THE EFFECT OF THE DEVELOPMENT OF CHINA-LAOS RAILWAY ON THAILAND'S EXPORT TRADE TO CHINA

SIYUAN WEI

A Thesis Submitted to the Graduate School of Naresuan University
in Partial Fulfillment of the Requirements
for the Doctor of Philosophy in Logistics and Supply Chain
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has been approved by the Graduate School as partial fulfillment of the requirements for the Doctor of Philosophy in Logistics and Supply Chain of Naresuan University

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Title THE EFFECT OF THE DEVELOPMENT OF CHINA-LAOS RAILWAY ON THAILAND'S EXPORT TRADE TO CHINA
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ABSTRACT

With the development of economic globalization, China's trade with Thailand has increased significantly. Trade performance and competitiveness have always been an important factor affecting Thailand's exports. The goal of this research was to analyze the effect of the development of the China-Laos railway on the export trade from Thailand to China. A literature review was undertaken to gain information regarding the main industries and provinces of Thailand involved in the export trade with China. Secondary data analysis was used to obtain information on the current main trade routes and on the new trade routes between Thailand and China that will be created after the completion of the China-Laos railway. The existing trade routes were compared with the potential new trade routes to identify and analyze the potential effect of the China-Laos railway on future China-Thailand trade, and the weighting of the various determining factors on the future export trade were calculated by applying the Analytic Hierarchy Process (AHP). The findings from that analysis were that the freight cost and journey time are the two most important determining factors in route selection, together with security, capacity and distance. TOPSIS method (Technique for Order of Preference by Similarity to Ideal Solution) was applied to compare the performance of the new and the existing routes based on these determining factors. Linear regression methods were applied to predict the export trade volume that the China-Laos railway will bring to Thailand in the future,

The prediction arising from the modelling is that the China-Laos railway will help Thailand achieve a total of $2,246,400,000 of exports to China, which will account for 7.43%-9.29% of Thailand's total export to China. The conclusions arrived at included that the new route is likely to provide better transportation performance for all Thai industries doing business with China, both importers and exporters. It was concluded that the new route has obvious advantages in safety, convenience and time factors. However, there is little difference in terms of cost and transport capacity between the existing routes and the new route of the China-Laos railway. Based on the results of this study, a framework was developed that encompasses all necessary considerations to take advantage of the new routes. This framework will be important in informing governments and companies in taking advantage of the new routes. The framework introduces the key roles that will be played by the new routes in enhancing trade between Thailand and China and provides valuable advice to governments and exporters on the rational use of the new routes to improve trade performance and export competitiveness.

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CHAPTER I

INTRODUCTION

Background

China is Thailand's largest trading partner. In 2019, bilateral imports and exports of goods between Thailand and China reached $80 billion, Among them, Thailand’s exports to China were $29.02 billion, accounting for 11.8% of Thailand's total export. Thailand's imports from China reached $50.98 billion, which was 21.2% of the Thailand's total imports. China is the largest source of Thailand's trade deficit, reaching $21.96 billion. In 2019, Thailand's plastic and rubber exports to China were the highest value commodities exported to China, with an export value of $7.48 billion, accounting for 25.8% of total exports to China. The export of mechanical and electrical products reached $6.24 billion, which was 21.5% of total exports to China. The export of plant products amounted to $3.7 billion; 12.8% of total exports to China, and was the third largest export category (Table 1). The total export value of these three types of products made up 60% of the total export value from Thailand to China over consecutive years. Increasing the export value of these products would reduce Thailand’s trade deficit with China.

This was the impetus for studying the export of these three types of products: plastic and rubber, mechanical and electrical products, and plant products. Thai products are mainly exported to five regions in China, namely Guangdong, Jiangsu, Shanghai, Shandong and Zhejiang. China and Thailand are not direct neighbors, having no common border, so trade was mainly been transported by sea, by road and by air. However, rail transportation has always been important in international trade, and when the China-Laos railway is completed, which is expected to be accomplished in December 2021, it will become an important alternate mode of transporting of goods and passengers between China and Thailand, with 18 daily services, 14 for transport of goods and 4 passenger services, While the railway is called the China-Laos railway, trade volume between China and Laos is small and the completion of the railway will have a more significant effect on trade between China and Thailand.

In anticipation of the completion of the railway and the commencement of services, Thai exporters need better detailed information regarding the China-Laos railway, particularly about the new routes that will be opened, and the suitability of these new routes for their own industry. To assist exporters to understand the potential of the new railway, a framework has been developed in this research program that will include a summary of the new routes that may be formed after the completion of the railway, with a comparison between the new routes and the existing routes. This framework will inform exporters and enable them to better understand the opportunities offered, and to adapt their logistics plans to take advantage of those opportunities, thereby enabling them to become more competitive and to increase their export volumes.

To develop this framework, the author first undertook a review of the literature discussing and describing the main export industries and destinations of products traded between Thailand and China, to gain a greater understanding of the facts. An analysis of available secondary data was then performed to ascertain and define the determining factors for route selection that would be applied to compare the potential performance of the new routes with that the existing routes. Subsequently, in-depth interviews were conducted with important exporters to ascertain their future requirements and their views and opinions on the importance of the new railway to the development of their businesses. AHP analysis (The Analytic Hierarchy Process) was used to calculate the weights of these determining factors for each industry. Finally, the TOPSIS analysis method (The Technique for Order of Preference by Similarity to Ideal Solutions method) was used to calculate and compare the performance of the new routes and the existing routes to choose the most suitable routes. The framework model developed in this research was therefore able to demonstrate the advantages of these new routes for increasing the volume of exports from the main exporting industries, which will contribute significantly to the reduction of the Thai trade deficit with China.

1. The main components of Thailand's exports to China

Thailand mainly exports three kinds of products to China, they are rubber and plastic, mechanical and electrical products and plant products. The data is summarized in table 1. The total export value of these three types of products made up

60% of the total export value from Thailand to China over consecutive years. Therefore, the author analyzed these three products as the main export products. And the paper found that they all apply to railway transportation.

Table 1 The main components of Thailand's exports to China

The main components of Thailand's exports to China						Units: dollars (million)
The customs classification	HS code	Commodity categories	In 2019	In 2018	Percentage increase	Percentage
category	code	total value	29,021	30,056	-3.40%	100%
class 7	39-40	Plastic, rubber	7,480	8,113	-7.80%	25.80%
class 16	84-85	Mechanical and electronic products	6,241	6,826	-8.60%	21.50%
class 2	06-14	Plant products	3,700	3,284	12.70%	12.80%
class 6	28-38	Chemical products	2,381	3,182	-25.20%	8.20%
class 17	86-89	Transportation products	1,487	1,070	39.10%	5.10%
class 18	90-92	Optics, clocks, medical equipment	1,383	1,271	8.80%	4.80%
class 9	44-46	Wood products	1,113	1,354	-17.80%	3.80%
class 4	16-24	Food, tobacco, beverages	1,079	853	26.50%	3.70%
class 5	25-27	Minerals	1,071	1,396	-23.30%	3.70%
class 15	72-83	Base metals and products	668	548	21.90%	2.30%
class 1	01-05	Live animals, animal products	639	353	81.10%	2.20%
class 11	50-63	Textiles and Raw Materials	494	503	-1.80%	1.70%
class 14	71	Precious metals	303	347	-12.70%	1.00%
class 8	41-43	Leather goods and bags	300	244	23.00%	1.00%
class 10	47-49	Cellulose pulp and paper	250	308	-18.70%	0.90%
		others	431	405	6.5%	1.50%

Source: Ministry of Commerce of the People's Republic of China

1.1 Thailand's export of plastics and rubber to China

Thailand commenced exports of plastic and rubber to China in 1989 so there is already more than 20 years of history of the export of these products from what is one of the largest industrial sectors in Thailand. The value of Thai exports of these products to China in 2019 reached $7.6 billion, which was 25.8% of all exports. In these product categories, the value of plastic products exported was $3.6 billion; 47.1% of this product category, and rubber exports valued at $4 billion accounted for 52.9% of the total of this product category. The export volume of plastics has been increasing since 2016 while the export volume of rubber has begun to decline. (Table 2) (Chuenchom, 2017).

Table 2 Exports of plastics and rubber to China

Year	Plastics and plastic goods	Rubber and articles thereof	The total value（US Dollars）	The percentage	
				Plastics	Rubber
2009	1,199,100,753	2,422,707,612	3,621,808,365	33.11%	66.89%
2010	1,827,610,524	3,944,835,007	5,772,445,531	31.66%	68.34%
2011	2,636,590,013	6,992,117,588	9,628,707,601	27.38%	72.62%
2012	2,777,587,138	5,817,232,466	8,594,819,604	32.32%	67.68%
2013	3,043,304,794	6,161,156,118	9,204,460,912	33.06%	66.94%
2014	3,235,239,234	4,619,306,756	7,854,545,990	41.19%	58.81%
2015	2,918,710,222	3,826,633,219	6,745,343,441	43.27%	56.73%
2016	2,653,535,520	3,718,154,116	6,371,689,636	41.65%	58.35%
2017	2,882,298,103	5,794,390,148	8,676,688,251	33.22%	66.78%
2018	3,411,560,845	4,800,120,821	8,211,681,666	41.55%	58.45%
2019	3,625,374,556	4,072,649,235	7,698,023,791	47.09%	52.91%

Source: Ministry of Commerce of Thailand

1.2 Thailand's export of mechanical and electronic products to China

Thailand's key exports to China are shown in Tables 3, and include automatic data processing equipment, electrical, commercial and consumer electronic and communication equipment, as well as automobiles and automobile parts and accessories.

In 2019, apart from electrical equipment which showed a 2% increase of $789,47,100, the other export categories showed decreases in the value of exports. The value of automatic data processing equipment, parts and accessories exported was $661,234,800, down 6% from the previous year, electronic components value was $465,876,800, down 2.46%, communication equipment and parts; $195,328,400, down 11.23%, and automobiles and automobile parts and accessories; $72,156,344, down 55.58%.

Table 3 Exports of mechanical and electronic products s to China

Year	automatic data processing equipment and its parts, accessories	electronic components	communication equipment and parts	automobile and its critical parts, accessories	electrical equipment
2018	$621,560,712	$477,626,410	$220,0387,52	$162,411,117	$80,582,653
2019	$661,234,800	$465,876,800	$195,328,400	$72,156,344	$78,947,100

1.3 Thailand's export of plant products to China

Thailand has a large and important agricultural sector and China is the largest exporter of plant products to Thailand. China and Thailand have reached an agreement of zero tariffs on fruit and vegetables, which has created good conditions for the trade of agricultural products between the two countries. (Nirat, 2016). In addition, the trade of plant products between China and Thailand is highly complementary rather than competitive. The main products are vegetables (HS 07), fruit (HS 08), cereals (HS 10), wheat (HS 11), as listed in Table 4. Although the trade in agricultural products between China and Thailand has experienced constant growth, in recent years, that growth has been weak when compared to the industrial products trade, and the proportion of exports is not high. However, with the further opening of the China market, Vietnam plant product exports have increased substantially, which has had a huge impact on Thailand. Thailand's exports of plant and agricultural products to China will face more severe challenges in the future (Ma, 2018).

Table 4 Exports of plant products to China

Year	Vegetables	Fruits	Cereals	Starch and malt
2017	1,092,152,578	663,913,892	573,716,839	550,871,952
2018	907,628,524	888,467,174	552,108,592	745,980,475
2019	538,434,272	1,017,780,267	303,862,662	679,924,086

Source: Office of Agricultural Economics of Thailand

2. **China-Laos railway**

The China-Laos Railway is an essential part of the Pan-Asia Railway, and the opening of the China-Laos railway, by connecting the regions along the course of the railway, will form a new economic growth circle and change the original economic spatial layout (Tao, 2017). This will promote the formation of regional economic integration and significantly promote the economic growth of both China and ASEAN.

The China-Laos railway connects Kunming, China, with Vientiane, Laos. The railway has a total length of more than 900 kilometers. The mainline in China has a length of 509 kilometers, and Laos has 414 kilometers (Xu and Liu, 2018). The designed speed is 160 km/h, but the freight services speed will be 120 km/h. There are 7 stations in the China section and 11 stations in the Laos section, as depicted in Figures 1 and 2. There will be 18 trips a day, including 4 passenger services and 14 freight services. The passenger fare is 4 cents /person/km, and the freight price is 7 cents /ton /km. (Huang, 2020). The China-Laos railway adopts the international railway standard, with a track spacing of 1,435 mm. The railway line has 170 Bridges and 72 tunnels, with a bridge to tunnel ratio of 63%. Single carriage Gross Weight is 60 tons maximum (Zhang, 2016). While the planned freight capacity is 19 million tons/year, the head of the construction of the railway has predicted that the upstream traffic of the line (from Vientiane to Boten) could reach 2.59 million tons/year in the initial stage, 3.62 million tons/year in the short term, and 6.45 million tons/year in the long term (Genjie Wang, 2017)

Figure 1 China section of the China-Laos Railway

Source: China Railway Eighth Bureau Design Drawing in September 2018 by Mei Zhengyou (senior engineer)

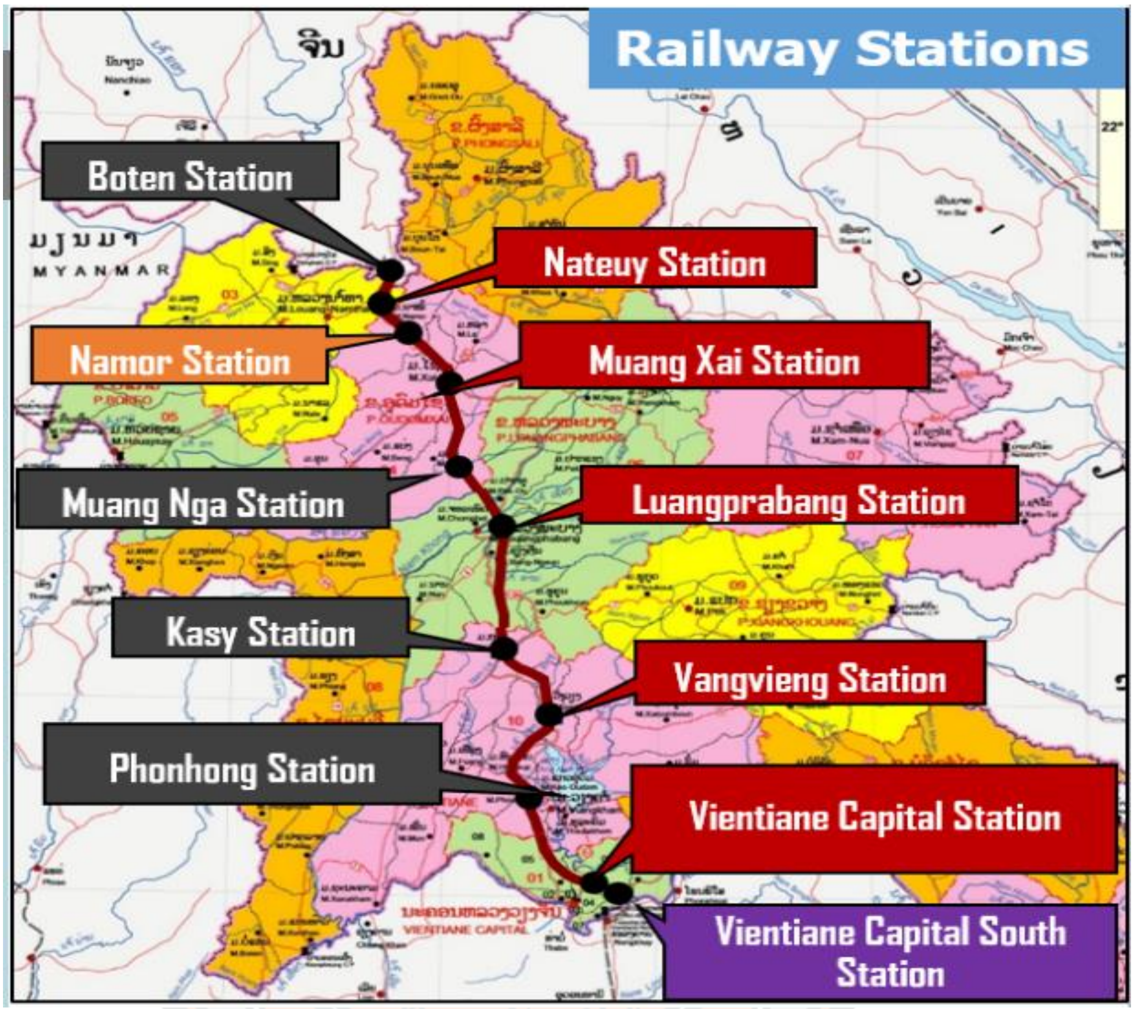

Figure 2 Lao section of the China-Laos Railway

Source: A study to develop a strategic plan for supporting Laos-China Railway construction project (Boten-Vientiane) in January 2019 by Dr. Boonsub Panichakarn

Research Questions

1. What are the routes for the export of the main industries from Thailand to China?

2. What are the determining factors for route selection for the main industries?

3. How to take advantage of these new routes from the connectivity by China-Laos railway to improve the trading performance for the Thai exports to China?

Objectives of the Study

1. To identify the main industries in Thailand with exports to China
2. To identify the existing routes of the exports of the Thailand's main industries exporting to China and the new routes from the connectivity by China-Laos railway
3. To identify the determining factors on route selection for Thailand's main industries of export from Thailand to China.
4. To evaluate whether the new routes from China-Laos railway will be advantageous for the industries over the existing ones.
5. To develop a framework for taking the advantage of these new routes to improve the trading performance between Thailand and China.

Research significance

Transportation has always been a critical issue affecting Thailand's exports to China. However, there have been only a few studies on rail transport between the two countries, and There is very little published research on the impact of the China-Laos railway on Thailand. To address this gap in the research, and to provide important information on the impact of the China-Laos railway and its potential role trade cooperation between China and Southeast Asian countries, these questions are addressed in this research.

The effect of the China-Laos railway on China-Thailand trade was the primary focus in this research. The main exporting industries and the main railway routes between Thailand and China were identified and analyzed to provide relevant and important reference information to producers, exporters and logistics companies likely to be impacted. As well, the determining factors for route choice were identified and analyzed to evaluate the benefits, or otherwise, of the new routes, to Thailand's exports to China. This will demonstrate how the railway will serve as an important mode of transportation and travel connection between Thailand and China.

The ultimate outcome of this research was a framework identifying and applying the determining factors for utilization of the railway to the benefit of Thai exporters, enabling and enhancing their analysis of the advantages of the new routes and the potential improvement of the trading performance between Thailand and China.

