DIRECT AND INDIRECT EFFECTS OF RISKS ON SERVICE-ORIENTED SUPPLY CHAIN: A COVID-19 PANDEMIC PERSPECTIVE

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STRUCTURED ABSTRACT

Purpose - A solid service-oriented foundation is required to make supply chain management a competitive advantage, especially in this Covid-19 pandemic. A well-established service-oriented supply chain becomes more adaptable to changing client expectations. This study aims at analysing the direct and indirect impact of risks on the service-oriented supply chain from a pandemic perspective.

Design/methodology/approach - The Q-sort method is applied with the participation of nine top-level managers to initially review the reliability, validity, and unidimensionality of research concepts. Then a questionnaire containing these measuring variables is developed to obtain the opinions of those who are experienced in logistics and supply chain management. These empirical data are analysed based on Structural Equation Modelling (SEM) to evaluate direct and indirect effects of risks on supply chain performance.

Findings - The risk is inherent in service-oriented supply chains, affecting both direct and indirect performance. The proposed risk model explains 33.6 percent of Supplier performance, 46.4 percent of Operational performance, 47.1 percent of Customer satisfaction, and 46.5 percent of Finance variation. We found that service-oriented supply chains effectively monitor demand risk. External risk has the smallest impact on supply chain performance measures, whereas demand risk has the smallest effect. That a service-oriented supply chain is focused on meeting customer demand and managing demand-related risks is reinforced by these findings.

Research limitations/implications - In the literature on supply chain risk management, resilience studies and disruption management receive less attention than studies on risk assessment and risk mitigation (Katsaliaki et al., 2021). Future supply chain risk management research should differentiate between risk-as an event and/or risk-as a process since they have different periodic effects on response management and resilience.

Originality/value - This is a pioneering study looking at the risk side of service-oriented supply chain. The data using in this research is from a large-scale survey supported by Japanese Government to promote ASEAN sustainable socio-economic development. This dataset collected during the Covid-19 pandemic to validate our models is an interesting and topical point of this study.

Keywords: Risk, Supply chain performance, Supply chain risk management, Service dominant logic**,** Service-oriented supply chain, Covid-19 pandemic.

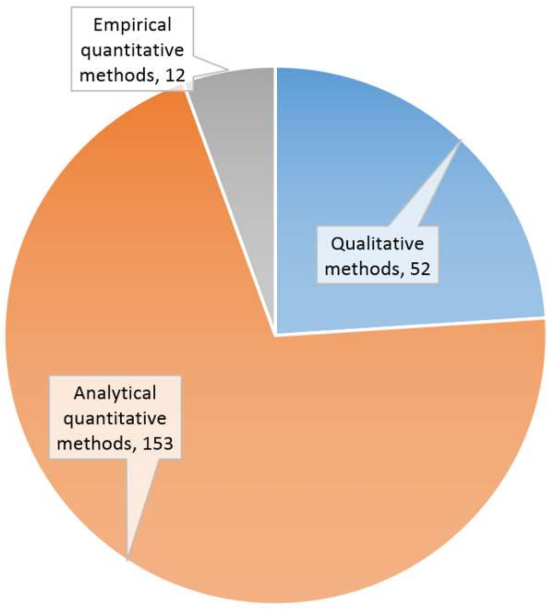
Paper type: Research paper.

1. Introduction

Queiroz et al. (2020) and Ivanov (2021) have pinpointed that the outbreak of Covid-19 pandemic has done a disservice to the economic climates of numerous nations and disrupted global supply chains. Additionally, the detriments of pandemic, according to IMF, prove more calamitous than the 1929 Great Depression.

The lack of clinical remedies and vaccinations exacerbate Covid-19 pandemic 's position. In response, the authorities imposed municipal lockdown and social distancing. The pandemic's direct and indirect effects on supply networks are notable (Roberton et al., 2020). Ivanov (2021) attributes supply chain management issues, labor shortages at internal business and logistics systems to the pandemic's spread and subsequent measures. The implementation of lockdown has impacted the workforce, global exports and imports, causing supply chain disruptions and supply-side shocks (Queiroz et al., 2020). The pandemic's impact on consumer behavior is seen in increased demand for online shopping and home services. Nonetheless, rising client demand has harmed the supply side (Ivanov, 2021). The pandemic's severe dangers impede manufacture (Ivanov, 2021; Queiroz et al., 2020).

Although both direct and indirect effects of risks on supply chains are undeniable (Vickery et al., 2003), little study has shed light on the influences of risks within the supply chain. Most supply chain risk research focuses on single relationships, qualitative research, or case studies, so current understanding is limited (Figure 1). Wagner and Bode (2008) claimed that large-scale empirical research' findings of inter-linkages across risks are scarce and primarily descriptive.



	Empirical quantitative methods	
Individual quantitative methods	Multiple regression model	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 modelling technique; Partial least squares analysis	1

Figure 1 - Research methodologies in the supply chain risk literature (2003 – 2020)

This study will analyse the direct and indirect impact of risks on the service-oriented supply chain from a Covid-19 pandemic perspective. A service-oriented supply chain that centres around the customers is well positioned to deal with the pandemic's demand risks. According to Prasetyanti and Simatupang (2015), service-oriented supply chain is a combination of service science and supply chain theory. Service-dominant logic assumes the customer is important and should be included in the value creation process. By embedding this logic into the supply chain, a service-oriented supply network becomes more adaptable in the face of customer demands. We obtained data from the Vietnamese construction industry, one of the most affected by the pandemic (Gamil & Alhagar, 2020).

The remainder of this article is as follows. Risks in the service-oriented supply chain are modelled prior to evaluation with empirical data from the Vietnamese construction industry. The results are then discussed and topics for future research and conclusions are drawn up.

