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The effect of risk on supply chain performance and operator performance: The case study of rice supply chains

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Supply chain risks hinder the cooperation among members, negatively affecting the supply chain and enterprises' performance. This study applies structural equation modeling (SEM) to demonstrate the relationship between risk, supply chain performance, and business performance in the Mekong Delta, Vietnam. Research data were collected from 142 rice enterprises. The result demonstrates that risks occurring in the supply chain negatively influenced the performance of the rice supply chain and the performance of rice enterprises. Besides, the study shows that rice supply chain performance positively impacts on rice business performance in the Mekong Delta, Vietnam.

1. Introduction

Business operations have more risks as product life cycles become shorter and supply chains expand globally (Christopher et al., 2011). Risks make supply chains complex and sensitive as well as hinder supply chain collaboration (Zsidisin, 2003; Zhao et al., 2013). As a result, risks negatively affect supply chain performances (Wilson, 2007; Wagner & Bode, 2008; Okoumba, 2018; Afshar & Fazli, 2018). As a result, supply chain performance is threatened and may lead to inefficiencies in enterprise efficiencies (Vickery et al., 2003; Chen et al., 2004; Sanchez & Pérez, 2005; Rai et al., 2006; Zhang et al., 2006; Qrunfleh & Tarafda, 2014). At the same time, risk significantly affects business results (Hendricks et al., 2007; Van Duijn et al., 2012) and the business performance of enterprises (Hendricks & Singhal, 2005; Wagner & Bode, 2008; Florian & Constangioara, 2014). Therefore, the severity of risks also influences supply chain performance and its members' performance as well. The Mekong Delta is known as the largest rice bowl in Vietnam. Therefore, the rice industry of the region has a strategic position in the development of Vietnam's agricultural sector, especially in ensuring national food security. Recently, problems of linkage risks in rice supply chains have become more common (Thanh & Nghi, 2019; Nguyen & Mai, 2021). Therefore, this study is conducted to demonstrate the relationship between risk, supply chain performance, and operator performance in rice supply chains in the Mekong Delta region of Vietnam.

2. Theoretical Framework and Research Hypotheses

2.1 Theoretical framework

Supply Chain Risk

Supply chain risks are defined as damages occurring in business operations and the process of supply chains, causing disturbances and disruptions in the distribution system of goods, services, information, and finance. This may negatively affect the performance of a particular member in the entire supply chain (Kersten et al., 2007; Wagner & Bode, 2008; Colin

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et al., 2011). Many studies mention several standard supply chain risks: supply risk, demand risk, regulatory risk, infrastructure risk, and disaster risk (Wilson, 2007; Wagner & Bode, 2008; Florian & Constangioara, 2014; Ho et al., 2015).

Supply Chain Performance

Supply chain performance is the ability to produce and deliver products/services to meet customer needs, bringing outstanding efficiency to its members (Vickery et al., 2003; Chen et al., 2004). According to Qrunfleh & Tarafdar (2014), supply chain performance is measured by three standard criteria: flexibility (Vickery et al., 1999) and, coordination among members (Stock et al., 2000), and the level of customer satisfaction (Chen et al., 2004).

Operator Performance

Operator performance is how a company fulfills its financial and market objectives compared to its competitors (Li et al., 2006; Qrunfleh & Tarafdar, 2014). To measure corporate performance, many studies have used the criteria such as sales growth, profit growth, market share growth, productivity growth, and competitiveness improvement (Stock et al., 2000; Narasimhan & Kim, 2002; Chen & Paulraj, 2004; Chang & King, 2005; Petersen et al., 2005; Li et al., 2006; Flynn et al., 2010; Cao & Zhang, 2011).

2.2 Research hypotheses

Relationship between supply chain risk and supply chain performance

High risks have negative impacts and lead to inefficiencies in the supply chain (Christopher & Lee, 2004). Transportation disruptions (infrastructure risks and supply risks) also harm the supply chain performance (Wilson, 2007). Afshar & Fazli (2018) presented that supply chain risks negatively impact supply chain performance. However, an excellent risk-management strategy improves supply chain performance (Okoumba, 2018). Thus, the research hypothesis is proposed:

H1: *Supply chain risks negatively affect rice supply chain performance in the Mekong Delta, Vietnam.*

Relationship between supply chain risk and operator performance

The higher the demand and supply risks, the lower the enterprise performance (Wagner & Bode, 2008). Supply chain risk directly impacts on business performance (Florian & Constangioara, 2014; Hendricks & Singhal, 2005). Therefore, the research hypothesis is suggested.