CHAPTER II

LITERATURE REVIEW

Introduction to Transportation Mode

1. Road transport

Road transport is the means of transport of passengers and goods by land, usually in large vehicles. Road transport has been an important part of goods transport since the end of the end of the 19th century with the advent of the automobile (Bacero, & Vergel, 2009). However, road transportation has been utilized mainly for short-distance passenger and cargo transport and in remote and economically backward areas, particularly areas with rugged terrain, and which are sparsely populated, roads have been the main mode of transport and communication, and often feeding into a transport trunk. Following World War 1, with the fast development of the automobile industry and the increase in highway construction and distance covered, road transportation became a major mode of long-distance transportation (Akbardin, 2018). After the end of World War II, road transportation developed rapidly. Many Countries in Europe and the United States, Japan and other countries have built a relatively developed road network, and the automobile industry has provided a solid material foundation to promote road transportation in the transportation industry to the leading position. The passenger and cargo turnover completed by road transport in developed countries accounts for about 90% of the total turnover of various modes of transport. (Cervero, & Colub, 2007). Road transport is a way of transporting passengers and goods over highways. It is an integral part of the transportation system. Mainly undertake short-distance passenger and cargo transport. The main means of transport in modern times is the automobile. Therefore, road transport generally refers to car transport. In rugged terrain, sparsely populated, railway and water transport is not developed in remote and economically backward areas, highway as the main mode of transport, play the role of transport trunk.

1.1 Flexible and adaptable

The density of road traffic on highways is more than ten times that of railways and water networks, with a significantly wider distribution. Road transport is also more flexible in terms of time and convenience as vehicles can be loaded and dispatched at any time, and with shorter connection time between each link (Juraj, 2019).

1.2 Direct transport

Cars are small in size and generally do not need to be changed during the journey. Passengers and goods can be transported directly door-to-door without change of vehicle during the journey. For goods transport, this provides a greater convenience than rail transport particularly (Stefano, 2020).

1.3 Fast capital turnover

Compared with rail, water and air transportation, road transportation requires simple fixed facilities and the cost of purchase and ownership of the transport vehicle is comparably much lower, allowing investment in both facilities and vehicles more available to both large and small operators, and the investment having a short payback period. According to available data, investments in road transport vehicles can be turned over 1 ~ 3 times a year, under normal operating conditions, while railway transport requires 3 ~ 4 years to turn over once. Given the huge investment in cargo ships, which will exceed $130 million, investment payback on ships is multi-year (Jara-Diaz, 2000).

1.4 Short transport distance and small transport volume

The normal load of cargo vehicles, trucks, lorries, tractors, prime movers, as they are variously known and styled, is in the range of 10 to 30 tones, but some road transport rigs, including those referred to as road trains in Australia, can haul up to 200 tons. Even this haulage capacity is much less than that of trains and ships. On a per mile/per tons cost basis, road transport is higher than rail or seagoing transport (Xian, 2020).

2. Air transport

Air cargo transport has developed rapidly since the 1960s, with the advent of the Boeing 747 and its predecessor, the Boeing 707. The large carrying capacity of these planes, and their successors, ushered in an era of incomparable superiority in air transport. With the development of smaller short-haul planes, air transport will be more important in the future, even for short routes. Air transport is swift and safe. The high efficiency of just-in-time has won a considerable market, greatly shortened the delivery time, and greatly promoted the capital turnover and circulation of the logistics supply chain (Chen, 2020). It is generally more urgent goods, road transport cannot meet the requirements of the customer's time, the customer will choose air transport. Air transport is swift and safe. The high efficiency of just-in-time has won a considerable market, greatly shortened the delivery time, and greatly promoted the capital turnover and circulation of the logistics supply chain. Airlines have poured flights into the cargo pie. But air freight costs more than sea freight and railway (ATAG, 2020).

2.1 High delivery speed

Market competition in the world is very fierce and fast changing. Time and cost are important factors for enterprises to consider, as is the efficiency of their logistics systems, especially in the face of the Just-in-Time replenishment policies being adopted by organizations in their agile and lean production and distribution systems. Air transportation has become a favorable factor for commodity competition in the current international market (Xia, 2017).

2.2 Suitability for fresh, perishable and seasonal goods

The time requirement of fresh and perishable goods is very high, and any transportation delay will reduce the market value of these goods (Matin, 2018). Air transportation, offering even over-night international delivery schedules, can ensure the freshness and quality maintenance these commodities, which is conducive to the development of long-distance markets. For seasonal goods, air transport can ensure that the market before the arrival of the selling season, avoiding the cost of missing the season caused by the goods cannot be sold.

2.3 Low damage rate and good safety

The value of the cargo transported by air is high, the ground operation process of air transportation is strict, and the management system is perfect, which makes the cargo damage rate very low and provides significant cargo safety.

2.4 Save packaging costs and speed up capital turnover

Fast air transportation, short transit time and fast delivery can reduce the quantity of goods required to be in stock, storage fees, insurance and interest expenses. In addition, air transport custody systems provide cargo security resulting in lower stock losses, product packaging is simplified by not requiring strong packaging materials, reducing the packaging costs, and insurance costs are lower due to the lower risk of loss or damage. Product circulation speed is accelerated, with accelerated capital turnover (Oscar, 2018).

2.5 Influence or Restrictions Imposed by Geographical Conditions

Geographical conditions at the location of airports and terminal impose no significant restrictions on goods storage and distribution. Air transport is very suitable for inland areas and remote areas with poor ground conditions and inconvenient transportation. The means that utilizing air cargo transport systems is conducive to the export of local resources and the development of local economies. Compared with road and railway transport, air transport terminals and facilities occupy less land area, making it undoubtedly very suitable for the development of external transport in a small and expensive area. (Norwood, 2002)

The specific operation of air transport mainly has flight transport, charter transport, centralized consignment, air express, container transport. The term "air transport" refers to aircraft that operate regularly, have a fixed route and a fixed departure station, transit station and destination station. Its biggest characteristic is that it can grasp the exact time of departure and arrival (Halpern & Graham, 2015). Charter transport refers to the leasing of the whole aircraft or part of the cabin space by an airline or a charter agent from one or more airports to a designated destination according to the conditions and rates agreed in advance between the two parties and the charterer. Generally speaking, charter fares are lower than flights, but the range of activities is smaller. Air express transport is air express. This method is especially suitable for the rapid transportation of small items such as urgent items, medical equipment, valuables, drawings, key parts, samples, documents and so on, which ADAPTS to the needs of the fast pace of modern society. Container transport mode in the use of air transport is the general trend. However, due to the special shape of aircraft cabin, in addition to the standard container that can be used in the cargo hold of large aircraft, the container generally needs to use non-standard boxes of different sizes, volumes and shapes. The use of container transport is mainly to improve transport efficiency, as well as saving packaging, conducive to turnover and so on (Koo,2016).

3. Sea-Going transport

Sea-Going transport is a mode of transport in which ships are the main means of transport, ports or port stations are the transport bases, and water areas including oceans, rivers and lakes are the scope of transport activities. Sea-Going transportation is still one of the most important modes of transportation in many countries of the world. It is the most important mode of transport in international logistics. Shipping makes up more than 80% of the total volume of international trade. Apart from bulk cargoes, such as coal, iron ore, petroleum products and bulk grains, most cargo is container cargo and huge container ships. The advantages of ocean transportation include large volume and low cost, although slow speed, high risk of navigation, and inaccurate sailing dates are disadvantages (Taehee, 2017).

3.1 Natural waterways

Marine transportation is carried out by means of natural waterways, not restricted by roads and tracks, and has stronger pass-ability. With the change of political, economic and trade environment and natural conditions, the transportation task can be adjusted and changed at any time.

3.2 Large carrying capacity

With the development of international shipping industry, modern shipbuilding technology is becoming more and more sophisticated, and ships are becoming larger and larger. Fifth-generation container ships up to a deadweight of up to 200,000 tons with a container carrying capacity in excess of 14,000 TEU (a measure of the container carrying capacity of 20’ containers).

3.3 Low freight

The sea transportation channels are naturally formed and do not require construction or maintenance except in the approaches to ports. Port facilities are generally built by governments, so the capital investments required by companies operating the sea transportation business is limited to the cost of their ships. The large carrying capacity, long service time, long transport mileage and low unit transport cost provide favorable conditions for the transport of low-value bulk goods as well as mixed cargoes carried in containers (Vasileios, 2017).

Sea-Going transport has the following four forms: 1) coastal transport. It is a way to use ships to transport passengers and goods through coastal channels near the mainland, generally using medium and small ships. 2) Offshore transportation. It is a form of transport using ships to carry passengers and goods through the sea lanes of neighboring countries on the mainland. Medium-sized ships or small ships can be used depending on the voyage. 3) Ocean transportation. It is the use of ships across the ocean long-distance transport form, mainly rely on large shipping volume. 4) Inland river transport. It is the use of ships in the inland rivers, rivers, lakes, rivers and other waterways for transportation of a way, mainly the use of small ships (Chang, 2019)

4. Railway transport

Railway freight transport has been a major mode of goods transportation for over a century. However, in the USA and North America rail transport cargo tonnage is just 25% of the cargo tonnage carried by road, and in Europe that percentage volume is even less. China's recent extension of rail cargo services, the Yiwu – London Railway Line, which is a freight railway route from Yiwu, China, to London, United Kingdom, covering a distance of roughly 12,000 km (7,500 miles). It is one of several long-distance freight railway routes from China to Europe on the "New Eurasian Land Bridge" which has elevated rail transport in importance in the international trade sphere. Railway transport is not usually affected by the climate and natural conditions, and provides significant transport capacity and cycling loading capacity (Yin, 2020). Rail transport units come in many different sizes and configurations enabling the carriage of many different types of cargo; bulk, liquid, container, refrigerated and frozen. Individual train sets are relatively free from weight and volume constraints, unlike road transport or air transport.

4.1 The accuracy and continuity of railway transportation are strong

The regularity of railway transport is almost unaffected by the weather or time of day of departure or arrival and adherence to timetables make rail a reliable transport partner (Michel, 2001).

4.2 The speed of railway transportation is relatively fast

With constant and consistent speeds, unhindered by other traffic on a protected right-of-way, and able to travel day or night, trains can travel up to 2,000 kilometers in a 24-hour period at speeds up to 120 kph, with passenger services on high-speed tracks travelling up to 200 kph.

4.3 Energy saving, low transportation cost

Railway tracks are fixed and unmovable after completion. There are few technical difficulties in constructing railway lines and in some city's small passenger trains, trams, can travel on train tracks and divert onto tram tracks into the center of the city. Current electrified rail routes extend up to 2,000 but can also be used by diesel-powered trains, which are able to travel very long-distance routes. Electrified railways also contribute less pollutants into the environmental. By running on steel tracks, the contact between track and train wheels is small, resulting in low friction of the steel-steel wheel-rail contact which saves energy. The cost of railway transportation is between 7% and 20% of the cost of road transportation with consumption per cargo unit of about 5% of the fuel cost of road transportation (Lewandowski, 2015).

Trade between China and Thailand

1. Trade Scenario between China and Thailand

In recent years, bilateral trade ranks first in Thailand's foreign trade volume, with increasing bilateral trade between the two countries as China's proposed "area" initiative was proposed with the Regional Comprehensive Economic Partnership (RCEP) agreement, initiated in 2015, providing more opportunities for the promotion of bilateral trade. However, the trade relationship between Thailand and China has not been without its problems.

Trade development between Thailand and China is unbalanced. Thailand has a large trade deficit with China. While the total value of Thailand-China trade in 2019 was $80 billion, Thailand's export to China were valued at $29.02 billion, which accounted for 11.8% of Thailand's total exports. However, Thailand's imports from China reached $51 billion, creating a trade deficit with China of nearly $22 billion. This deficit was reached after 10 consecutive years of growth but a reduction in

Thailand's export value to China (Xue, 2011). 2. Bilateral trade between Thailand and China is more competitive than complementary, and the development history between the two countries has favored China. Both countries rely on labor-intensive products with low pay for manufacturing industry workers to gain competitiveness in the market. Mechanical and electronic products, chemical products and iron and steel products are mainly exported by both two countries, so their trade is highly competitive (Zheng, 2014).3. The Thai government's support for industries is inadequate and this has affected the process of bilateral trade liberalization. For example, the Thai government has adopted a series of preferential policies for agricultural products to promote agricultural production, such as the government policy of buying the rice crop from farmers at a price 40%-50% higher than the market price, and then the government is responsible for selling or exporting rice. This has resulted in Thai rice being more expensive and therefore less competitive in the Chinese domestic market. For example, the proportion of investment must be made by More than 51% Of Thais, and the proportion of employed employees must be more than 4-to-1 between Thais and Chinese.

2. Factors affecting the development of trade between China and Thailand

In 1996, before the financial crisis in Southeast Asia, Thailand's main export products were mainly agriculture. The total export value of rubber was 23.6% of Thailand's total export value, followed by rice at 12.7%. Computers and components ranked third with 8.3%. On the other hand, China's main export products to Thailand included, amongst others, textile and clothing, steel products, chemical products. Since 2000, China-Thailand economic and trade relations have become increasingly close. According to the bilateral agreement negotiated by China and Thailand on accession to the WTO, over 90 percent of the commodities traded between the two countries would be subject to the "zero tariff" policy. China has pledged to substantially reduce import tariffs and non-tariff barriers, covering 39 items of agricultural products, 12 items of aquatic products and 85 items of industrial products. The average import tax rate has been reduced from 30.2 percent to 13 percent (Zhang, 2016). In 2001, among the top 10 Thai export projects, China received about 61% of total Thai exports. In November 2002, China and ASEAN signed the Framework Agreement on Comprehensive Economic Cooperation between China and ASEAN (Bhatcharabhorn, 2014). In April 2004, the Kunming-Bangkok Highway was built by China, Laos and Thailand, linking the three countries, starting from Kunming city, Yunnan Province, China, through Laos to Bangkok, the capital of Thailand, The Kun-Man Highway is 1,800 kilometers long and is a ‘black top’ or concrete, full sealed road, dual carriageway in parts. It is an important international channel for China into southeast Asia and is part of the implementation of the strategy of western development. In June 2004, Thailand became the first ASEAN country to recognize China's market economy status. Tariffs on agricultural products have been substantially reduced, greatly promoting the development of bilateral trade between China and Thailand (Pattaraporn, 2017). With the China-ASEAN Free Trade Agreement in 2010 and the Signing of the Regional Comprehensive Economic Partnership Agreement between China and Thailand in 2020, the bilateral Trade volume between China and Thailand has maintained steady growth. However, there are still some factors restricting the development of trade between China and Thailand, including the CNY-THB exchange rate, trade policy, logistics cost and Thai politics. These factors have kept Thailand from being competitive in its exports and have allowed Vietnam to gain market share in some goods in recent years. China and Vietnam trade has more geographical advantages than China and Thailand trade, compared with China's developing Guangxi Qinzhou port, Fangcheng port and Dongxing Free Trade Zone, and the rapid development of the economy. The quality of Vietnamese products keeps improving, and logistics costs in Vietnam are lower than in Thailand. More and more Thai products exports to China are being replaced by Vietnamese products. Although the logistics industry of China and Thailand has developed to some extent in recent years, its level is still an important factor for the existence of Sino-Thai trade (Jinhua You, 2017). Thailand's road infrastructure basically covers the whole country with good highways, but, since Thailand's exports to China have to go through Laos, the poor road conditions in Laos and the different driving direction (Laos and China are left-hand drive, and Thailand is right-hand drive), increase transportation time and transportation cost. Thailand's railway coverage is small, and Laos has no railway. Although there are many ports in Thailand that can meet the needs of water transportation, Bangkok port is responsible for 85% of the export volume and almost all the import volume of the whole country, which indicates that there are serious imbalance of port development and underutilization of water transportation. Often used in the Golden Triangle area river transport is also limited by the weather, water levels in the Mekong River, and river boat transport capacity, resulting in high transport costs (Tanattarat, 2018).

China-Laos railway

1. The effect of China-Laos Railway construction on China's Economy and Trade

The Belt and Road cooperation initiatives were proposed by Chinese President Xi Jinping in September and October 2013. This new “Silk Road” runs through the Continents of Asia, Europe and African, relying mainly on land transport connecting key seaports. China has signed 201 cooperation documents with 138 countries and 31 international organizations to jointly build the One Belt and One Road. The Trans-Asian Railway is an important part of the "One Belt and One Road" strategy, and it is also the freight Railway network used by China to link the Eurasian continent (Li, 2016). As the first section of the Pan-Asian Railway, the China-Laos Railway is regarded by the Chinese government as an important section to show China's railway technology to the world. It is also an expression of China's soft power in infrastructure construction. Its construction will also provide reference for the future China-Thailand railway and China-Singapore Railway. It will set an example for railway cooperation outside China and accumulate valuable experience for the future development of China-Singapore and China-Europe freight trains (Sisomphone, 2020). China-Laos railway crosses the border between China and Laos and China with Laos and Thailand, opening up a new economic and trade route with ASEAN countries. It strengthens the economic and trade exchanges of the three countries and provides a new mode of transportation for South East Asian countries logistics organizations. It plays a promoting role in accelerating the contact between countries along the "One Belt and One Road" and China, and will promote economic contact between China and ASEAN countries. The high cost of logistics and the single mode of land transport, i.e., road transport, have been important obstacles to the economic and trade exchanges between China and Southeast Asian countries. The construction of the China-Laos railway will relieve the pressure on logistics services and transport between China and other Southeast Asian countries, further opening up South East Asia to China (Wang, 2019).

2. The effect of the China-Laos Railway on Thailand's Economy and Trade

Thailand railways have 100 years of history, but little has been done in recent years to develop and extend the railway network. Thailand has therefore been highly dependent on road and sea transport. In international trade, 70% is carried by sea and 90% of that uses Bangkok Port at Khlong Toei and Laem Chabang Port. Bangkok Port is about 65 kms from the ocean, up the Chayo Phrahya and has limited channel depth, restricting the size of container ships that can use Bangkok Port and road access to the port is limited, with substantial traffic density problems. General ocean transportation is mainly concentrated in Laem Chabang Port, and road transportation is also subject to local conditions of transport capacity and transport distance to the rest of the country which extends north by nearly 1,000 kms and south by 2,000 kms, and is ill-served by rail freight services in both directions. China-Laos Railway, when completed and operational with services to Bangkok, will be combined with road transportation to form multimodal transport network, which will have an important impact on the medium and long-distance freight transport market. Thai exports to China mainly include plastic and rubber, small mechanical and electrical products, and plant products, all of which are suitable for railway transportation and the China-Laos railway will improve the efficiency of cargo transportation and reduce logistics costs, and share the pressure of road transportation, especially but not limited to the dense urban area of Bangkok (Liu, 2019).

Thai products are exported to the main provinces of China

Thailand's export products are mainly exported to these five areas in China: Guangdong, Jiangsu, Shanghai, Shandong and Zhejiang, Guangdong imports reached $15.2 billion in 2018, accounting for 39% of the total, followed by the Yangtze River Delta Economic Circle, and the three major economic strong provinces of Jiangsu, Shanghai, Zhejiang, which, together, accounted for 32%, including $6.01 billion in Jiangsu, 16%, Shanghai $4.68 billion, 12%, and Zhejiang $1.36 billion, 4%. The main export products are plastic and rubber products, mechanical and electrical products, plant products. The export amount of plastic and rubber products is $8.11 billion, 26.99% of the total, mechanical and electrical products, $6.826 billion, 22.71%, and plant products, $3.284 billion, 12.80%. (Table 5). Given the importance of these leading provinces, the primary focus of this research was on the export routes to these five provinces (Figure 3).