2. Theoretical background

2.1 Service-oriented supply chain

Inaction will stifle social growth; just as institutional logic has strangled scientific advancement. A new perspective is proposed to change the old in the realm of economic and social interchange between human actors, individually and collectively, and the supply chain. Initially, production was simple, with products moving from suppliers through producers to markets. Increasing demand has led to complex supply systems (Christopher & Peck, 2004a). Supply chain efficiency is threatened by changing consumer trends, particularly in Covid-19 pandemic. Quang and Hara (2019) say that evolving client demands, new technology, firm growth, and structural changes propel service-oriented supply chains forward. Online shopping, home delivery, and other emerging trends during the pandemic demonstrate that people prefer services to buying stuff. As a result, a more robust service-oriented supply chain is a possible solution.

The introduction of service science into supply chain theory is a service-oriented supply chain, where the customer is the centre of processes (Prasetyanti & Simatupang, 2015). Wu and Wu (2015) discovered this integration and suggested that supply chain and service science have many similarities and may complement each other. For example:

- A supply chain is a series of interconnected enterprises that must have a strong-oriented base in order to satisfy customer needs.
- Each member in the supply chain serves as both a customer and a supplier and performs value-added activities on products. A dual-sided role's success necessitates information sharing between parties.

Service-Dominant Logic is a novel marketing concept that evaluates goods and services based on their ability to meet customer demands (Vargo & Lusch, 2004). An argument supporting the suitability of partnership and relationship-based approaches to the aforementioned concerns (Vargo & Lusch, 2004). To generate value, service-dominant thinking must incorporate the client. In this service science model, customers co-create value, transforming the supply chain into a value-creation network, or value constellation, as follows:

> *[…] naturally perceiving and responding spatial and temporal structure of largely loosely coupled value, proposing social and economic actors to interact through institutions and technologies to: coproduce service offerings; exchange service offering; co-create value (Lusch, 2011).*

The value can only be created through value co-creation which is a beneficial interaction between customers and supply chain stakeholders. Meanwhile, the contact is the result of a chain of linked value activities that present a value for meeting consumer expectations. Therefore, the supply chain should be regarded as a service ecosystem (Flint et al., 2014).

Facility design, inventory management, shipping and distribution rules, sourcing activities, and price decisions, are not ignored in a service-oriented supply chain (Prasetyanti & Simatupang, 2015). Therefore, risks in a service-oriented supply chain are all-encompassing and intertwined.

2.2 Supply chain risks

Risk treatment attitude varies depending on the firm/supply chain strategy (Quang & Hara, 2019; Wagner & Bode, 2008). Traditional strategic management research in supply chain risk management divides strategy into two dimensions: process and content. Several academics have studied method and/or content to identify supply chain vulnerabilities (Thun & Hoenig, 2011; Wagner & Bode, 2008). Despite the huge number of hazards described, Truong Quang and Hara (2018) hypothesized that internal and external supply chain aspects should be included in this framework.

This argument is supported by the contingency theory, whose central premise is that:

> *[...] high supply chain efficiency and business performance when supply chains consider the context in which strategy is formulated and executed (Wagner & Bode, 2008).*

As such, supply chains should match their structure with the context and environment, i.e., external pressures. "Opportunities are lost, costs rise, and supply chain maintenance is threatened" unless this "match" is reached (Child, 1972).

Duncan (1972) defines the environment as "the totality of physical and social elements that have an effect on supply chain performance." This concept encompasses both internal and external supply chain risk elements. Expanding the scope of risks, Wagner and Bode (2008) claimed that:

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

In line with this approach, Jüttner (2005) investigated risk not only at a company's processes, but also at supply chain flows from initial suppliers to end-user delivery. In empirical research of 67 German automotive companies, Thun and Hoenig (2011) found a considerable difference in the influence of internal and external supply chain risks on performance.

Because the authors classified hazards according to different levels of impact, Ho et al. (2015) provided a novel and more complete idea to this point of view. Supply chain risk was defined as "the likelihood and impact of unexpected macro and/or micro-level events or conditions that are detrimental to any part of a supply chain that results in failures or irregularities at the operational, tactical, or strategic level". From this approach, there are two forms of risk in a service-oriented supply chain (Figure 2):

- External risk is relatively rare and adverse external events or phenomena that may have strong impacts on supply chain performance (Thun & Hoenig, 2011).
- Internal risks are incidents that occur regularly and are caused by internal company operations or connections with supply chain network partners. They are more likely to occur than external supply chain hazards, although they have a lesser impact on performance (Thun & Hoenig, 2011).

Figure 2 - Risks on Service-Oriented Supply Chain

These various supply chain risk events are interrelated in intricate patterns, with one risk leading to another or influencing the outcome of other risks (Wagner & Bode, 2008). Although supply chains include such interconnections, the unpredictability and significance of these interconnections escalates in the pandemic.

