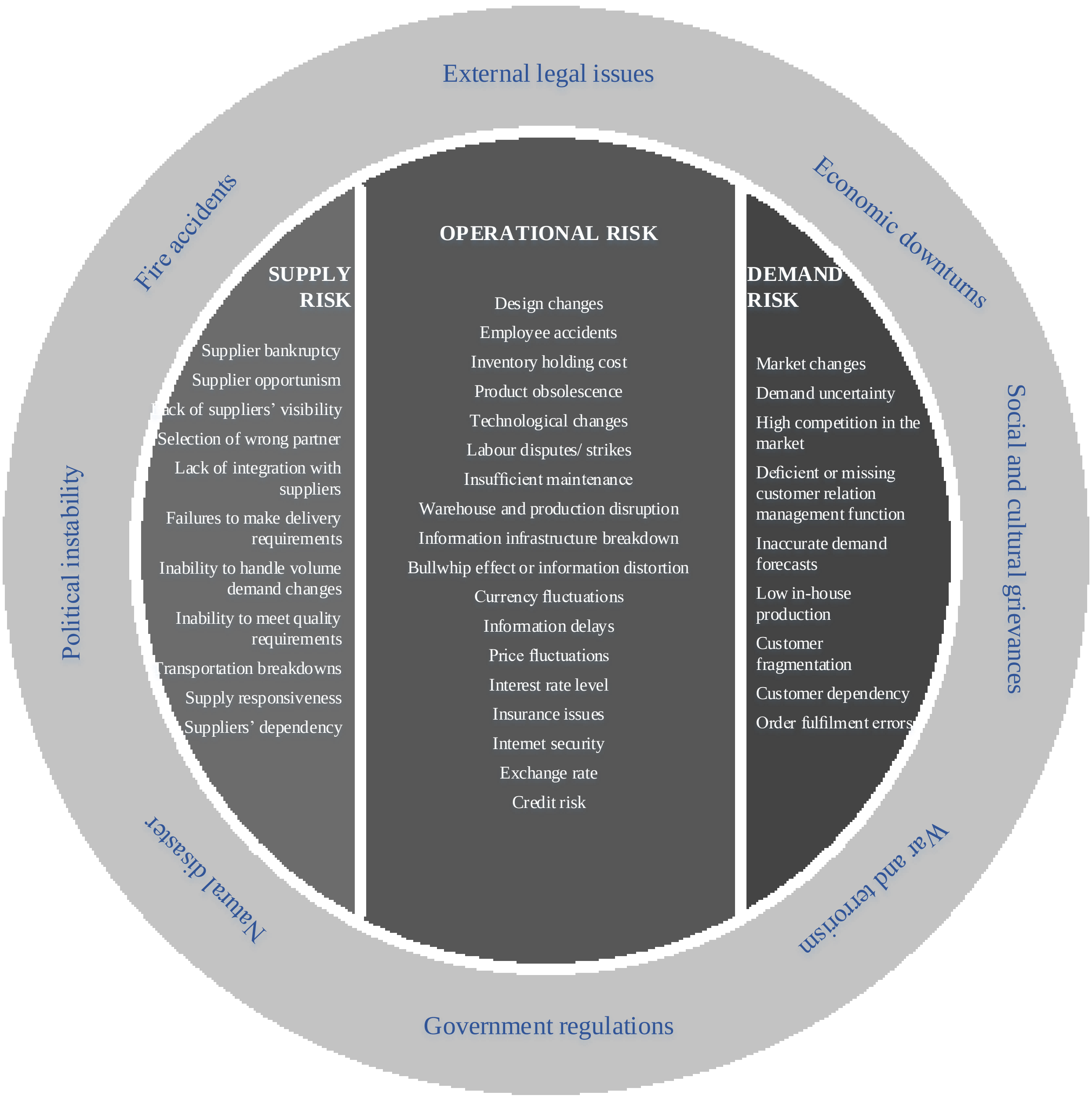


Figure 5.3: Supply chain risks

Risks that are shown in the Figure 5.3 have received numerous attention in the SC risk literature as an extensive result of documenting 169 journal articles published between 2003 and 2016. Each risk has different attributes that lead to various impacts on SC performance (Truong Quang and Hara 2017d). For instance, internal risks are ordinary workday problems that might directly affect supply chains, i.e. supply risk, operational risk and demand risk (Rice and Caniato 2003). These risks have a high likelihood to occur but a lower impact on performance than external SC risks (Thun and Hoenig 2011).

Conversely, external SC risks rarely occur but can lead directly or indirectly to disturbances within supply chain activities, e.g. natural disaster, economical-, political- and social issues, war, terrorists, etc.

5.3 THEORETICAL MODEL

As mentioned in the chapter 4, as the "push" mechanism, high-order risks will "push" the lower-order risks, increasing severity of each and all risk(s) on SC performance. Same as the previous one, in this chapter, risks are also categorized into three main groups:

- The first-order risks – the "push" factor, e.g. natural disasters, political and economic issues, etc., known as external risks, have influences on all activities of the supply chain.
- The second-order risks - infrastructure risks, e.g. supply and demand risks, cause disruptions in processes of the supply chain.
- The third-order risks – the "pushed" factor, e.g. operational risk, are ordinary workday problems that might directly affect SC performance and receive push effects from other risks.

The theoretical model and the competitive model representing the relationship between risks and SC performance are visually depicted in Figure 5.4. The hypotheses of relationships were discussed in the previous chapters (referring to the section 4.2 for details). In the center of the model are three core risks pertaining to the internal activities of the supply chain; Supply risk – Operational risk – Demand risk. These three risks have a direct effect on SC performance, which is measured by five crucial dimensions, including: supplier performance, internal business, innovation and learning, customer service and finance. The rest of the model describes the push effect among SC risks.

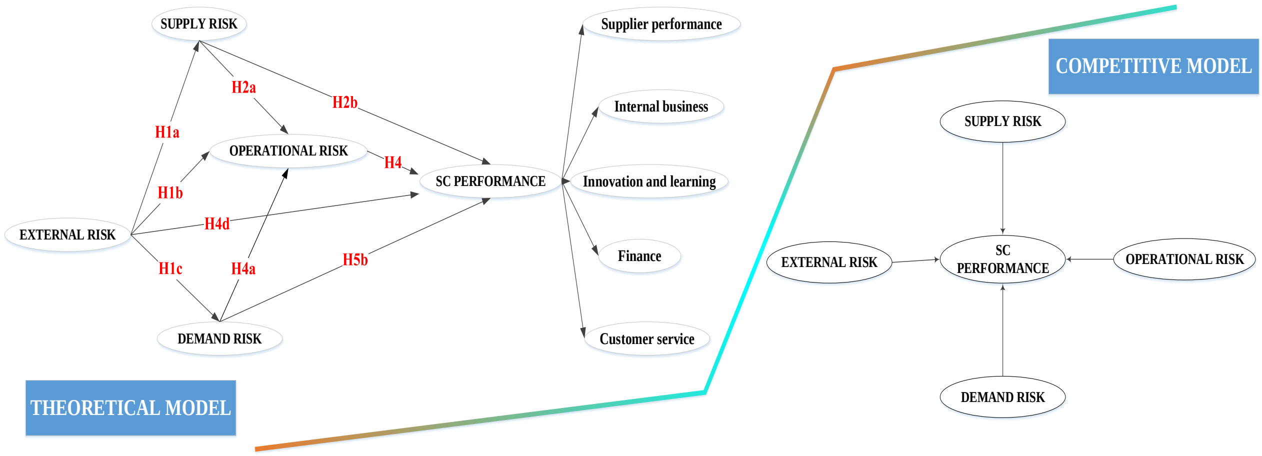


Figure 5.4: Theoretical model and Competitive model

5.4 RESULTS

In the total of 283 responses, there are 192 service-oriented firms were filtered as describing in the Table 5.1. Most of these companies are service providers, e.g. building material distribution, construction executive, design and transportation, but there are 40 service-oriented manufacturers (37 building material manufacturers and 3 concrete producers) also belonging to our sample. These companies have high authorized capital, working in this industry from 5 to 20 years and labour intensive.