Table 5 Thai products are mainly exported to Chinese provinces

Province	Thai Products Exported to Chinese Provinces (USD)				
	2016	2017	2018	Growth Rate (2017-2018)	Proportion
1 Guangdong	13,803,591,617	13,260,389,838	15,248,768,720	15%	39%
2 Jiangsu	5,632,824,482	5,999,267,013	6,014,308,982	0.30%	16%
3 Shanghai	4,487,400,808	4,553,041,793	4,683,007,972	2.90%	12%
4 Shandong	4,318,120,349	4,091,297,618	3,978,173,764	-2.80%	10%
5 Zhejiang	2,058,189,714	1,586,880,942	1,367,207,454	-13.80%	4%
6 Others	8,037,696,081	7,685,594,349	7,387,660,529	-3.88%	19%
7 Total	38,337,823,051	37,176,471,553	38,679,127,421	4.04%	100%

Source: General Administration of Customs, P.R. China

1. **Guangdong province**

Guangdong is a provincial-level administrative region of the People's Republic of China, the largest economic province in China and the economic center of southern China. It is located in the southernmost part of Mainland China, covering a land area of 179,800 square kilometers. It has many ports, the main ports are Zhanjiang Port, Shenzhen Shekou Port and Guangzhou Port for import and export trade.

Figure 3 Locations of Zhanjiang Port, Shenzhen Shekou Port and Guangzhou Port

The most important railway station of the Railway system is Guangzhou Railway Station. Located in Guangzhou city, Guangdong province, China, is under the jurisdiction of China Railway Guangzhou Bureau Group Co., Ltd.

Guangzhou Railway Station is a junction where the Guangzhou-Shenzhen Railway, Beijing-Guangzhou Railway, Guangzhou-Mao Railway, Guangzhou-Foshan-Zhao Qing Intercity railway and Guangzhou Metro Line 2 and Line 5 meet. It is one of the most important railway passenger stations in Guangdong province and one of the main railway hub stations in China. The station covers a total area of 120,000 square meters, the waiting room 8,504 square meters, the ticket office 1,108 square meters, and the packing warehouse 3,823 square meters. The station has 4 platforms and 7 lines, and can handle 30,000 passengers per day.

2. The Economic circle of the Yangtze Delta

The Yangtze River Delta Economic Circle is located in the alluvial plain of the Yangtze River as it reaches the East China Sea. It is the largest economic zone in China and is positioned by the central government as an economic center with the strongest comprehensive strength in China, an important international gateway in the Asia-Pacific region, an important advanced manufacturing base in the world, and the first region in China to join the world-class city agglomeration. The Yangtze River Delta city cluster includes Shanghai, Jiangsu and Zhejiang, covering an area of 354,400 square kilometers, accounting for 3.69% of the land area. It is the most economically developed and urbanized region with the highest degree of urban agglomeration in China. The Yangtze River Delta city cluster has been one of the six internationally recognized world-class city clusters, and is committed to becoming the world's largest metropolis circle by 2020. The main port is Shanghai port. The main station of The Economic Circle of The Yangtze Delta is the Shanghai station which is located in Jing'an District of Shanghai, adjacent to the Shanghai Long Distance Passenger terminal. It is a special station under the jurisdiction of China Railway Shanghai Bureau Group Co. Ltd., and an important part of Shanghai’s railway hub. With a total area of 97,000 square meters, the South Square covers an area of 67,000 square meters, and the North Square covers an area of 30,000 square meters. It is the terminal station for the Beijing-Shanghai Railway, Shanghai-Kunming Railway and Shanghai-Nanjing Intercity Railway trade fair, with an annual passenger volume of 67 million (2018).

3. Shandong province

Shandong province is a coastal province in eastern China and is one of the most economically developed provinces in China, and one of the most economically powerful and fastest growing provinces in China, ranking third in economic aggregate since 2007. The annual throughput of coastal ports in Shangdong reached 1.34 billion tons, ranking the second in China, with Qingdao, Rizhao and Yantai having over 300 million tons. Inland river navigable mileage is 1,150 kilometers, inland river port transit capacity of 45.67 million tons, throughput of 79.2 million tons. Jinan is the capital of Shandong Province and the main station is Jinan Railway Station which is located in Jinan city. Tis station is a special Station under the jurisdiction of the Jinan Railway Bureau Group Co. Ltd., which is located at the intersection of the Beijing-Shanghai Railway, Jiaoji Passenger Dedicated line and Handan Railway. The total construction area of Jinan Railway Station is 120,000 square meters, with the railway having 7 sets and 10 lines. Over 14 million passengers use Jinan Railway Station per year.

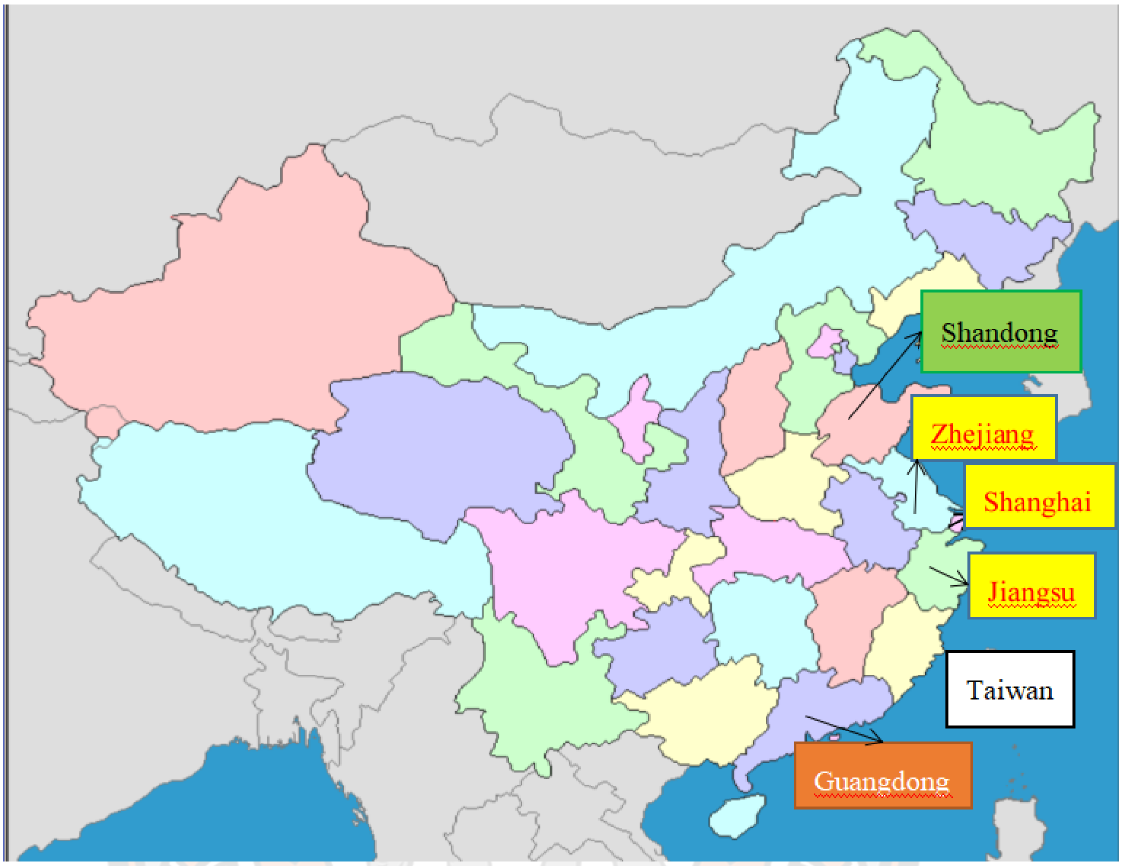

Figure 4 Thai products are exported to the main provinces

Export routes for major industries from Thailand to China

The five provinces are divided into three regions. The first is Guangdong which is the south China economic center. Shanghai, Jiangsu, Zhejiang are the Yangtze River delta economic center, and Shandong, which is an important economic hub in northern China. Through the literature review method, the author summarizes the routes being used in other papers as follows:

Table 6 The main route for export transportation

R3A	Bangkok-Chiangkong-Houayxay (Laos)-Boten-Mohan (China)-Jinghong-Kunming-	Guangdong
R9	Bangkok-Mukdahan-SavannaKhet (Laos)-Dansavanh-Lao Bao (Vietnam)-Hanoi-Lang Son-Huu Nghi-Nanning (China)-	Guangdong
R12	Bangkok- Panom-Tha Kek (Laos)-Na Pao-Cha Lo (Vietnam)-Hanoi-Lang Son-Huu Nghi-Nanning (China)-	Guangdong
S1	Bangkok- Chabang Port-Port of Guangzhou, Foshan (Shenzhen Shekou Port)-	Guangdong
S2+R	Bangkok- Chabang Port- Port of Zhanjiang-	Guangdong
R9	Bangkok-Mukdahan-SavannaKhet(Laos)-Dansavanh-Lao Bao (Vietnam)-Hanoi-Lang Son-Huu Nghi-Nanning (China)-	Shanghai Zhejiang Jiangsu
R12	Bangkok-Nakorn Panom-Tha Kek (Laos)-Na Pao-Cha Lo (Vietnam)-Hanoi-Lang Son-Huu Nghi-Nanning (China)-	Shanghai Zhejiang Jiangsu
S2	Bangkok-Laem Chabang Port-Shanghai Port-	Shanghai Zhejiang Jiangsu
S3	Bangkok-Laem Chabang Port-Port of Guangzhou, Foshan-	Shanghai Zhejiang Jiangsu
S4	Bangkok-Laem Chabang Port-Hong Kong Port-Qingdao Port-	Shandong
S5	Bangkok-Laem Chabang Port-Kaohsiung Port-Qingdao Port-	Shandong
S6	Bangkok-Shanghai Port-	Shandong

Source: Wanhai Shipping Co. Ltd., Evergreen Marine Co. Ltd., OOCL Shipping Co. Ltd., Baohan International Logistics Co. Ltd.

R = Road transportation S = ship transportation

Identify the determining for making the route selection

The selection of a route is one of the most important factors in transportation. However, the selection of transportation routes is a complex, mufti-criteria decision problem. To be able to recommend appropriate routes, many different factors must be considered, such as distance, cost, delivery time, security, transportation capability, and so on. To lead this research, 19 literature reviews were collected through the second-hand data method and summarized the determining factors of the selection route they adopt (Promupsorn, 2019). Cost and time are the most frequently used factors in other literature, followed by security and transportation capacity, and finally distance and convenience (Table 7)(Liu, 2006), (Xia,_2012), (Zang, 2013), Yadav (2013), Wang (2018).

Table 7 Summary of the determining factors

Author (year)	Distance	Cost	Time	Security	Transportation capacity	others
Maciej.H（2018）		✓	✓		✓	
Maciej.H（2020）		✓	✓	✓		
Etoh（2011）		✓	✓			✓
Fareed (2012)	✓	✓	✓		✓	
Gong &Wu (2007)	✓	✓	✓			
Guan (2014)	✓	✓	✓	✓		
Huang (2020)		✓		✓		✓
Cheng (2011)		✓			✓	✓
Jia (2015)	✓	✓	✓	✓		
Lei (2014)		✓	✓	✓		✓
Zhu (2009)		✓	✓	✓	✓	
Liu (2006)		✓	✓	✓	✓	
Xie (2009)		✓	✓			
Ji (2012)		✓	✓		✓	
Zang (2013)	✓		✓			

Author (year)	Distance	Cost	Time	Security	Transportation capacity	others
Tian (2016)		✓	✓			✓
Zhu (2013)		✓	✓	✓	✓	
Wang (2018)	✓	✓	✓			
Yadav (2013)	✓		✓		✓	
Total 19	7	17	17	8	8	5

Note: ✓: These factors are used in their papers

Determining Factors for Route Evaluation

From the literature review, six determining factors were identified; which are time, cost, distance, transport capacity, and security. Then, the author later interviewed experts in various industries to determine the importance of these factors. Experts said weather, road conditions, customs clearance and cargo handling also need to be considered. Therefore, after adopting the opinions of each expert, they are uniformly summarized as convenience. the six determinants have been identified. Defining and calculating these six factors will affect the results of the AHP analysis and application of the TOPSIS method. Finally, based on the research and literature review, the determining factors selected were: (Juraiiuck Khowattanachai,2003)

Time: When we evaluate the performance of the route, Time is the duration length of the journey from the source warehouse to the destination merchant. Choosing different modes of transportation also means identifying different starting and end points. Land transportation provides direct door-to-door service while rail and ships do not. In order to maintain a standard basis for calculation and analysis of transport time, the door-to-door transportation time is used on the calculations, this time will include transport time, customs declaration time, turnaround time, loading and unloading time. (Ji,2006).

Cost: In production, research, retail, and accounting, a cost is the value of money that has been used up to produce something or deliver a service, and hence is not available for use anymore. In business, the cost may be one of acquisition, in which case the amount of money expended to acquire it is counted as cost. In this case, money is the input that is gone in order to acquire the thing. This acquisition cost may be the sum of the cost of production as incurred by the original producer, and further costs of transaction as incurred by the acquirer over and above the price paid to the producer. Usually, the price also includes a mark-up for profit over the cost of production. More generalized in the field of economics, cost is a metric that is totaling up as a result of a process or as a differential for the result of a decision. Hence cost is the metric used in the standard modeling paradigm applied to economic processes. In this paper, This cost includes shipping and handling charges, customs charges, storage charges, quarantine fees, tariffs and other fees, as well as freight postage costs, maintenance, equipment depreciation and management fees, etc.

Distance: Generally, the description of distance can be divided into three kinds: physical distances. theoretical distances and directed distances. That’s how far you actually travel in real life. The distance has some influence on the preference of transportation route, thus when we choose a route, it must be economically viable to use that route (Trope Y, 2010).

Transportation capacity: Transport capacity is divided into transit and Conveying Capacity. Here, transit is defined as the capacity of vehicles carrying cargo on a particular transport route, and the direction of travel and sections within the route (implying stages that may require cargo transfer), all under particular transport organization conditions. Different transportation modes have different transport capacities. China and Thailand mainly import and export cheaper products that are categorized as heavy goods of low value, so for practical purposes air transport is disregarded in the analysis and route choice decision. The capacity of rail transport and water transport is obviously much greater than road transport. A road transport vehicle in a long-haulage situation may be legally restricted, if not practically restricted, to less than 50 tons load weight whereas trains and ships, as units of transport, can carry thousands to tens of thousands of tons of cargo. Rail and shipping routes therefore have high transportation capacity, which can reduce the transportation costs per unit of the goods and save time (Zuo, 2007).

Security: Security against theft and for cargo damage protection and, in the case of perishable goods, maintenance of quality, is an important factor for choosing the mode of transportation and routes. Logistics considerations must include the damage rate of goods and the price of having high transportation security.

Convenience: Generally, railway and road transportation are more convenient, because there are so many traffic lines in railways and highways. However, rail and shipping services require more extensive and therefore more expensive terminals for loading and unloading cargoes than road transportation.

Railway and highway networks are more complex and intricate than sealines. However, land-based routes can be affected by weather events, such as floods, debris flow, washaways and landslides. Sealines are also potentially affected by the weather events, such as heavy rains and storms, and in the eastern Pacific, seasonal typhoons. (Wu,2009). As Thailand and China are not neighboring countries, the processing and time requirements of customs clearance are also factors to be considered under the heading of convenience. As well, relevant to the current discussion, land transport passes through Laos where poor road conditions prevail causing inconvenience and time delays for land transportation.

AHP Analysis

The Analytic Hierarchy Process (AHP) is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. It was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then.

AHP helps decision makers find a solution to a problem that best suits their goal and their understanding of the problem, rather than prescribing a "correct" decision. It provides a comprehensive and rational framework for structuring a decision problem, by representing and quantifying the elements of the problem, and relating those elements to overall goals, while evaluating alternative solutions (Saaty, Thomas L,2008).

AHP analysis is based on a three-tier hierarchy. The highest tier is the purpose of solving this problem, the middle tier selects the suitable factors for achieving the goals, and the lowest tier includes the various measures and schemes identified to solve the problem. Decision makers must identify the determining factors that must be considered, and then compare each against the others. Policy makers can identify scores of potential factors based on expert opinion or searches of the published literature. When the decision maker has obtained the results from AHP analysis, it is necessary to calculate the combinatorial weight vector and apply a combinatorial consistency test. The best combination of the target weight vector according to the formula is applied for a composite consistency check. If these pass inspections, it can be assumed that a viable decision can be made according to the results of the combined weight vectors. However, if the composite consistency check fails under inspection, a new model must be constructed according to the consistency ratio in the greater paired comparison matrix (Saracoglu, 2013).

TOPSIS method

The TOPSIS method was first proposed in 1981（Wang & Yoon, 1981）. It is a ranking method based on the similarity between a limited number of evaluation objects and an idealized goal, and it evaluates the relative merits of existing objects. There are two idealized goals in the Ideal Solution; one is certainly the Ideal goal (the Ideal Solution) or the optimal target and the other is an Ideal target that is not a worse (negative Ideal Solution) nor the worst targets, objects should be the best the distance with the optimal target recently, with the worst goal, as far as distance calculation can be used in Ming test distance, is to take an examination of commonly used Euclidean geometry distance, distance is a special case.

TOPSIS method is a sequential optimization technique for the similarity of ideal objects and a very effective method in the analysis of multi-objective decision making. After the normalization of the data standardization matrix, the optimal target and multiple targets in the worst target are identified (represented by an ideal solution and an ideal solution), and the evaluation target and ideal solution and the distance of the ideal solution are calculated, the goal and ideal solution degree are identified, according to the size of the degree of sorting, ideal solution as the basis of evaluation target quality. The value of closeness is between 0 and 1. The closer the value is to 1, the closer the evaluation target is to the optimal level. Conversely, the closer the value is to 0, the closer the evaluation goal is to the worst level. This method has been successfully applied in many fields such as land use planning, material selection evaluation, project investment, medical and health care, etc., which obviously improves the science, accuracy and operability of multi-objective decision analysis. (Greener, & Devillers, 2011)

The TOPSIS method is rarely used in route selection problems, being usually applied to quantitative analysis, whereas the data calculated by TOPSIS method is persuasive. It has the advantages of being real, intuitive and reliable. Therefore, the results of the calculation are also conducive to the analysis of the author. It avoids the subjectivity of data, does not need the objective function, does not need to pass the test, and can describe the comprehensive influence strength of multiple influence indexes well. There is no strict limitation on the data distribution, sample size and index number, this will be suitable for the author to use the in-depth interview method to collect small sample data. There are several determining factors of this paper, TOPSIS method is suitable for multi-index system, which is more flexible and convenient.

The TOPSIS process is carried out as follows:

Step 1

Create an evaluation matrix consisting of m alternatives and n criteria, with the intersection of each alternative and criteria given as, we therefore have a matrix X_{ij}, we therefore have a matrix $(x_{ij})_{m*n}$.