H2: *Supply chain risks negatively affect the performance of rice enterprises in the Mekong Delta, Vietnam.*

Relationship between supply chain performance and operator performance

If supply chain performance meets customer needs, this improves the performance of enterprises (Vickery et al., 2003; Chen et al., 2004; Sanchez & Pérez, 2005). Furthermore, in a study in 2014, Qrunfleh & Tarafda confirmed that supply chain performance has a positive impact on the performance of enterprises participating in that supply chain. As a result, the research hypothesis is proposed.

H3: *Supply chain performance positively affects operator performance in the Mekong Delta, Vietnam.*

Based on the literature review and the proposed research hypotheses, the study applies the participatory rural appraisal (PRA) method with two experts in rice supply chains and four rice enterprises. The result helps identify appropriate scales for the research model. So, the research model is set up as follows:

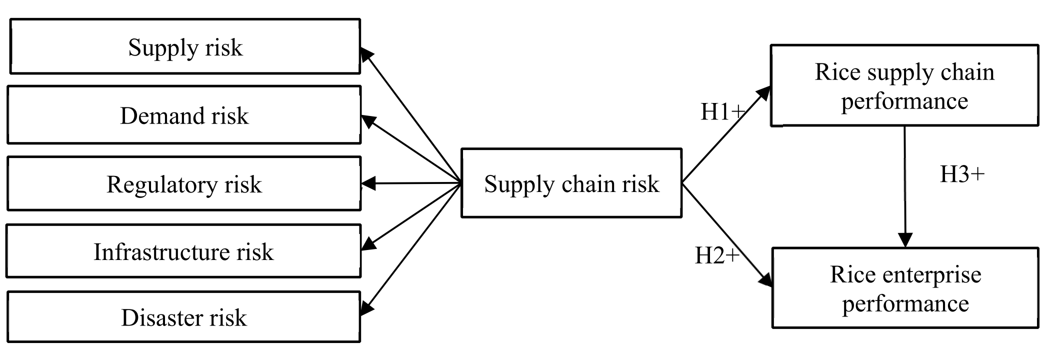

Fig.1. Proposed research model

Table 1
Interpretation of observed variables in the research model

Factor	Observed variables	Scale	References
Supply risk (SR)	SR1: Logistics activities of suppliers are low-quality (late delivery, late order response, etc.)	Likert 1-5	Wagner & Bode (2008), Florian & Constangioara (2014), Punniyamoorthy et al. (2013)
	SR2: Suppliers' product quality is not optimized.	Likert 1-5	
	SR3: High possibility of unexpected problems that suppliers do not promptly handle.	Likert 1-5	
Demand risk (DR)	DR1: Customer demands are diverse and challenging to predict.	Likert 1-5	Wagner & Bode (2008), Florian & Constangioara (2014), Zhao et al. (2013)
	DR2: Customer demands are constantly changing.	Likert 1-5	
	DR3: The connection with customers is not close, and the information about customer demands is distorted.	Likert 1-5	
Regulatory risk (RR)	RR1: Legal regulations change regularly, which is hard to adapt.	Likert 1-5	Wagner & Bode (2008), Punniyamoorthy et al. (2013), Florian & Constangioara (2014)
	RR2: The establishment and operation of supply chains face administrative barriers.	Likert 1-5	
	RR3: The legal system and management policies are complicated.	Likert 1-5	
Infrastructure risk (IR)	IR1: Time waste or inability to provide products/services due to disruption of infrastructure (information technology, road systems).	Likert 1-5	Wagner & Bode (2008), Florian & Constangioara (2014)
	IR2: Disruption of visual information technology infrastructure (computer viruses, management software failures)	Likert 1-5	
	IR3: Inability to provide products/services due to technical reasons (damages to equipment, tools, vehicles, etc.)	Likert 1-5	
Disaster risk (DIR)	DIR1: The epidemic is becoming more and more complicated.	Likert 1-5	Wagner & Bode (2008), Florian & Constangioara (2014), Punniyamoorthy et al. (2013)
	DIR2: Environmental pollution is getting more and more serious.	Likert 1-5	
	DIR3: Natural disasters (storms, tropical depressions, floods) and climate change.	Likert 1-5	
Supply chain performance (SP)	SP1: The supply chain meets the detailed requirements of special customers.	Likert 1-5	Vickery et al., (1999), Chen et al., (2004), Qrunfleh & Tarafdar (2014)
	SP2: The supply chain provides products that meet the needs of various choices and prices.	Likert 1-5	
	SP3: The supply chain quickly adjusts to respond promptly to customer needs.	Likert 1-5	
	SP4: The supply chain responds to customer requests fast and flexibly.	Likert 1-5	
Operator performance (OP)	OP1: Our company has grown in sales and profits.	Likert 1-5	Flynn et al., (2010), Li et al., (2006), Cao & Zhang (2011)
	OP2: Our company has grown in market shares.	Likert 1-5	
	OP3: Our company has improved its competitive position.	Likert 1-5	
	OP4: Our company has improved labor productivity.	Likert 1-5	

