RISK MODELLING OF THAI CASSAVA CHIP SUPPLY CHAIN AS EXPORT TO CHINA

Thagoon Siriyod[1], Chatrudee Jongsureyapart[2]*, Suthep Nimsai[3]
and Singha Chiamsiri[4]
[1, 2, 3, 4] School of Management, Mae Fah Luang University,
Chiang Rai, Thailand

ABSTRACT

The study aims to review and construct various supply chain risks and supply chain performance of Thai cassava chip supply chain export to China and to test the relationship between the supply chain risks and supply chain performance. The primary theoretical model was constructed of four main supply chain risk factors which are product risks, demand side risks, logistical and infrastructural risks, and political risks, and five main supply chain performance variables which are dependability, speed, qualities, information and response adapted from E.Y. Nyamah et al., (2017) and from S.M. Zanjirchi et al., (2017). Therefore, the questionnaires were distributed to 46 Thai cassava chip exporters and analyzed using PLS-SEM algorithm. With the confidence intervals of 95%, demand side risks and political risks impact supply china performance. Thai government and Thai entrepreneur can analyze the results of possible risk factors and develop supply chain of Thai cassava chip industry.

Keywords: 1) Thai Cassava Chip 2) Supply Chain Risk 3) Supply Chain Performance

1. Introduction

Cassava is used in many contexts such as food and energy security and agriculturist's income. From 2012 to 2016, world's cassava production increases 2.88% per year, and most cassavas planted areas are in Africa followed by Asia, Latin America and Oceania reaching to 54.44, 34.52, 10.94 and 0.10 percent respectively. In 2016, Thailand has highest planted area about 38% in ASEAN followed by Indonesia, Vietnam, Cambodia and Philippines with 28, 14, 13 and 6% respectively. In Thailand, cassava is the fifth agricultural crop preceded by wheat, maize, rice and potato. For production, Thailand's average growth rate of cassava planted area, harvested area and production from 2012-2017 reaching to 0.45, 0.36 and 0.95 % respectively (Office of Agricultural Economics Thailand, 2017). Moreover, in 2017 Thailand has about 322 drying yards (cassava chip producer), and most of Thai manufacturers have high experience, knowledge including hi-tech machineries , and from market side, Thailand exports more than 85% of cassava chips while the rest is consumed domestically in alcohol, chemical and animal feed industry (Jongsureyapart et al., 2018). Furthermore, according to Global Trade Atlas (2018), in 2018, Thailand is the biggest cassava exporter in the world with 53 percent of market share, and it has the highest exporting cassava chip value in the world with proportion of 90.52%. Thai cassava chip is mostly exported to China in 99.35% also. Therefore, the export of cassava chip plays the important role in Thailand especially to China.

However, from 2015 to 2017, the trend of cassava chip exporting to China is decreasing due to high competition in cassava chip market of ASEAN countries especially Vietnam and Cambodia. Therefore, to prepare for high intensity of market competition, supply chain risks and supply chain performance are considered as the important issues in the industry to discuss for improving of Thai cassava chip's supply chain exporting to China.

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[1] E-mail: Thagoon.sir@gmail.com

2. Literature Review

2.1 Supply chain risk

Risks in supply chain are consider as any events disrupting 3 important flows in the supply chain to oppositely result the possible outcomes' distribution (Ho, et al., 2015; Harland, et al., 2003; Tang, 2006; Zsidisin, 2003; Juttner, et al., 2003). However, it is difficult to definitely identify due to its industry. According to Jemison (1987), it mentioned that there is not the certain definition of risk, but it depends on the particular field of the study. In addition, the risk formula depends on the perspective and understanding of the assessor's in the particular field that can be perceived as a knowledge-based evaluation (Aven, 2012). Therefore, the study adapts risks in cassava chip supply chain which is agricultural product from study of Nyamah et al. (2017), in agricultural food supply chain, there are many risk (disruptions) consisted of market issue, logistical and infrastructural issue and political issue (Fitzgerald, 2005; Hauser, 2013; LaLonde, 2004; Peide and Wang, 2008; Nyamah, et al., 2014). In addition, according to the study of Zanjirchi et al. (2016), product risk consisted of quality of the product, cost (the price of the product) and process (product manufacturing process) (Schoenherr, et al., 2008; Tang, 2006).