Step 2

The matrix $(x_{ij})_{m*n}$is then normalized to form the matrix

$R = (r_{ij})_{m*n}$, using the normalization method

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{k=1}^{m} x_{kj}^2}}, i = 1,2, \ldots\ldots, m, j = 1,2, \ldots\ldots, n \qquad (1)$$

Step 3

Calculate the weighted normalized decision matrix

$t_{ij} = r_{ij} \times w_j, i = 1,2, \ldots\ldots, m, j = 1,2 \ldots\ldots, n$ where $w_j = W_j / \sum_{K=1}^{n} W_k, j = 1,2, \ldots\ldots, n$ so that $\sum_{i=1}^{n} w_i = 1$, andW_j is the original weight given to the indicator $v_j, j = 1,2, \ldots\ldots, n$.

Step 4

Determine the worst alternative(C_w) and the best alternative(C_b):

$$C_w = \{\langle \max(t_{ij} \mid i = 1,2\ldots\ldots,m) \mid j \in j_-\rangle, \langle \min(t_{ij} \mid i = 1,2\ldots\ldots,m) \mid j \in j_+\rangle\} \equiv \{t_{wj} \mid j = 1,2\ldots\ldots,n\},$$

$$C_b = \{\langle min(\, t_{ij}|i = 1,2 \ldots \ldots, m)|j \in j_-\rangle, \langle max(\, t_{ij}|i = 1,2 \ldots \ldots, m)|j \in j_+\rangle\} \equiv \{t_{wj}|j = 1,2 \ldots \ldots, n\},$$

$j_+ = \{j = 1,2, \ldots \ldots, n|j\}$associated with the criteria having a positive impact, and

$j_- = \{j = 1,2, \ldots \ldots, n|j\}$associated with the criteria having a negative impact.

Step 5

Calculate the L^2-distance between the target alternative and the worst condition C_w

$$S_{iw} = \sqrt{\sum_{j=1}^{n}(t_{ij} - t_{wj})^2}, i = 1,2, \ldots \ldots, m \qquad (2)$$

and the distance between the alternative i and the best condition C_b

$$S_{ib} = \sqrt{\sum_{j=1}^{n}(t_{ij} - t_{bj})^2}, i = 1,2, \ldots \ldots, m \qquad (3)$$

where S_{iw} and $S_{ib}$are L^2-norm distances from the target alternative i to the worst and best conditions, respectively.

Step 6

Calculate the similarity to the worst condition:

$$T_{iw} = S_{iw}/(S_{iw} + S_{ib}), 0 \leq T_{iw} \leq 1, i = 1,2, \ldots \ldots, m. \qquad (4)$$

$T_{iw} = 1$if and only if the alternative solution has the best condition; and

$T_{iw} = 0$if and only if the alternative solution has the worst condition.

Step 7

Rank the alternatives according to $T_{iw}(i = 1,2, \ldots \ldots, m)$.

CHAPTER III

RESEARCH METHODOLOGY

Research Flowchart

This chapter presents the research procedure undertaken. The overall research procedure of this research encompasses six steps, and the methodology framework of this research is depicted in Figure 5.

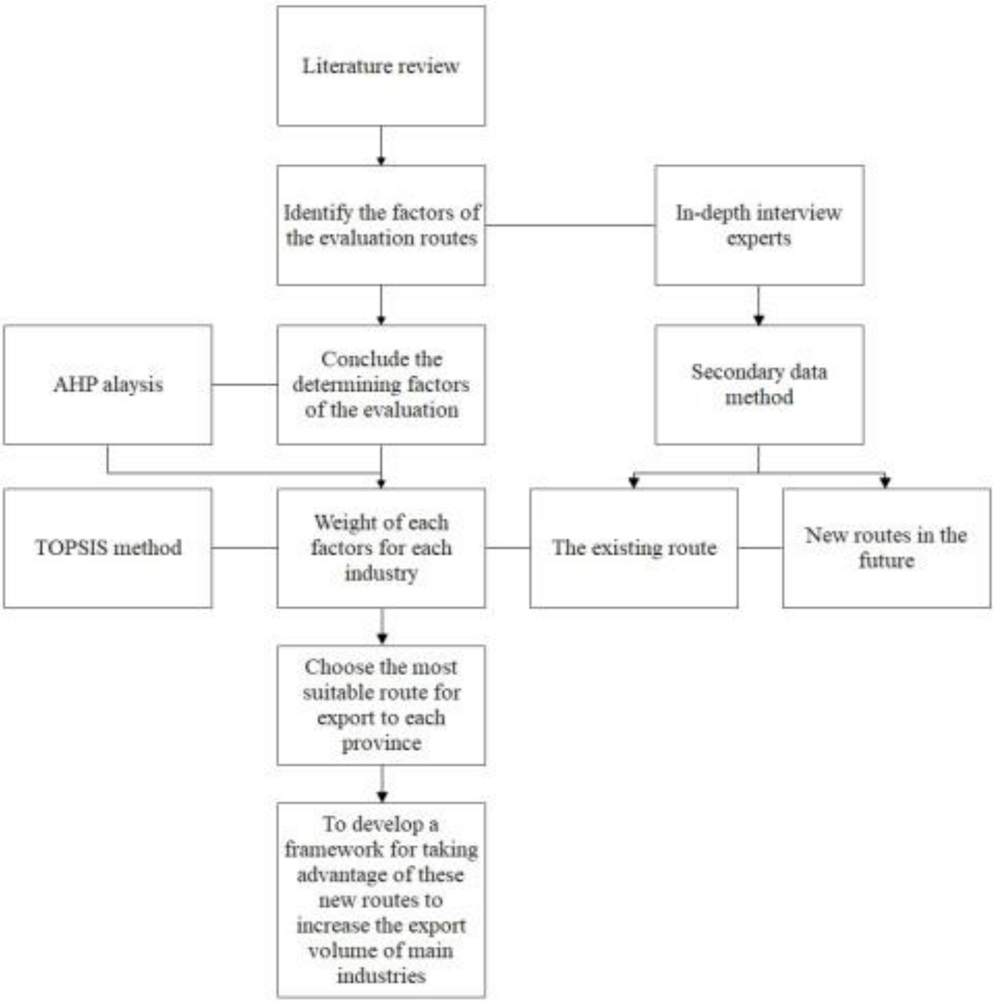

Figure 5 Research Flowchart

Step 1: Review the relevant literature about route selection and summarize the factors that were presented in the published research regarding route selection.

Step 2: Identify and select the relevant factors that needed to be considered for route evaluation.

Step 3: Interview experts to confirm and conclude the selection of determining factors of the evaluation.

Step 4: Apply AHP analysis ascertain the weight of each factor for each industry.

Step 5: Interview experts and scrutinize second-hand data methods to obtain information on existing routes and new routes.

Step 6: Use the TOPSIS method to compare the existing routes and the future new routes to calculate the score of all routes base on the weight of each factor.

Step 7: Basing the selection on these scores, choose the most suitable route for each industry.

Step 8: Considering the results, together with the actual condition of each route, develop a framework model to inform the best selection of these new routes to increase the export volume of main industries.

In-depth interviews

In-depth interviewing is a qualitative research technique that involves conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea, program, or situation. In-depth interview is an unstructured, direct, one-on-one mode of seeking information. The author adopted three approaches in these interviews: specific questions, open-ended questions, probing questions. (Carolyn Boyce, 2006).

The author interviewed these experts and professionals from a number of different companies involved in the import – export and logistics industries.

A leading export company for main industries: This company has a certain scale, China is an important customer of the company, the company has been engaged in import and export trade between China and Thailand for a long time.

A leading freight forwarding company: This company has land and sea transportation business from Thailand to China, and sea freight forwarding business can cover the major economic and trade provinces of China. Since some industrial companies do not have their own logistics systems and need third-party logistics, these logistics companies will also know the main routes and which industries are suitable for which routes.

Experts in the field of logistics were interviewed

The expert has been engaged in education and research in the field of logistics for many years and has a deep understanding of the trade and transportation between China and Thailand.

This expert has extensively studied border trade and understands the most common modes and routes of transportation between China and Thailand.

The head of the National Key Project [A study to develop a strategic plan for supporting Laos-China Railway construction project (Boten-Vientiane)] Team in Thailand

Head of the China-Laos railway project: An important person in charge of the construction of the China-Laos railway, he(she) should be aware of the actual situation of the railway and its impact on logistics and trade between China and Thailand.

Secondary data analysis for this study

Researchers use information gained from secondary data analysis which is data and information that a third person has gathered for their own purposes. Researchers leverage on this secondary data analysis to answer new research questions, or to examine alternative perspectives on the original question of a previous study.

In the current research, the export routes used by major industries were obtained from published research. This was followed up by conducting in-depth interviews with companies and experts in related industries. The second-hand data method was then used to identify the most frequently-used and most appropriate routes for the main industries being considered in the research, and these routes were then used to compare with the new routes that would be formed after the completion of the China-Laos railway.

AHP analysis for this study

AHP is an approach that uses a hierarchical model, having levels of goals, criteria, possible sub-criteria, and alternatives.

First, to set up a hierarchy of transport route decisions, in this study, we hypothesized that there were four factors for route selection.

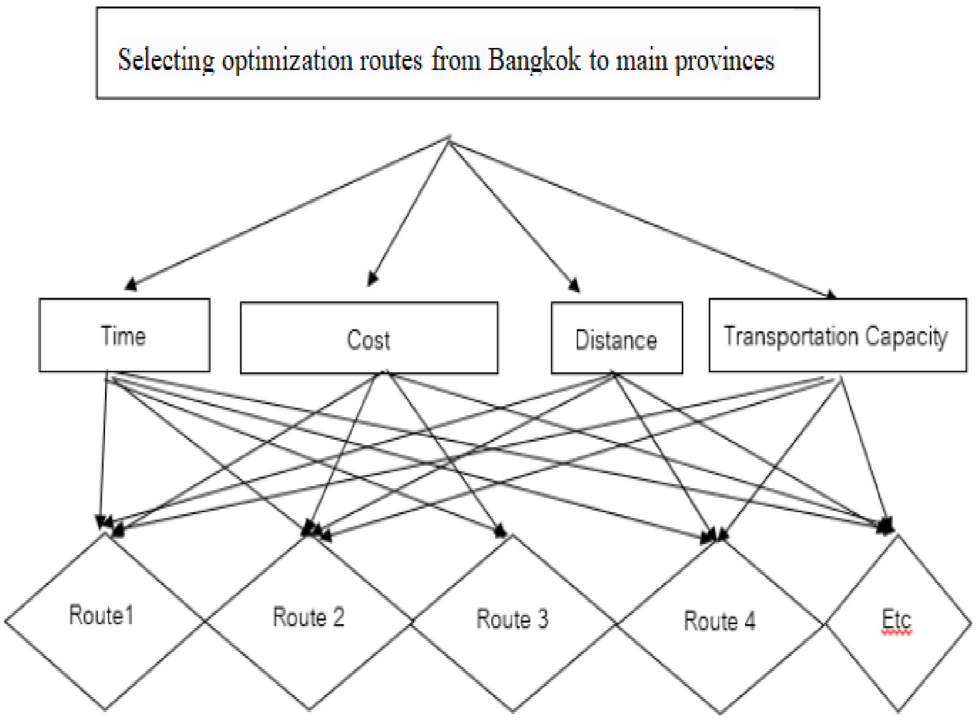

Figure 6 The fundamental scale according to Saaty (1990)

Table 8 Saaty scale to compare criteria in pairs

Intensity of importance on	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment slightly favor one activity over another

Intensity of importance on	Definition	Explanation
5	Essential or Strong importance	Experience and judgment strongly favor one activity over another
7	Very strong importance	An activity is strongly favored and its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2.4.6.8	Intermediate values between the two adjacent judgments	When compromise is needed

Table 9 For example

	Time	cost	Distance	Capacity
Time	1	1/a	1/b	1/e
cost	a	1	1/d	1/f
Distance	b	d	1	1/g
Capacity	e	f	g	1

This can be defined as a method of normalized arithmetic averages. The prepared pairwise comparison matrix is normalized as a result of the normalization, matrix $a= [a_{ij}]$ is transformed into matrix $r = [r_{ij}]$. The elements of matrix B were calculated according to the following formula:

$$r_{ij}= {a_{ij}} \Big/ {\sum_{i=j}^{N} a_{ij}}$$

Calculating the preference between the elements under investigation (prioritization vector; w = [w_i]) is performed by calculating the arithmetic averages from the row of the normalized comparison matrix. The components of this vector were calculated according to the formula:

$$w_i = (1/n)\sum_{j=1}^{N} r_{ij}$$

Priorities calculation and consistency checking

Once the matrix A is built, it is possible to compute a priority vector, which is the normalized eigenvector of the matrix. The priority vector shows relative weights among criteria or sub-criteria. The next step is to calculate λ_{max}, to lead to the consistency index and the consistency ratio. Consider $[A_X = \lambda_{max}X]$ where x is the eigenvector, aside from priorities calculation of criteria or sub-criteria. AHP measures also the consistency of the comparison by using the Consistency Index CI, Random Consistency Index RI, Consistency Ratio CR, Perfect consistency means zero value of CI (CI = 0), while accepted consistence ratio CR is less than 10% (CR < 0.1), which means the subjective judgment can be accepted. After we check that this judgment can be applied, we get the weight of each factor.

$$\lambda_{max} = \frac{\sum_{i=1}^{n}\frac{Ax_i}{x_i}}{n} \quad \text{CI} = \frac{\lambda_{max}-n}{n-1}$$

Where CI is the consistency index; λ_{max} is the maximum eigenvalue, n is the size of the measured matrix

CR is the consistency ratio,

CI is the consistency index,

RI is the random consistency index.

CR = $\frac{CI}{RI}$

Table 10 Values of the Random Index (RI) for small problems

1	2	3	4	5	6	7	8	9	10
0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

In this study, the author understands that different industries choose different routes, the weights of the determining factors are also different. So, The AHP analysis will be used to calculate the weight of the determining of each industry. The authors assume the following:

Table 11 The weight of the determining factors of main industries

	Plastics and rubber	Mechanical and electronic products	Plant products
Time	0.3	0.1	0.4
cost	0.3	0.4	0.4
Distance	0.2	0.4	0.1
Capacity	0.2	0.1	0.1

TOPSIS analysis for this study

The TOPSIS method uses "ideal solution" and "negative ideal solution" as two basic concepts. The so-called “ideal solution” is an optimal solution (scheme), whose attribute value reaches the best value in each alternative scheme. The negative ideal solution is the worst solution envisaged, with each attribute value reaching the worst of the alternatives. This method was used to evaluate route performance in order to choose the "ideal solution”. The most suitable present routes were compared with the new routes to be formed after the completion of the China-Laos railway. It was assumed that there were five routes to Guangdong with four determining factors, namely time, cost, distance and capacity. The authors also get specific data on these lines and then set up a performance table (Carolyn Boyce,2006).

Table 12 Performance table (example)

	Cost （dollar）	Distance（km）	Time（hour）	Capacity（ton）
Route 1	2000	1000	104	50
Route 2	3000	500	75	350
Route 3	4000	1000	25	50
Route 4	1000	1200	245	2000
Route 5	2000	600	68	350

First, deal with the statistics with TOPSIS in the same trends and normalization and defined good，

Table 13 Homotrendization and Normalization

Homotrendization	Normalization
$R = \begin{matrix} 2000 & 1000 & 104 & 1950 \\ 3000 & 500 & 75 & 1650 \\ 4000 & 1000 & 25 & 1950 \\ 1000 & 1200 & 245 & 0 \\ 2000 & 600 & 68 & 1650 \end{matrix}$	$R_1 = \begin{matrix} 0.343 & 0.497 & 0.364 & 0.540 \\ 0.514 & 0.248 & 0.262 & 0.457 \\ 0.686 & 0.497 & 0.0874 & 0.540 \\ 0.171 & 0.596 & 0.857 & 0 \\ 0.343 & 0.298 & 0.238 & 0.457 \end{matrix}$

The author assumes that the weight of each factor obtained by the AHP method is 1, And then the negative ideal and the positive ideal are computed

$$T1 = (0.686{,}0.596{,}0.857{,}0{,}540)$$
$$T2 = (0.171{,}0.248{,}0.0874{,}0)$$

Next, the distance between each evaluation object and the optimal scheme and the worst scheme was calculated (D^{+}best, D^{-}worse). The formula ($S = \frac{D^{+}}{D^{+}+D^{-}}$) is used to obtain the evaluation reference value. The larger the reference value is and the higher the evaluation result is, that is the optimal scheme. In this case, the higher safety coefficient indicated that the fifth route is the optimal route based on these four factors.

Table 14 Results

	D^{+}	D^{-}	S	Ranking
Route 1	0.608	0.677	0.4731	4
Route 2	0.714	0.597	0.5446	2
Route 3	0.776	0.786	0.4968	3
Route 4	0.745	0.844	0.4688	5
Route 5	0.772	0.512	0.6012	1

Through this study, the most suitable routes for exporting were found for these industrial products. Based on these routes and expert opinions, the framework was proposed that gives valuable suggestions to interested parties engaged in these industries, so that they can better understand the new routes generated after the opening of the China-Laos railway. The framework will provide them with the knowledge to choose the best routes that suit their needs, and allow these organizations and industries to adjust their transport modes and cultivate relevant talents according to the new routes. When companies in these industries are able to adopt the new routes properly, it will help Thai industries to increase their trade volume.

CHAPTER IV

THE SITUATION OF THAILAND'S MAIN INDUSTRIES EXPORTING TO CHINA

China-Laos railway development

From April 2010, when China and Laos reached consensus on the joint construction and joint operation of the China-Laos railway for the first time, to December 2016, the construction of the China-Laos railway project went through six years of twists and turns, with several changes during the project. The total investment of the project is about 37.4 billion yuan in Laos, and the two sides will carry out the construction according to 7:3 equity ratio and joint venture. The specific investment proportion is as follows:

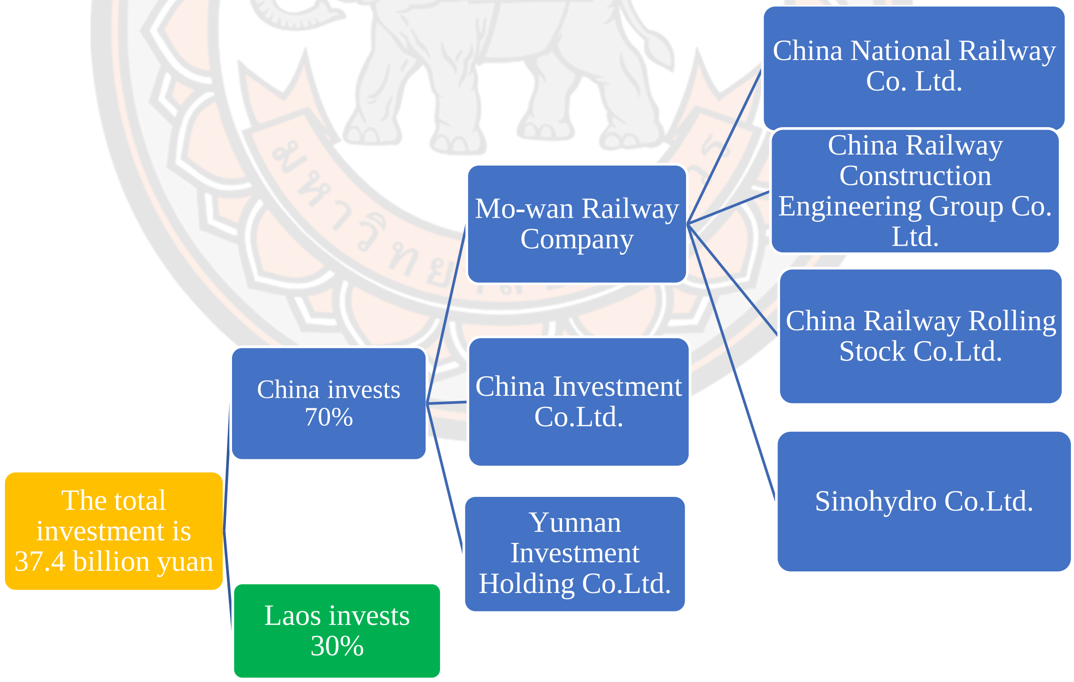

Figure 7 Schematic diagram of investment in China-Laos railway

The China-Laos railway adopts the international railway standard, with a track spacing of 1435 mm. The railway has 170 Bridges and 72 tunnels, with a bridge to tunnel ratio of 63%, and a single carriage carrying weight of 50-60 tons. The planned final freight capacity should reach 19 million tons/year after commencement of operations.