Table 5.1: Survey sample characteristics

Firm profile	Freq.
Operation fields	
Building Material Distribution	9
Construction executive	19
Design (architecture and construction)	53
Transportation	71
Building Material Manufacturing (sand, stone, additive, etc.)	37
Concrete production	3
Full-time employees	
Less than 10	8
10 - 200	99
200 - 300	44
More than 300	41

Firm profile	Freq.
Years of business	
< 5 years	31
5 - 10 years	65
10 - 20 years	70
20 - 30 years	17
30 - 40 years	6
40 - 50 years	3
Authorized capital	
<20 billion VND*	39
20 - 100 billion VND	49
> 100 billion VND	104

**VND: Vietnamese Dong*

Respondent profile	Freq.
Job title	
Top-level manager	9
Middle-level manager	44
First-level manager	86
Coordinator	28
Others	25

Respondent profile	Freq.
Working area	
Purchasing	6
Logistics	6
Operations/ Projects	115
Human Resources	19
Risk Management	6
Finance	6
Sales	22
Marketing	4
Others	8

In the next step, traditional psychometric approaches were used to assess validity and reliability of measures (Hair et al. 1995). Accordingly, convergent validity will be evaluated by the Principal Component Factor Analysis using Varimax as the method of rotation to explore the underlying structure of measurement items (Gerbing and Anderson 1988). As a result, after deleting some items that do not get threshold values, the remaining items load on unique components with factor loadings larger than 0.6, implying that all of them meet the established standards for convergent validity (Appendix 6).

Chi-square differences among research concepts are carried out to test discriminant validity (Garver and Mentzer 1999). Six pairs from four research concepts are compared by two models for each pair (Table 5.2). The first one is to allow free correlation between the two constructs, and the other is to fix the correlation between the two constructs at 1.0 (Hair et al. 1995). The results in the Table 2 indicated that all the differences among research concepts are significant at P<0.001. Thus, we can conclude that all research concepts are discriminant (Garver and Mentzer 1999).

Table 5.2: Chi-square difference between research concepts

	SR	OR	DR	ER
SR	1			
OR	56.524	1		
DR	121.985	117.827	1	
ER	81.408	73.475	127.058	1

**All chi-square differences were significant at the 0.001 level*

Reliability is tested by Cronbach's Alpha and Item-total correlation (Hair et al. 1995). According to the results, all item-to-total correlations are above 0.475, Cronbach's alpha coefficients range from 0.737 to 0.904, implying reliability of constructs (Appendix 6).

All above, the measures possess sufficient validity and reliability to proceed with hypotheses testing.

Table 5.3 presents the comparison between two models. We can see that the impact of each risk on the SC performance in the theoretical model is greater than in the competitive model. The last column (Difference) shows the greater amount, implying the push effect. For example, with regard to operational risk, the difference is -0.191. As in the theoretical model, operational risk is affected by external risk, supply risk and demand risk. By these effects, it leads to an increase (0.191) in the impact of operational risk on SC performance, i.e. the increase of "0.191" is the push effect of external risk, supply risk and demand risk on operational risk. These results support our first hypothesis: “By the push effect, the impact of each risk on performance is greater than each single effect.”

Table 5.3: Comparison between the theoretical model and the competitive model

				THEORETICAL MODEL	COMPETITIVE MODEL	DIFFERENCE (PUSH EFFECT)
RELATIONSHIPS	SR	--->	SCP	-0.86***	-0.584***	-0.276
	OR	--->	SCP	-0.55**	-0.359***	-0.191
	DR	--->	SCP	-0.141*	-0.116*	-0.025
	ER	--->	SCP	-0.538**	0.183**	-0.721
	SR	--->	OR	0.405*		0.405
	DR	--->	OR	-0.218**		-0.218
	ER	--->	SR	0.779***		0.779
	ER	--->	OR	0.638**		0.638
	ER	--->	DR	0.507***		0.507
GOODNESS OF FIT	*Chi-square/df*			1.573	2.014	
	CFI			0.91	0.821	
	RMSEA			0.055	0.073	
R^2				**65%**	**52%**	

*Notes: *p<0.1; **p<0.05; ***p<0.01*

Regarding goodness of fit, the results in the Table 5.3 showed that the theoretical model is more suited to the data than the competitive model. Moreover, the coefficient of R^2 in the theoretical model is also higher than. These empirical evidence support the second hypothesis, confirming the mechanism of the push effect.

5.5 DISCUSSION

This chapter aims to two main objectives:

- Validating the mechanism of the push effect.
- Examining risk behaviour at service-oriented firms.

For the first purpose, as the results in the table 5.3 all risks detrimentally affect SC performance. However, compared with the competitive model, risks in the theoretical model have greater effects on SC performance, confirming our first hypothesis: “By the push effect, the impact of each risk on performance is greater than each single effect.”

Figure 5.5: The push effect of external risk on supply risk

Particularly, the push effect of external risk on supply risk increases the impact of supply risk on SC performance an amount of 0.276 (Figure 5.5). The flood in Thailand (2001) is a certain example for such. The flood washed out the offices of Western Digital, causing shortages of hard disk drives. As a result, prices were doubled, leading to a loss at between US$225–$275 million, more than four times of the initial estimation (US$50 million).

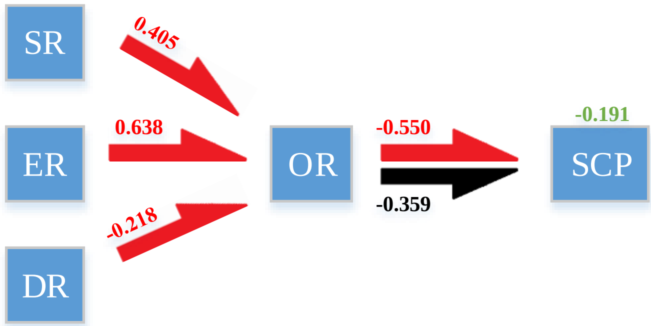


Figure 5.6: The push effect of supply, external and demand risks on operational risk

The push effect of supply, external and demand risks on operational risk, causing a decrease of 0.191 in SC performance (Figure 5.6). It is worth noting that this result classifies two kinds of push effect: positive and negative. Supply risk causes failures in delivering inbound goods/services to purchasing. Meanwhile, production facilities are highly vulnerable to natural disaster. These such engender disruptions in operating activities that directly affect financial performance of the supply chain (Kim and Chavas 2003, Williams et al. 1995). These influences are called "positive" push effects that increase the impact of the pushed factor on output (Truong Quang and Hara 2017g).

Conversely, an increase of demand risk will lead to a decrease of operational risk, enhancing performance of the chain, known as the "negative" push effect (Truong Quang and Hara 2017g). This interesting result reflects a special characteristic of service-oriented firms whose the central management starts from meeting customer demand, known as demand chain management (Truong Quang and Hara 2017c). When demand-related risks occur, they always have contingency plans / solutions that are able to decrease their impact on operating activities, thereby the impact of operational risk on SC performance also reduces.

Figure 5.7: The push effect of external risk on demand risk

Political and economic instabilities engender demand variability, bankruptcy, etc. that make firms unable to forecast market demands (Truong Quang and Hara 2017b). Firms have to produce more, have more inventory, resulting in increasing product cost (Truong Quang and Hara 2017g). This situation is a typical case illustrating the push effect of external risk on demand risk (Figure 5.7).

We can see that external risk causes "push" effect on all three internal risks, i.e. it is a "push" factor that affects all activities of SC. The loss of this risk will be difficult to fully evaluate if only assessing it as a single one. For instance, as in the competitive model, external risk has a positive effect on SC performance (0.183), meaning that when it occurs and higher degree of danger, it will increase SC performance. It is a strange result since natural disasters usually cause damages rather than bringing benefits. However, if considering the theoretical model, external risk has a strong and negative effect on SC performance. According to the result, this "push" factor can explain 53.8% variance of SC performance that we do believe to reflecting the "real" effect of external risk. Thus, it is imperative to examine external risk in a system that contains a variety of SC activities instead. These findings are in accordance with the hypotheses of the push effect.

Regarding the impact of all risks on SC performance, we can see that the theoretical model is more suited to the data and explains variance of SC performance more effectively than the competitive model. These results again confirm the mechanism of the push effect. Through the push effect, the proposed risks can explain 65% variance of SC performance compared with 52% of the competitive model. It is a remarkable rate as SC performance is not only influenced by SC risks, but also by other factors; e.g. innovation, SC management practices, etc. Therefore, if a company can manage the mechanism of the push effect, they can mitigate the impact of risks on SC performance.

Table 5.4: Comparison to previous studies

				SEM MODEL	WAGNER AND BODE	THUN AND HOENIG
RELATIONSHIPS	SR	--->	SCP	Strong *(-0.86***)*	Strong	Strong
	OR	--->	SCP	Average *(-0.55**)*		Average
	DR	--->	SCP	Low *(-0.141*)*	Strong	Strong
	ER	--->	SCP	Average *(-0.538**)*	No	Low
PERSPECTIVES				Vietnam	Germany	
TYPE OF BUSINESS				Service-oriented firms	Manufacturers	

These findings have some common things with previous empirical studies (Table 5.4). For instances, Thun and Hoenig (2011) analyzed probability of occur and impact of various risks on the SC based on a survey of 67 manufacturing plants in the German automotive industry. Five types of risk, comprising supply-, demand-, information-, operational- and external risks, have negative effect on SC performance. Particularly, supply-, demand- and information risks highly impact on the SC while external risk has a low effect. Also in Germany, Wagner and Bode (2008) conducted a cross-sectional survey administered with 545 manufacturers, 148 service providers and 67 traders also found the same results. We can see that compared with our findings, there are two main differences with regard to the potential impact of demand- and external risks, reflecting the object and our research perspective.

