Risk Factor Analysis of the Value Chain for Sawn Rubberwood Timber Exports to China

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***Abstract*— This study aims to propose risk factor analysis and to estimate how risk factors impact the average production efficiency of Thai sawn rubberwood timber exports to China as this impact could represent an aspect of the market. Data from the Risk in Value Chain concept and in-depth interviews with Thai sawn rubberwood timber exporters were used to identify the variables. The data collected from the distributed questionnaires were analyzed using exploratory factor analysis. Four significant risk factors were extracted and found to be reliable: irregularity, volatility, dependability, and ambiguity. The researchers used multiple regression analysis to estimate how risk factors impact the average production efficiency. As statistically significant results with confidence intervals of 95%, risks from irregularity and volatility were two factors that had highly negative impacts on average production efficiency. The Thai government and sawn rubberwood timber exporters could use these results as a guide to carefully develop a strategy or to plan for their future business.**

***Keywords*—** *risk factor; value chain; sawn rubberwood timber; exploratory factor analysis*

1. Introduction

Rough-sawn kiln-dried rubberwood (hereinafter referred to as RSKD) is currently one of the important industries that contribute to the continuous growth of Thailand's agricultural sector.

Current entrepreneurs and stakeholders in the sawn rubberwood industry supply chain pay attention to and look for market opportunities. There was a continuous increase in both export value and quantity from 2013 to 2017, with an average rate of change of 16.73% and 26.21%, respectively. The current major markets for Thai RSKD are China, at approximately 49 billion Thai baht or approximately 99% of Thai RSKD 2017 export value, followed by Malaysia, India, Vietnam, and Taiwan[1].

There was a problem with Thai RSKD exports to China in 2016 when the world's unstable economic situation decreased Chinese exports to the United States and the European Union, which resulted in the deceleration in Thai RSKD exports to China. Moreover, the price for Thai RSKD exports was steadily increasing, so that China bought less RSKD from Thailand per period [2]. Wood and wood product exports in the 3rd quarter of 2017 showed an upward trend compared to 2016 because of improvements in economic conditions in trade partner countries, such as the recovery of China's economy. However, global economic instability, such as China's unstable domestic economic situation due to the debt problem in the business sector, unstable politics in EU, and the fluctuation of the money market around the world [3], still limits the potential growth of Thailand's exports.

Ref. [2] stated that the RSKD industry would encounter more intense competition. Currently, there are approximately 499 RSKD factories, including small, medium, and large factories ([2], [4]), with approximately 80% of the factories located in the southern area and some factories located in the eastern area of Thailand.

Although production is increasing both in value and quantity, from the preliminary study, there is more intense competition entering the market from new competitors and the expansion of existing competitors. Hence, it is important to identify risk factors in the value chain and to understand how the exports of RSKD to China may impact production efficiency from the perspective of Thai exporters in order to provide suitable information that can help Thai exporters plan, create a strategy, and develop the RSKD export industry carefully in the future.

2. Literature review

2.1 Rubberwood

The authors have studied the agricultural product; however, there are only a few research studies related to sawn rubberwood timber in Thailand. Therefore, the authors will review and develop from existing studies. According to [5], a study of supply chain management for rubberwood manufacturing, the logistics management of the rubberwood industry consists of inbound logistics (intermediaries, transportation, grading and raw material reception), operational logistics (sawmills) and outbound logistics (quality checking, product storing, and delivering). Ref. [5] stated, as shown in figure 1, that there are three sub-industries that involve rubberwood:

a) The primary industry consists of groups of rubber farmers, intermediaries or entrepreneurs who cut down rubber trees and deliver those logs to sawmills.

b) The secondary industry is a group of rubberwood processing businesses, such as sawmills; wood drying factories; and veneer, fiberboard, and particle board factories.

c) The tertiary industry is a group of furniture and rubberwood-based-product manufacturers who are the users of the semi-finished product.

