Research Article

Supply Chain RISK on Performance of Thai Maize Exported to Market in ASEAN Countries: A Multi-Group Analysis of Producer Sizes

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Abstract

The study aims to determine and construct supply chain risks and supply chain performance of the Thai maize supply chain exported to ASEAN markets, and examine the effect of the risks in the supply chain and the supply chain performance together with the sizes of producers as moderate variables. A total of 228 questionnaires were distributed to 203 small producers and 25 medium and large Thai maize producers exporting maize to ASEAN markets. PLS-SEM algorithm and PLS-MGA were used to analyze the data by SmartPLS 4. The findings showed that storage risks, labour risks, supply-side risks, governmental and policy risks, and information flow risks significantly affected supply chain performance. Moreover, according to PLS-MGA, information flow risks significantly affected supply chain performance among groups.

Keywords: ASEAN, Thai maize, Supply chain risks, Supply chain performance, PLS-MGA

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Introduction

Maize was originally used in Mexico and Central America. It is used in many applications such as human food, livestock feeding ingredients and energy. Mazie has the biggest proportion among coarse grains consisted of rice, barley and sorghum. In 2021, United States of America had the biggest maize production in the world followed by Argentina, Ukraine and Brazil respectively. World Bank Group (2022) presented that ASEAN's GDP growth rate was 5.2, 6.1 and 4.4 percent in 2017, 2018 and 2019 to prove that ASEAN has the effective and strong economic potential. For maize export volume in 2020, Myanmar was the biggest country exporting maize in ASEAN in proportion of 55.43 percent followed by Vietnam in proportion of 29.92 percent and Lao PDR in proportion of 9.36 percent respectively. Among ASEAN countries in 2020, Thailand is the fifth biggest country exporting maize in ASEAN. Thailand exported the maize to Myanmar in proportion of 39.53 percent followed by Vietnam in proportion of 37.81 percent and Cambodia in proportion of 8.89 percent respectively. However, from 2017 to 2020, the average quantity of Thai maize exported to ASEAN countries decreased 99.50 percent, and its average value decreased 99.04 percent (International Trade Centre, 2022).

From the mentioned study, decreases of maize harvest and export volume causing the study of risk factors in Thai maize supply chain are important for identifying and estimating related risk factors accurately leading to enhancement and potential of Thai maize competitiveness. Therefore, the study aims to study the relationship between supply chain risk factors and supply chain performance of Thai maize exported to ASEAN countries between sizes of producer as the moderators.

Research Objectives

1. To determine the risks of Thai maize supply chain on the supply chain performance exported to ASEAN countries market.
2. To examine the effect between supply chain risks and Thai maize supply chain performance between sizes of producers as the moderating factors.

Hypothesis

H1. The storage risks affect supply chain performance
H2. The labour risks affect supply chain performance
H3. The supply risks affect supply chain performance
H4. The demand risks affect supply chain performance
H5. The financial risks affect supply chain performance
H6. The governmental and policy risks affect supply chain performance
H7. The information flow risks affect supply chain performance

H8. The relationship between the supply chain risk factors and supply chain performance will be different between small Thai maize producers and medium and large producers

Literature Review

Supply chain risk

Risk is uncertainty causing negative and/or unexpected decisions' consequence (Sitkin & Pablo, 1992). Recently, the dynamics of the business environment are changing leading risks from different perspectives, so the organizations should strategically prepare themselves at any time. However, definitions of risk depend on its different contexts. Therefore, this study mentioned the risk in agricultural supply chain since it is closed to maize supply chain. Wagner and Bode (2008) claimed that supply chain risks are negative consequences from supply chain disruption interrupting its operations. Ho, Zheng, Yildiz and Talluri (2015) defined risks in supply chain as all events negatively affect any flows in supply chain terminating distribution to customer; for example, supply risks, demand risks, operational risks, informational risks, logistics and infrastructural risks and climatic risks. Nevertheless, risks in agricultural supply chain are different from industrial products due to more multiple players and sensitive environment (Kern, Moser, Hartmann, & Moder 2012). From the studies, risk sources in agricultural supply chain are various; for example, demand risk, supply risks, environmental risks, biological risks, managerial and operational risks, human or personal risks, logistics and transportation risks and technological risks (Jaffee, Siegel, & Andrews, 2010) political and governmental risks, storage risks, financial institutional risks and information flow risks (Rathore, Thakkar, & Jha, 2017).