Our empirical study focuses on service-oriented firms whose the core management starts from meeting customer's demand, i.e. demand chain management. Thus, their activities aim to manage well to reduce demand-related risks at a minimum. Moreover, customers of service-oriented firms require high consistency (Truong Quang and Hara 2017c). Therefore, when they accept a service/ a company, it is rare to change to others. Meanwhile, manufacturing firms manage their SC from upstream to downstream, i.e.

supply chain management, the products of manufacturing firms are tangible and the difference of product specifications is not high (Truong Quang and Hara 2017b). Hence, the barriers to conversion are low. Customers are easy to change products of competitors. In many cases, customers today use this product, tomorrow ask for ones of other companies (Solomon et al. 2012). Hence, it is hard to control demand risk in manufacturers.

Regarding the external risk, in the context of Vietnam, a developing country, the barriers of economics and politics are relatively high, the existence of a larger number of procedures, corruption, etc., rather than in developed countries (Truong Quang and Hara 2017g), explaining why external risks have a greater impact on SC performance.

5.6 SUMMARY OF THE CHAPTER 5

This chapter verified the push effect of risks on SC performance in the context of service-oriented firms. Empirical evidence found in the Vietnam construction sector proved that the mechanism of the push effect can increase the degree of impact of each and all risks on outputs. According to the results, by the push effect, risks can explain up to 65% variance of SC performance compared with 52% of the model without push effect. Moreover, the research found two kinds of the push effect: (1) positive – increasing the impact of "pushed" factors on outputs and vice versa for (2) negative.

As mentioned in the chapter 4, the mechanism of the push influence will be broken if the coefficient of "α" is eliminated. With respect to implement this idea effectively and efficiently, practitioners and managers can apply the resultant model as a "road map" to reduce SC risks as well as the mechanism of the push effect in their context to achieve this purpose.

Moreover, there are some interesting distinctions comparing with previous studies, implying the difference between manufacturers and service-oriented firms. Vargo and Lusch (2008) argued that service-oriented firms will be a new trend since the modern-day industry tends to more focus on customer demand. Supply chain management gradually shifted towards demand chain management that organizations will not make and sell units of output but producing customized services to customers (Hilletofth 2011).

As mentioned above, another reason for these distinctions can be of different research contexts. Hence, it is imperative to compare the mechanism of the push effect between manufacturer-oriented firms and service-oriented firms in the same industry/supply chain to clarify their distinctions. To this end, the chapter 6 will apply the theory of Good Dominant Logic and Service Dominant Logic to find differences between these two types of firms.

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CHAPTER 6: MANUFACTURING-ORIENTED FIRMS AND SERVICE-ORIENTED FIRMS

In the same supply chain, "what are differences between service-oriented firms and manufacturing-oriented firms" is the question that this chapter has addressing. For an insight, the student will focus on internal risks in the supply chain, e.g. supply risk, operational risk, demand risk, finance risk, information risk and time risk. The theory of Service Dominant Logic and Goods Dominant Logic will be a background to understand characteristics of these two types of firms that are discussed below.

6.1 MANUFACTURING-ORIENTED FIRMS AND SERVICE-ORIENTED FIRMS

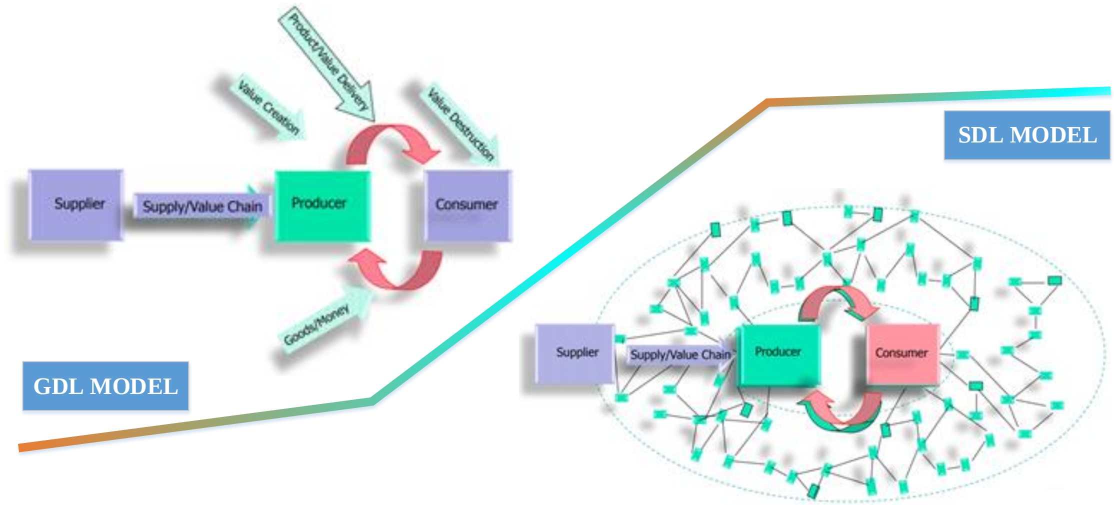
6.1.1 Operand resources and Operant resources

Resources in the world are limited (Ponting 1991). With continued geometric population growth, in the near future, resources would be soon run out of (Malthus 1888). Resources referred here can be land, minerals, animal life, plant life, etc., i.e. natural resources. Constantin and Lusch (1994) defined them as operand resources on which an operation or act is performed to produce an effect. Malthus (1888) stated that these resources are essentially "static stuffs" and to be captured as a competitive advantage.

Vargo and Lusch (2004) argued that resources should be considered not only as "static stuffs" but also as intangible and dynamic functions of human ingenuity and appraisal, e.g. skills and knowledge. As this viewpoint, resources are not static or fixed, known as operant resources that are invisible and intangible, employed to act upon operand resources (Constantin and Lusch 1994).

6.1.2 Goods Dominant Logic (GDL) and Service Dominant Logic (SDL)

People exchange for goods that serve primarily as operand resources (Vargo and Lusch 2004). Economic exchange is fundamentally concerned with units of outputs (tangibility) which are embedded with value during the manufacturing process (Capon and Glazer 1987). Firms supporting this point of view (GDL), temporarily called as manufacturing-oriented firms, has factors of production (largely operand resources) and their efforts aim to convert its operand resources into outputs at a low cost (Truong Quang and Hara 2017f). Thus, standardization, traits of manufactured outputs, the separation of production and consumption, nonperishability are normative qualities (Zeithaml et al. 1985). Value is embedded in the operand resource, determined by the manufacturing-oriented firms throughout exchange in production processes and generally among members in the supply chain, i.e. “value-in-exchange” (Truong Quang and Hara 2016a). In other words, value is added before use and more concentrated into exchanges between suppliers and manufacturing-oriented firms, i.e. supply chain management (Figure 6.1). At these firms, moreover, services are treated as “an immaterial product/ residual/ add-on” that is a kind of intangible goods and address to enhance the value of goods (Figure 6.2) (Converse 1921, p. vi; see (Fisk et al. 1993)).



Source: Adapted from the presentation of Stephen Vargo "Transforming Business Models with Technology and Innovations." Frontiers in Service Conference, Bergen, Norway. June 26, 2016.

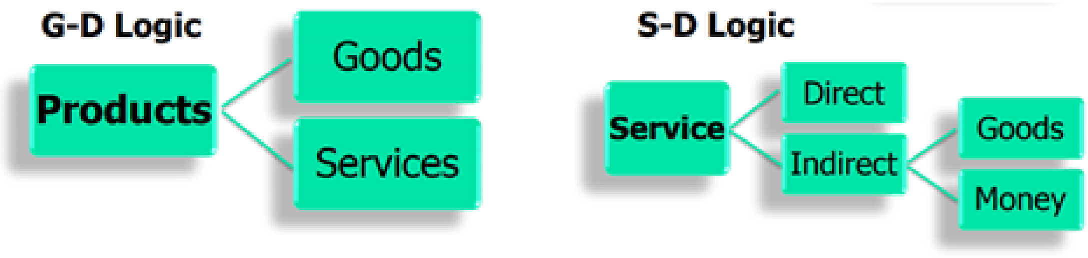
Figure 6.1: GDL and SDL models

Conversely, SDL considers service as a process rather than an add-on of output (Vargo and Lusch 2004). All economic exchange represents both collaborative value creation and partially derived demand, i.e. demand chain management (Truong Quang and Hara 2017a). Service-oriented firms do not make and sell units of output but to produce customized services to customers (Truong Quang and Hara 2017f). Scholars supporting SDL realized that customers are not buying output, but rather the service capabilities of that output (Phillips et al. 1999). Thus, firms should develop collaborations and partnerships with customers (Bucklin and Bucklin 1970).