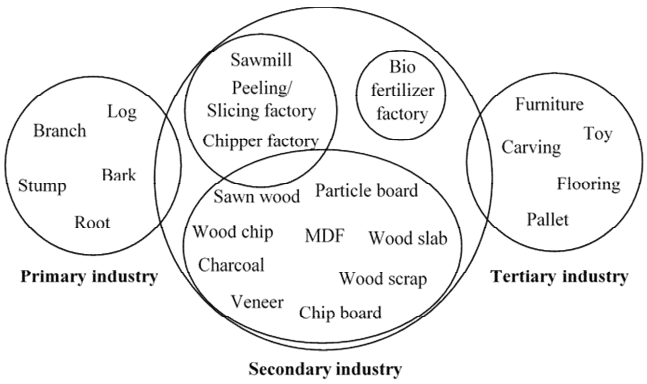

Figure 1. Rubberwood in sub-industries

2.2 Risk in the value chain

According to [6], there are five categories of risk impacting the performance of the value chain. Risks are identified by the level of risk and where the outcomes take place. Hence, the authors use this theory as a guideline to identify risks. Since there is little research about risk in the wood manufacturing industry, researchers review risks in business broadly to include as many risks as possible.

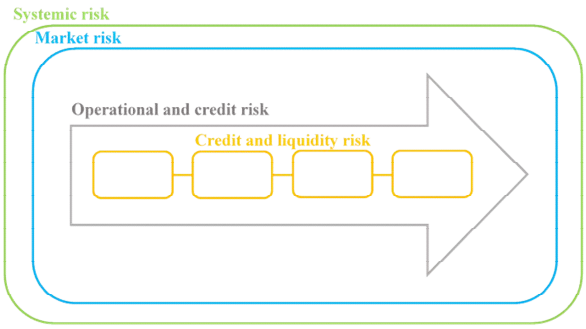

Figure 2. Categories of risk in the value chain

2.2.1 Systemic risks

Systemic risks impact the economy at large. Political, macroeconomic, sociocultural and environmental factors are examples of the potential causes of risks. Ref. [7] stated that supply chain management had been facing many constraints, and it would be more difficult to make a decision when there were disasters and catastrophes. The transportation system was damaged by harsh weather conditions in the United States which also destroyed the transportation infrastructure [8]. The airport was unable to operate, and other modes of transportation, such as maritime, were damaged during the Tsunami in 2004 ([9], [10]). According to [11], “Climatic natural disasters, political risk, and international trade”, if occurrences of disaster and the level of political risk in origin and destination countries are increasing, a reduction in trade will result. In addition, ref. [12] stated that the changing of government management regimes, unnecessary governmental interference, and the insurgence of civilians posed political risks. The study of [13] showed that government interference impacted many businesses in Russia, but the level of impact was different; for example, the impacts for forest products and machine industries were lower compared to dairy and other agricultural products. According to [14], an examination of the value added tax (VAT) and its impact on economic growth in Nigeria showed both positive and negative results in that it increased the income of the economy but adversely impacted Nigeria’s business sector. The diversity of obstacles, consisting of high taxes and anti-competitive

technical standards, restrained the competitiveness of business owners and "s" sized businesses in the export market [15]. Moreover, ref. [10] and [16] believed that the variation in foreign currency exchange rates, regardless of which currency is being used, is a risk encountered by firms conducting business using foreign currencies in correlation with the statement in [17] concerning risk management in international business that unexpected exchange rate fluctuations cause financial risk, which induces unanticipated profits or losses. Furthermore, variations in exchange rates are a major factor that can cause international risks for the timber market [18]. Decreasing global trade activities, money conservation, developing countries' capital outflows and quality of life are results of the world financial crisis [19].