External risk

Natural catastrophes, such as earthquakes and tsunamis; war and terrorism; diseases (Covid-19 pandemic), etc., can cause irreversible damage to a service-oriented supply chain (Ivanov, 2021; Quang & Hara, 2019; Queiroz et al., 2020; Shareef et al., 2020). To exemplify,

- On March 11, 2011, the Tōhoku earthquake and huge tsunami waves at Miyako, Tōhoku' Iwate Prefecture, Japan, are natural disaster repercussions. Although it was only 6 minutes, it caused a $360-billion-dollar economic loss (Fire and Disaster Management Agency, 2020).
- Hurricane Harvey, the costliest tropical storm on record with anticipated devastation of over 125 billion dollars, shuttering not only 11 percent of US oil refining capacity and 25% of oil output in the Gulf of Mexico, but also 90 percent of the country's capacity to create and ship base plastics.
- According to Hansen et al. (2013), an economic recession generates fluctuations in market demand, poor financial implications, a highly dynamic, complex operating business environment (Quang & Hara, 2018), and can even disrupt supplier-buyer ties (Krause & Ellram, 2014). In addition, having a multitude of procedures generates delays, difficulties in transactions among supply chain members, and capital access (Dreher & Gassebner, 2013).
- Different local cultures, languages, and politics are another hurdle for service-oriented businesses (Quang & Hara, 2019). Inconsistencies can lead to miscommunications, which can stifle a service-oriented supply chain. For example, Airbus lost 4.8 billion Euros owing to a two-year delay in introducing the A38. The political pressure to "fulfil" the expectations of four diverse European nations could cause the delay, aside from technical concerns. Cultural variations can also impact corporate procedures like demand forecasting and material planning (Quang & Hara, 2019).
- The recent Covid-19 pandemic has aroused researchers' and clinicians' interest. This pandemic has caused an economic shock, with over 170 countries experiencing negative GDP growth per capita (IMF, 2020). Due to the lack of a vaccine, efficient treatments, and non-pharmaceutical measures, supply chain management and logistics systems face major supply and demand challenges (Ivanov, 2021; Queiroz et al., 2020). Economic growth and financial stability have been hampered by social distancing, according to Barichello (2020).

External risks apparently affect internal supply chain risks and service-oriented supply chain performance. Therefore, here are our proposal of several hypotheses:

H1: External risk adversely affects Supply risk (H1a), Operational risk (H1b), Demand risks (H1c), and Finance (H1d).

Supply risk

Supply risk is concerned with adverse "upstream" events in the service-oriented supply chain network that affect the ability of the focal firm to meet customer demands (both quantity and quality) within anticipated costs and time or cause threats to customer life and safety (Truong Quang & Hara, 2018). The firm is faced with supplier bankruptcy, price fluctuations, unstable quality and quantity of inputs, etc. (Quang & Hara, 2019; Shareef et al., 2020) which engender failures in delivering inbound goods or services to the purchasing firm and throughout the downstream service-oriented supply chain (Shareef et al., 2020).

For instance, tire quality in 2000 was found at Wilderness AT Firestone, killing and injuring numerous people in the US. Even worse, this unfavourable issue ended the nearly 100-year company relationship between Ford Motor Company and Firestone.

Similarly, in the case of Robert Bosch, the change in the quality of the high-pressure pump for the diesel fuel injection system in early 2005 resulted in significant production losses in most German automobile suppliers, affecting the entire supply chains. Moreover, lockdown because of pandemic gives rise to a shortage of disruptions, eventually resulting in supply-side shocks to the service-oriented supply chain (Barichello, 2020). Therefore, we propose the following hypotheses:

H2: Supply risk adversely affects Operational risk (H2a), Supplier performance (H2b), and Operational performance (H2c).

Operational risk

Operational risks are disruptions caused by appalling events within an organisation that influence a service-oriented supply chain's internal ability to produce goods and services, quality and timeliness of production, and/or profitability (Felfel et al., 2018; Truong & Hara, 2018). This reflects the challenge of determining optimal order and production quantities, safety stock levels, and other inventory policies that significantly affect service-oriented supply chain performance regarding costs and profitability (Felfel et al., 2018).

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%. 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.

Strikes at two General Motors parts factories in 1998, resulted in the closure of 100 other parts factories, followed by 26 assembly plants, leaving dealer lots vacant for months.

Kate (2013) asserted that the majority of labour accidents resulting from employees taking more than three days off work – or affecting their ability to perform their usual duties – were caused by handling accidents. Although several accidents at work can have minor effects, their serious repercussions are insuperable. Hence, we propose the following hypotheses:

H3: Operational risk adversely affects Supplier performance (H3a) and Operational performance (H3b).

Demand risk

A service-oriented supply chain is driven by customer demand (Prasetyanti & Simatupang, 2015). According to Hançerlioullar et al. (2016), demand risk emerges from uncertainty around consumers' unpredictable needs (2016). Thus, the likelihood of customers placing orders with the focal firm, along with variations in volume and assortment, significantly impact the service-oriented supply chain network (Quang & Hara, 2019; Shareef et al., 2020). Taking these risks further prevents firms from anticipating market expectations (Yan et al., 2020), resulting in high costs, obsolescence, inefficient capacity utilization, disorganized operations, and poor customer service (Wagner & Bode, 2008; Yan et al., 2020).

Demand uncertainty causes order backlogs, planning problems, and the bullwhip effect, according to George et al. (2004). Changes in customer demand quickly raise product costs and harm stochastic inventory systems (Yan et al., 2020). Poor demand forecasts and inflexible procurement arrangements with downstream supply chain partners cost Cisco Systems Inc. $2.5 billion in inventory in 2001. Thus, we offer the following hypotheses:

H4: Demand risk adversely affects Operational risk (H4a), Operational performance (H4b) and Customer satisfaction (H4c).