2.2 Supply chain performance

Supply chain performance is important to the enhancement of industry's competitiveness. The competitiveness of the supply chain can be achieved by supply chain players' integration and getting insights for effective decision making from supply chain performance's measurements (Benson and Clay, 1998; Chan and Qi, 2003). However, the supply chain performance is difficult to measure. The supply chain performance's measurement is important to monitor the strategies' achievement although the measurement of the particular supply chain depends on its own specific variables' implementation (Campos and Ramirez, 2013). Therefore, the study adepts the supply chain performance measurement from the closets industry from the study of Nyamah, et al. (2017), there are the studies suggesting agri-food supply chain performance measurements consisted of dependability, speed, qualities and information response (Lee and Billington, 1993; van der Vorst, 2005; Aramyan, et al., 2007; E.Y. Nyamah, et al., 2017).

Therefore, the supply chain risks can affect supply chain performance due to many studies. The supply chain risks are considered as unreliability and uncertainty interrupting the response between demand and supply in the supply chain (Tang and Musa, 2011), and the uncertainty can affect supply chain performance. The study of Badea, et al. (2014) examining the negative factors in the supply chain, and the purpose was to identify factors disturbing the supply chain's effectiveness, and the subject is how the supply chain performance affected by the vertical and horizontal concepts due to supply chain risk (as cited in S.M. Zanjirchi, et al., 2016). Hence, the firms should focus on supply chain risks to improve supply chain performance. To have the effective supply chain is very difficult (Nooraie and Parast, 2016) because the important issue to deal with is risks' consequences affecting supply chain performance (Christopher and Lee, 2004; Chandra and Grabis, 2007; Ritchie and Brindley, 2007; Chopra and Sodhi, 2014). According the study of Nyamah et al (2017), to observe the agricultural food supply chain can support and help the managerial levels and firms to manage risks for developing supply chain performance. Therefore, the researcher reviews and construct supply chin risks and supply chain performance of Thai cassava chip exporting to China according to the adaptation of the following table:

Table 1: The supply chain risk and the supply chain performance variables

Main variables	Sub- variables	Title/purpose and Data sources	Design /methodology/ approach
Supply chain performance	**Supply chain performance** - Dependability: meeting quoted or anticipated delivery dates and quantities on a consistent basis - Speed: time between order receipt and customer delivery - Qualities: number of faultless delivery - Information: information richness in carrying out delivery - Response: response to number of urgent deliveries	**Title :** Agri-food supply chain performance: an empirical impact of risk **Purpose:** to hypothesize the main risk factors (probability and consequence) and to prioritize the particular factors affecting agri-food supply chain operations in Ghana together with understanding the relationship between the main risk factors and to describe the risk factors impact on agri-food supply chain performance in Ghana **Data sources:** (E.Y. Nyamah et al., 2017)	Cross-sectional survey data were collected using a structured questionnaire. The relationship between the various risk factors and agri-food chain performance was collected using the Pearson correlation. The ways that firms' supply chain operations are affected by the main risk factors collected using an ordinary least square regression model to measure the sequence of some major risk factors on agri-food chain performance in Ghana
Demand side risk	**Supply chain risk factors** - Unanticipated or very volatile customer demand - Insufficient or distorted information from your customers about orders or demand quantities - Changes in food safety requirements		
Logistical and infrastructural risks	- Incremental changes in energy cost - Undependable transport - Conflicts, labor disputes affecting transport - Lack of infrastructure and services unit		
Political risks	- Political instability, war, civil unrest or other socio- political crises - Interruption of trade due to disputes with other countries - Changes in the political environment due to the introduction of new laws, stipulations		
Product risk	- Quality of product - Cost - Process	**Title :** Risk-agility interactive model: a new look at agility drivers **Purpose:** to examine the effectiveness of risk as a driver on the organizational agility. **Data sources:** (S.M. Zanjirchi et al., 2016)	Questionnaires used to identify influential risk factors of supply chain and indicators of organizational agility. The data from questionnaire evaluated using structural equation modeling technique to decide the relationship between supply chain risk and the organizational agility.