2.2.2 Market risks

Market risks impact a specific economic sector. Customer needs change and technology shifts. Prices of raw materials and finished goods swing. Availability of raw materials and substitutes and the criterion of product quality are additional examples of market risks. According to [20], the price fluctuation of raw materials causes price variation in finished goods, and it can result in a serious condition if the raw material determines the price of the finished goods. In addition, ref. [18] stated in the study of "The Risk Assessment of China's Timber Imports Based on SWI Index" that timber price variation from the countries of origin was a major factor that increased the cost of raw materials and influenced market risk. Ref. [18] also stated that the resource risks in question suggested the ability of countries of origin to sustainably supply the resources that usually belong to the countries with an abundance of resources. Moreover, ref. [21] analyzed risks in the Australian timber industry and found 11 categories of risks, with rivalry from substitutions, decrease in demand for timber products, and availability of wood supply as the most important; according to [22], the study of "Substitution in the Finnish Forest Industry's Roundwood Procurement" showed that Finnish domestic roundwood prices would be impacted negatively by substituting Russian imports for domestic roundwood. Furthermore, ref. [23] stated that the demand for timber grew in parallel with the growth of population and income, but it later was maintained by the use of substitutes, such as plastics, metals and recycled timber products.

2.2.3 Operational risks

Operational risks impact the value chain of a specific industry and sometimes occur in one operation or between the connection of two operations. Operational risks such as machine problems, inaccurate demand forecasting, and unfulfilled order quantity, impact the flow of materials and information. According to [24], inaccurate demand forecasting creates unexpected situations along the supply chain. Forecasting is the activity of gathering information from every level in the supply chain to make demands more visible and more effectively forecast [25]; in addition, great costs result from poor forecasting, for example, hurried and missed revenue, excess and outdated material, and ruined relationships with suppliers. Moreover, ref. [26] studied the impact of forecast accuracy on operational performance, and, surprisingly, there was no relationship between forecasting accuracy and delivery performance. According to [27], the cost to a manufacturing companies when a machine is not working is large, resulting in schedule delays or in accidents. The result from the study of [27] showed that 55% of total cost was related to decreases in capacity, with 19% related to the cost of nonworking labor during machine downtime and 14% related to the cost of labor in repairing the machine; this finding correlated with the study of [28] that showed that the efficiency and effectiveness of production, cost, and profits were impacted by tool or machine downtime in Swedish manufacturing companies. Moreover, machine downtime results from the inappropriate treatment of equipment, such as twenty-four seven operations without breaks and inattention of management to these issues, which result in the unplanned factory closures and low productivity [29]. Additionally, the study of [30] identified that machine downtime in shipyard production systems caused delays, motivation lost, money lost and more. According to the study of [31], one factor with a high impact on the construction industry was the shortage of skilled labor, with 75% of building contractors facing shortages, which cost time and money. Furthermore, ref. [32] stated that the Australian minerals and energy industries were impacted by skilled-labor shortages, which would impede national growth and development. In 2007, eight

mineral commodities in Australia lost global market share due to skilled-labor shortages, which continued to constrain resource projects in 2010. Additionally, a major issue that impacted sustainable construction is the shortage of project managers, and these skill shortages resulted in increases in cost, time overruns, reduced quality, increased accident rates and frequent rework [33].

2.2.4 Credit and liquidity risks

Credit and liquidity risks both have the impacts on value chain or one particular operation regarding monetary steadiness. The errors occur when receiving money from customers, which can tremendously impact the financial flow of a company, are credit risks. Moreover, information asymmetries and informality of enterprise can develop credit risk. The errors occur when a company attempting to achieve short-period promise can be liquidity risks. Long credit term, company financial status, and credit limit are the example of factors that can lead to credit risks. According to [34], the performance of a group of business was impacted by the information asymmetry which can become an absolute factor for the existing of a group as each member wish to earn more profit from business and willing to destroy a group for it. Moreover, asymmetric information can cause market failure as each player in a cluster are informed unequally, for example, the information related to quality, price, and safety along the supply chain to the final customer. It impacted all players along the agricultural and food supply chain [35]. Ref. [36] stated and concluded that, the situation that customers were allowed to pay later when buying something from suppliers was called trade credit. Moreover, small companies were facilitated with trade credit and avoiding from financial constraint, but liquidity constraint can occur if the companies giving trade credit were facing with liquidity shocks. According to [37], big and key customers, who usually delay the period payment longer than give and cause to overdue, are usually offered with trade credit and better credit terms. However, suppliers suffred from giving trade credit when they have credit constraint from financial institutions which can decrease the competitive advantage in the market. Ref. [38] stated there are many fundamental sources of external funds which are the important factor for small enterprises to sustain their financial flow, employ new staffs, buy new items or tools, and develop their enterprise, and bank credit is one of them. Also, the inability of SMEs to access credit from official financial institutions, whose perceptions are that SMEs are risky and not sustained, is the main obstacle for the SMEs sector to grow [39]. Furthermore, there is a need to access adequate credit in order to develop the enterprise in the aspect of, for instance, staff development, money paybacks, enterprise expansion, and inventory increment ([40], [41]).