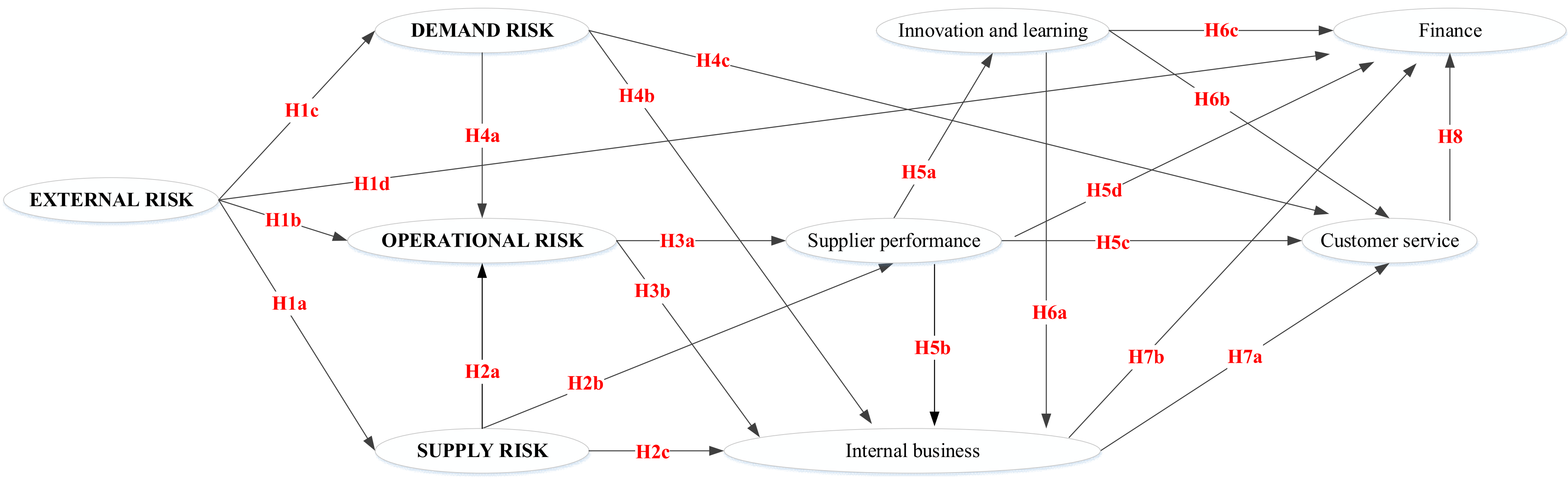


Figure 3 - Hypothesized model

On the right side of the model, Figure 3 graphically displays the postulated model of the relationship between risks and service-oriented supply chain performance. Principally, cost has been utilized to measure supply chain performance as a key performance indicator (KPI). The objective of supply chain management is to minimise costs and waste, allowing for a more efficient supply chain. Nonetheless, this metric is typically historical and does not indicate the current or future business performance (Quang et al., 2016).

Return on Investment (ROI) has been suggested as a "solution" to measure supply chain performance (Fernandes et al., 2017; Truong et al., 2017). The ROI, according to Quang et al. (2016), does not provide an objective assessment of the smaller businesses. This variable is beneficial for comparing similar companies in their industry, but it does not allow for cross-sector comparison.

Similarly, for evaluating firms in different industries, growth indicators such as revenue growth, profit growth, productivity growth, etc. become inconsequential. When compared to effective apparel businesses, an ineffective company underperforming in the software industry (a strong growth sector) will have greater revenue/profit growth, etc.

Apparently, financial measures are of paramount significance. However, in a comprehensive scale of service-oriented supply chain performance, more sophisticated, intangible, and strategic-oriented indicators must be balanced (Truong et al., 2017).

A modern methodology explains how short- and long-term indicators affect the success of service-oriented supply chains (Kaplan & Norton, 1992). As a result of this method, two conceptions arise:

- "Lagging" indicators, such as financial measures, describe what has transpired in the past.
- "Leading" measurements provide a forewarning of potential future events. Customer-oriented metrics, such as customer satisfaction, delivery timeliness, etc., or *innovation and learning-oriented metrics*, such as the number of new products developed anually, workforce flexibility, etc., are two examples.

Furthermore, Chopra and Sodhi (2012) and Quang et al. (2016) stated that supply chain management entails tracking and attempting to improve *operational and strategic performance measures*, as follows:

- *Operational performance:*
  - Supplier performance: reliability, response time.
  - Innovation and learning: number of a new product developed per year, workforce flexibility.
  - Operational performance: the amount of production waste, costs of inventory management, workforce productivity.
  - Customer satisfaction: delivery timeliness, percentage of "perfect orders" delivered, product value perceived by the customer, product/ service quality, response time to customer queries.

- *Strategic performance:* market share growth, return on investments (ROI).

The balanced scorecard approach, developed by Kaplan and Norton (1992), acknowledges the limits of traditional financial performance measurement and incorporates the strategy of a service-oriented supply chain into its performance goals. This approach also incorporates intangible assets including innovation, labour skills, supplier capabilities, and customer satisfaction (Truong & Hara, 2018). For long-term growth, this new approach shifts focus from physical assets to the physical and intangible resources of a service-oriented supply chain (Truong & Hara, 2018). This study identifies a set of service-oriented supply chain performance measurements, including (1) supplier performance, (2) innovation and learning, (3) operational performance, (4) customer satisfaction, and (5) finance, based on the balanced scorecard model.

Supplier Performance

High supplier performance must ensure that input materials meet quality requirements and needs (Quang et al., 2016). Suppliers are the driving force for new technology (Duong et al., 2019; Fernandes et al., 2017; Schiele, 2006) and innovation (Kaynak and Hartley, 2008). Understanding how suppliers can help a company innovate is critical (Schiele, 2006). Suppliers must be involved in the early stages of product conception and development. Suppliers' ability to provide creative, sustainable supply chain solutions adds value to sustainability and commercial performance (Schiele, 2006). The influence of buyer-supplier collaboration and supplier engagement in product development has been extensively studied (Kaynak & Hartley, 2008; Yeung, 2008). (Duong et al., 2019).