Supply chain risk on Supply chain performance

Supply chain performance includes performance indicators of products, services and processes related to organization's objectives in specific industry (Rosenau, Griffin, Castellion, & Anschuetz, 1996) It is necessary for improving industry's competitiveness. Hendricks and Singhal (2005) mentioned that there is significant relationship between supply chain risks and supply chain performance. Similarly, most studies summarized that supply chain risk could reduce supply chain performance (Yeboah, Feng, Daniel, & Joseph, 2014). Aramyan, Lansink, van der Vorst and Vankooten (2007) proposed that performance measurement refers to process of measuring the effectiveness and efficiency of activities and action; however, the supply chain performance could be measured in different ways depended on industry to monitor the achievement of organization's strategy. For instance, some companies improving supply chain performance's indicators which are quality and safety product, profit and flexibility had higher possibility to cope with risk and uncertainty and to design contingency strategies. (Li, Ragu-Nathan, Ragu-Nathan, & Rao, 2006). Chan (2003) proposed that there were many types of cost associated with supply chain performance which were distribution costs,

manufacturing costs, inventory costs, warehouse costs, incentive costs and subsidies, intangible costs and overhead costs; moreover, he addressed that time was another important performance comprised of customer response time, lead time and on-time delivery.

Firm size as a control variable

Small and medium-sized enterprises (SMEs) play important roles in several countries around the world. Apparently, different sizes of firms have particular organizational structure, management and operation according to Durst and Edvardsson (2012) indicating that different organization sizes adopt particular decision-making processes and strategic planning. For smaller organizations, they have greater managerial centralization in choosing annual and monthly plan. The manager is centrally important to a smaller organization where the general management could make decisions for both strategic and operational level while most large organizations have higher hierarchical structures and the managers have to follow company's vision, mission and strategy. Consequently, the firm size can be applied as mediator variable in supply chain management and disruptions (Sreedevi & Saranga, 2017) by categorizing firm size from number of employees including annual turnover of the companies. However, this study applied firm size category in Thailand. SMEs Development Bank of Thailand (2008) categorized manufacturing industries by number of employees and fixed assets excluding land (Million Baht). First, for small manufacturing industries, a number of employees and fixed assets must not exceed 50 employees and 50 million Baht. Second, for medium manufacturing industries, a number of employees and fixed assets must be between 50-200 employees and between 50-200 million Baht. Finally, for large manufacturing industries, a number of employees and fixed assets must be higher than 201 employees and 201 million Baht.