However, there are some variables added after an in-depth interview with Thai RSKD entrepreneurs had been done. The risk indicators were listed as shown in table 1.

Table 1. Risk variables

Category	Variables
Systemic	Exchange rate fluctuation
	Political events
	Unfavorable tax policy
	Natural disaster
Market	Threat from substitution
	Supply scarcity
	Demand fluctuation*
	Raw material price fluctuation
	Product price fluctuation*
	Less major market*
Operational	Forecasting inaccuracy
	Machine downtime
	Skilled labor shortage
	Delayed transport*
	Damaged from transport*
Credit	Information asymmetries
	Language barrier*
	Unreliable supplier*
Liquidity	Inability to access to credit
	Long credit term
	Sell through intermediary*

Note: Variables marked with * are discovered from an the in-depth interview.

3. Methodology

Data used in this research come from both primary and secondary sources. Primary data are collected by visiting and interviewing the exporters and sawmill owners, using questionnaires consisting of two parts, namely, the background information of the business (e.g., the number of employees and the income per year), and the risk management section

that consisted of the questions related to potential risk factors that could impact the Thai RSKD export industry, which were all rating questions. Likert scales (5-point scales) are implemented so that the respondents could rate the factors where 5 = Strongly agree, 4 = Agree, 3 = Neutral, 2 = Disagree, and 1 = Strongly disagree.

Moreover, self-administered questionnaires (completed by respondents while visiting them at their businesses) were used since the RSKD producers and exporters might give some feedback regarding the questionnaire so that the authors could adapt and edit the questionnaire before sending it to the rest of the population. As there are no data indicating the total number of Thai RSKD exporters, the questionnaires were sent to the whole population of 499 RSKD producers to identify the number of Thai RSKD exporters. Data were analyzed using multiple regression analysis to evaluate how potential risk factors impact production efficiency in the industry.

The data gathered are then analyzed for dimension deduction using exploratory factor analysis to help develop a more valid model. Subsequently, the extracted factors are tested to determine whether each factor was reliable using Cronbach's alpha. Last, the model is tested again using multiple regression to highlight important factors that impact average production efficiency, as it reflects the situation of the Thai RSKD industry.

4. Results

4.1. Descriptive Statistics

Out of 499 questionnaires (paper and electronic), 152 questionnaires were returned (response rate of 30.46%). There were 117 RSKD exporters from the total responses. Of these exporters, 48.7% have been operating for more than 15 years followed by 5-10 years and 10-15 years with 17.9% each and fewer than 5 years with 15.4%. Approximately 76.9% of RSKD exporters are small size businesses who have revenue of less than 500 million baht per year, followed by medium and large size business with the percentage of 15.4 and 7.7, respectively. More than half of the respondents (53.8%) report that they have 101 to 300 workers, followed by companies that have fewer than 100 workers (25.6%), 301 to 500 workers (2.6%), and more than 500 workers (17.9%). For average production efficiency, which is measured by dividing average production capacity (containers) by max production (containers), approximately 33.33% of exporters have 91-100% average production efficiency, followed by 81-90%, 71-80%, less than 60%, and 61-70% with the percentages of 25.64, 17.95, 12.82, and 10.26, respectively.