The head of the construction of the China-Laos railway predicted that the upstream traffic of the line (from Vientiane to Boten) could reach 2.59 million tons/year in the initial stage, 3.62 million tons/year in the short term and 6.45 million tons/year in the long term. While studying the impact of the China-Laos railway on Thailand's export to China, the upward transit volume (from Vientiane to Boten) was considered. It is expected that cargo volumes will reach 2.59 million tons within 5 years, the initial stage, and 3.62 million tons within 5-10 years; the short term. The long-term target is 5.46 million tons after 10 years of operation （Li Jia, 2014). The main components of this volume include the freight traffic volume between Southwest and Northwest China and Singapore and Malaysia, together with the freight traffic volume produced by enterprises in Thailand, plus the freight traffic volume of trade between Southwest and Northwest China and Southern Laos (Jiang,, & Toth, 2016). (Table 15).

Table 15 Railway traffic volume from Vientiane to Boding

Composition	Preliminary stage	Short term	Long term (Thousand tons)
Freight traffic volume of trades between Southwest and Northwest China and Singapore and Malaysia	1,240	1,650	2,480
Freight traffic volume produced by enterprises in Thailand	1,200	1,770	2,600
Freight traffic volume of trade between Southwest and Northwest China and Southern Laos	150	200	390

Source: CREGC Architectural & Construction Engineering Co. Ltd., Feasibility study report of China-Laos railway project

Export freight volume and trade volume

Thailand is an important trading partner of China. While the export volume of Thailand to China was only about $282 million in 2000, by 2019, the export volume of Thailand to China has reached just over $28 billion and the freight volume of Thailand's exports to China had reached 32,000,00,000 kg. The trade volume and freight volume of Thailand's exports to China from 2000 to 2019 is shown in Table 16.

Table 16 The trade volume and freight volume of Thailand's exports to China from 2000 to 2019

Year	Trade volume (US dollar)	Freight volume (Kg)
2000	2,816,304,972	3,237,132,152
2001	2,862,718,112	3,328,741,991
2002	3,554,360,382	4,181,600,449
2003	5,701,476,618	6,707,619,551
2004	7,097,953,563	8,253,434,376
2005	9,134,204,228	10,379,777,532
2006	11,774,180,471	13,533,540,771
2007	14,872,545,725	16,900,620,142
2008	15,997,870,399	18,388,356,780
2009	16,123,831,401	18,322,535,683
2010	21,473,195,343	24,401,358,344
2011	27,402,402,319	32,238,120,375
2012	26,899,634,089	31,278,644,290
2013	27,238,223,902	32,426,457,026
2014	25,084,369,426	29,511,022,854
2015	23,732,457,481	27,920,538,213
2016	23,799,611,178	28,674,230,335
2017	29,505,999,885	33,823,110,678
2018	30,175,446,054	33,262,621,395
2019	28,068,462,812	31,937,894,963

Source: UN trade and General Administration of Customs

Forecast of the China-Laos railway trade volume for Thailand

Linear regression analysis was used to calculate the value of the export trade per the freight volume and established that there is a relationship between export freight volume (independent variable) and export trade volume (dependent variable) and also established a one-to-one equation with a goodness of fit. The result is shown in table 17

Table 17 Linear regression analysis ($y = b + ax$)

	Unnormalized coefficient		Normalized coefficient	TT	Significance	VVIF
	B	The standard error	Beta			
(constant)	1,966,862,397	1,010,677,104	-	0.946	0.068	
Export freight volume	0.826	0.044	0.976	18.563	0.000	1.000
R Square			0.953			
F			344.584			
P			<0.001			
Dependent variable: trade volume of export						

The independent variable is export freight volume, and the dependent variable is the trade volume of Exports. The calculation results in Table 16 are interpreted as follows:

The independent variable can explain 95.30% of the variation degree of the dependent variable, and the model fitting degree is 95.30% >30% (Lange, 1989).

The linear regression model is F=344.584, F is the variance test of the regression model, P<0.05, The probability of coincidence is less than 5%, which can negate the null hypothesis, and the difference between the two groups is significant. The independent variable can affect the dependent variable.

The significance test value of the constant is 0.068>0.05, The probability of coincidence is more than 5%. Therefore, the constant has no statistical support. The constant value has no support of statistical significance is since when there is no freight the trade must be zero. Hence, we use the equation with no constant, $y = ax$. The results are in table 18.

Table 18 Linear regression analysis ($y = ax$)

	Unnormalized coefficient		Normalized coefficient			VVIF
	B	The standard error	Beta	tT	Significance	
Export freight volume	0.864	0.005	1.000	8.563	0.000	1.000
R Square			0.989			
F			31,691.221			
P			<0.001			
Dependent variable: trade volume of export						

The calculation results in Table 18 are interpreted as follows:

The independent variable can explain 98.90% of the variation degree of the dependent variable, and the model fitting degree is 98.90%>95.30%, Therefore, we can think that the equation without the constant term can better express the relationship.

The linear regression model is F=31,691, F is the variance test of the regression model, P<0.05, The probability of coincidence is less than 5%, which can negate the null hypothesis, and the difference between the two groups is significant. The independent variable can affect the dependent variable.

B value in the linear regression equation is 0.864, which means that the independent variable has a significant positive influence on the dependent variable by increasing export freight volume by 1 kg and the dependent variable by 0.864 dollars. The regression equation between independent variables and dependent variables is as follows:

$$y = 0.864x \qquad (1)$$

then, the residuals of the linear regression model are a normal distribution, which means that the calculation results of the model are accurate and reliable. Next, we used the value of 0.864 export trade per freight volume to estimate the trade when the added capacity by the China-Laos railway connection becomes available. The estimated trade volume of the China-Laos railway is summarized in Table 19.

Table 19 The trade volume of the China-Laos railway

Time period	Export freight volume (Kg)	Trade volume of Export (US dollars)
Preliminary stage (Within 5 years)	1,200,000,000	1,036,800,000
Short term (Within 5-10 years)	1,770,000,000	1,529,280,000
Long term (10 years later)	2,600,000,000	2,246,400,000

Thailand's export to China has been maintained at $25 billion to $30 billion from 2011-2019, And in the three years since has been maintained at about $28 billion (Valinluck, T., 2019). The World Trade Organization predicts that by 2035, Thailand's exports to China will reach $35 billion (Zhiyong Qiu, 2014). Therefore, we can assume Thailand's export volume to China will be between US $28 billion and US $35 billion from 2020 to 2035 (Li, 2014). Formula 2 can be used to calculate how much of Thailand's trade could be shared by the China-Laos railway. The share ratio of the China-Laos railway will be 3.43%-4.29% before 2025. Then, in the period 2025-2030, the sharing rate will reach 5.06% - 6.32%, and after 2030, China-Laos railway transportation volume will reach saturation, and the sharing rate will reach 7.43%-9.29%. The volume of trade that can be carried by the new routes depends on the volume that the China-Laos railway can carry. This is also the trade volume that can be transported by the new routes after the completion of the China-Laos railway. The proportion of Thailand's export to China was 92% by sea and 8% by land in 2018. Therefore, it can be assumed that the new transportation mode will play an important role in Thailand's export trade to China after the completion of the China-

Laos railway. Next, analysis of which new routes are better than the existing ones after the completion of China-Laos railway was undertaken, which proved that these new routes can indeed share the volume of exports as predicted.

$$\text{Share ratio} = \frac{\text{Trade volume ofthe China–Laos railway}}{\text{Thailand's Export Trade}} \tag{2}$$

Thailand's main export route to China

The main industries of Thailand exports to China's Guangdong, Shandong, and Yangtze River Delta economic circle are shown in previous paper, which lists the main export routes identified in the literature review and from the secondary data. Different industries use different routes, so in order to determine which route each industry is now using, some of the industry's export companies were interviewed. Here are eight companies interviewed about rubber and plastics, The choice of these companies was as follows:

Table 20 Thailand's main export route to China for rubber and plastics

No	Company	Industry	Area	Choice
1	Wanhai Shipping Co. Ltd.	Third-Part Logistics (Natural rubber)	Shandong	S4
2	Evergreen Marine Co. Ltd.	Third-Part Logistics (Natural rubber)	Shandong	S4
3	OOCL Shipping Co. Ltd.	Third-Part Logistics (Latex products)	Shandong Shanghai	S4
4	F.R. ENTERPRISE Co. Ltd.	Plastic recycling (PP, HDPE, LDPE)	Shandong Shanghai Guangdong	S4 S2 S1
5	F.R. ENTERPRISE Co. Ltd.	Plastic recycling	Shanghai Guangdong	S2 S1
6	ENGTHAI GLOBAL TRADE Co. Ltd.	LDPE granules	Shandong Shanghai Guangdong	S4 S2 S1
7	CTS International Logistics Co. Ltd.	Third-Part Logistics (PP, HDPE, LDPE)	Guangdong Shanghai	S1 S2

No	Company	Industry	Area	Choice
8	SM GREEN SUPPLIER Co. Ltd.	Rubber	Shandong Shanghai Guangdong	S4 S2 S1

According to the in-depth interviews undertaken, the route for exports to Shandong is S4, the route for exports to the Triangle economic circle of the Yangtze River is S2, and to Guangdong is route S1.

Then, for the six companies interviewed about mechanical and electronic products, their choice of route was as follows:

Table 21 Thailand's main export route to China for mechanical and electronic

No	Company	Industry	Area	Choice
1	Wanhai Shipping Co. Ltd.	Third-Part Logistics (Auto parts, small household appliances)	Shandong	S6
2	Evergreen Marine Co. Ltd.	Third-Part Logistics (Motorcycle parts)	Shandong	S6
3	OOCL Shipping Co. Ltd.	Third-Part Logistics (High-end equipment and large mechanical and electrical)	Shandong Shanghai	S6 S3
4	CTS International Logistics Co. Ltd.	Third-Part Logistics (Auto parts, small household appliances)	Shanghai Guangdong	S3 S2/R9
5	Gunkul Engineering Public Co. Ltd.	Electrical equipment	Shandong Shanghai Guangdong	S6 S3 S2
6	Sail Construction Group（Thailand) Co. Ltd.	Mechanical and electrical	Shandong Shanghai Guangdong	S6 S3 S2/R9

Also based on the in-depth interviews of industry experts, the Shandong export route is S6, the route for exports to the Triangle economic circle of the Yangtze

River is S3, and the route for exports to Guangdong is (S2+R)/R9. Based on the interviews with experts in six companies exporting plants products, their choice of route was as follows:

Table 22 Thailand's main export route to China for plants products

No	Company	Industry	Area	Choice
1	Baohan International Logistics Co. Ltd.	Sell Thai plant products and fruit products	Guangdong	R9
2	Pawin Golden Rice Co. Ltd.	Thai rice	Guangdong Nanning	R3A
3	Erawan Design Ltd., PART.	Tree and arbor	Shandong Shanghai Guangdong	S6 R9 R9
4	CTS International Logistics Co. Ltd.	Third-Part Logistics (The main export bonsai)	Shanghai Guangdong	S3 R9
5	Thai Cereals World Co. Ltd.	Cereals	Shandong Shanghai Guangdong	S6 R9 R9
6	Muenlee Global Trade Co. Ltd.	Durian	Shandong Shanghai Guangdong	- R9 R3A

The route for exports to Shandong is S6, to the Triangle economic circle of the Yangtze River is route R9, and for exports to Guangdong the routes are R9 or R3A.

CHAPTER V

CASE STUDY

In this chapter, the AHP analysis method was used to identify the determining factors of Route Selection. The TOPSIS method was adopted to choose the most suitable route for each industry.

the most suitable route for Thailand to export to China is discussed, and also the proposed framework developed to take advantage of these new routes to improve trading performance.

The Determining Factors of Route Selection on AHP

The hierarchy of all decision determining factors has been identified, as shown in Figure 8. This chapter synthesizes the priorities of criteria and decision determining factors of the hierarchy by using a nine-point scale. The questionnaire survey was sent to five experts: two plastics manufacturing company managers, a rubber company salesman, a logistics company director, and a professional academic at a university. Tables 23-28 show the weight of each criterion stated by each of the 5 interviewees.

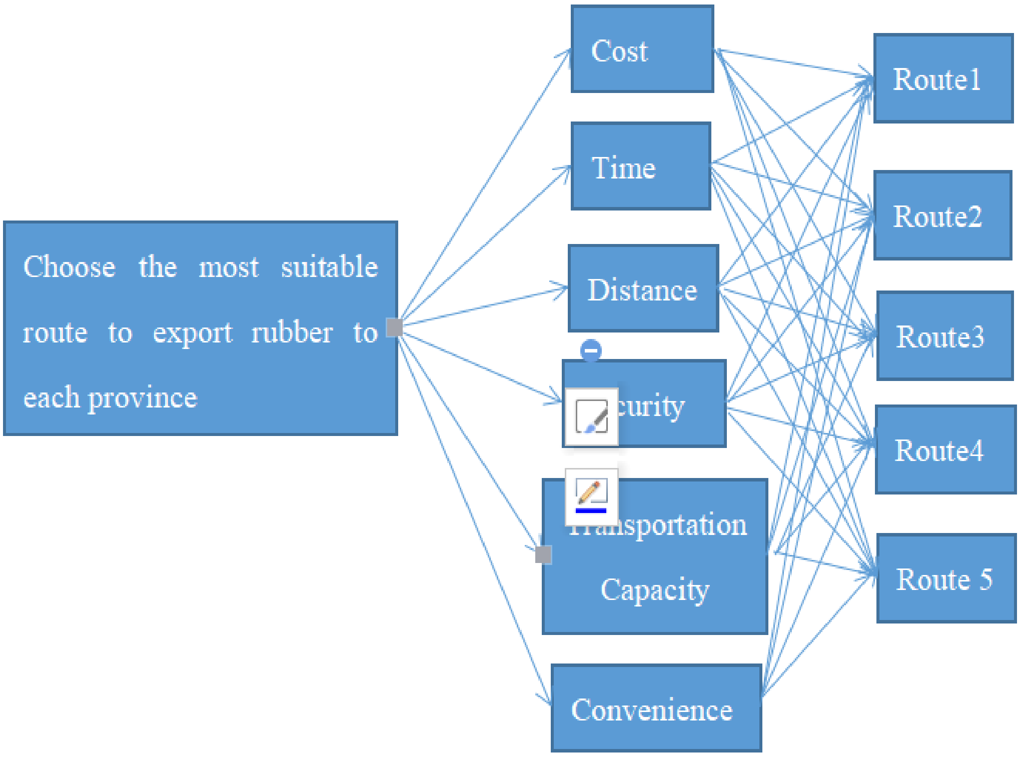

Figure 8 The AHP Structure of Determining Factors

Table 23 The Pairwise Comparison Matrix of Criteria of Interviewee 1

Interviewee 1	Cost	Time	Convenience	Distance	Security	Transportation Capacity
Cost	1	5	3	7	2	3
Time	1/5	1	1/2	2	1/3	1/3
Convenience	1/3	2	1	3	1/2	1
Distance	1/7	1/2	1/3	1	1/3	1/4
Security	1/2	3	2	3	1	1
Transportation Capacity	1/3	3	1	4	1	1
Weight	0.387	0.071	0.133	0.048	0.193	0.169
λ_{max}=6.092	CR=0.018	RI=1.240	CI=0.0148（Inspection）			

Table 24 The Pairwise Comparison Matrix of Criteria of Interviewee 2

Interviewee 2	Cost	Time	Convenience	Distance	Security	Transportation Capacity
Cost	1	6	5	7	2	3
Time	1/6	1	1/2	2	1/5	1/4
Convenience	1/5	2	1	3	1/3	1/2
Distance	1/7	1/2	1/3	1	1/5	1/4
Security	1/2	5	3	5	1	2
Transportation Capacity	1/3	4	1	4	1/2	1
Weight	0.405	0.058	0.095	0.041	0.252	0.149
λ_{max}=6.031	CR=0.006	RI=1.240	CI=0.005（Inspection）			

Table 25 The Pairwise Comparison Matrix of Criteria of Interviewee 3

Interviewee 3	Cost	Time	Convenience	Distance	Security	Transportation Capacity
Cost	1	4	5	3	1/5	1/4
Time	1/4	1	3	2	1/5	1/3
Convenience	1/5	1/3	1	1/2	1/5	1/4
Distance	1/3	1/2	2	1	1/6	1/5
Security	5	5	5	6	1	2
Transportation Capacity	4	3	4	5	1/2	1
Weight	0.159	0.088	0.045	0.058	0.393	0.257
λ_{max}=6.536	CR=0.107	RI=1.240	CI=0.086（Inspection）			

Table 26 The Pairwise Comparison Matrix of Criteria of Interviewee 4

Interviewee 4	Cost	Time	Convenience	Distance	Security	Transportation Capacity
Cost	1	4	5	6	1/2	4
Time	1/4	1	2	3	1/4	1
Convenience	1/5	1/2	1	1/2	1/7	2
Distance	1/6	1/3	2	1	1/6	1/2
Security	2	4	7	6	1	5
Transportation Capacity	1/2	1	1/2	2	1/5	1
Weight	0.290	0.102	0.065	0.058	0.399	0.086
λ_{max}=6.566	CR=0.113	RI=1.240	CI=0.091（Inspection）			

Table 27 The Pairwise Comparison Matrix of Criteria of Interviewee 5

Interviewee 5	Cost	Time	Convenience	Distance	Security	Transportation Capacity
Cost	1	1/5	1/4	2	1/3	1
Time	5	1	2	6	2	5
Convenience	4	1/2	1	3	1/2	3
Distance	1/2	1/6	1/3	1	1/5	1/2
Security	3	1/2	2	5	1	4
Transportation Capacity	1	1/5	1/3	2	1/4	1
Weight	0.084	0.351	0.202	0.05	0.243	0.069
λ_{max}=6.135	CR=0.027	RI=1.240	CI=0.022（Inspection）			

All the data from the five expert's lists were summarized and it can be seen from the data that the different experts gave different weights to each factor. The average value of all the data was calculated, which is convenient for evaluating the route. The data is shown in Table 28.