Moreover, while GDL implies that production is a process of embedded value and destruction of value will occur when consumption (Figure 6.1), in contrast, an assumption of SDL is that:

[...] One party does not produce value while the other consumes/ destroys value (Vargo and Lusch 2004, Vargo and Lusch 2008), pp. 257).

This is a value co-creation process, in which each party bringing its own resource accessibility and integrability into that process (Truong Quang and Hara 2017f). In this theory, the customer is primarily an operant resource, a co-producer of service (Truong Quang and Hara 2017f). Value results from the beneficial application of operant resources and determined by the consumer on the basis of "value in use" (Truong Quang and Hara 2017a). Vargo and Lusch (2004) argued that in either case – service provided directly or through goods – the knowledge and skills of service-oriented firms are essential sources of value creation, instead of the goods, which are only sometimes used to convey them. Hence, in this SDL's viewpoint, goods are "appliances" for service provision, i.e. conveyors of competences (Figure 6.2) (Truong Quang and Hara 2017f).

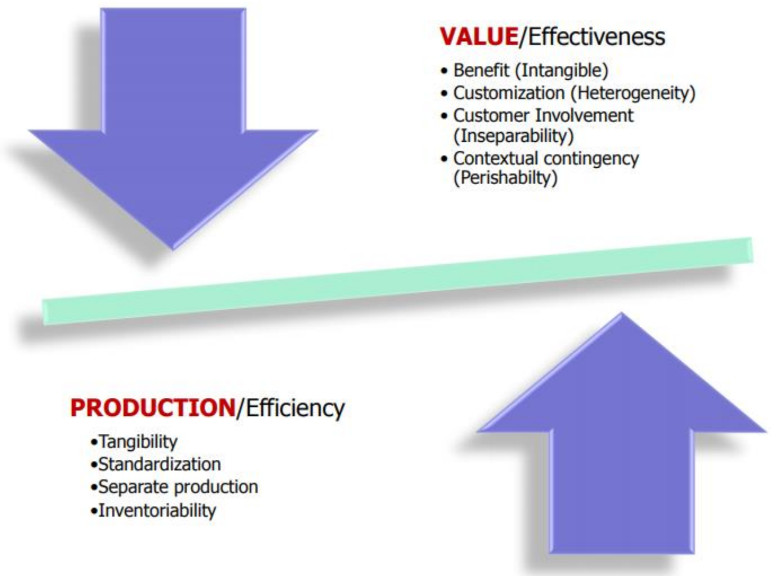


Source: Adapted from the presentation of Stephen Vargo and Robert Lusch "Service-Dominant Logic: An Evolution or Revolution in Marketing Theory and Practice?"John Molson School of Business, Concordia University Montreal, October 20, 2011.

Figure 6.2: Products and Service

Another distinction associated with efficiency versus effectiveness (Figure 6.3). Vargo and Lusch (2008), pp. 257) supposed that a goods-center model towards the primacy of efficiency. Manufacturing-oriented companies find ways to provide efficient that requires production activities to isolate from the customer and results in standardized, inventoriable goods. Meanwhile, Vargo and Lusch (2008), father of "SDL," stated that efficiency and effectiveness can be seen as complementary. In the relationship between these two concepts, Vargo and Lusch (2008) described as:

> *[…] effectiveness is necessary before efficiency has relevance but efficiency is often both a component (buyer's perspective) of effectiveness and also necessary for long-term effectiveness (seller's perspective). Thus, effectiveness can be seen as a path to efficiency.*



Source: Adapted from the presentation of Stephen Vargo and Robert Lusch "Service-Dominant Logic: An Evolution or Revolution in Marketing Theory and Practice?" John Molson School of Business, Concordia University Montreal, October 20, 2011.

Figure 6.3: Efficiency and effectiveness

McQuail (1994), **the author of "mass communication,"** asserted that most communications with the market at the manufacturing-oriented firms are one-way, i.e. mass communication. Information flows from the offering firm into the market or to segments of markets. On the contrary, a service-centered view of exchange inferred that customers' demand increasingly specializes and turns to firm's domesticated market relationships for services outside of firm's competences (Truong Quang and Hara 2017f). Thus, a communication process characterized by dialogue, asking and answering questions is imperative (Prahalad and Hamel 2006).

(Duncan and Moriarty 1998), pp. 03) deduced differences between manufacturing and service-oriented firms that one is a functional, mechanistic, production-oriented model; the other is a more humanistic, relationship-based model. (Lavastre et al. 2014), pp. 3385) supposed that at firms having different characteristics, risk behaviours and their impact on SC performance also vary. Agreed to this, with empirical evidence at 300 Australian companies, Subramaniam et al. (2009) found that company characteristics have a significant association with an organization's risk management strategies, policies and processes. Empirical data at U.S. interstate motor carriers also indicated that characteristics of firms can be a reliable predictor of accident risk (Moses and Savage 1994), pp. 173). Hence, we proposed the following hypothesis:

H: There is a distinction in the impact of risks on SC performance between manufacturing and service-oriented firms.*

6.2 RESULTS

From 283 usable responses, there are 192 service-oriented firms and 91 manufacturing-oriented firms (Table 6.1). Particularly, in the group of service-oriented firms, 164 are "pure" service providers and 28 service-oriented manufacturers. Regarding the group of manufacturing-oriented firms, there are 63 "pure" manufacturers and 28 manufacturing-oriented service providers. The number of service-oriented manufacturers are greater than manufacturing-oriented service providers, confirming that service-oriented firms will be a new trend in the modern-day industry.

Table 6.1: Sample characteristics

Firm profile			Freq.
Operation fields	Manufacturing-oriented firms	Building Material Manufacturing (sand, stone, additive, etc.)	33
		Concrete production	30
		Construction executive	28
	Service-oriented firms	Building Material Manufacturing (sand, stone, additive, etc.)	9
		Concrete production	19
		Building Material Distribution	53
		Construction executive	71
		Design (architecture and construction)	37
		Transportation	3
VND: Vietnamese Dong			283

Firm profile		Freq.	
		Manufacturing-oriented firms	Service-oriented firms
Years of business	< 5 years	10	31
	5 - 10 years	29	65
	10 - 20 years	33	70
	20 - 30 years	18	17
	30 - 40 years	1	6
	40 - 50 years	0	3
Authorized capital	<20 billion VND	9	39
	20 - 100 billion VND	20	49
	> 100 billion VND	62	104
Full-time employees	Less than 10	1	8
	10 - 200	23	99
	200 - 300	25	44
	More than 300	42	41

Table 6.2 presents the validated results of research hypotheses. Accordingly, the impacts of supply, operational and demand risks on SC performance are supported. Conversely, there are no relationships that are found between pairs of finance risk & SC performance, information risk & SC performance and time risk & SC performance. These six SC risks, moreover, can explain 68.6% of the variance of SC performance.

Table 6.2: SEM results

Hypotheses	Relationships			Standardized estimate	p	Result
H1	Supply risk	--->	SCP	-0.366	.006	Support
H2	Operational risk	--->	SCP	-0.477	.009	Support
H3	Demand risk	--->	SCP	-0.184	.029	Support
H4	Finance risk	--->	SCP	0.079	.257	No support
H5	Information risk	--->	SCP	-0.055	.657	No support
H6	Time risk	--->	SCP	0.126	.142	No support
Goodness of fit: Chi-square/df = 1.835, CFI = .911, RMSEA = .054. **R^2 = .686**						

Additionally, the research results indicated that there is a difference of risk behaviours between these two compared groups in the significance of $p < 0.001$. Table 6.3 shows the comparison between manufacturing and service-oriented firms.

Table 6.3: Comparison between manufacturing and service-oriented firms

Relationships			Manufacturing-oriented firms	Service-oriented firms
Supply risk	--->	SCP	NONE	-0.587**
Operational risk	--->	SCP	-0.636***	NONE
Demand risk	--->	SCP	-0.449***	NONE
Finance risk	--->	SCP	NONE	NONE
Information risk	--->	SCP	0.209*	-0.234*
Time risk	--->	SCP	NONE	NONE
R^2			**92%**	**61%**

*Notes: *p<0.1; **p<0.05; ***p<0.01*

We can see that except for the impacts of finance and time risks on SC performance not found in both groups, operational and demand risks in the group of manufacturing firms have strong and negative effect on SC performance. Meanwhile, supply risk detrimentally affects SC performance in the group of service-oriented firms.