Research framework

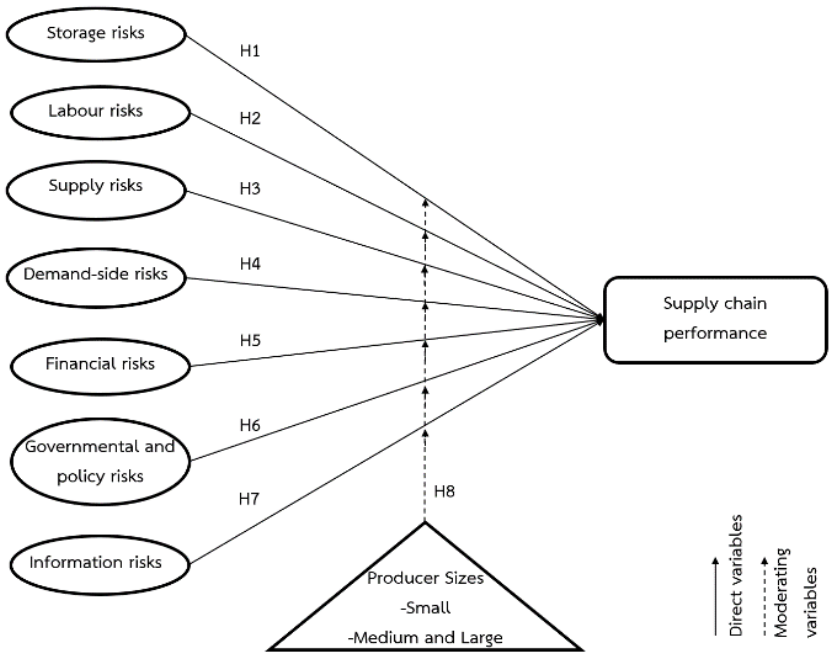

Figure 1 Conceptual Framework

Research method

The study uses a mixed method, qualitative and quantitative methods, with an in-depth interview and questionnaires to achieve its purpose. The respondents are Thai maize producers who export Thai maize to ASEAN countries market and registered in Thai Department of Internal Trade. The data will be analyzed by PLS-SEM algorithm and multigroup analysis (MGA) using SmartPLS 4 software to test the relationship of supply chain risks on supply chain performance between small producers and medium and large producers of Thai maize exported to ASEAN countries.

For the sampling requirements, the researcher applies ten-time rule of PLS-SEM which is the minimum sample size should be 1) larger than 100, 2) more than 10 times of the highest number of inner model to the construct (Chin, 1998) and 3) the proportion of groups should be higher than 90:10 for PLS-MGA (Becker, Rai, Ringle, & Völckner, 2013). Therefore, the questionnaires were distributed to 228 maize producers registered in Thai Department of Internal Trade divided into 203 small and 25 medium and large Thai maize producers exporting to ASEAN countries.

The data was studied from primary and secondary sources from both Thai and international journals. Theories of the supply chain risks and the supply chain performance

were identified from literature review while in-depth interview and questionnaire were collected from Thai maize producers as the primary source. The questionnaire consists of three parts which are, firstly, general information (annual company revenue, the age of company, number of employees, etc.), secondly, the supply chain risks affecting to maize supply chain performance with Likert scale (1=Strongly Disagree and 7=Strongly Agree), and thirdly, participants' opinion and comment.

Findings

Descriptive statistics

The samples were divided into two groups, small companies and medium and large companies, based on SMEs Development Bank of Thailand's categorization (2008). Most businesses had less than 10 years business operation (34.65%), less than 50 million Baht of fixed assets (89.04%), less than 50 employees (86.84%), less than 50 million Baht of annual average revenue (60.09%), more than 201 tons of annual production volume (56.14%), and Thai maize businesses mostly exported their products to Myanmar (38.16%) among ASEAN.

Construct Reliability and Validity

The measurement of construct reliability and validity in PLS-SEM comprised of outer loading, Cronbach's **α**, composite reliability and average variance extracted (AVE). However, the loading score, Cronbach's **α**, composite reliability and AVE must be higher than 0.7, 0.7, 0.8 and 0.5 respectively to achieve the requirement (Juana-Espinosa & Rakowska, 2018) shown in table 1.

Table 1 Construct Reliability and Validity

Latent variables	Formative variables	Loading	Cronbach's α	Composite reliability	AVE
Demand	CCT	0.868	0.797	0.798	0.711
	DFU	0.836			
	ECD	0.826			
Finance	CPP	0.780	0.779	0.783	0.598
	FCE	0.817			
	FSP	0.704			
	IFS	0.788			
Gov	ABR	0.858	0.730	0.764	0.645
	IGR	0.833			
	ITD	0.712			