Furthermore, supplier performance is a crucial element in the long-term viability of the service-oriented supply chain. Service-oriented supply chains benefit from high-quality input provided on time and in the desired quantity, which enables them to prevent downtime, process deviation, and the level of damaged materials. High supplier performance can help reduce inventory, waste, and safety stock costs (Yeung, 2008). Hence, the following hypotheses are proposed:

H5: Supplier performance positively impacts Innovation and learning (H5a), Operational performance (H5b), Customer satisfaction (H5c), and Finance (H5d).

Innovation & Learning

Due to severe global competition, service-oriented supply chains must constantly enhance their products and processes. A service-oriented supply chain's value is proportional to the ability of innovation and learning which relates to the capacity to offer new goods, increase customer value, and improve operational efficiency (Quang et al., 2016). Service-oriented supply chain members can expand into new markets to maximize revenue and profit margins. According to Kaplan (2009), product and process innovation measures should be used to enhance delivery times, cycle times, defect rates, and productivity.

Inter-organizational learning enables enterprises discover new perspectives on strategy, markets, and relationships (Schiele, 2006). Their positive impact on supply chain performance indicators includes reduced cycle times (Boyer et al., 2003), increased resilience (Comfort, 1994), and increased relationship commitment (Boyer et al., 2003). This results in a broader pool of options to choose from and better implementation of those selected. The following hypotheses are offered:

H6: Innovation and learning positively impacts Operational performance (H6a), Customer satisfaction (H6b), and Finance (H6c).

Operational performance

The capability of service-oriented supply chain to minimise management costs/cycle times/lead times, improve quality/workforce/skills/productivity, and improve the efficiency of raw material utilisation and distribution capacity is operational performance compatible with business processes (Duong et al., 2019; Heizer et al., 2008; Truong & Hara, 2018). Kaynak and Hartley (2008) demonstrated that organisations with high operational performance generally produce excellent products/services, respond quickly to client requests, and deliver quickly to increase customer satisfaction and revenue..

By eliminating inessential costs, the prices offered to customers can be lowered (Truong & Hara, 2018). This increases customers' satisfaction (Duong et al., 2019), giving rise to a surge in market share and sales revenue (Truong et al., 2017). Additionally, increasing the efficiency of warehouse utilisation, machineries, and equipment, etc., improves return on assets (Kaynak & Hartley, 2008).

According to Kaplan (2009), outstanding customer performance is the result of procedures, activities, and decisions that occur throughout the firm. To meet customer expectations, a corporation should integrate customer orientation into operational performance measures. Hence, we propose the following hypotheses:

H7: Operational performance positively impacts Customer satisfaction (H7a) and Finance (H7b).

Customer satisfaction

Customers are an essential aspect of a service-oriented supply chain, and value-added activities focus on meeting their needs (Vargo & Lusch, 2008). Customers are primarily concerned about quality, delivery, price, and service. The service-oriented supply chain aims to "create value for consumers." Customers who are content with their products/services will not seek for alternatives (Fernandes et al., 2017). They are also less price-conscious and willing to pay a higher price, resulting in more sales revenue and profits. A satisfied customer will also recommend to other potential customers, thereby increasing market share. Hence, we propose the following hypotheses:

H8: Customer satisfaction positively impacts Finance.

3. Methodology

3.1 Instrument development

Only when an instrument can cover the content domain of each construct is it deemed effective (Li et al., 2005). Furthermore, the observed items measuring a construct should converge with each other and be distinguishable from those used to assess other constructs. Each construct should be reliable, succinct, and applicable. Hence, there are three following main stages to develop an effective instrument:

- Definitions of constructs and the corresponding observed items are on top of the agenda in the first stage.
- After an extensive literature review and revising based on a structural interview of academicians, the measuring scales are identified.

The Q-sort method is applied with the participation of nine top-level managers to initially review the reliability, validity, and one-dimensionality of research concepts. Table 1 describes the selected supply chain risk factors and service-oriented supply chain performance measurement.

Table 1 - Supply chain risk factors and Supply chain performance measures

RISKS	External risk	Supply risk	Operational risk	Demand risk
	Natural disaster	Selection of the wrong partner	Inventory holding cost	High competition in the market
	Political instability	Supplier bankruptcy	Design changes	Inaccurate demand forecasts
	External legal issues	Lack of integration with suppliers	Technological change	Demand uncertainty
	War and terrorism	Supplier opportunism	Warehouse and production disruption	Market changes
	Economic downturns	Suppliers' dependency	Labor disputes/ strikes	Customer dependency
	Government regulations	Supply responsiveness	Employee accidents	Customer fragmentation
	Fire accidents	Vague inspection/acceptance procedure of the supplier	Working conditions	High level of service required by customers
	Corruption	Price fluctuations	The products quality and safety	Deficient or missing customer relation management function
	Social and cultural grievances	Inability to handle volume demand changes	Insufficient maintenance	Low in-house production
	Decease Pandemic (Covid-19)	Inability to meet quality requirements	Variability in process	Order fulfilment errors
		Transport providers' fragmentation		Customer bankruptcy
		Transportation breakdowns		Receivables risk
		Port capacity and congestion		Reputation risk
	(Barichello, 2020; Dreher & Gassebner, 2013; Felfel et al., 2018; Hailu, 2020; Hançerlioğulları et al., 2016; Ivanov, 2021; Kate, 2013; Krause & Ellram, 2014; Meixell & Gargeya, 2005; Prasetyanti & Simatupang, 2015; Quang & Hara, 2019; Queiroz et al., 2020; Shareef et al., 2020; Truong & Hara, 2018; Truong Quang & Hara, 2018; Wagner & Bode, 2008; Yan et al., 2020)			