Table 28 The Priority of Six Factors on Average for Rubber and Plastics

Interviewee	Cost	Time	Convenience	Distance	Security	Transportation Capacity
1	0.387	0.071	0.133	0.048	0.193	0.169
2	0.405	0.058	0.095	0.041	0.252	0.149
3	0.159	0.088	0.045	0.058	0.393	0.257
4	0.290	0.102	0.065	0.058	0.399	0.086
5	0.084	0.351	0.202	0.05	0.243	0.069
Average	0.265*	0.134	0.108	0.051	0.296*	0.146

Table 28 shows the summary weight of all factors which indicate that security and cost are the two most important determining factors, with weights of 0.296 and 0.265. These factors were used to evaluate routes for export rubber and plastics.

The author uses the same method to calculate the weight of each factor of export mechanical, electronic and export plants. These results are summarized in table 29 and table 30.

Table 29 The Priority of Six Factors on Average for Mechanical and Electronic

Interviewee	Cost	Time	Convenience	Distance	Security	Transportation Capacity
1	0.351	0.191	0.135	0.043	0.178	0.102
2	0.302	0.215	0.130	0.044	0.216	0.093
3	0.140	0.216	0.145	0.065	0.235	0.199
4	0.229	0.238	0.055	0.049	0.338	0.091
5	0.256	0.245	0.045	0.028	0.320	0.106
Average	0.255*	0.221	0.102	0.046	0.257*	0.118

Table 30 The Priority of Six Factors on Average for Plants

Interviewee	Cost	Time	Convenience	Distance	Security	Transportation Capacity
1	0.13	0.41	0.04	0.26	0.07	0.09
2	0.32	0.33	0.08	0.09	0.10	0.07
3	0.07	0.03	0.18	0.18	0.40	0.14
4	0.26	0.41	0.10	0.04	0.14	0.06
5	0.39	0.30	0.07	0.04	0.11	0.09
Average	0.234*	0.296*	0.094	0.122	0.164	0.09

Performance of existing route and new route for various industries

1. New export routes for main industries from Thailand to China after the completion of the China-Laos railway

When the China-Laos Railway between China and Laos, connecting to Bangkok in Thailand, new railway routes will be formed after the completion of the project which is expected to be in December 2021. These routes are summarized in Table 31.

Table 31 New export routes after the completion of the China-Laos railway

T1	Bangkok-Nong Khai Station-The Vientiane South Station（Laos）-Mohan Station（China）-Kunming Station-	Guangdong
T2	Bangkok-Nong Khai Station-The Vientiane South Station（Laos）-Mohan Station（China）-Kunming Station-Chengdu Station-	Shanghai Zhejiang Jiangsu
T3	Bangkok-Nong Khai Station-The Vientiane South Station（Laos）-Mohan Station（China）-Kunming Station-Nanchang station	Shandong

Note: T= train transportation

2. Export process of existing and new routes

The export process of the existing routes and the new routes is different, as for the export process, the author mainly takes plant products as an example. This paper interviews with Pawin Golden Rice Co. Ltd., Muenlee Global Trade Co. Ltd. and customs staff of China Mohan border, then combined with secondary data collected by the authors. a simplified figure of export process is drawn in figure 9 -11. From the process, this study makes a table for comparison between existing and new routes in table 32. The author compares existing and new routes in 9 aspects according to the export process.

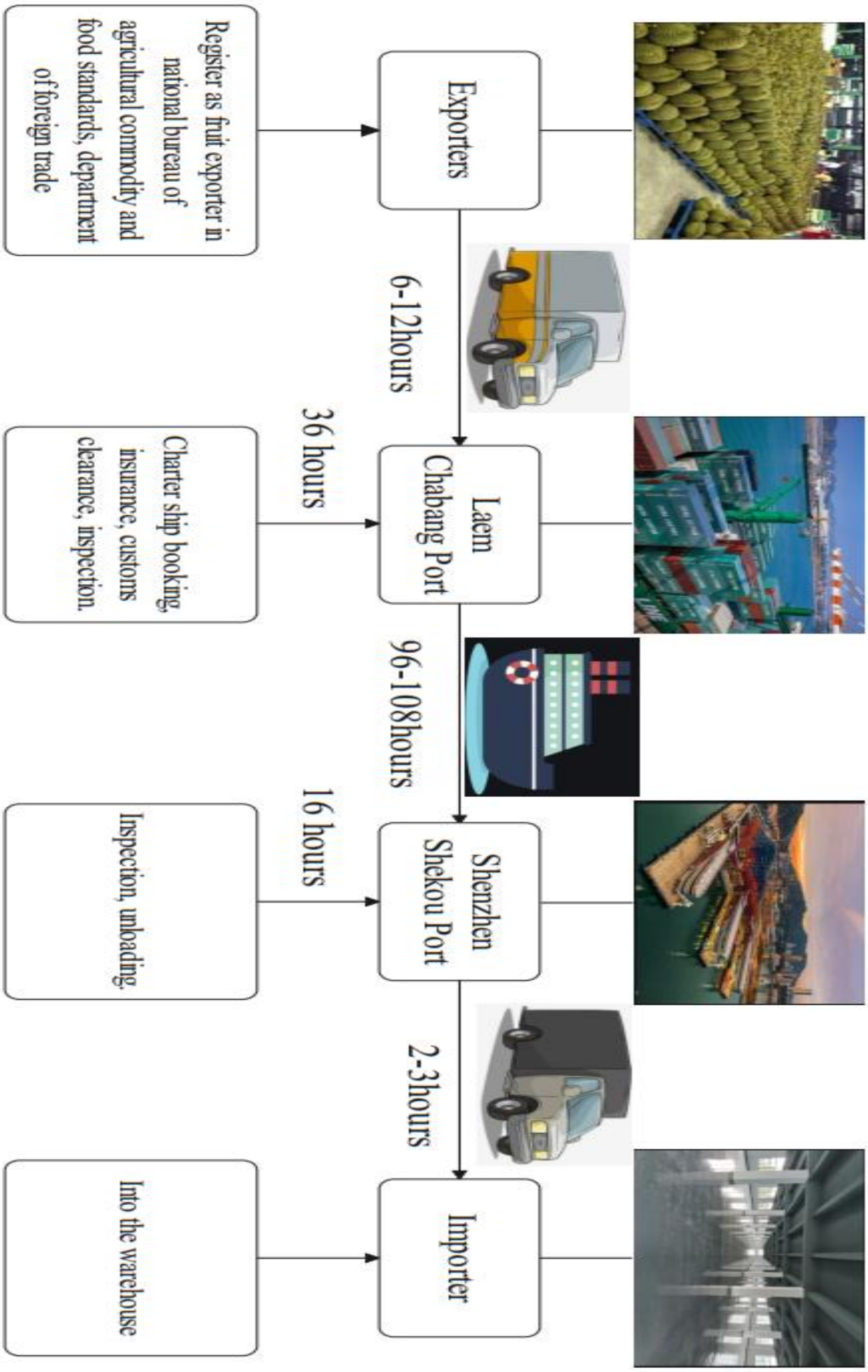

Figure 9 Sea-Going transport

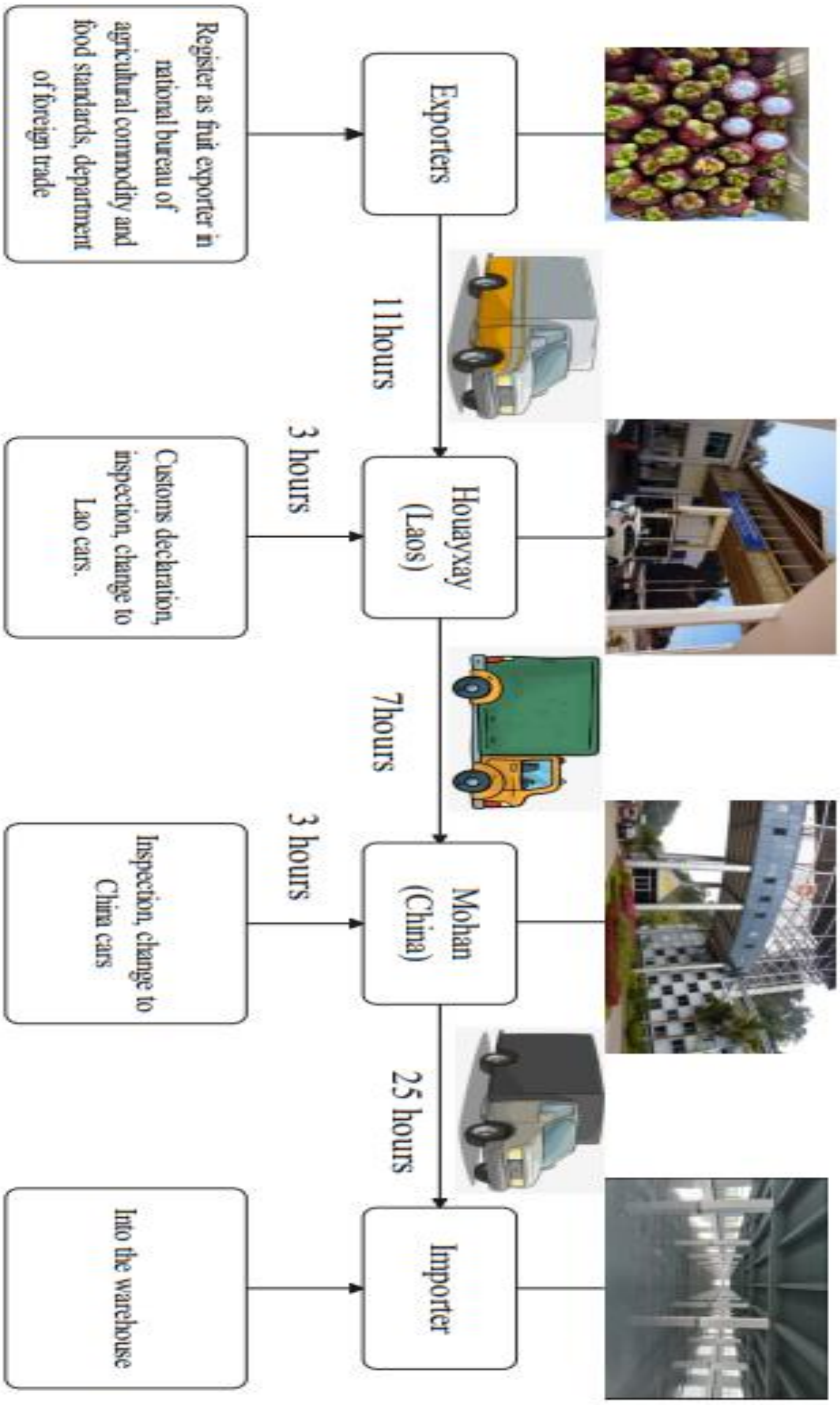

Figure 10 Road transport

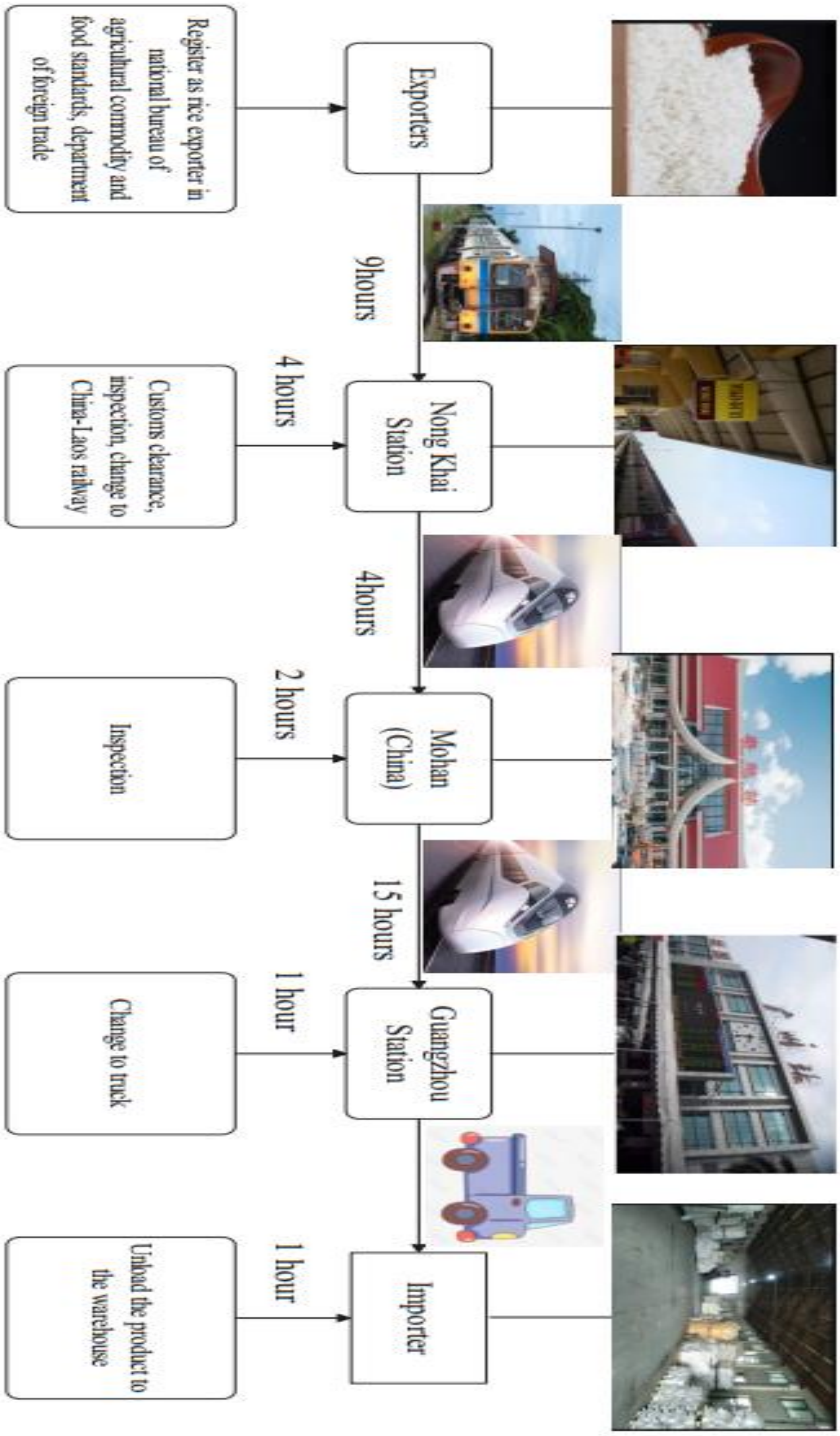

Figure 11 Railway transport

Table 32 Comparison between existing and new routes

Term / No	Routes	Existing routes S1	Existing routes R3A	New routes T1	The optimal route
	The mode of transportation	Sea-going transport	land transport	railway transport	-
1	Transport capacity	High	Low	Middle	S1
2	Number of customs declarations	1	2	1	S1 T1
3	Number of inspections	2	3	2	S1 T1
4	Important transshipment points (transition points for changing modes of transport)	2	2	3	S1 R3A
5	Customs declaration and inspection time	Long time	Short time	Very short time	T1
6	Loading and unloading time	Very Long time	Short time	Long time	R3A
7	Transport time	Long time	Short time	Very Short time	T1
8	Distance	Long	Very Short	Short	R3A
9	Condition of Transport（Road conditions, weather affects conditions）.	Bad	Middle	Good	T1

Note: S1: Bangkok- Chabang Port-Port of Guangzhou, Foshan (Shenzhen Shekou Port)

R3A: Bangkok-Chiangkong-Houayxay (Laos)-Boten-Mohan (China)-Jinghong-Kunming- Guangdong

T1: Bangkok-Nong Khai Station-The Vientiane South Station-Mohan Station-Kunming Station-Guangdong

From the table, the author compares the new routes with the existing routes for qualitative analysis. we can find that the new routes have advantages in six aspects. They are number of customs declarations, number of inspections, customs declaration and inspection time, transport time and condition of transport. And the other three aspects are worse than the existing lines, the main reason are as follows:

First of all, in terms of transport capacity, the new routes are worse than the sea transport. Then, rail transport cannot do "door to door" transport, it needs to change the mode of transport, this will make the transportation process more complicated. So, this aspect is inferior to land transport, but rail transport can carry much more goods than road transport. In addition, loading and unloading time is also longer than road transport. Rail transport is affected by the terrain, its transport distance is also longer than road transport.

3. Route performance of export transport for various industries

Based on information received in in-depth interviews with experts, new routes have been identified that will become available on completion of the China-Laos railway. These experts indicated their selection of the Common routes among the existing routes. The existing routes and new routes are shown in Table 33 and Figure 9.