Latent variables	Formative variables	Loading	Cronbach's α	Composite reliability	AVE
Info	DIS	0.763	0.726	0.727	0.647
	INA	0.820			
	LMI	0.828			
Labour	CWF	0.808	0.716	0.721	0.637
	IPD	0.770			
	LSW	0.817			
Store	CIS	0.806	0.717	0.719	0.639
	ISW	0.773			
	LSF	0.818			
Supply	POY	0.828	0.710	0.709	0.633
	SDF	0.776			
	SOB	0.781			
Perf	TIME	0.847	0.899	0.911	0.834
	QASF	0.917			
	FLEX	0.972			

From table 1, for risk factors, the lowest loading score of all indicators is FSP in financial risks at 0.704 while the highest loading score of all indicators is CCT in demand risks at 0.868. For Cronbach's α among risk factors, the lowest value of all constructs is supply risks at 0.710 while the highest value of all constructs is demand risks at 0.797. For composite reliability among risk factors, the lowest value of all constructs is supply risks at 0.709 while the highest value of all constructs is demand risks at 0.798. For AVE among risk factors, the lowest value of all constructs is financial risks at 0.598 while the highest value of all constructs is demand risks at 0.711. Moreover, for supply chain performance factors, the lowest and highest values of loading score are 0.847 and 0.972 while the values of Cronbach's α, Composite reliability and AVE are 0.899, 0.911 and 0.834 respectively. Hence, all indicators and construct pass the minimum requirement.

To examine discriminant validity, Fornell-Larcker Criterion and Heterotrait-Monotrait ratio of correlations (HTMT) are measured (Henseler, Hubona, & Ray, 2016) for explicitly distinguishing the construct from the others shown in table 2 and 3.

Table 2 Discriminant validity: Fornell-Larcker Criterion

	Demand	Finance	Gov	Info	Labour	Perf	Store	Supply
Demand	**0.843**							
Finance	0.291	**0.774**						
Gov	0.390	0.210	**0.803**					
Info	0.290	0.079	0.212	**0.804**				
Labour	0.325	0.194	0.240	0.283	**0.798**			
Perf	0.563	0.283	0.606	0.428	0.534	**0.913**		
Store	0.380	0.058	0.298	0.314	0.324	0.513	**0.799**	
Supply	0.517	0.197	0.424	0.430	0.350	0.657	0.325	**0.796**

Note: The bold numbers are the square root of the AVE values of each respective construct.

Table 3 Discriminant validity: Heterotrait-Monotrait ratio of correlations (HTMT)

	Demand	Finance	Gov	Info	Labour	Perf	Store	Supply
Demand								
Finance	0.364							
Gov	0.503	0.266						
Info	0.381	0.122	0.288					
Labour	0.427	0.252	0.303	0.393				
Perf	0.665	0.322	0.721	0.532	0.664			
Store	0.502	0.118	0.386	0.435	0.455	0.640		
Supply	0.683	0.261	0.583	0.596	0.489	0.818	0.452	

From table 2 according to Valaei and Nikhashemi (2017). the square root of AVE should exceed all off-diagonal values of the particular construct with the other constructs. For instance, in table 2, the intercorrelations of demand risk is 0.843 which is the highest value in its intercorrelations (from the original AVE value of demand risks which is 0.711). Likewise, supply chain performance whose the square root of AVE is 0.913 which is the highest value in its intercorrelations (from the original AVE value of supply chain performance which is 0.834). In addition, in table 3, the highest HTMT of the model is 0.818 between the supply risks and supply chain performance which should be lower than 0.9 for discriminant validity (Henseler et al., 2016). In summary, all constructs of the model meet all minimum requirement of discriminant validity both Fornell-Larcker Criterion and HTMT.

Structural model

PLS-SEM is not able to analyze a standard goodness-of-fit statistic prior efforts so that it can assess the model prediction's quality of the endogenous constructs applying the coefficient of determination (R^2) and path coefficient. R^2 ranged from 0 to 1 with 1 representing predictive accuracy. R^2 value of the model is 0.703 representing that exogenous variables moderately affect endogenous variable because the R^2's acceptable rule of thumb values 0.75, 0.50 and 0.25 considered substantial, moderate and weak predictive effect respectively. To illustrate, R^2 value (0.703) represented the agricultural supply chain performance can be explained by supply chain risks which consisted of storage risks, labour risks, supply-side risks, demand-side risks, financial risks, governmental and policy risks and information flow risks 70.3% which is moderate.