Another interesting result relates to information risk. There is a negative influence on SC performance found in the service group, it, in contrast, is a positive impact in the manufacturing's group.

Finally, R^2 that explains for % variance of SC performance in the manufacturing-oriented firms (92%) is higher than the one in the service-oriented firms (61%).

6.3 DISCUSSION

Empirical evidence at 283 construction firms notably shed light on the relationship between six critical risks in the supply chain and SC performance. Accordingly, risks do not affect SC performance separately, but simultaneously. In a bad situation six risks incur at the same time, they can explain 68.6% variance in SC performance. It is a significant percentage because SC performance is not only dependent on risks, but also on other factors, e.g. politics, economy, external environment, etc., known as external factors. In other words, in the same condition of macro factors, firms that can manage well these SC risks are able to get sustainable competitive advantages (Truong Quang and Hara 2016a).

Moreover, the impact of risks on SC performance varies between manufacturing & service-oriented firms. In the manufacturing group, six critical risks can explain 92% variance of SC performance. Meanwhile, it is 61% for the service group, implying that risks existing at manufacturing-oriented firms have a greater effect on SC performance rather than at service-oriented firms. Particularly, there is significant relationship between supply, operational and demand risks and SC performance. These risks pertaining to product flow are ordinary workday problems (Rice and Caniato 2003). Therefore, they have a high likelihood to occur and directly affect SC performance (Thun and Hoenig 2011). Wagner and Bode (2008) categorized these types of risk as "contextual variables" that must necessarily be factored into strategic SC decisions.

Conversely, finance risk, information risk and time risk have no relationship with SC performance. In the SC network, finance, information and time are "infrastructure" elements that aim to ensure the healthy functioning of the chain (Ho et al. 2015). Any disruptions relating to these elements can lead to serious problems for processes in the supply chain – especially supply, manufacturing and downstream activities (Ho et al. 2015). Thus, although the direct impact of these risks on SC performance is not significant, they might affect other risks, thereby having indirect effects on SC performance. Future research should examine interrelationship among SC risks that are able to show indirect effects of SC risks on SC performance and consolidate this statement as well.

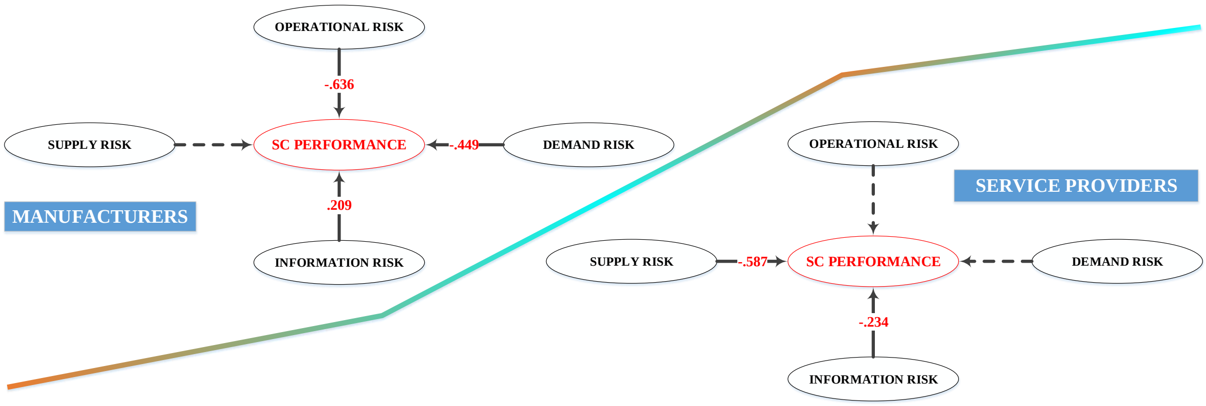
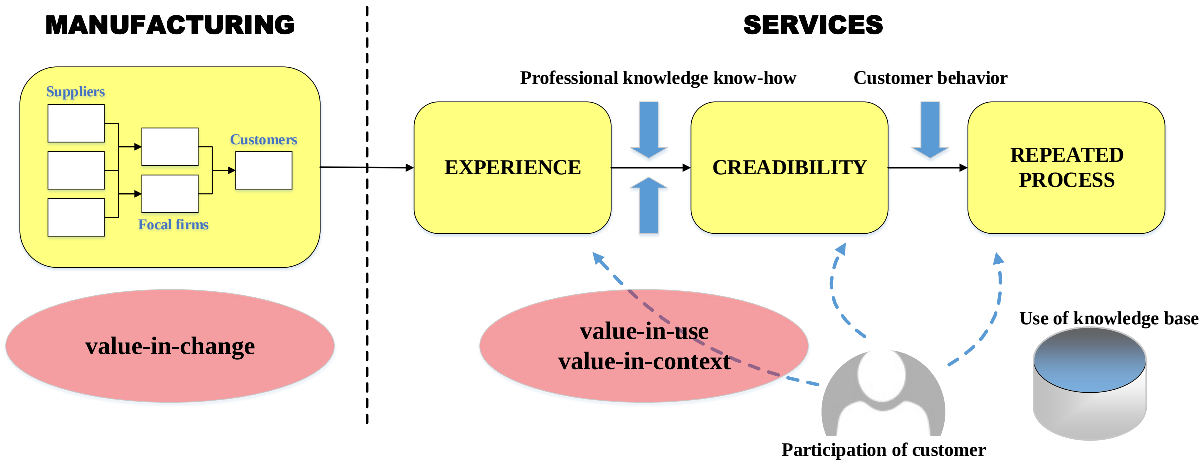


Figure 6.4: The impact of SC risks on SC performance in two compared groups

Figure 6.4 describes the differences between manufacturing and service-oriented firms that can be explained based on the theory of GDL and SDL. As mentioned above, manufacturing-oriented firms manage their SC from upstream to downstream, i.e. supply chain management (Figure 6.5). Values come from exchanging among members in the chain, especially between suppliers and manufacturers, known as value-in-exchange. Thus, they will focus more on supply-related activities, i.e. take efforts/ resources to minimize this type of risk. Moreover, inputs of manufacturing-oriented firms are "visible" (Morris and Johnston 1987), explaining why the impact of supply risk on SC performance is not found in this group.



Source: Adapted from the research proposal of the project of "An Empirical Study on Services Value Chain based on the Experiential and Credibility Values"

Figure 6.5: Supply chain management and Demand chain management

Conversely, inputs of service-oriented firms are "vague" (Morris and Johnston 1987). Their management starts from meeting customer’s demand, i.e. demand chain management, a core activity of service-oriented firms (Vargo and Lusch 2008). In this type of business, moreover, production and consumption are concurrent. Thus, values will be created through the processes of consuming and dependent upon the context of providing services (operational processes), known as value-in use/ value-in-context (Figure 6.5) (Truong Quang and Hara 2016a). Demand- and operational-related activities, therefore, receive much attention.

Moreover, customers of service firms require high consistency (Truong Quang and Hara 2017a). Since they accept a product/ a company, it is rare to change to others. Meanwhile, the products of manufacturing firms are tangible and high level of standardization (Truong Quang and Hara 2017f). Thus the barriers to conversion are low, customers are easy to change in using products of competitors. In many cases, customers today use this product, tomorrow ask for ones of other companies (Solomon et al. 2012). Hence, it is hard to control demand risk at manufacturing-oriented firms.

Another interesting result relates to information risk that can increase effectiveness of SC in the manufacturing group but has a negative effect on SC performance at service-oriented firms. This finding supports the argument of Jüttner (2005), implying that risks are not only losses, in some cases, they can bring opportunities for companies. Evidently, information risk, when it incurs, reduces quantity and quality of information to members of the chain, decreasing SC performance as the results of the service group. In the operating processes, it is necessary that all employees understand what customer’s needs, information of processes, service, etc. The more information shared, the higher service quality improved (Lee et al. 2004a). However, this argument is not completely right in case of manufacturing-oriented firms. Too much received information, sometimes will disrupt processes (Truong Quang and Hara 2017f). Employees do not know what they need to do, how to operate, etc. It is particularly true in developing countries where require a large amount of human capital, but quality of labour is still low (Truong Quang and Hara 2017f). This perhaps can explain when information risk occurs, performance of manufacturing SC is increased. Agreed to this, Gardner and Cooper (2003) stated that:

[…] Firms must be careful about providing more data than channel partners or firms need for their contributions to the supply chain, inadvertently giving away competitive information. However, brand share data concerning suppliers, which is not as easily known, can cause channel conflict. Including retail share data in a distributed map, while sensitive, may not be a critical risk. The same data in an environment without the alternative data sources could be very detrimental.