Source: The researcher adapted from (E.Y. Nyamah et al., 2017; S.M. Zanjirchi et al., 2016)

2.3 Effects of supply chain risks to supply chain performance

From the literature review, the researcher constructed the supply chain risk factors consisting of demand side risk, product risks, logistical and infrastructural risks and political risks, and the construct of supply chain performance consists of dependability, speed, qualities, information and response. Therefore, the study hypothesize the impact of the supply chain risks and the supply chain performance by the following the reasons:

H1. The demand side risk affects supply chain performance:

Demand side risks can be the source of mismatch between the expectation of the customer and the reality, so it can disturb the physical distribution of products from the firm to the customer (Christopher and Lee, 2004; Lee, et al., 1997; McKinnon, 2006). Moreover, from the study's result of Sosa et al. (2014), the demand side risks which were considered as independent variables had the positive relationship to the seller performance in the supply chain. Therefore, demand side risks can be the impact of supply chain performance.

H2. The product risks will affect supply chain performance:

Product risks have three sub variables consisting of product quality, the price of the product and product manufacturing process (Schoenherr, et al., 2008; Tang, 2006). Furthermore, quality of product and process is one of main ASCOS (absolute supply chain strategy orientation) factors affecting supply chain performance (Morita, et al., 2018). Therefore, the product risk can be influential the supply chain performance.

H3. The logistical and infrastructural risks will affect supply chain:

Logistics and infrastructure are one of important issues in most supply chains. Logistics and infrastructure are the important factors in agri-food supply chain in terms of the right product delivering to the customer at the right volume with the right condition to the right time, place and cost (Brimer, 1995; Tarantilis, et al., 2004; Aghazadeh, 2004). Hence, the ineffective logistics and infrastructure can lead some disruptions in the supply chain performance. The interruption of any decision-making; for example, reliable and affordable transportation, information system and effective communication can negatively affect the agri-food supply chain performance (Jaffee, et al., 2010; Joshi, et al., 2009; Aramyan, et al., 2007). Therefore, the logistical and infrastructural risks can lead some impacts to the supply chain performance.

H4. The political risks will affect supply chain performance:

The political issues can displace the employees and workers from the duties, and it can cause export's delay, logistics payment process of the work and firms' performance (Ksoll, et al., 2009). Therefore, the political risks can be the risk factor affecting the supply chain performance.

3. Research Methodology

The study uses mixed method between qualitative and quantitative methods by in-depth interview in field work and questionnaires to achieve its objectives. The respondents are Thai cassava chip exporters in Thai cassava supply chain industry who export Thai cassava chip to China market and registered in The Thai Tapioca Trade Association. The data will be analyzed by PLS-SEM algorithm using SmartPLS 3.2.7 software to test the relationship between supply chain risks on supply chain performance of Thai cassava exporting to China

For the sampling description, the researcher applies the guideline of PLS-SEM sampling technique of ten time rule: the minimum sample size should be more than 1) 10 times of the highest number of formative indicators used to measure one construct in the constructed model

and 2) 10 times of the highest number of structural paths directed at a particular dependent variable construct in the structural model (Barclay, et al., 1995). According to the highest number of the formative indicators in this study is 5; therefore, the sample size should be minimum at 50. However, all numbers of Thai cassava chip exporters registered in The Thai Tapioca Trade Association are only 46 (almost 50), but all of them are in the managerial level of 46 companies.