Bootstrapping technique with 5000 iterations (two-tail) is applied to examine the results of hypothesis by analyzing the significant level of all constructs' paths. The bootstrapping technique provides original Sample, standard error, T statistics values and P values in the following table:

Table 4 Structural relationships, path coefficient and hypothesis testing

	Original sample (O)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values	Decision
Demand⟶ Perf	0.110	0.060	1.836	0.066	Not supported
Finance⟶ Perf	0.070	0.037	1.873	0.061	Not supported
Gov ⟶ Perf	0.300	0.046	6.519	0.000	Supported
Info ⟶ Perf	0.081	0.039	2.073	0.038	Supported
Labour⟶ Perf	0.230	0.057	4.052	0.000	Supported
Store ⟶ Perf	0.186	0.045	4.089	0.000	Supported
Supply⟶ Perf	0.283	0.052	5.479	0.000	Supported

Table 5 PLS-MGA results between small Thai maize producers and medium and large producers

	Difference	1-tailed p-value	2-tailed p-value	Decision
Demand ⟶ Perf	0.048	0.425	0.850	Not supported
Finance ⟶ Perf	0.131	0.265	0.530	Not supported
Gov ⟶ Perf	0.061	0.333	0.665	Not supported
Info ⟶ Perf	-0.534	0.980	0.040	Supported
Labour ⟶ Perf	0.055	0.387	0.774	Not supported
Store ⟶ Perf	0.120	0.221	0.443	Not supported
Supply ⟶ Perf	-0.088	0.653	0.695	Not supported

H1. The storage risks will affect supply chain performance:

From the results in the table 4, the storage risks significantly affect supply chain performance with coefficient parameter 0.186, standard error 0.045 and t-statistics 4.089 and p-value 0.000 which is lower than 0.05. Therefore, the H1 is supported.

H2. The labour risks will affect supply chain performance:

From the results in the table 4, labour risks significantly affect supply chain performance with coefficient parameter 0.230, standard error 0.057 and t-statistics 4.052 and p-value 0.000 which is less than 0.05. Therefore, the H2 is supported.

H3. The supply risks will affect supply chain performance:

From the results in the table 4, supply risks significantly affect supply chain performance with coefficient parameter 0.283, standard error 0.052 and t-statistics 5.479 and p-value 0.000 which is less than 0.05. Therefore, the H4 is supported.

H4. The demand risks will affect supply chain performance:

From the results in the table 4, demand risks do not significantly affect supply chain performance with coefficient parameter 0.110, standard error 0.060 and t-statistics 1.836 and p-value 0.066 which is larger than 0.05. Therefore, the H4 is not supported.

H5. The financial risks will affect supply chain performance:

From the results in the table 4, financial risks do not significantly affect supply chain performance with coefficient parameter 0.070, standard error 0.037 and t-statistics 1.873 and p-value 0.061 which is larger than 0.05. Therefore, the H5 is not supported.

H6. The government and policy risks will affect supply chain performance:

From the results in the table 4, political side risks significantly affect supply chain performance with coefficient parameter 0.300, standard error 0.046 and t-statistics 6.519 and p-value 0.000 which is less than 0.05. Therefore, the H6 is supported.

H7. The information flow risks will affect supply chain performance:

From the results in the table 4, information flow risks significantly affect supply chain performance with coefficient parameter 0.081 standard error 0.039 and t-statistics 2.073 and p-value 0.038 which is lower than 0.05. Therefore, the H7 is supported.