3. Research Methodology

3.1 Analytical method

The analytical methods are carried out in the following order to test the research hypotheses. Step 1: Reliability test by Cronbach's Alpha coefficient. Step 2: Exploratory factor analysis (EFA) to evaluate the convergent and discriminant value of the scales. Step 3: Confirmatory factor analysis (CFA) to assess the relevance of the data to the market. Step 4: Structural equation modeling (SEM) to test the research hypotheses.

3.2 Data collection method

In the exploratory factor analysis (EFA), the minimum sample size should be 50, preferably 100. It is better to maximize the observation ratio per measurement variable by 5:1, which means every measurement variable needs at least five observations (Hair et al., 1998). Furthermore, applying the structural equation modeling (SEM), the study needs to achieve a large sample size because it is based on sample distribution theory (Raykov & Widaman, 1995). To reach reliability requirements in SEM, a sample size from 100 to 200 is accepted (Hoyle, 1995). The survey subjects are enterprises participating in the rice supply chain in the Mekong Delta, Vietnam. Quota sampling is used to conduct the survey and collect data. The criteria used to group the survey subjects are the location of the enterprise's head office, the size of the enterprise, and the enterprise's market. The survey areas are concentrated in the following provinces/cities: Can Tho City, An Giang Province, Dong Thap Province, and Tien Giang Province. After the data screening, the study acquired 142 observations. Thus, the sample size meets the reliability requirements for the research hypothesis test.

4. Research Results and Discussion

4.1 Evaluate the reliability of scales

The scale development process is carried out in two steps to test the reliability (Narasimhan & Jayaram, 1998), including Cronbach's Alpha test and exploratory factor analysis (EFA). According to the result in table 2, the scales are reliable, with Cronbach's Alpha values greater than 0.6 (Nunnally, 1978; Peterson, 1994). The Disaster risk scale has the lowest value (0.681) and the highest value is the Operator performance scale (0.900). Besides, the corrected item-total correlation of variables is greater than 0.3, so no observed variables are excluded from the research model (Slater, 1995; Hair et al., 2006).

Table 2
Test the reliability of scales

Observed variable	Mean	Standard deviation	Factor loading	Cronbach's Alpha
Supply risk (SR)				0.746
SR1	2.92	0.776	0.712	
SR2	2.89	0.725	0.715	
SR3	2.94	0.865	0.708	
Demand risk (DR)				0.717
DR1	3.27	0.922	0.748	
DR2	3.25	0.887	0.599	
DR3	3.32	0.880	0.596	
Regulatory risk (RR)				0.786
RR1	2.95	0.766	0.656	
RR2	2.93	0.778	0.742	
RR3	3.04	0.752	0.674	
Infrastructure risk (IR)				0.741
IR1	3.25	0.934	0.626	
IR2	3.08	0.879	0.749	
IR3	3.20	1.047	0.581	
Disaster risk (DIR)				0.681
DIR1	2.88	0.838	0.633	
DIR2	2.75	0.844	0.702	
DIR3	2.88	0.911	0.659	
Supply chain performance (SP)				0.758
SP1	3.63	0.821	0.814	
SP2	3.55	0.830	0.620	
SP3	3.48	0.769	0.624	
SP4	3.44	0.871	0.522	
Operator performance (OP)				0.900
OP1	3.08	0.956	0.834	
OP2	3.27	1.026	0.762	
OP3	3.18	1.015	0.772	
OP4	3.30	0.967	0.799	

The EFA analysis gives the following statistical values: (1) Bartlett's test of the correlation among observed variables meets the requirement with Sig. = 0.000 (Hair et al., 1998); (2) The model's suitability test is guaranteed with KMO = 0.835 (Hair et al., 1998); (3) Test of cumulative variance test reaches 68.9%, higher than 50% (Anderson & Gerbing, 1988). This shows that the observed variables included in the model have high explanatory power; (4) The reliability of the observed variables is satisfactory with Factor loading values > 0.5 (Hair et al., 1998). Therefore, 7 factors are created from 23 observed variables, consistent with the proposed scales. Confirmatory factor analysis (CFA) is used to test the relevance of the research data. The test result in table 3 points out guaranteed statistical indicators as follows: Chi-square/df = 1.196 < 2 with P = 0.028 ≤ 0.05. The TLI and CFI values reach 0.958 and 0.965; respectively, all are higher than 0.9. RMSEA = 0.037 < 0.08 (Anderson & Gerbing, 1988; Hair et al., 2014). This proves that the model fits the market data. Furthermore, the standardized regression weights of scales are all > 0.5, and the unstandardized regression weights are statistically significant, so the model achieves convergent validity. Besides, the correlation coefficients among factors are all less than 1, and the standard deviation is less than 0.05. Therefore, the research model reaches discriminant validity.