In the purpose of mitigating SC risks, Table 6.4 presents severity of risk factors, which have significant effects on SC performance in both groups. Accordingly, risk factors in the service group are mostly greater than 3 - the average level. Particularly, price fluctuations and distorted information are ones having the highest degree of danger in the corresponding risk type. For the manufacturing group, most of the risk factors are also greater than the average level. It is worth noting that accidents, customer bankruptcy and distorted information are risk factors having the highest degree of danger in three SC risk type, respectively.

Table 6.4: The degree of danger of risk factors in two groups

		MANUFACTURING-ORIENTED FIRMS	SERVICE-ORIENTED FIRMS
SR	Supplier bankruptcy		3.19*
	Price fluctuations		**3.40**
	Unstable quality of inputs		3.34
	Unstable quantity of inputs		3.06
OR	Design changes	3.04	
	Technological changes	3.12	
	Accidents	**3.24**	
	Labour disputes	3.12	
DR	Demand variability	3.43	
	High competition in the market	3.40	
	Customer bankruptcy	**3.54**	
	Customer fragmentation	3.15	
IR	Communication breakdown with project team	2.70	2.96
	Information infrastructure breakdown	2.84	2.94
	Distorted information	**3.13**	**3.25**

**Min = 1, Max = 5*

Chopra and Sodhi (2012) recommended some solutions to cope with price fluctuations by building inventory, having multiple sources of supply or signing long-term contracts.

For instance, in 2002, many companies selectively hold inventories after learning of the impending California dockworker's strike. As a consequence, when supply was disrupted, as predicted, losses were minimal. Stockpiling inventory is ideally used as a hedge against price fluctuations for commodity products with low holding costs and no danger of obsolescence (Truong Quang and Hara 2017f).

Contracting with redundant suppliers can be another good option, but only if firms can maintain the economies of scale. The global automobile manufacturer – Toyota, seek out local economies of scale by single-sourcing at the plant level, but recruiting redundant suppliers globally. Thus a firm might be the sole supplier to a Toyota plant, it must keep prices down to rival for business across the entire Toyota network. Moreover, long-term contracts can keep price stably, but they in contrast can badly reduce profits if prices for the contracted goods fall. An example in California, obligations signed by the Mayor during the peak of its electricity crisis in 2001 forced the state to pay 8 times more than the 2002 market price (Sodhi and Tang 2012).

With regard to accidents, the National Safety Council reported that human behaviour was associated with 94% of all injuries and illnesses (Loafman 1996). This has revealed the importance of focusing on employee behaviour as a critical element in achieving better safety standards. From this point of view, Behaviour-Based Safety (BBS) can be a promising method. Behaviour-based safety displays two major strengths: (1) a focus on employee behaviour which is claimed to be the main source of injuries and illnesses (McSween 2003) and (2) encouraging employee involvement in safety issues so that safety is not seen solely as the management's responsibility. The aim of BBS is to reinforce workers to behave safely during their activities. A typical BBS intervention consists of basic safety training (antecedent), followed by a periodic observation and positive feedback (consequence) to enforce safe behaviour (Guastello 1993). Komaki et al. (1980) found that lost time accident per month was reduced from 3.0 to 0.4 during intervention or injury rate was decreased from 6.9 in pre-intervention to 4.9 during intervention as an investigation of Fellner and Sulzer-Azaroff (1984) with 158 workers from 17 divisions of the paper mill.

Customer bankruptcy is an extremely bad situation causing a big disruption in the SC (Truong Quang and Hara 2017f). Srinivasan and Kim (1988) suggested one way avoiding this dilemma is to evaluate the financial health of customers and identify clients who might become bankrupt. Firms can carefully monitor the credit status of their clients by having each one complete a credit application and credit agreement. It is imperative to conduct a credit check on clients who place large orders (Gaudenzi and Borghesi 2006). Battiston et al. (2007) encouraged firms to follow up with periodic credit checks, which many small business fails to do, aim at identifying a customer may be heading for bankruptcy.

The last one – distorted information is found to have the highest degree of danger among information risks in both groups. Information distortion gives actors in the chain the wrong incentives and is the opposite of sound collaboration and communication within the chain (Handfield and Nichols 2002, Huong Tran et al. 2016). Machuca and Barajas (2004) suggested that companies need to adapt Electronic Data Interchange (EDI) and share their information in a transparent way in order to improve their communications and reduce the information distortion. The interchange of electronic data makes this information available from downstream to upstream in the SC and provides rapid transmission and sharing of accurate, reliable information throughout all the stages of the SC (Lee et al. 2004a). This information sharing through EDI creates greater stability in orders placed with the factory and this will lead to more stable production levels which in turn leads to more efficient production planning, less need for expensive corrections and hence a reduction to the cost for the supply chain (Machuca and Barajas 2004). However, it is essential that quality and quantity of shared information are key factors to the success of the supply chain (Gardner and Cooper 2003).

6.4 SUMMARY OF THE CHAPTER 6

This chapter discussed and provided empirical evidences of different risk behaviours between manufacturing and service-oriented firms. As a consequence, the risks occurring at manufacturing-oriented firms have stronger and negative effect on SC performance than the ones at service-oriented firms. With respect to improve SC performance, manufacturing-oriented firms should pay much attention on operational and demand risks that adversely affect SC performance and "treat" information risk as an opportunity. For service-oriented firms, it is necessary to manage supply risk which can explain 58.7% variance of SC performance. In addition, service quality will be improved remarkably if information risk is well managed.

It is worthwhile that the application of the GDL and SDL theory to identify different characteristics between two compared groups is a "breakthrough" of this study. This approach is able to provide an insight into differences between two groups, since classifying two types of business based on resources, value, network, effectiveness vs efficiency and communication. Upcoming studies can apply this approach into their own contexts to verify these results.

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CHAPTER 7: CONLUSION AND FUTURE RESEARCH

This chapter summarizes main findings of this thesis. Contributions of theory and practice then will be discussed before suggesting some new directions for further research.

7.1 THE SUMMARY OF MAIN FINDINGS

This thesis aims at providing an extensive picture of risks and performance in the supply chain. In this picture, risks were classified into three categories with regard to their level of impact on performance, i.e. core risks (supply risks, investor-related operational risks, contractor-related operational risks and demand risks), infrastructure risks (finance, information and time risks) and external risk (human-made risks and natural risks). These risks are not independent, as multiple risks occur simultaneously. They have links, creating a "push" effect, thus increasing the severity of each and all risk(s) on supply chain performance. Empirical evidence found at 283 Vietnam construction companies proved that by the push effect, the impact of each and all risk(s) on supply chain performance is greater than each and total of single effects(s), explaining up to 73% variance of supply chain performance.

Moreover, the mechanism of the push effect is confirmed at 192 service-oriented firms, a new trend in the now-a-day industry, as risks can explain up to 65% variance of SC performance compared with 52% of the model without push effect. Also, this research found two kinds of the push effect: (1) positive – increasing the impact of "pushed" factors on outputs and vice versa for (2) negative.

There is a significant difference of risk behaviours between service-oriented firms and manufacturing-oriented firms that were distinguished by the theory of Goods Dominant Logic and Service Dominant Logic. Accordingly, risks existing at the manufacturing-oriented group have a greater effect on supply chain performance (92%) than service-oriented firms (61%). Manufacturing-oriented companies should pay much attention on operational and demand risks that adversely affect SC performance and "treat" information risk as an opportunity. Meanwhile, for service-oriented companies, it is necessary to manage supply risk which can explain 58.7% variance of

SC performance. In addition, service quality will be improved remarkably if information risk is well managed.

Another contribution with regard to supply chain performance. In attempting to have a comprehensive performance scale, this study utilized the balance scorecard model to define a set of measures for SC performance, supplier performance, internal business, innovation and learning, customer service and finance that are more contemporary, intangible and strategic-oriented.

7.2 THEORY CONTRIBUTION

As an extensive review of 160 SCRM-related journal articles between 2003 and 2016, some following research gaps were found:

- The number of risk identification studies are quite limited, especially empirical research.
- There is a lack of the Structural Equation Modeling's application, one of the most modern and complex methods that can receive the highest accuracy in the quantitative research.
- The service and construction sectors has not been fully investigated yet from the literature.

By the SC mapping approach, a technique that was recommended for a long time but were not used popularly in the SC risk body, a conceptual framework that covers various dimensions of risks in the SC network is proposed and validated by empirical data at Vietnam construction sector. This can be a premise for the next phase, e.g. developing a new concept in the SC risk body of literature – the "push" effect, validating this concept at service-oriented firms, comparing service-oriented firms and manufacturing-oriented firms. It can be expected that findings explored in this study are able to offer useful guidance for identifying and assessing SC risks, as well as contribute to theory regarding the relationship between risks and performance in the SC. Moreover, the proposed models can be used as a 'guideline' for reducing the impact of risks, especially push effects.