4.2. Exploratory Factor Analysis

In the analysis, the authors used factor analysis to extract factors from 19 items by using the principal component extraction method together with Varimax rotation, the Kaiser-Meyer-Olkin value of 0.721, which verified that the sampling was adequate [42], and Barlett's test of sphericity $p<0.001$. The factor scores for synthetic variables were generated by using the Anderson-Rubin method, which made the mean equal to 0 and standard deviation equal to 1. Analysis using Kaiser's criterion identified 6 components with an eigenvalue above 1; however, there was one factor with only one variable that was internationally unacceptable. Therefore, the authors had to remove the factor according to the point of inflexion identified in the screening test [43], which justified the 4 components to be retained. Thus, factor analysis was run again according to these criteria. The percentage of variance explained after re-running the analysis was 63.47%. Rotation, eigenvalues, factor loadings, the percentage of variance explained for each factor, and Cronbach's alpha are illustrated in Table 2. The variables grouped on the same factors recommended that factor 1 represented risk from irregularity, factor 2 represented risk from volatility, factor 3 represented risk from dependability, and factor 4 represented risk from ambiguity.

Table 2. Summary of exploratory factor analysis results for risk factors (n=117)

Item	Rotated Factor Loadings			
	Risk from Irregularity	**Risk from Volatility**	**Risk from Dependability**	**Risk from Ambiguity**
Machine downtime	**0.777**	0.049	0.005	0.055
Political events	**0.777**	-0.049	0.028	0.159
Natural disaster	**0.716**	0.270	-0.066	-0.043
Forecasting inaccuracy	**0.692**	0.279	-0.028	0.272
Skilled labor shortage	**0.638**	0.356	0.295	0.066
Supply scarcity	**0.568**	0.168	0.196	-0.018
Delayed transport	**0.568**	0.183	0.121	0.397
Supplier's reliability	**0.556**	0.034	-0.031	0.376
Unfavorable tax policy	**0.523**	0.296	0.426	0.129
Demand fluctuation	0.149	**0.899**	-0.003	0.043
Product price fluctuation	0.009	**0.850**	-0.002	0.244
Raw material price fluctuation	0.344	**0.687**	-0.192	0.205
Less major market	0.362	**0.549**	0.248	-0.272
Threat from substitution	0.344	**0.527**	0.358	-0.334
Sell through intermediary	-0.064	-0.058	**0.859**	-0.014
Long credit term	0.175	0.215	**0.762**	0.041
Inability to access credit	0.029	-0.222	**0.743**	0.332
Information asymmetry	0.282	-0.049	0.191	**0.786**
Language barrier	0.126	0.244	0.082	**0.784**
Eigenvalues	6.213	2.352	2.005	1.490
% of variance	32.70	12.38	10.55	7.84
Cronbach's α	0.865	0.809	0.741	0.716

Notes: Extraction method: principal component analysis; rotation method: Varimax; KMO=0.72; Barlett's test of sphericity $p<0.001$; items load on factors more than 0.5 were indicated in bold.

The authors dropped two items with a factor loading lower than 0.5 based on [44] that showed that a factor loading over 0.5 was enough when the sample size was between 100 and 200. The two factors dropped were *exchange rate fluctuation* and *damaged from transport*. However, dropping these items allowed the researchers to avoid the multicollinearity problem in further analysis in this study when multiple regression was performed. Cronbach's alpha values were all above 0.7, following the instruction suggested by [45] that the dimension was acceptable when Cronbach's alpha value was above 0.7, and it would be preferred if the value was above 0.8. According to factor analysis, the authors proposed the following model for estimating the impact of risks on average production efficiency of Thai RSKD export industry (figure 3).