Table 33 The existing and new routes of each industry

Industry	Existing route	New route	Destination (province)
Rubber and plastics	Bangkok-Shanghai Port-Qingdao port（S6）	Bangkok-Nong Khai station-The Vientiane South Station-Mohan Station-Kunming Station-Nanchang station (T3)	Shandong
	Bangkok-Laem Chabang Port-Shanghai Port (S2)	Bangkok-Nong Khai Station-The Vientiane South Station -Mohan Station-Kunming Station- (T2)	Shanghai Zhejiang Jiangsu
	Bangkok- Laem Chabang Port-Port of Guangzhou, Foshan (Shenzhen Shekou Port) (S1)	Bangkok-Nong Khai Station-The Vientiane South Station-Mohan Station-Kunming Station (T1)	Guangdong

Industry	Existing route	New route	Destination (province)
Mechanical and electronic	Bangkok-Shanghai Port-Qingdao port (S6)	Bangkok-Nong Khai station-The Vientiane South Station-Mohan Station-Kunming Station-Nanchang station (T3)	Shandong
	Bangkok-Laem Chabang Port-Port of Guangzhou, Foshan (S3)	Nong Khai Station-The Vientiane South Station-Mohan Station-Kunming Station- (T2)	Shanghai Zhejiang Jiangsu
	Bangkok-Mukdahan-Savanna Khet (Laos)-Dansavanh-LaoBao -Hanoi-Lang Son-HuuNghi-Nanning (China)(R9) Bangkok-Laem Chabang Port- Guangzhou, Foshan (S1+R)	Bangkok-Nong Khai Station-The Vientiane South Station-Mohan Station-Kunming Station (T1)	Guangdong
Plant products	Bangkok-Shanghai Port(S6)	Bangkok-Nong Khai station-The Vientiane South Station-Mohan Station-Kunming Station-Nanchang station (T3)	Shandong
	Bangkok-Mukdahan-Savanna Khet (Laos)-Dansavanh-Lao Bao (Vietnam)-Hanoi-Lang Son-Huu Nghi-Nanning (China)(R9)	Bangkok-Nong Khai Station-The Vientiane South Station -Mohan Station-Kunming Station-Chengdu Station (T2)	Shanghai Zhejiang Jiangsu
	Bangkok-Mukdahan-Savanna Khet (Laos)-Dansavanh-Lao Bao (Vietnam)-Hanoi-Lang Son-Huu Nghi-Nanning (China)(R9) Bangkok-Chiangkong-Houayxay (Laos)-Boten-Mohan (China)-Jinghong-Kunming (R3A)	Bangkok-Nong Khai Station-The Vientiane South Station-Mohan Station-Kunming Station (T1)	Guangdong

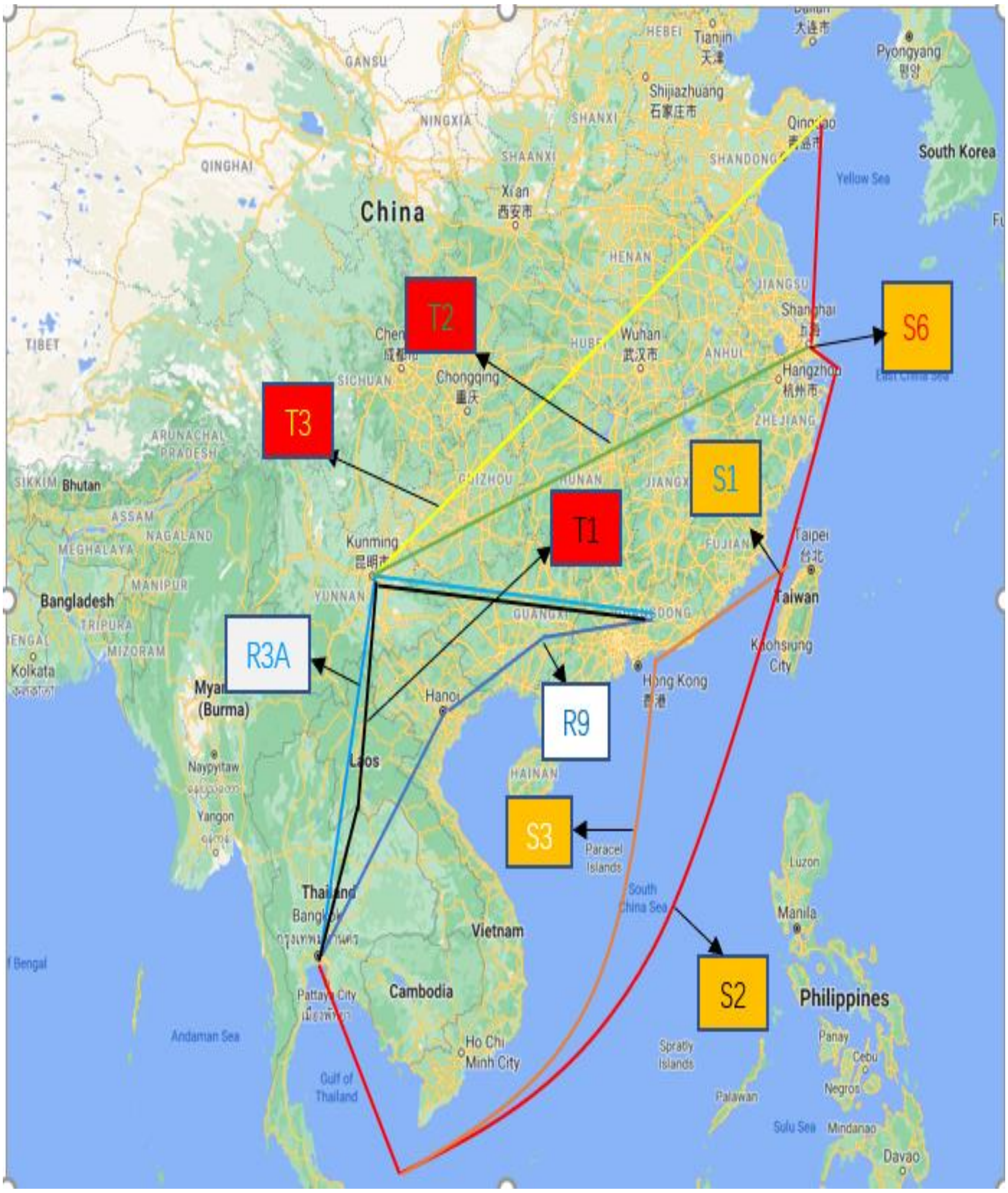

Figure 12 The existing routes and new routes

Note: S6 (The red line): Bangkok-Shanghai Port-Qingdao port

S1 (Orange line): Bangkok- Chabang Port-Port of Guangzhou, Foshan (Shenzhen Shekou Port)

S2 (The red line): Bangkok-Laem Chabang Port-Shanghai Port

S3 (Orange line): Bangkok-Laem Chabang Port-Port of Guangzhou, Foshan-Shanghai Port

R3A (Blue line): Bangkok-Chiangkong-Houayxay (Laos)-Boten-Mohan (China)-Jinghong-Kunming- Guangdong

R9 (Dark blue line): Bangkok-Mukdahan-Savanna Khet (Laos)-Dansavanh-Lao Bao (Vietnam)-Hanoi-Lang Son-Huu Nghi-Nanning (China)-Guangdong

T1 (Black line): Bangkok-Nong Khai Station-The Vientiane South Station-Mohan Station-Kunming Station-Guangdong

T2 (Green line): Bangkok-Nong Khai Station-The Vientiane South Station -Mohan Station-Kunming Station-Chengdu Station-Shanghai

T3 (Yellow line): Bangkok-Nong Khai station-The Vientiane South Station-Mohan Station-Kunming Station-Nanchang station-Shandong

It was concluded that there are 6 determining factors of cost, time, convenience, distance, safety, and transportation capacity. Convenience and safety are qualitative indicators for which a 5-point Likert scale was adopted, with 5 being very convenient, 4 being relatively convenient, 3 being convenient, 2 being not convenient, and 1 being very inconvenient. The scores were obtained from interviews with the five experts, and then averaged. The other four determining factors will use the actual data of each industry and route. The performance of each route is summarized as follows:

Table 34 Rubber and plastics

Province	Route	Cost dollar/tons	Time hours	Capacity tons	Distance km	Security	Convenience
Shandong	S6	232	235	11000	7255	1.6	2.2
	T3	229	47	3200	2865	3.4	3.4
Shanghai Zhejiang Jiangsu	S2	198	175	9000	6455	1.8	2.4
	T2	220	38	3200	2745	3.4	3.6
Guangdong	S1	185	156	7500	3676	1.8	2.6
	T1	167	34	3200	2084	3.6	4

Table 35 Mechanical and Electronic

Province	Route	Cost dollar/tons	Time hours	Capacity tons	Distance km	Security	Convenience
Shandong	S6	260	225	11000	7432	1.6	2
	T3	224	47	3200	2865	3.4	3
Shanghai Zhejiang Jiangsu	S3	215	165	9000	5985	1.8	2.2
	T2	227	38	3200	2745	3	3.2
Guangdong	R9	218	62	28	2186	2.4	1.8
	S1	202	137	7500	4045	2.6	1.6
	T1	211	34	3200	2635	3.6	3.8

Table 36 Plants

Province		Cost dollar/t	Time hours	Capacity tons	Distance km	Security	Convenience
Shandong	S6	245	225	11000	7432	1.4	2
	T3	224	47	3200	2865	3.2	2.8
Shanghai Zhejiang Jiangsu	R9	298	78	28	2499	2.2	2. 2
	T2	227	38	3200	2745	3	3.4
Guangdong	R9	244	52	28	2186	2.2	1.8
	R3A	289	49	28	2558	2.2	1.6
	T1	211	34	3200	2635	3	3.2

The optimal route for each industry

The TOPSIS method was used to compare the routes of various industries. In the first comparison, for the export of latex and plastic to Shandong, the two routes selected were S4 for latex and T3 for plastics.

The TOPSIS analysis used the statistics, applying them to the same trends and normalization and defined goods,

$$R=\begin{matrix} 260 & 225 & 11{,}000 & 7{,}432 & 1.6 & 2 \\ 224 & 47 & 3{,}200 & 2{,}865 & 3.4 & 3 \end{matrix} \quad (1)$$

$$R1=\begin{matrix} 0.771 & 0.981 & 0.960 & 0.930 & 0.426 & 0.543 \\ 0.702 & 0.196 & 0.279 & 0.367 & 0.905 & 0.840 \end{matrix} \quad (2)$$

The assumed weights of each factor obtained by the AHP method were 0.265, 0.134, 0.108, 0.051, 0.296, and 0.146 which were used to compute the negative ideal and the positive ideal.

The next step was to calculate the distance between each evaluation object and the optimal scheme and the worst scheme (best, worse).

The formula ($S = \frac{D^+}{D^+ + D^-}$) was used to obtain the evaluation reference value. The smaller the reference value is, the higher the evaluation result is, which is the optimal plan in Table 37.

Table 37 The result of logistics performance comparison

Route	D+	D-	S	Ranking
T3*	0.074	0.597	0.285	1
S4	0.184	0.074	0.714	2

It can be seen that the new train route T3 is better than the existing route S6 in terms of comprehensive logistics performance. Subsequently, the same method was used to compare other routes, and the results are shown in Table 38.

Table 38 The result of logistics performance comparison for each industry

Province	Industry	Route (S)			The optimal route
Shandong	Rubber and Plastics	S6(0.714)	T3(0.285)		T3
	Mechanical and Electronic	S6(0.747)	T3(0.253)		T3
	Plants	S6(0.699)	T3(0.301)		T3
Shanghai Zhejiang Jiangsu	Rubber and Plastics	S2(0.710)	T2(0.290)		T2
	Mechanical and Electronic	S3(0.721)	T2(0.268)		T2
	Plants	R9(0.732)	T2(0.279)		T2
Guangdong	Rubber and Plastics	S1(0.742)	T1(0.257)		T1
	Mechanical and Electronic	R9 (0.545)	S1+R (0.489)	T1 (0.237)	T1
	Plants	R9 (0.731)	R3A (0.502)	T1 (0.08)	T1

Discussion

Analysis of the data and the outcomes of the various analysis processes resulted in the comprehensive logistics performance of the new routes being shown to be obviously better than that of the existing routes in all industries. The first conclusion arrived at was that, while the products exported from Thailand to Shandong had mainly used S6 (Bangkok-Shanghai Port-Qingdao Port) in the past, the new route T3 (Bangkok - Nong Khai Station - Vientiane South Station - Mohan Station - Kunming Station - Nanchang Station) has more advantages in comprehensive transportation performance.

This route, T3, has obvious advantages in terms of time, distance, safety and convenience. The new route, which combines railway and land transportation, has a shorter transportation distance and a faster transportation speed than S6. The new route is not limited by the influence of weather and benefits from the simple customs clearance process of the China-Laos railway. The transport distance for exports from Bangkok to Shandong province is very long, and the navigation risks of sea transportation are great, meaning that the sailing times, ETD, ETA and voyage duration time, are not easy to plan. Therefore, the new routes are superior to the existing routes in terms of security and convenience. However, the new route has less capacity than the existing route and has no cost advantage.

For the export routes to the Yangtze River Delta region, the existing route for rubber and plastic export is S2, and the route for mechanical and electrical products is S3, while the new route is T2. The new routes have advantages in terms of time, distance, safety and convenience. T2 is inferior to the existing route S3 in terms of cost and transportation capacity. The existing route for transporting plants is R9 (Bangkok – Mukdahan - Savanna khet – Donavan - Lao Bao - Hanoi – Langson - Huu Nghi- Halves), which has the main advantages of transport time and shorter distance. However, the new route T2 (Bangkok - Nong Khai Station - Vientiane South Station - Mohan Station - Kunming Station – Chengdu- the Yangtze River Delta region), which will become available on completion of the new China-Laos railway stations, will save more time and will have a huge advantage in cost, transportation capacity, safety and convenience. This is mainly due to the poor road condition of R9 route and the long time for customs clearance, which significantly affect the convenience and safety. As well, route T2 is rail transportation which allows higher transportation speed and greater transportation capacity than R9.

The export route from Thailand to Guangdong for the transport of plastic and rubber is mainly S1 (Bangkok - Chabang Port – Guangzhou Port, Foshan Port). This is a sea route with the disadvantages of that mode of transportation and is inferior to the new route T1 (Bangkok - Nong Khai Station - Vientiane South Station - Mohan Station - Kunming Station) in terms of convenience and security, and has no advantage in cost due to the short transportation distance. S1 is only superior to T1 in terms of transportation capacity.

The existing routes for shipping mechanical and electronic products include two R9 and S1+R. R9 is Bangkok – Mukdahan - Savanna Khet – Dansavanh - Lao bao - Hanoi - Lang son - Huunghi-Nanning) and S1+R (Bangkok - Laem Chabang Port- Guangzhou, Foshan), The main advantages of R9 are short transportation distance and time. The new route T1 has no advantages in these three dimensions, but it is better than R9 in terms of transportation capacity, convenience and safety. Compared with S2+R, the new route T1 is inferior to it in cost and transportation capacity, but considering it in terms of time, convenience and safety, the new route has absolute advantages.

There are two existing routes for transporting plant products, R9 and R3A. R3A is superior to T1 in cost and distance and inferior to T1 in other terms. The results of the calculations in this study show that the new routes outperform the existing routes in terms of transport performance in all industrial exports. The main reason is that the new routes get high scores for safety and convenience. Further, comparing with the land transportation routes, the new route has apparent advantages in terms of cost, time, and transportation capacity. Compared with other sea transportation, the new routes have huge advantages in terms of distance and time.

The framework developed in this study, discussed next, has indicated strong preference for the new routes. On the one hand, the framework gives full play to the advantages of the new routes in terms of safety and convenience; on the other hand, it can reduce the cost and time and improve the transportation capacity, so that the new routes are clearly more advantageous for exports.

Framework for improving trade performance

This framework describes the main roles in the new routes and provides advice for those roles. This framework will help Thai exporters to improve their trade performance and the competitiveness of Thai products. The framework is shown in Figure 13,

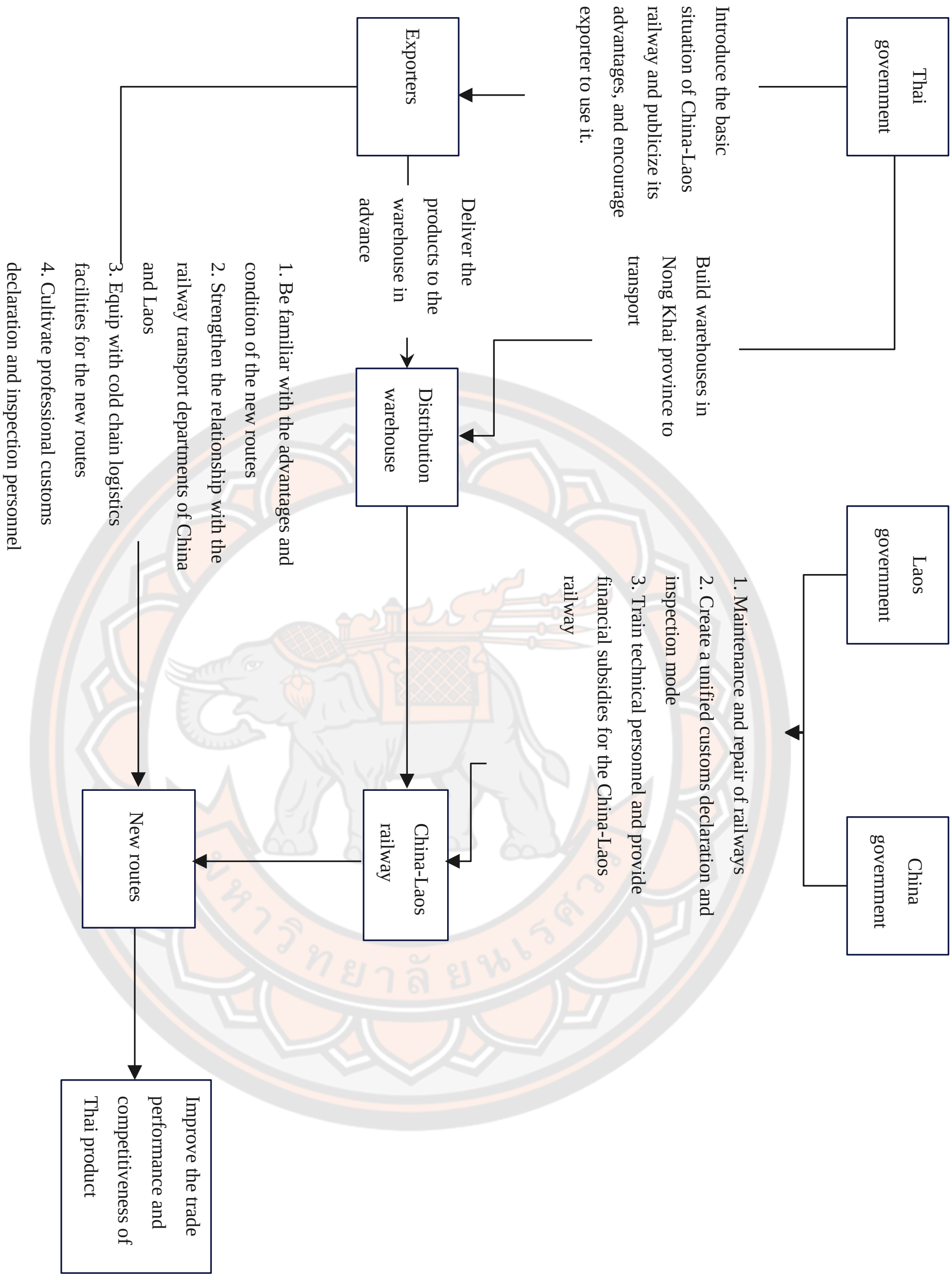

Figure 13 The Framework

Through the above series of research methods and arguments, this paper finally proves that the new routes are superior to the existing routes based on the determining factors. However, if the government and exporters see the data comparison directly, they may not fully understand the new routes, and will not directly try to abandon the existing routes to choose new routes. Because the new routes have the disadvantages of railway transport and the details that need to be paid attention to, how to reduce the disadvantages of the new routes, better play the advantages of the new line will be very important.

Therefore, the author puts forward this framework, which mainly introduces the main roles of the new routes if the exporter uses the new routes. The main roles include government, distribution warehouse, China-Laos railway and new routes, and the framework briefly introduces the process for exporters to use the new routes. In addition, the framework also proposes some suggestions for closer collaboration between various roles, which will give full play to the advantages of the new routes, thus improving the trade performance and competitiveness of Thai Product. The author will mainly introduce each role in the framework and make suggestions for each role based on the research results of the paper.

1. The Thai government

The Thai government is the first Thai side to learn about the China-Laos Railway and should learn from this experience to provide help for the future construction of the China-Thailand railway. And for Thai exporters, Thai government should promote the new routes to Thai exporters in Thailand. Since few companies know about the new routes. that will be opened once the new railway become operational, the government needs to introduce the basic situation of China-Laos railway and publicize its advantages, and encourage exporter to use it. Then, The Thai government needs to Build warehouses in Nong Khai Province to transport, because this paper proposes that the new routes lack advantages in convenience and cost, one of the main reasons is that railway transportation is limited by punctuality and full load rate. Due to the small scale of many plant and electromechanical enterprises, they cannot fully load a container, and plant products often need to be kept fresh and preserved. In order to keep the train full, while waiting for other goods to be loaded, it will definitely damage the plants. Nong Khai province is an important border between Thailand and Laos. It is most appropriate to set up a distribution warehouse here. Since the train is not available at every moment, the goods can be transported to the warehouse for storage in advance, and then transferred to the train according to the departure time of the train, which can also ensure the quality of the goods and the full capacity of the train.