The data was collected from both primary and secondary sources. For the primary source, the researcher visited and in-depth interviewed Thai cassava chip exporters for supply chain risk and supply chain performance's identification; moreover, the researcher sharpened and strengthened the supply chain risks and the supply chain performance using literature review as the secondary source. The questionnaire consists of 3 parts which are firstly general information (company profile name, company annual revenue, the age of company, number of employee, exporting transportation mode, export proportion to China and export quantity), secondly the supply chain risks affecting to cassava ship supply chain, and thirdly the supply chain performance affecting to cassava ship supply chain with Likert scale (1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree). Therefore, the primary theoretical model was constructed as the following figure:
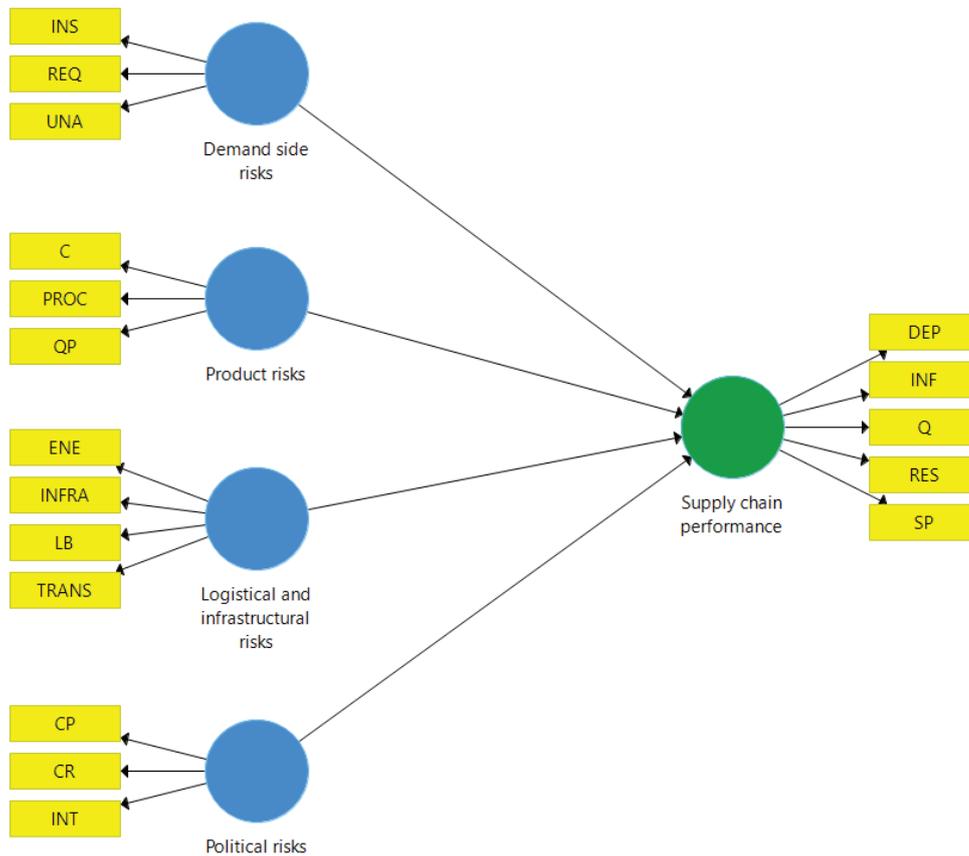