SUPPLY CHAIN PERFORMANCE INDICATORS	Supplier performance	Innovation and learning	Operational performance	Customer satisfaction	Finance
	Material cost	Number of a new product developed per year	Amount of production waste	Delivery timeliness	Market share growth
	Supply disruptions	Workforce flexibility	Costs of inventory management	Percentage of "perfect orders" delivered	Return on Investments (ROI)
	Reliability	Reducing new product launch times	Workforce productivity	Product value perceived by the customer	Return on Equity (ROE)
	Response time	Product development cost	Cycle time	Product/ Service quality	Return on Sales (ROS)
			Engineering efficiency	Product availability	Operating income

		Make improvements within a specific time period	Defect rates	Response time to customer queries	Sales
			Reducing setup times	Premium freight usage on both the inbound and outbound side	Cash-to-cash cycle time
		Specific improvement goals for the existing processes	Shipping and handling cost		Cash flow
			Efficiency use of facilities/ equipment		Revenue
			Production cost		Profitability
			Lead time		Shareholder value
			Order time		Sales growth
			Labor cost		
			Yield		
			Unit cost		
			Teamwork		
	(Boyer et al., 2003; Chopra & Sodhi, 2012; Comfort, 1994; Duong et al., 2019; Fernandes et al., 2017; Heizer et al., 2008; Kaplan, 2009; Kaplan & Norton, 1992; Kaynak & Hartley, 2008; Quang et al., 2016; Schiele, 2006; Truong & Hara, 2018; Truong et al., 2017; Vargo & Lusch, 2008; Yeung, 2008)				

A questionnaire containing these measuring variables is developed to obtain the opinions of those who are experienced in logistics and supply chain management. Respondents are asked to evaluate the impact degree of risks on their actual supply chain performance over the past five years. A five-point Likert-type scale is conducted with a value of 1 – expressing "strongly disagree", and a value of 5 – expressing "strongly agree".

3.2 Large-scale data collection

The empirical data analysed in this research are results of large-scale surveys supported by a Japanese government project and carried out in Vietnam's construction industry with approximately 6,600 companies. This project objective is a promotion of sustainable socio-economic development in the ASEAN region. Consequently, 285 usable responses are received, as shown in Table 2.

Table 2 - Sample characteristics

Company profiles	**Percentage**
Operation fields	
Building Material Manufacturing (sand, stone, additive, etc.)	14.74
Building Material Distribution	18.6
Concrete production	17.89
Construction executive	34.74
Design (architecture and construction)	12.98
Transportation	1.05

Respondent profiles	**Percentage**
Job title	
Top-level manager	5.26
Middle-level manager	21.75
First-level manager	46.32
Coordinator	16.49
Others	1.18
Working area	
Purchasing	4.21
Logistics	4.21
Operations/ Projects	55.44
Human Resources	9.12
Risk Management	3.86
Finance	2.46
Sales	14.74
Marketing	3.16
Others	2.81

3.3 Data analysis process

Non-response bias was applied to evaluate differences between respondents who replied to mail at the first time and those in the follow-up emails. The results of the independent T-test showed no significant conflict on average scores of all measured items, indicating non-response bias.

Empirical data are analysed based on Structural Equation Modelling (SEM). SEM considers two principal components for the procedure: (1) the cause-and-effect processes are formed by a sequence of structural equations, and (2) these causal relationships between concepts are demonstrated through a diagram to clarify the theory. Hair et al. (1995) asserted that to ensure the SEM technique is conducted effectively, the constructs and the corresponding observed items need to be analysed and refined for their reliability and validity. Traditional psychometric methods were applied with Cronbach alpha and Factor Analysis.

Tables 3 & 4 present the test results of measurement scales. Consequently, some variables were deleted from structural models due to not achieving a threshold value and all observed items load on the corresponding constructs with the minimum value of factor loading is .437, which entails that the measurement scales meet the standard criteria for convergent validity. Additionally, all item-to-total correlations are above .487, and the minimum value of Cronbach's alpha coefficients is .742, which means the reliability of the constructs is achieved.

Table 3 - Test results of "risk"

Observed items	**Factor loadings**	

	Supply risk (1)	External risk (2)	Demand risk (3)	Operational risk (4)	Item – total correlation
External legal issues		.746			.536
Economic downturns		.758			.550
Fire accidents		.714			.487
Natural disaster		.713			.589
Decease Pandemic		.696			.564
Supplier bankruptcy	.802				.686
Price fluctuations	.775				.670
Inability to meet quality requirements	.519				.606
Transportation breakdowns	.697				.629
Design/Technological change				.750	.652
Warehouse and production disruption				.737	.620
Labour disputes/ strikes				.437	.586
Employee accidents				.522	.552
Inaccurate demand forecasts			.638		.538
Demand uncertainty			.564		.500
High level of service required by customers			.720		.612
Customer bankruptcy			.771		.628
Cronbach's Alpha	**.823**	**.769**	**.768**	**.792**	
Eigenvalue	**1.024**				
Variance Extracted	**68.328**				

Moreover, there are 4 factors of risk extracted at Eigenvalue =1.024 and Variance Extracted = 68.328 (Table 3) and 5 factors of supply chain performance were extracted Eigenvalue = 1.045 and Variance Extracted = 75.400 (Table 4). These results consolidated our conceptual model and proving the discriminant validity of constructs.