Throughout the thesis, the technique of Structural Equation Modeling is applied to validate concepts and research models. This technique involves the simultaneous evaluation of multiple variables and their relationships, thus it is appropriate to examine the impact of various risks on SC performance, especially the "push" effect. Moreover, the most important strength of SEM is that the relationships among numerous latent constructs can be addressed in a way that reduces the error in the model (Hair et al. 1995). This feature enables assessment and ultimately elimination of variables characterized by weak measurement (Hair et al. 1995). Agreed to this, Hair et al. (2014) stated that:

> […] Concept and theory development require the ability to operationalize hypothesized latent constructs and associated indicators, which is only possible with SEM.

Furthermore, it is worth noting that the application of the Goods Dominant Logic and Service Dominant Logic theory to classify manufacturing-oriented firms and service-oriented firms is also a "novelty of approach" of this study. Different characteristics between two compared groups are identified and explained with respect to resources, value, network, effectiveness vs efficiency and communication, providing an insight into risk management activities in the supply chain network.

7.3 PRACTICAL CONTRIBUTION

Risks are not independent, as they occur simultaneously (Truong Quang and Hara 2015). Understanding such, companies will have a systematic view of risks in the whole SC network whereby they can define risks in their own context and assess the "real" effect of risks on SC performance (Truong Quang and Hara 2017d). Conversely, this could be a reason that leads to solutions of risk prevention not achieving desired outcomes, as risk mitigation plans only focus on a single risk instead of a complex system that contains numerous risks have links with each other (Truong Quang and Hara 2017a).

There are several conceptual frameworks of the impact of risks on SC performance were developed in this thesis. It is worthwhile that the proposed model can explain more than 50% variance of SC performance. It is significant rates, as SC performance is not only influenced by SC risks, but also by other factors; e.g. innovation, SC management practices, etc. Therefore, if a company can manage these risks, they can mitigate the effect of risks on SC performance.

Particularly, by the proposed supply chain map, firms will have a visible and systematic view, whereby they can highlight critical SC risks in their context, so resources can be allocated appropriately and pertinent strategies implemented to mitigate risks. Moreover, understanding the model of the push effect among SC risks, firms can predict the "real" degree of danger of risks on performance in their SC and mitigate the effect of risks in the entire supply chain network. Accordingly, the mechanism of the push influence will be broken if mutual interaction among risks was minimized. Practitioners and managers can apply the resultant model as a "road map" in their context to achieve this purpose. Furthermore, the models of comparison between manufacturing and service-oriented firms provide a thorough view of risk behaviours, thereby proposing appropriate solutions for each type of company.

7.4 DIRECTIONS FOR FURTHER RESEARCH

According to Sampaio et al. (2016), SC risk is an extensive concept. Therefore, despite this research attempting to integrate various dimensions of SC risks in a conceptual framework, it is imperative to validate this framework in a range of contexts in different sectors and supply chains. Each sector/SC will have disparate characteristics that been to be considered. Therefore, like risk sources and types, the risk factors will be distinct among different industries/SCs, such as the public sector, renewable-energy sector and bioenergy, biomass and service, which were all missing in the literature. These distinct risk factors should be integrated into the framework under the corresponding SC risk types. This reflects the characteristics of industries/SCs but it is still necessary to define a more comprehensive model.

Another approach can be examining and analysing risks in the SC under industry-centric focus. This approach aims to a broader view and can be a platform to suggest implications/solutions for Associations, Governments in the effort of risk mitigation and monitoring.

For the push effect, it is imperative to find out a model in which the push effect of risks on SC performance is highest/ lowest or to examine the push effect of SC risks on each dimension of SC performance, e.g. supplier performance, internal business, innovation and learning, customer service and finance. Otherwise, it is possible to take time series into consideration and classify long-term and short-term risks.

In the scope of this research, there are some relationships that are not supported. Perhaps, they will be significant if more interrelations that indicate indirect effects are examined. Otherwise, among four new established concepts, investor- & contractor-related operational risks and natural risk contain only two measurement items that somewhat detract reliability of constructs. Future research should base on characteristics of survey industries/ research contexts, adding new SC risk factors that aim to increase reliability of these research concepts. Furthermore, to fully examine SC risks, the next empirical studies should also take into account past risk behaviours and the likelihood of occurrence instead of only looking into the level of impact mentioned in this research.

Finally, beside risks, there are numerous factors impacting SC performance that are not considered in this study. While risks have negative effects on SC performance, other factors; e.g. innovation, SC management practices, etc., have positive effects on SC performance. Future research should validate the mechanism of the push effect in terms of applying innovation, SC risk management practices, etc., or integrate SC risks and these factors into a model that examines how they mitigate SC risks, and the impact of these relationships on SC performance. The above discussion implies new directions for researchers.

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APPENDIX 1

Date: **QUESTIONNAIRE** No:

Dear Sir/Madam,

We, a research team from the University of Kyoto – Japan, are conducting a research project entitled "Supply chain risk management in the construction supply chain" We kindly invite you to fill out the following questionnaire. Your response is of the utmost importance to us and to the success of the project."

PART I: COMPANY INFORMATION

1. Type of business:
☐ 100% Locally-owned ☐ 100% Foreign-owned ☐ Joint Venture

2. Operation fields:
☐ Building Material Manufacturing (sand, stone, additive, etc.) ☐ Building Material Distribution
☐ Concrete production ☐ Construction executive
☐ Design (architecture and construction) ☐ Transportation

3. Years of business:
☐ Less than 5 years ☐ From 5 - 10 years ☐ From 10 - 20 years
☐ From 20 - 30 years ☐ From 30 - 40 years ☐ From 40 - 50 years

4. How many full-time employees work for your company?
☐ Less than 10 ☐ 10 - 200
☐ 200 - 300 ☐ More than 300

5. Authorized capital:
☐ Less than 20 billion VND ☐ From 20 to 100 billion VND ☐ Above 100 billions VND

6. What is the main target customer of your firm:
☐ Industrial Construction (B2B) ☐ Civil Construction (B2C)

PART II: RISKS IN THE CONSTRUCTION SECTOR

Could you please describe **the occurrence** *(in the past)* and **estimate the probability** *(likelihood in the future)* of each following risk as well as **to what extend** has your firm in the past five years experienced **a negative impact in supply chain management** due to ... (5-point scale: not at all - to a very large extent)
E.g. the first risk, Supplier bankruptcy, from the left side, if it was used to happen in the past, click "yes" and vice versa. Then to estimate its' likelihood in the future *(from **1 – very low** to **5 – very high**)*. Accordingly, from the right side, to describe its degree of danger.

Occurrence			**Probability**					**RISKS**	**Degree of danger**				
Yes	**No**		**Very low**				**Very high**		**Not at all**				**Very large extent**
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Supplier bankruptcy	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Price fluctuations	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Unstable quality of inputs	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Unstable quantity of inputs	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Design changes	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Technological changes	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Accidents	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Labor disputes	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Demand variability	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	High competition in the market	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Customer bankruptcy	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Customer fragmentation	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Currency fluctuations	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Inflation	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Interest rate level	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Stakeholders (request late changes, new stakeholders, etc.)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Communication breakdown with project team	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Information infrastructure breakdown	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Distorted information	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Delays in supply activities	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Delays in operations activities	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Delays in distribution activities	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Delayed payment	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Information delays	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Economic downturns	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	External legal issues	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Corruption	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Fire accidents	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Natural catastrophes	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
☐	☐		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	Cultural differentiation	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

PART III: SUPPLY CHAIN PERFORMANCE

Evaluate the following supply chain performance indicators compared to your major competitor (5-point scale: significantly worse - significantly better).

		Significantly worse			**Significantly better**	
1	Response time of our suppliers.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
2	The degree of reliability on our suppliers.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
3	Workforce productivity.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
4	Amount of production waste.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
5	Costs of inventory management.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
6	Number of new product developed per year.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
7	Workforce flexibility.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
8	Delivery timeliness.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
9	Response time to customer queries.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
10	Percentage of "perfect orders" delivered.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
11	Product/ service quality.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
12	Product value perceived by the customer.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
13	Market share growth.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
14	Return on Investments (ROI).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

PART IV: GENERAL INFORMATION *(This part is to classify and summarize data)*

1. What is your job title?

☐ Top-level manager ☐ Middle-level manager ☐ First-level manager
☐ Coordinator ☐ Others: …………………

2. What is your working area?

☐ Purchasing ☐ Logistics ☐ Operations/ Projects
☐ Human Resources ☐ Risk Management ☐ Finance
☐ Sales ☐ Marketing ☐ Others: …………………

THANK YOU VER MUCH FOR YOUR COOPERATION!