Figure 1: Primary theoretical model

4. Results

4.1 Outer model evaluation
The researcher ran the data by PLS-SEM algorithm with SmartPLS 3.2.7 software, and it showed the correlation between observed variables and latent variables of the model.
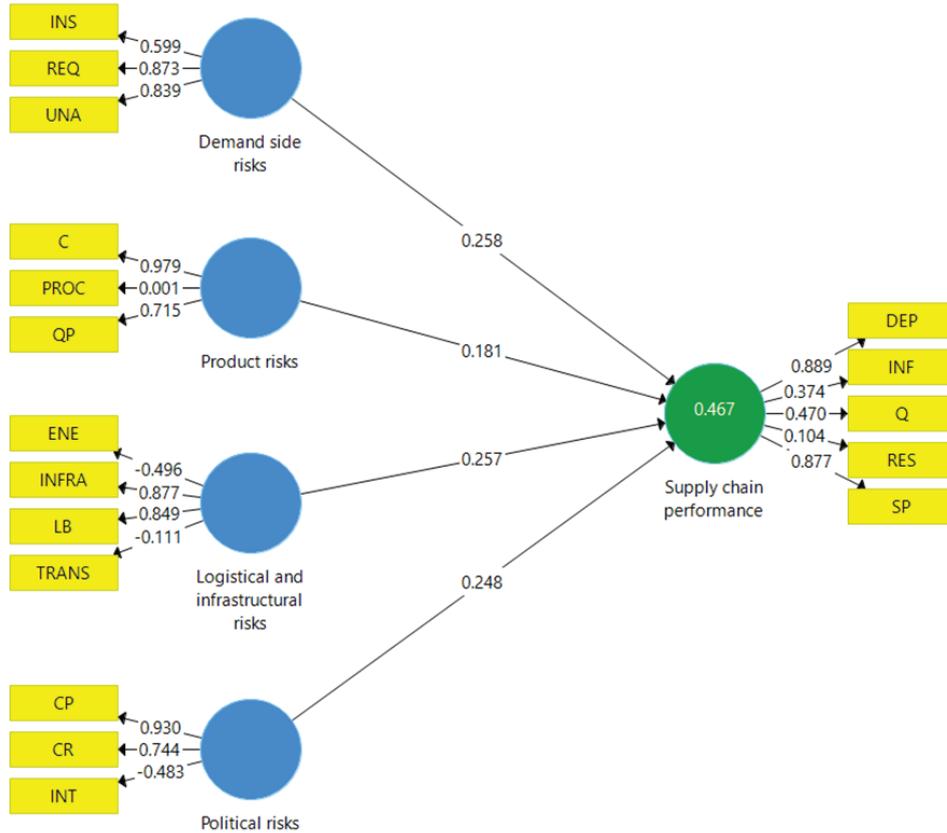

Figure 2: Full PLS-algorithm model

The figure 2 showed the outer loading score between observed variables and latent variables of the model. According to Hair, et al. (2014), he mentioned that the convergent validity of all sub variables must be more than 0.7. Therefore, the indicators of all sub variables which are less than 0.7 would be dropped out. The removed sub variables are INS (0.599) from Demand side risk (the latent variable 1), PROC (0.001) from Product risk (the latent variable 2), ENE (-0.496) and TRANS (-0.111) from Logistical and infrastructural risks (the latent variable 3), INT (-0.483) from Political risks (the latent variable 4), and INF (0.374), Q (0.470) and RES (0.104) from Supply chain performance (the latent variable 5).

4.2 Construct Reliability and Validity
After running PLS-SEM algorithm and dropping out the sub variables which are less than 0.7. The correlations among the rest of the construct model are evaluated to acquire the requirement of construct validity (table 2) and discriminant of validity (table 3 and 4) shown in the following table:

Table 2: Construct validity

Latent variables	Independent variables	Loading	Cronbach's α	Composite reliability	AVE
Demand side risk	REQ	0.902	0.750	0.889	0.800
	UNA	0.886			
Product risk	C	0.980	0.720	0.846	0.737
	QP	0.717			
Logistical and infrastructural risks	INFRA	0.914	0.801	0.910	0.834
	LB	0.912			
Political risks	CP	0.941	0.736	0.877	0.781
	CR	0.822			
Supply chain performance	DEP	0.950	0.858	0.933	0.874
	SP	0.920			

Note: AVE stands for average variance extracted

According to Juana-Espinosa and Rakowska (2018), they said that loading must be higher than 0.7 for reliability indicators. On the other hand, for consistency reliability Cronbach's α must be higher than 0.7, composite reliability must be higher than 0.8, and AVE must be higher than 0.5. From the table 2, all of the indicator loading values are higher than 0.7. In addition, all of Cronbach's α values are larger than 0.7, all of the composite reliability values are bigger than 0.8, and all of the AVE value are higher than 0.5. Therefore, all of the values meet all of the requirements of reliability and validity. To illustrate, Cronbach's α is able to show the estimation of the reliability of the variables due to their interrelationships; however, the composite reliability can show the individual reliability of items due to their different indicator loadings (Hair et al, 2014). Additionally, AVE is considered as the great mean value of squared loadings of indicators' group which is similar to a construct's communality. Hence, 0.5 of AVE means that the construct can describe its indicators with larger than half of the variance (Hair et al, 2014).