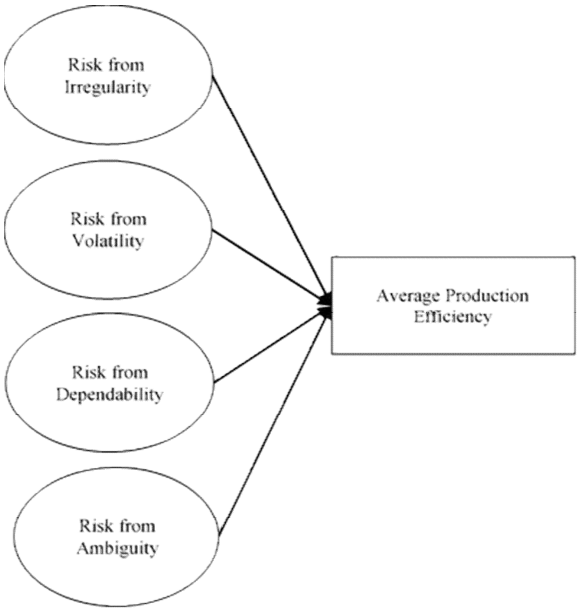

Figure 3. Categories of risk in the value chain

4.3. Multiple Regression Analysis

To discover the impact of risks on the average production efficiency of the Thai RSKD export industry, multiple regression analysis was implemented using factor scores generated from factor analysis using the Anderson-Rubin method.

Table 3 demonstrates how average production efficiency was affected by risk factors. After completing the analyzing procedure, reliability test, and multiple regression analysis, the overall results indicated that the proposed model was statistically significant with a significance value of 0.000 ($p < 0.05$), and the model explained 69.2% of the variance in average production efficiency. The regression coefficients supported the following conclusions:

- the significant predictors of average production efficiency were the risks from irregularity, volatility, dependability, and ambiguity;
- the most important factor that impacted average production efficiency was the risk from *irregularity*;
- the second most important factor that impacted average production efficiency was the risk from *volatility*;
- the third most important factor that impacted average production efficiency was the risk from *dependability*;
- the fourth most important factor that impacted average production efficiency was the risk from *ambiguity*.

Table 3. Multiple regression analysis for risks affecting average production efficiency.

Risks	Error	Standardized Coefficients β	Significance	Tolerance	t	VIF
Irregularity	0.007	-0.574	0.000	1.000	-10.963	1.000
Volatility	0.007	-0.512	0.000	1.000	-9.779	1.000
Dependability	0.007	-0.210	0.000	1.000	-4.012	1.000
Ambiguity	0.007	-0.236	0.000	1.000	-4.505	1.000
R^2		**0.692**				
Significance		**0.000**				

Notes: Significant at a confidence level of 95% ($p<0.05$)

5. Discussion

Four factors were extracted for estimating average production efficiency, which were the risks from irregularity, volatility, dependability, and ambiguity, comprised of 19 variables after deducting two variables that had factor loadings lower than 0.5, namely, exchange rate fluctuation and damage from transport. After validating the factors, the researchers tested the model's reliability using a Cronbach alpha over 0.7 as standard, and all the factors passed. The model from exploratory factor analysis was proposed, and researchers continued to estimate the impacts from risk factors on average production efficiency using multiple regression analysis and factor scores generated using the Anderson-Rubin method. The result from multiple regression analysis indicated that risk from irregularity was the most important factor that impacted average production efficiency, which is consistent with results from [26], [27], [28], and [31], followed by volatility, which was similar to the results of [22], dependability, as supported by [37], and ambiguity, which was in accordance with [35].

6. Conclusion

The authors proposed risk factor analysis constructed from literature review and in-depth interviews with Thai RSKD entrepreneurs and estimated the impact on average production efficiency from the following risks factors: risks from irregularity, volatility, dependability, and ambiguity. The authors sent 499 questionnaires to all RSKD producers in Thailand [4] and performed exploratory factor analysis to develop a more valid model.

As the Chinese market situation is unpredictable, and the increase in supply from the Thai side is threatening the Thai RSKD export industry, entrepreneurs should be concerned about the risks from each of these factors, but should be most concerned about irregularity and volatility according to the results of this study.

The limitations of this study were that the sample size was small, and there were limited sources in the literature. It could be better for future studies to implement structural equation modeling, as it could provide more insight and accurate results; however, a larger sample size would be needed. The authors also suggest a study using more variables that could represent the situation more broadly and not only in average production efficiency.

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