Table 4 - Test results of "supply chain performance"

Observed items	**Factor loadings**					**Item – total correlation**
	Customer satisfaction (1)	**Operational performance (2)**	**Supplier Performance (3)**	**Innovation & Learning (4)**	**Finance (5)**	
Reliability			.944			.700
Response time			.763			.700
Number of new product developed per year				.671		.620
Product development cost				.860		.620
Workforce productivity		.776				.699
Defect rates		.913				.699
Product availability	.541					.590
Delivery timeliness	.525					.580
Product value perceived by the customer	.918					.690
Response time to customer queries	.831					.740
Percentage of "perfect orders" delivered	.493					.520
Market share growth					.788	.530
Return on Investments (ROI)					.652	.530
Cronbach's Alpha	**.827**	**.804**	**.820**	**.768**	**.688**	
Eigenvalue	**1.045**					
Variance Extracted	**75.400**					

Moreover, there are 4 factors of risk extracted at Eigenvalue =1.024 and Variance Extracted = 68.328 (Table 3) and 5 factors of supply chain performance were extracted at Eigenvalue = 1.045 and Variance Extracted = 75.400 (Table 4). These results consolidated our conceptual model and proved the discriminant validity of constructs.

Results

Table 5 shows direct and indirect effects of risks on supply chain performance. Some notable results:

- The proposed risk model can be explained by 33.6% variance of Supplier performance, 46.4% Operational performance, 47.1% Customer satisfaction, and 46.5% of Finance.
- External risk including Covid-19 pandemic, causes supply unfulfillment, operational disruption, and demand fluctuation. There is no direct relationship found between External risk and Finance, but indirectly through other risks.

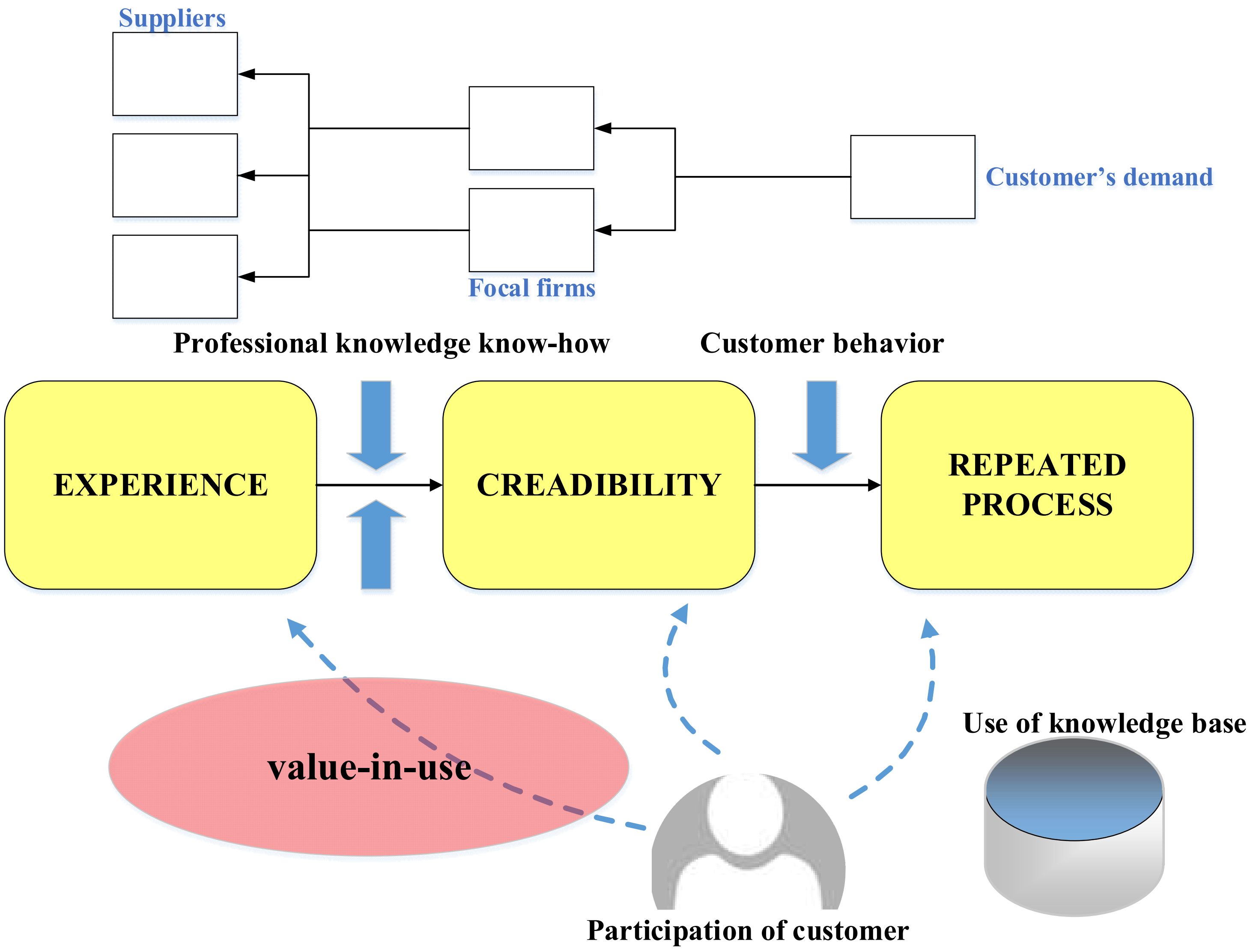
- Supply risk engenders fluctuations in raw materials. Consequently, firms have to stock, resulting in high inventory costs, which indirectly affects internal business efficiency. Moreover, we found indirect effects of supply risk on supplier performance through operational risk.
- Changes in design and technology of operational processes make suppliers fail to react in time, affecting supplier reliability and responsiveness.
- Risks have no impact on Innovation and learning.

Table 5 - Direct and indirect effects of risks on supply chain performance indicators.