Table 3: Discriminant validity: Fornell-Larcker Criterion

	Demand side risk	Product risk	Logistical and infrastructural risks	Political risks	Supply chain performance
Demand side risk	**0.894**				
Product risk	0.169	**0.859**			
Logistical and infrastructural risks	0.349	0.495	**0.913**		
Political risks	0.317	0.396	0.356	**0.884**	
Supply chain performance	0.403	0.366	0.459	0.480	**0.935**

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

According to Valaei and Nikhashemi (2017), they said that AVE's squared root values must be equal or higher than all off-diagonal values of each construct. For example, off-diagonal values of demand side risk is 0.894 which is equal or lower than AVE's squared root values of demand risk which is 0.894 (from original AVE value of demand side risk which is 0.800). Similarly, off-diagonal values of supply chain performance is 0.935 which is equal or lower than AVE's squared root values of demand risk which is 0.935 (from original AVE value

of demand side risk which is 0.874). All in all, all of the off-diagonal values of latent variables in Fornell-Larcker Criterion are equal or lower than AVE's squared root values of themselves. According to Fornell and Larcker (1981), Fornell-Larcker Criterion is able to test discriminant validity; therefore, all of the Fornell-Larcker Criterion's evaluation meets all of discriminant validity's requirement.

Table 4: Discriminant validity: Loading and Cross Loadings Criterion

	Demand side risk	Product risk	Logistical and infrastructural risks	Political risks	Supply chain performance
REQ	**0.902**	0.229	0.296	0.336	0.373
UNA	**0.886**	0.067	0.329	0.228	0.347
C	0.202	**0.980**	0.455	0.381	0.401
QP	-0.005	**0.717**	0.458	0.306	0.116
INFRA	0.287	0.486	**0.914**	0.298	0.421
LB	0.351	0.418	**0.912**	0.354	0.417
CP	0.302	0.395	0.340	**0.941**	0.507
CR	0.255	0.288	0.285	**0.822**	0.301
DEP	0.387	0.402	0.455	0.521	**0.950**
SP	0.364	0.268	0.397	0.360	**0.920**

Note: The bold numbers describe an item's loadings which is larger than all of its cross-loadings compared to other constructs.

According to Chin (1998), he said that for cross loadings criterion, the loadings' values of indicators must be equal or higher than their cross loading constructs. From the table 4, all independent variables' loading are equal or higher than their cross loading constructs from other latent variables except their own latent variables. For example, REQ has the highest cross loading construct (0.902) in demand side risk, and it is similar to UNA which has the highest cross loading construct (0.886) in demand side risk. Moreover, DEP has the highest cross loading construct (0.950) in supply chain performance, and it is similar to SP which has the highest cross loading construct (0.920) in supply chain performance. Therefore, loading and cross loadings criterion evaluation of the model meets the requirement of discriminant validity.

4.2 Inner Model Evaluation

PLS-SEM algorithm cannot construct a standard goodness-of-fit statistic prior efforts to emerge a corresponding statistic, so it can be the model's problem (Henseler and Sarstedt, 2013). However, PLS-SEM algorithm can be accessed by using model's quality due to the prediction's capability of the endogenous constructs (inner model) consisting of coefficient of determination (R^2), and path coefficient (Hair et al, 2014). Therefore, the study will show R^2 values in the following table while path coefficient will be presented in the further step.

Table 5: R-Square

	R^2
Supply chain performance (latent variable 5)	0.368

R^2 measured the model's accuracy of prediction, or in another way, R^2 can represent how much exogenous variables can affect endogenous variable(s). The value of R^2 will be ranged from 0 to 1 with 1 interpreting perfectly predictive ability. Additionally, there are many disciplines related to R^2, but the scholar must meet "rough" rule of thumb considering for acceptable R^2 whose values 0.75, 0.50 and 0.25 meaning substantial, moderate and weak levels

of predictive ability respectively (Hair et al., 2011; Henseler et al., 2009). To illustrate, the table 5 shows R² value (0.368) which means Supply chain performance (latent variable 5) can be explained by supply chain risks consisting of demand side risk (latent variable 1), product risk (latent variable 2), logistical and infrastructural risks (latent variable 3), and political risks (latent variable 4) in the amount of 36.8%. Therefore, the predictive ability of supply chain risks to supply chain performance is 0.368 which is weak.