Table 3
CFA and SEM analysis result

Evaluation criteria	CFA	SEM	Comparative indicator	References
χ^2/df	1.196	1.164	≤ 2	Anderson & Gerbing (1988), Hair et al. (2014)
P-value	0.028	0.047	< 0.05	
TLI	0.958	0.965	≥ 0.9	
CFI	0.965	0.969	≥ 0.9	
RMSEA	0.037	0.034	≤ 0.08	

Based on the test result, the scales' composite reliability (Pc) is satisfactory, with a minimum value of 0.68. Although the average variance extracted from some scales is a bit low (0.4 < Pvc < 0.5), the Pc values of scales are more significant than 0.6. Hence, all scales meet the reliability requirement (Fornell & Larcker, 1981).

Table 4
Scale testing result

Factor	Number of observed variables	Composite reliability (P_c)	The average variance extracted (P_{vc})	References
Supply risk (SR)	3	0.75	0.50	Fornell & Larcker (1981)
Demand risk (DR)	3	0.72	0.46	
Regulatory risk (RR)	3	0.79	0.55	
Infrastructure risk (IR)	3	0.75	0.50	
Disaster risk (DIR)	3	0.68	0.42	
Supply chain performance (SP)	4	0.76	0.44	
Operator risk (OP)	4	0.90	0.69	

4.2 Research hypothesis test

Structural equation modeling (SEM) is used to test research hypotheses. Based on the result in table 5, hypotheses H1, H2, and H3 are accepted with a 99% significance level.

Table 5
Research hypothesis test result

Relationship	Unstandardized			Standardized estimated value	Significance	Hypothesis
	Estimated value	Standard error S.E	Critical ratio C.R			
SP ← SCR	-0.743	0.195	-3.816	-0.514	***	H1: accepted
OP ← SCR	-0.673	0.225	-2.993	-0.359	***	H2: accepted
OP ← SP	0.495	0.152	3.265	0.382	***	H3: accepted

Hypothesis H1: *Supply chain risk negatively affects rice supply chain performance.* The above table shows that supply chain risk and supply chain performance had negative relationships; the standardized estimated coefficient reaches -0.514. Suppose supply chain risks occur with high levels and different types (supply, demand, regulatory, infrastructure, and disaster). In that case, the performance of the rice supply chain will decrease. Research results confirm that supply chain risks lead to the complexity and sensitiveness of supply chains, which hinder the cooperation between members (Zsidisin, 2003; Zhao et al., 2013). This negatively influences supply chain performance (Wilson, 2007; Wagner & Bode, 2008; Okoumba, 2018; Afshar & Fazli, 2018).

Hypothesis H2: *Supply chain risk negatively affects the performance of rice enterprises*. This hypothesis is accepted with a statistical significance of $p = 0.000$ and a standardized estimated coefficient of -0.359. This represents an inverse relationship between supply chain risk and operator performance. This finding is similar to studies proposed by Hendricks & Singhal (2005), Wagner & Bode (2008), Florian & Constangioara (2014). Therefore, supply chain risk-management strategy plays an essential role in improving the performance of enterprises participating in it.

Hypothesis H3: *Supply chain performance positively affects the performance of enterprises.* The final result indicates that the performance of the supply chain is positively correlated with the enterprise's performance with the standardized estimated coefficient of 0.382 and the statistical significance level $p = 0.000$. Therefore, the low supply chain performance may lead to inefficiencies in business performance (Vickery et al., 2003; Chen et al., 2004; Sanchez & Pérez, 2005; Rai et al., 2006; Zhang et al., 2006; Qrunfleh & Tarafda, 2014). On the contrary, if the supply chain meets customer needs, it helps improve the performance of enterprises (Vickery et al., 2003; Chen et al., 2004; Sanchez & Pérez, 2005).

5. Conclusion

The study has demonstrated a close relationship between supply chain risk, supply chain performance, and rice enterprise performance. Supply chain risks negatively affect supply chain performance and operator performance. At the same time, the study shows a beneficial relationship between supply chain performance and rice enterprise performance. The results confirm the critical role of supply chain risk-management strategy in improving the supply chain performance and efficiency of enterprises in the Mekong Delta region, Vietnam.

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