Hypothesis	Statements			Results	Direct effect	Indirect effect
H1a	External risk	-->	Supply risk	.253	.253	0
H1b	External risk	-->	Operational risk	.124	.124	.185
H1c	External risk	-->	Demand risk	.121	.121	0
H1d	External risk	-->	Finance	Unsupported		.110
H2a	Supply risk	-->	Operational risk	.668	.668	0
H2b	Supply risk	-->	Supplier performance	Unsupported		.433
H2c	Supply risk	-->	Operational performance	.357	.357	.105
H3a	Operational risk	-->	Supplier performance	.647	.647	
H3b	Operational risk	-->	Operational performance	Unsupported		.028
H4a	Demand risk	-->	Operational risk	Unsupported		
H4b	Demand risk	-->	Operational performance	.245	.245	.020
H4c	Demand risk	-->	Customer satisfaction	Unsupported		.093
H5a	Supplier performance	-->	Innovation and learning	Unsupported		
H5b	Supplier performance	-->	Operational performance	Unsupported	.030	.013
H5c	Supplier performance	-->	Customer satisfaction	.225	.225	.027
H5d	Supplier performance	-->	Finance	.158	.158	.120
H6a	Innovation and learning	-->	Operational performance	.229	.229	
H6b	Innovation and learning	-->	Customer satisfaction	.248	.248	.063
H6c	Innovation and learning	-->	Finance	Unsupported	.008	.188
H7a	Operational performance	-->	Customer satisfaction	.277	.277	
H7b	Operational performance	-->	Finance	.225	.225	.121
H8	Customer satisfaction	-->	Finance	.437	.437	

Model fit: IFI = .918, TLI = .904, CFI = .916, RMSEA = .053, Chi-square/df = 1.797.
R^2 (Supplier performance) = .336, R^2 (Innovation and learning) = .023, R^2 (Internal business) = .464, R^2 (Customer service) = .471, R^2 (Finance) = .465

- Specially, only operational performance is affected by demand risk. Moreover, external risk has a tiny influence on demand risk. These findings emphasized the benefits of service-oriented supply chains, whose management begins with meeting customer needs (Sengupta et al., 2006; Vargo & Lusch, 2008). Thus, operations of the chain will minimize demand risk and its repercussions. Furthermore, production and consumption are concurrent in this type of business. Hence, values will be generated through consumption processes, known as value-in-use (Figure 4). Customers of service-oriented businesses expect high consistency and rarely switch services/companies once they accept one.



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 4 - Service-oriented supply chain

5. Conclusions and future research

A powerful service-oriented platform is undoubtedly essential to turn supply chain management into a competitive advantage. Furthermore, a service-dominant logic approach should be included into supply chain management. As well as a series of interconnected value-creating actions performed by multiple stakeholders, the supply chain should be understood as a movement of products and a value constellation.

The risks within service-oriented supply chains have direct and indirect effects on the operation of such chains. From the study, service-oriented businesses provided a good observation for demand risk. Demand risk has the smallest impact on supply chain performance metrics, while external risk has a little impact on demand risk. These findings support the characteristics of a service-oriented supply chain, in which efforts and attention are directed towards meeting customer demand, resulting in demand-related risks being addressed and mitigated.

Furthermore, the proposed risk model constitutes 33.6% variance of Supplier performance, 46.4% Operational performance, 47.1% Customer satisfaction, and 46.5% of Finance. These are crucial ratios since supply chain performance is influenced by supply chain strategy, methods, etc. In other words, a company's supply chain performance will improve if these risks are effectively managed.

Our findings that supply chain risks, such as supply risks, operational risks, and demand risks, considerably influence supply chain performance, are comparable to those of Wagner and Bode (2008), Hendricks and Singhal (2003), and Hendricks and Singhal (2005). However, compared to our results, Wagner and Bode (2008) showed that supply risk and demand risk only explain .09 and .08 of the variances in supply chain performance, respectively. The two research approaches were distinct, yet the outcomes did not contradict each other. Unlike Wagner and Bode's (2008) approach, we examined both direct and indirect consequences. Practitioners are paying close attention to this Covid-19 pandemic-related empirical investigation. Thus, substantial supply chain risks immediately impacted respondents. Furthermore, the data used in this study came from Vietnamese enterprises. Therefore, the outcomes are only relevant to organisations with similar economic, political, cultural, and geographic conditions. Hence, future research should focus on repeating this study in diverse contexts with possibly varying risk profiles.

An innovative approach is to use strategic content/processes/contexts to explain service-oriented supply chain performance. The focus of previous qualitative and conceptual research has been on strategic content (Khan et al., 2008; Lin & Zhou, 2011). Some argued about operational risk and interruption risk (Svensson, 2007), while others offered generic guidance (Christopher & Peck, 2004). However, neither theories nor empirical research have comprehensively examined the implications of these tactics between risk and supply chain performance.

In the literature on supply chain risk management, resilience studies and disruption management receive less attention than studies on risk assessment and risk mitigation (Katsaliaki et al., 2021). Future supply chain risk management research should differentiate between risk-as an event and/or risk-as a process since they have different periodic effects on response management and resilience.

In an attempt to adequately address supply chain risks, (Carranza, 2008) proposed the following two approaches:

- Knowledge-based / knowledge-driven: refer to the judgement of the experts / decision-makers.
- Data-driven: aim at using empirical data.

The use of literature studies, Q-sort, and empirical data in the Vietnam construction industry to identify and assess supply chain risks is an innovative approach. As stated previously, future research can validate the conclusions in a different context/industry. A global poll will also reveal fascinating cultural differences in supply chain risk management.

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