4.3 Hypothesis test

The results of hypothesis tests are computed by bootstrapping technique with 5000 iterations (one-tail) to analyze the structural relationships' significant level. Therefore, Path coefficient values are evaluated from PLS-SEM algorithm while bootstrapping technique provides standard error and T statistics values in the following table:

Table 6: Structural relationships, path coefficient and hypothesis testing

	Original sample	Sample mean	Standard error	T statistics	Decision
Demand side risk → Supply chain performance	0.213	0.213	0.126	1.683	Supported
Product risk → Supply chain performance	0.101	0.106	0.151	0.666	Not supported
Logistical and infrastructural risks → Supply chain performance	0.231	0.243	0.168	1.375	Not supported
Political risks → Supply chain performance	0.290	0.286	0.160	1.816	Supported

The path model is run through the bootstrapping with 5000 iterations and one-tail results in the figure below.
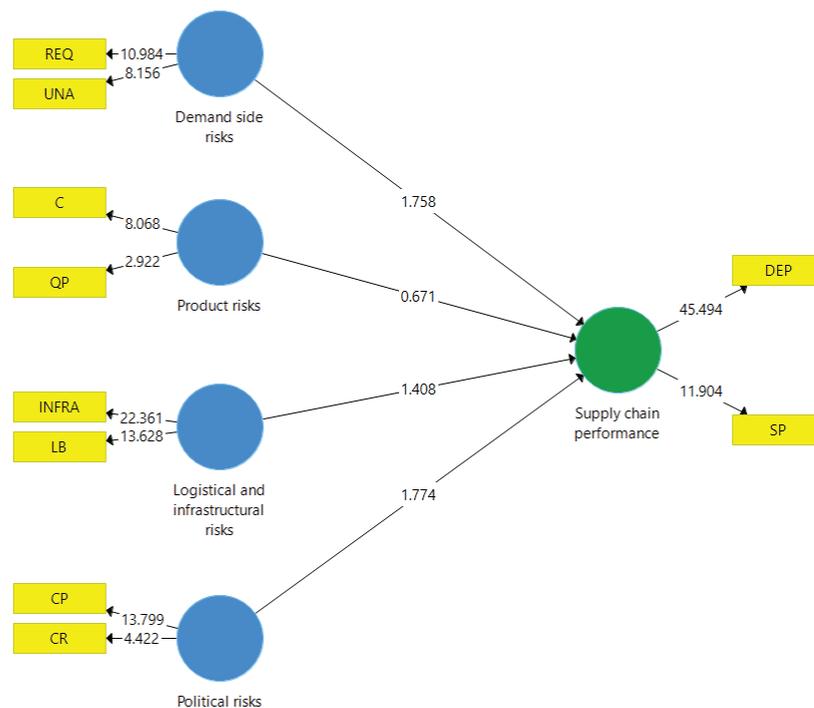

Figure 3: Bootstrapping results with 5000 iterations

According to the hypotheses of the study, the indicators meeting the requirements will be analyzed consisting of demand side risks (REQ = changes in food safety requirements and UNA = unanticipated or very volatile customer demand), product risks (C = cost and QP = quality of product), logistical and infrastructural risks (INFRA = lack of infrastructure and services unit and conflicts and LB = labor disputes affecting transport), political risks (CP = political instability, war, civil unrest or other socio- political crises and CR = changes in the political environment due to the introduction of new laws, stipulations), and supply chain performance (DEP = dependability and SP = speed).

H1. The demand side risk affects supply chain performance:

From the results, demand side risks affect supply chain performance with coefficient parameter 0.213, standard error 0.126 and t-statistics 1.683 (from t table significant 5% with 45 sample numbers' degree of freedom) which is larger than 1.68. Therefore, the H1 is supported. It is also supported by many studies. Demand side risks can be the source of mismatch between the expectation of the customer and the reality, so it can disturb the physical distribution of products from the firm to the customer (Christopher and Lee, 2004; Lee et al., 1997; McKinnon, 2006). Moreover, from the study's result of Sosa et al. (2014), the demand side risks which were considered as independent variables had the positive relationship to the seller performance in the supply chain. Therefore, demand side risks can be the impact of supply chain performance.