H8. The relationship between the supply chain risk factors and supply chain performance will be different between small Thai maize producers and medium and large producers :

From the results in the table 5, the supply chain risk factors affect supply chain performance between small Thai maize producers and medium and large producers in information flow risks with p-value 0.040 which is less than 0.05. Therefore, the H8 is supported.

Conclusion

The study was conducted to review and construct supply chain risks and supply chain performance in Thai maize industry exporting to ASEAN countries. PLS-SEM with 70.3 percent of R^2 value representing prediction's moderate quality. The finding indicated that the supply chain risks in Thai maize industry exporting to ASEAN countries consist of governmental and policy risks (Comprised of ABR: Administrative Barriers (e.g., customs, trade regulations) quota restrictions, IGR: Change in/inadequate government regulations or safety standards, ITD: Interruption of trade due to disputes with other countries), information flow risks (comprised of DIS: Demand, inventory status, order, INA: Information accuracy, LMI: Lack of market price information), labour risks (Comprised of CWF: Carelessness and a lack of motivation among the workforce, IPD: Interpretation problems with documents, contracts and permits, LSW: Lack of skilled workers), storage risks (comprised of CIS: Contamination in store, ISW: Inadequate storage at warehouses, LSF: Lack of storage facilities), and supply risks (comprised of POY: Poor yield, SDF: Non-availability of suppliers or dependency on few suppliers, SOB: Supplier goes out of business or bankruptcy) impacted on supply chain performance whose three main variables are TIME; Lead time, QASF; Quality and safety, COST; Cost. For PLS-SEM multigroup analysis: PLS-MGA, the supply chain risk factors affect supply chain performance through different sizes of producer in information flow risks because information system requires an employee and staff with IT knowledge to run and maintain. Hence, small Thai maize producers exporting to ASEAN countries lacking of technology assets due to limited budget and resource significantly perceived information flow risks on supply chain performance which is different from the larger producers.

Discussion

From the results of hypothesis by bootstrapping technique, SMEs and large companies in Thai maize industry faced with storage risks, labour risks, supply-side risks, governmental and policy risks, and information flow risks. However, the study's PLS-MGA finding contributes to

the significant differences of information flow risks on supply chain performance between Thai maize small and medium and large companies. Based on many studies, Welker, Van der Vaart and Van Donk (2008) mentioned the smaller company also shared their information and decision such as direct communication and e-mail through supply chain, but it would be ineffective methods owing to lack the know-how and the resources. The reasons are IT adoption in smaller company was aligned with the manager's level of software knowledge, and it required skilled personnel, cost and knowledge (Hosseini, Banihashemi, Chileshe, Namzadi, Udaeja, Rameezdeen, & McCuen, 2016). On the other hand, most medium and large companies have their own information technology system to manage their supply chain, range of products and variants due to its high complexity. Due to the larger IT investment, the medium and large companies have predictive demand information while the small company has only customer order (Son, Ha, & Lee, 2019) causing higher performance and competitiveness. Therefore, in spite of smaller size of business, they also have their own supply chain, and it is difficult to overlook the importance of information flow which is extremely necessary for forecasting demand, supply chain operation and customer satisfaction fulfillment in the digital and informational age.

Recommendation

For managerial recommendation, due to limited financial and human resources and IT knowledge, the strategic level of small Thai maize producers should support manager and head staff to take intensive IT course, and the organization should use third-party IT services to decide which information technology and knowledge are useful and appropriate to the small producers and supply chain, and then the organization can invest in the most important IT asset such as tracking and tracing system that can lower supply chain risks by increasing supply chain transparency and collaboration (Sheffi & Rice, 2005) to improve competitiveness.

For academic recommendation, a researcher should study information technology and system accompanied to the advantageous characteristics of small Thai maize producers; for example. Singh, Garg, and Deshmukh (2008) found most small companies have simple and flexible supply chain, so they can response to immediate feedback and demand compared to larger companies. Moreover, the researcher should consider the impact of IT and innovation on supply chain transparency and collaboration to maximize small Thai maize producers' supply chain performance.

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