APPENDIX 2

Statistical Analysis of EFA and CFA

To what extend has your firm in the past five years experienced a negative impact in SC management due to the below indicators (5-point scale: not at all - to a very large extent)

Supply risk: Eigenvalue = 2.612, Variance Extracted= 65.307%, Cronbach's Alpha = 0.822

Measurement items	EFA		CFA		
	Factor loadings	**Item – total correlation**	**Standardized Regression Weights**	**Standard errors**	R^2
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Supplier bankruptcy	0.836	0.686	0.785	0.035	0.616
Price fluctuations	0.824	0.667	0.753	0.039	0.567
Unstable quality of inputs	0.776	0.603	0.678	0.04	0.46
Unstable quantity of inputs	0.796	0.628	0.717	0.042	0.514

Operational risk: Eigenvalue = 2.519, Variance Extracted= 62.964%, Cronbach's Alpha = 0.802

Measurement items	(1)	(2)	(3)	(4)	(5)
Design changes	0.831	0.668	0.785	0.039	0.617
Technological changes	0.805	0.628	0.734	0.045	0.539
Accidents	0.777	0.596	0.676	0.044	0.457
Labour disputes	0.759	0.574	0.649	0.054	0.422

Demand risk: Eigenvalue = 2.363, Variance Extracted= 59.087%, Cronbach's Alpha = 0.769

Measurement items	(1)	(2)	(3)	(4)	(5)
Demand variability	0.742	0.539	0.654	0.048	0.428
High competition in the market	0.709	0.504	Deleted		
Customer bankruptcy	0.803	0.61	0.656	0.051	0.43
Customer fragmentation	0.816	0.627	0.651	0.052	0.423

Finance risk: Eigenvalue = 2.236, Variance Extracted= 74.52%, Cronbach's Alpha = 0.829

Measurement items	(1)	(2)	(3)	(4)	(5)
Inflation	0.838	0.646	0.732	0.044	0.535
Interest rate level	0.856	0.673	0.745	0.042	0.555
Currency fluctuations	0.896	0.744	0.886	0.048	0.785
Stakeholders requests			Deleted		

Information risk: Eigenvalue = 2.274, Variance Extracted= 75.796%, Cronbach's Alpha = 0.837

Measurement items	(1)	(2)	(3)	(4)	(5)
Information infrastructure breakdown	0.86	0.686	0.793	0.046	0.628
Distorted information	0.876	0.711	0.789	0.046	0.623
Communication breakdown with project team	0.875	0.712	0.812	0.035	0.659

Time risk: Eigenvalue = 3.381, Variance Extracted= 67.617 %, Cronbach's Alpha = 0.879

Measurement items	(1)	(2)	(3)	(4)	(5)
Delays in supply activities	0.809	0.7	0.787	0.043	0.619
Delays in operating activities	0.825	0.719	0.776	0.045	0.602
Delays in distribution activities	0.851	0.75	0.788	0.047	0.621
Delayed payment	0.822	0.711	0.766	0.043	0.586
Information delays	0.803	0.688	0.747	0.039	0.558

External risk: Eigenvalue = 1.332, Variance Extracted= 79.411%, Cronbach's Alpha (M1) = 0.798, Cronbach's Alpha (M2) = 0.905

Measurement items		(1)	(2)	(3)	(4)	(5)
Economic downturns	**Human-made risks (M1)**	0.83	0.644	0.759	0.041	0.575
External legal issues		0.831	0.652	0.776	0.044	0.602
Corruption		0.839	0.633	0.73	0.052	0.533
Fire accidents	**Natural risks (M2)**	0.94	0.827	0.954	0.135	0.91
Natural catastrophes		0.946	0.827	0.867	0.118	0.752
Cultural differentiation				Deleted		

Evaluate the following SC performance indicators compared to your major competitor (5-point scale: significantly worse - significantly better).
SC performance: Eigenvalue = 1.105, Variance Extracted= 73.11%, Cronbach's Alpha (Supplier performance) = 0.822, Cronbach's Alpha (Internal business) = 0.815, Cronbach's Alpha (Innovation and learning) = 0.805, Cronbach's Alpha (Customer service) = 0.828

Constructs	**Observed items**	**Factor loadings**					**Standardized Regression Weights**	**Standard errors**	**R^2**
		(1)	**(2)**	**(3)**	**(4)**	**Item – total correlation**			
Supplier performance	Reliability	**0.884**	0.131	-0.028	0.2	0.697	0.788	0.072	0.621
	Response time	**0.882**	0.123	0.126	0.133	0.697	0.89	0.086	0.793
Internal business	Amount of production waste	0.236	**0.728**	0.247	0.212	0.642	0.775	0.037	0.601
	Costs of inventory management	0.122	**0.849**	0.102	0.187	0.715	0.82	0.037	0.673
	Workforce productivity	0.001	**0.842**	0.109	0.146	0.646	0.725	0.045	0.525
Innovation and learning	Number of new product developed per year	-0.033	0.126	**0.889**	0.182	0.699	0.772	0.088	0.595
	Workforce flexibility	0.134	0.201	**0.862**	0.178	0.699	0.906	0.062	0.821
Customer service	Delivery timeliness	0.156	0.195	0.398	**0.604**	0.595	0.678	0.039	0.46
	Percentage of "perfect orders" delivered	0.119	0.361	0.002	**0.674**	0.581	0.646	0.045	0.418
	Product value perceived by the customer	0.016	0.111	0.195	**0.83**	0.69	0.778	0.038	0.605
	Product/ Service quality	0.143	0.174	0.149	**0.828**	0.744	0.83	0.04	0.688
	Response time to customer queries	0.392	0.041	0.089	**0.609**	0.521	0.587	0.058	0.344
Finance	Market share growth Return on Investments (ROI)	Deleted							

APPENDIX 3

	SR	OR	DR	FR	IR	TR	ER
SR	.808						
OR	.632**	.793					
DR	.334**	.309**	.769				
FR	.299**	.350**	.142*	.863			
IR	.522**	.629**	.227**	.359**	.871		
TR	.409**	.457**	.428**	.254**	.472**	.822	
ER	.411**	.474**	.207**	.403**	.414**	.544**	.891

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

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

APPENDIX 4

Goodness-of-fit statistics	Structural model	Recommended values for satisfactory fit of a model to data
χ2/df	1.806	<3.0[a]
RMSEA	.053	<0.08[b]
CAIC	1851.163	< Saturated model and independence model[c]
CAIC for Saturated Model	4924.276	
CAIC for Independent Model	6264.228	
PGFI	.697	>0.5[d]
PNFI	.731	>0.5[d]
CFI	.904	>0.9[b]

APPENDIX 5

RELATIONSHIPS			STANDARDIZED REGRESSION WEIGHTS	SIGNIFICANT LEVEL
SR	--->	OR	0.351	***
SR	--->	SCP	0.373	0.009
OR	--->	SCP	0.71	0.012
DR	--->	OR	0.141	0.021
DR	--->	SCP	0.165	0.062
FR	--->	SR	0.033	0.651
FR	--->	DR	-0.001	0.987
FR	--->	OR	0.003	0.963
FR	--->	SCP	0.009	0.91
IR	--->	SR	0.427	***

IR	--->	OR	0.383	***
IR	--->	SCP	-0.008	0.954
TR	--->	IR	0.222	0.143
TR	--->	DR	0.39	0.01
TR	--->	OR	-0.2	0.125
TR	--->	SCP	0.141	0.457
ER	--->	TR	0.78	***
ER	--->	IR	0.424	0.016
ER	--->	FR	0.48	***
ER	--->	SR	0.315	0.006
ER	--->	DR	0.041	0.818
ER	--->	OR	0.403	0.033
ER	--->	SCP	-0.492	0.107

APPENDIX 6

Constructs		**Observed items**	**Factor loadings**	**Eigenvalue**	**Variance extracted**	**Item – total correlation**	**Cronbach's alpha**
SR		Supplier bankruptcy	0.832	2.499	62.486	0.668	0.799
		Price fluctuations	0.804			0.628	
		Unstable quality of inputs	0.738			0.549	
		Unstable quantity of inputs	0.784			0.602	
OR		Design changes	0.795	2.403	60.071	0.606	0.777
		Technological changes	0.788			0.597	
		Accidents	0.754			0.556	
		Labour disputes	0.763			0.568	
DR		Demand variability	0.705	2.238	55.949	0.485	0.737
		High competition in the market	0.697			0.475	
		Customer bankruptcy	0.794			0.579	
		Customer fragmentation	0.791			0.579	
MR	M1	Economic downturns	0.814	1.486	78.971	0.615	0.79
		External legal issues	0.854			0.663	
		Corruption	0.832			0.619	
	M2	Fire accidents	0.942			0.825	0.904
		Natural catastrophes	0.954			0.825	
		Cultural differentiation	Deleted				
Threshold values			**> 0.4**	**> 1**	**> 50%**	**>0.35**	**> 0.7**