H2. The product risks will affect supply chain performance:

From the results, product risks do not affect supply chain performance with coefficient parameter 0.101, standard error 0.151 and t-statistics 0.666 (from t table significant 5% with 45 sample numbers' degree of freedom) which is less than 1.68. Therefore, the H2 is not supported. However, due to the reasons from statistic of cassava production and the in-depth interview, Thailand is has the highest cassava production in ASEN comparing to Vietnam and Cambodia as the competitors. Although, therefore, China whose cassava demand is very high still imports cassava chip from Thailand with less consideration on the product risk.

H3. The logistical and infrastructural risks will affect supply chain:

From the results, logistical and infrastructural risks do not affect supply chain performance with coefficient parameter 0.231, standard error 0.168 and t-statistics 1.375 (from t table significant 5% with 45 sample numbers' degree of freedom) which is less than 1.68. Therefore, the H3 is not supported. According to World Bank (2018), Thailand has logistics performance index in 32th rank with 3.41 LPI score which are higher than Vietnam and Cambodia, and it is quite high rank comparing to ASEAN countries; moreover, it is related to in-depth interview that from exporter's perspective, Thailand has higher effective logistics and infrastructure comparing to the competitors such as Vietnam and Cambodia.

H4. The political risks will affect supply chain performance:

From the results, political side risks affect supply chain performance with coefficient parameter 0.290, standard error 0.160 and t-statistics 1.816 (from t table significant 5% with 45 sample numbers' degree of freedom) which is larger than 1.68. Therefore, the H4 is supported. Moreover, it is supported that the political issues can displace the employees and workers from the duties, and it can cause export's delay, logistics payment process of the work and firms' performance (Ksoll, et al., 2009). Furthermore, in developing countries, its policy can change many times, but there is an indicator which highly political risk can lead market failures (Stiglitz, 1998). For example, according to Zinyama (2007), he said that Zambian Government changed its corn export three times in one year. Therefore, the political risks can be the risk factor affecting the supply chain performance in Thailand due to the mentioned reasons about developing country.

5. Conclusions

The study was conducted to review and construct supply chain risks and supply chain performance in Thai cassava chip industry exporting to China.The study showed that the supply chain risks in Thai cassava chip industry exporting to China consist of demand side risks (from independent variables: Changes in food safety requirements and Unanticipated or very volatile customer demand), product risks (from independent variables: Cost and Quality of product), logistical and infrastructural risks (from independent variables: Lack of infrastructure and services unit and Conflicts, labor disputes affecting transport), and political risks (from independent variables: Political instability and Changes in the political environment). On the other hand, supply chain performance in Thai cassava chip industry exporting to China consist of dependability and speed.

Additionally, the study was conducted to enhance the understanding of how the mentioned supply chain risks affect supply chain performance in the particular industry. The construct validity (consisting of loading, Cronbach's α, composite reliability and AVE values), and discriminant validity (consisting of Fornell-Larcker Criterion and Loading and Cross Loadings Criterion) meet the requirement. Furthermore, R-Square value is equal to 0.368. It means the supply chain risks consisting of demand side, product, logistical and infrastructural, and political risks are the weak predictive indicators of supply chain performance. However, from the hypothesis test, H1 "demand side risks can affect supply chain performance", and H4 "political risks affect supply chain performance" are supported due to coefficient parameter, standard error and t-statistics values (from t table significant 5% with 45 sample numbers' degree of freedom). Even if, H2 "product risks can affect supply chain performance", and H3 "logistical and infrastructural risks can affect supply chain performance" are not supported. Therefore, demand side risks and political risks in supply chain risks have relationship and direct effect on supply chain performance in Thai cassava chip industry exporting to China in perspective of Thai exporters.

6. Acknowledgement

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