2. Distribution warehouse

Distribution warehouse is an important infrastructure for new lines. First of all, warehouse personnel should have strong logistics expertise and be able to help enterprises carry out quality checks on incoming goods. Then, warehouses must have cold-chain storage technology, because many times plants and fruits cannot be exported the same day, which can help exporters manage their goods. Finally, the distribution warehouse should have a complete ERP system to strictly track the information of goods and standardize the warehousing and warehousing of goods.

3. Laos government

Since the main section of the new routes is in Laos, The Lao government is a major factor in determining the cost of the China-Laos railway, as the maintenance and repair of the railway is an important cost factor of the railway. Therefore, the Lao government should prevent the track from being affected by the environment and weather, and prevent local people from damaging the track and stealing important railway property. In the long term, the Lao government could try to lower freight rates to encourage more businesses to use the railway if it can guarantee the smooth transport of the railway in long time. Then, the Lao government needs to maintain the railway and simplify customs clearance to make it more convenient for Thai exporters. Because customs declaration and inspection are an important factor affecting convenience, the new routes can be better than other routes in convenience, the important reason is that customs declaration only needs one time, and inspection only needs two times. Therefore, the Lao government should ensure the efficiency of customs declaration and inspection, which can save time and be more convenient.

4. Chinese government

The China-Laos railway is the main link affecting the efficiency of the new line, and the most important factor affecting the China-Laos railway transportation is railway maintenance. The Chinese government holds the advanced technology of high-speed railway construction, and China-Laos railway is the first railway built by China in Southeast Asia. China needs to take on the responsibility of maintaining the railway so that it can be transported in a long and healthy way, which is convenient for Thai exporters as well as Chinese importers. At the national level, this will help lay the groundwork for the Chinese government to win more orders for high-speed railway. In the long term, China also needs to help Laos to train railway technicians, whether it is railway transportation service or railway maintenance. Because the high-quality service will also enable more Thai exporters to use the China-Laos railway. When Laos can fully manage the China-Laos railway in the future, the cost of manpower, resources and technology will be reduced, which will greatly reduce the operation cost of the railway. By reducing operating costs, The Lao government could help lower freight rates, which would make the new route more cost-effective.

In addition, As the Chinese government establishes the main part of the new routes, an important goal of the Chinese government in building the China-Laos railway is to increase trade with Thailand and Laos. they can subsidize the new routes as is being done on the China-Europe railway to subsidize the railway sector, so the railway interests can reduce the cost of rail transportation, and the cost of new routes can be reduced, which will allow more exporters to use the new routes and improve the performance and efficiency of the routes, so that the three countries can benefit from the services offered.

5. **For the exporters**

The beneficiaries of the new railway will be Thai exporters, but only if they are fully informed about the advantages offered and the new routes that will be available to them for their export activities. This was a major consideration in this study; to improve the trade competitiveness of Thai exporters by providing information and modelling capabilities. The study has proven that the new routes are better than some existing routes in terms of logistics performance. Exporters need to understand that new routes are superior to all other routes in terms of safety and time, shorter transport time and safe transport of goods with lower propensity for damage, which will improve the trade competitiveness of goods. If exporters consider these two factors to be the most important for transport their goods, the new routes should be preferred. Considering the size of exporters, some suggestions have been proposed in this study for exporters of different sizes companies. As well, the study found that, as exports of plastics and rubber, mechanical and electrical are produced by large enterprises, the customs declaration and inspection of railway transportation will be different from other transportation modes. The important factors that affect the convenience of railway transportation include (1) customs declaration and inspection must be simplified and expedited, (2) large enterprises must familiarize themselves fully with the railway transport customs clearance and inspection procedures. This will make it more convenient for exporters to use the new routes. By having expeditious customs declaration inspection and efficient loading and unloading procedures, the total time required by customs and immigration regulations can be significantly shortened.

The paper points out that transportation cost and transportation time are the determining factors affecting the route, and the new routes has no absolute advantage in transportation cost. Therefore, exporters should try to avoid increasing transportation cost as much as possible due to their own problems. Since the new routes is mainly for rail transport, loading goods, unloading goods on time and ensuring full train capacity can reduce transport costs and transport time. It is necessary for exporters to make good use of distribution warehouses if they want to ensure punctual shipment and increase train capacity. Plants, mechanical and electrical products can be transported to the warehouse in advance because of the small single export volume. The warehouse can help keep the products well, so as to avoid damage of the goods and facilitate the timely export of the goods. it reduces costs and improves convenience.

Another important aspect of rail transportation is that the railway system cannot provide "door to door" service. Hence, exporters must arrange local transportation at the destination railway terminus, or be familiar with the distribution network available to customers after unloading from the railway. For small and medium-sized enterprises that have requirements for urgent transport time, the new routes will suit them well, but they will be limited by the transport unit capacity of the railway cargo wagons which will increase costs if they cannot fill the cargo to capacity. An obvious solution, suggested in this study is that exporters form cooperative groups or perhaps an Export Chamber of commerce to and gather their products in the distribution warehouse and co-operatively share cargo space to reduce transportation costs. Some small companies who are exporting plants must also understand the cold-chain logistics of new routes for the plant products that need freezer of chiller cold-chain facilities.

It is also a potential business opportunity for third-party logistics companies to contract for the delivery of small quantities of cargo that they can then compile into an economic cargo volume, thus reducing transport costs to their exporter clients. These various options can bring preferential transport prices and professional transport services to Thai enterprises.

This framework and these suggestions will help Thai exporters better understand the whole process of the new routes, and when they understand the safety and convenience of the new routes, they will be able to further take advantage of these factors. In terms of transportation capacity, time and cost, they will be able to narrow the gap and be better than the existing routes. Finally, the goal of improving the trade performance and competitiveness of Thai product can be achieved.

CHAPTER VI

CONCLUSION

Conclusion

The purpose of the current study is to analyze the effect of the development of the China-Laos railway. First of all, the author analyzes the trade between Thailand and China, and the trade between Laos and China. The paper found that the completion of China-Laos railway will mainly affect Thailand's export trade to China. Trade performance has always been an important factor that affects Thai industry exported to China. The first thing the author needs to consider is what industries Thailand exports to China, thus, the first objective of the paper is to identify the main industries in Thailand with exports to China. Using literature review, the authors identified the main industries are plastics and rubber, plant products, mechanical and electrical products. Next, the author's second objective it to identify the existing routes of the exports of the Thailand’s main industries exporting to China and the new routes from the connectivity by China-Laos railway. This paper uses the second data analysis to determine the existing and new routes for each major industry to export each province. In order to prove that the new route is superior to the existing route. The third objective of the article is to identify the determining factors on route selection for Thailand's main industries of export from Thailand to China., these determining factors will be used as the criteria to choose the route. The author used literature review method and AHP analysis method to determine the weight of the determinants. And then, the fourth objective of the article is to evaluate whether the new routes from China-Laos railway will be advantageous for the industries over the existing ones. The author uses the TOPSIS method to prove that all major industries exported by new routes are superior to existing ones. The final goal is to develop a framework for taking the advantage of these new routes to improve the trading performance between Thailand and China. This paper puts forward a framework for both the government and exporters to give full play to the advantages of the new route, so as to improve the trade performance of exports.

The China- Laos railway is expected to be completed by December 2021, will provide new transportation connectivity between Thailand and China. However, Thai industry generally, and trade exporters particularly, have limited understanding of the potential benefits that this railway connectivity will bring. For this study, specific information about the China-Laos railway was gained from a literature review. Secondary data was identified and used to identify the determining factors of route choice that can be used by other researchers in future route selection. In-depth interviews were conducted with five professional experts to ascertain their professional and knowledgeable the actual information of China-Laos railway and the transportation performance of each route. AHP analysis and the TOPSIS method were applied to prove the advantages of the new routes after the completion of China-Laos railway. All the new routes gained higher scores in this analysis for comprehensive transportation performance, and the analysis demonstrated that that the new routes have an absolute advantage over the existing export routes used by Thai exporters, in terms of safety, convenience and time, but provided no advantages in terms of transportation capacity and transportation cost compared with some sea transportation routes. As well, when compared with other land transport, transport time and transport distance advantages are not obvious. The linear regression method was used to forecast the trade volume that can be brought by the new route, and showed that the new route will account for 7.43%-9.29% of the total trade ratio of Thailand's export to China after 2030 and the new routes will replace many existing routes. These analysis results demonstrate the impact of the China-Laos railway on export trade from Thailand to China. Hence, if exporters take advantage of these new routes, they can improve their trade performance and competitiveness. The framework for building a competitive advantage from the connectivity provided by the railway, that was developed, describes the main roles of the new routes and provides advice for those roles. As a conclusion to the study. relevant suggestions were put to the government and to exporters, informing them of the advantages that can accrue to them if the new routes are effectively and efficiently exploited. This is a significant contribution to the body of knowledge by this study, by the development of the framework that can be used to take the advantage of these new routes to improve the trading performance between Thailand and China. A further significant outcome of this study was the demonstration of, and proof supporting the impact of the China-Laos railway on Thailand's export trade to China, which must be seen as being of great significance to Thai exporters. Thai exporters must understand the specific situation of the new routes and its advantages, and be able to make reasonable use of the routes, and the findings from this study provide the means to achieve that understanding, thereby improving trade performance and export competitiveness of Thai industry and exporters particularly.

Contribution

The author mainly sums up the contribution of this study in two aspects, one is Academic, the other is Managerial.

1. Academic

1.1 This paper uses literature review method and secondary data method to select the factors for route selection, and asks the experts of various industries for these determinants to finally determine the determinants for comparing routes. These factors will provide reference for other authors to study route selection.

1.2 The author uses AHP analysis method and TOPSIS method to choose route, these two methods combine qualitative and quantitative data to select routes. which will provide valuable reference for other paper in route selection.

1.3 there is very little research on China-Laos railway in the academic world. This paper analyzes the influence of the China-Laos railway on main industries and forecasts the trade volume that the railway will bring in the future. Among them, each industry is analyzed separately and the expert opinions of each industry are adopted. Such a research method makes the author's research more convincing.

1.4 China-Pan-Asia railway has always been a major project between China and Southeast. This paper will provide reference for the influence of China-Thailand railway and China-Singapore railway on the trade between China and Southeast Asia.

1.5 The author describes the main roles of The China-Laos railway by proposing a framework approach, and puts forward some suggestions for the main roles, so as to bring the advantages of the China-Laos railway into play. This framework can be used as a reference for other articles to study railway problems in the future.

2. Managerial

2.1 This paper introduces the main industries and main routes that Thailand exports to China, and introduces the performance of each route in detail, which will be convenient for enterprises to get business opportunities.

2.2 This paper provides detailed information and performance of China-Laos railway to governments and businesses in main industries in Thailand. This will enable the enterprise to use the route according to its own situation.

2.3 This paper provides framework and valuable suggestions for the government and Thai exporters to make reasonable to take advantage of the China-Laos railway.

Future Research Directions

Although this research is considered to be complete, it is not without its limitations, which should be noted for future research. Some limitations and recommendations for further research and elaboration include:

1. While this research addressed the three main Thai industries exporting to China it did not study the effect of the completion of the China-Laos railway on the subsequent level of exports, particularly any surge in the value of exports from other industries. Nor was the possibility of industries previously unable to be involved in exporting their products, to gain export advantages from the new railway and to use new routes for their exports.

2. In the selection of the determinants, six decision factors were obtained by summarizing information gained from the literature review. However, this method ignores many decision factors that would influence the exporting organizations. For example, national policy factors and customs inspection and quarantine policies and practices need to be further considered with information from experts.

3. There is a bias in the choice of the starting point and the end point of the export process. Although the main export companies of the three major industries are concentrated in Bangkok, the products exported from Thailand to China are mainly exported to Guangdong Province, Yangtze River Delta region and Shandong

Province. Bangkok, however, is not truly representative of the whole of Thailand where rural and agricultural industries prevail, nor do China's main importing provinces and regions discussed represent the whole of China.

4. Finally, impacts on the local environment and the local people in Laos of the railway, and of future developments that will inevitably occur after the completion of the China-Laos railway, are also not considered in the proposed framework.

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APPENDIX

APPENDIX A QUESTIONNAIRE

Dear Sir or Madam,

Thank you for cooperation for this interview.

I am Mr. Siyuan Wei, a PhD student in School of Logistics and Supply Chain, Naresuan University, Thailand. I am making research titled as **the effect of the development of China-Laos Railway on Thailand's export trade to China**, thus I need your kind help for the qualitative analysis. Your kind suggestion and help are highly appreciated.

1. What's your occupation?

☐ logistics specialist ☐ railway builder

☐ government agent ☐ teacher

☐ Employee of trading company □ others

2. Do you know anything about China-Laos Railway?

☐ yes ☐ no

3. What export trade is the company mainly engaged in?

☐ mechanical and electronic ☐ plastics and rubber

☐ plant products ☐ others

4. What kind of research does the expert mainly engage in？

☐ Transportation ☐ Inventory and warehouses,

☐ International trade ☐ Agricultural economy

☐ others

5. What is Thailand's main route for exporting mechanical and electronic to Guangdong, Shandong and the Yangtze River economic circle?

6. What is Thailand's main route for exporting plastics and rubber to Guangdong, Shandong and the Yangtze River economic circle?

7. What is Thailand's main route for exporting plant products to Guangdong, Shandong and the Yangtze River economic circle?

8. If and when the China-Laos railway is built, will the company use it? And give reasons for your decision.

9. What factors are used to select the routes? （multiple choice）

☐ time ☐ cost ☐ convenience

☐ security ☐ distance ☐ capacity

☐ others

10. What other factors should be taken into account in the route selection?

ANALYTIC HIERARCHY PROCESS QUESTIONNAIRE

Questionnaire

Dear Sir or Madam,

Thank you for cooperation for this interview.

I am Mr. Wei Siyuan, a PhD student in School of logistics and supply chain, Naresuan University, Thailand. I am making research titled as **the effect of the development of China-Laos Railway**; thus, I need your kind help for the qualitative analysis. Your kind suggestion and help are highly appreciated.

Notes:

1. Please mark "√" for the answer you choose.

2. Explanation：For presents a scale used for quantifying managerial judgments for AHP analysis. Scoring rules: The response scale is a nine-point rating scale，range from equally preferred score = 1, and extremely preferred score = 9, least to most dependent level 1-9.

1 AHP Measurement scale (Saaty's 1-9 scale)

AHP Saaty's 1-9 scale	
Preference judgments	Numerical rating
Extremely Preferred	9
Very Strongly Preferred	7
Strongly Preferred	5
Moderately Preferred	3
Equally Preferred	1
The intermediate values of 2,4,6, and 8, provide additional levels of discrimination.	

If A1 is Moderately Preferred than A2, please select 3; If A3 is strongly preferred with A1, please select 5; If A2 is equally preferred with A3, please select 1

2 AHP Pairwise Example

	Saaty's 1-9 scale																	
A1	9	8	7	6	5	4	3√	2	1	2	3	4	5	6	7	8	9	A2
A1	9	8	7	6	5	4	3√	2	1	2	3	4	5√	6	7	8	9	A3
A2	9	8	7	6	5	4	3	2	1√	2	3	4	5	6	7	8	9	A3

3 Please according to the important level, compare each route evaluation factors to select a most consistent score

Criteria																		
cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	distance
cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	convenience
cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	time
cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	security
cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	TC
distance	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	convenience
distance	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	time
distance	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	security
distance	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	TC
convenience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	time
convenience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	security
convenience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	TC
time	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	security
time	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	TC
security	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	TC

(TC=Transportation capability)

DATA ACQUISITION BY TOPSIS METHOD

Questionnaire

Dear Sir or Madam,

Thank you for cooperation for this interview.

I am Mr. Siyuan Wei, a PhD student in School of logistics and supply chain, Naresuan University, Thailand. I am making research titled as **the effect of the development of China-Laos Railway**; thus, I need your kind help for the qualitative analysis. Your kind suggestion and help are highly appreciated.

Notes:

1. Please mark "√" for the answer you choose.

2. Explanation: Since my paper needs to evaluate the security and convenience of some routes, they are qualitative indicators and need to be scored by experts. I will use a 5-point scale, and the meaning of each point is explained as follows:

Table 39 Determining factors

Determining factors		Score
Very security	Very convenient	5
Relatively security	Relatively convenient	4
Security	Convenient	3
Insecurity	Inconvenient	2
Very insecurity	Very inconvenient.	1

I will summarize and list each route in the first table below, and let the experts give score to each route.

Table 40 Route performance

Number (Name)	Route	Destination (province)	Score
R3A	Bangkok-Chiangkong-Houayxay(Laos)-Boten-Mohan (China)-Jinghong-Kunming-	Guangdong	
R9	Bangkok-Mukdahan-Savanna Khet (Laos)-Dansavanh-Lao Bao (Vietnam)-Hanoi-LangSon-Huu Nghi-Nanning (China)-	Guangdong	
R12	Bangkok- Panom-Tha Kek (Laos)-Na Pao-Cha Lo (Vietnam)-Hanoi-Lang Son-Huu Nghi-Nanning (China)-	Guangdong	
S1	Bangkok- Chabang Port-Port of Guangzhou, Foshan (Shenzhen Shekou Port)-	Guangdong	
S2+R	Bangkok- Laem Chabang Port- Port of Zhanjiang-	Guangdong	
R9	Bangkok-Mukdaharn-SavannaKhet(Laos)-Dansavanh-Lao Bao (Vietnam)-Hanoi-LangSon-Huu Nghi-Nanning (China)-	Shanghai Zhejiang Jiangsu	
R12	Bangkok-Nakorn Panom-Tha Kek (Laos)-Na Pao -Cha Lo (Vietnam)-Hanoi-LangSon-Huu Nghi-Nanning (China)-	Shanghai Zhejiang Jiangsu	
S2	Bangkok-Laem Chabang Port-Shanghai Port-	Shanghai Zhejiang Jiangsu	
S3	Bangkok-Laem Chabang Port-Port of Guangzhou, Foshan-	Shanghai Zhejiang Jiangsu	
S4	Bangkok-Laem Chabang Port-Hong Kong Port-Qingdao Port-	Shandong	
S5	Bangkok-Laem Chabang Port-Kaohsiung Port-Qingdao Port-	Shandong	
S6	Bangkok-Shanghai Port-	Shandong	

APPENDIX B FIGURE FOR RESEARCH

Figure 14 Qingdao port (1)

Figure 15 Qingdao port (2)

Figure 16 Guangzhou port (3)

Figure 17 Guangzhou port (4)

Figure 18 Foshan port

Figure 19 China Mohan International Logistics Center

Figure 20 Mohan-Boten Border Control Station

Figure 21 Jinghong Station(outside)

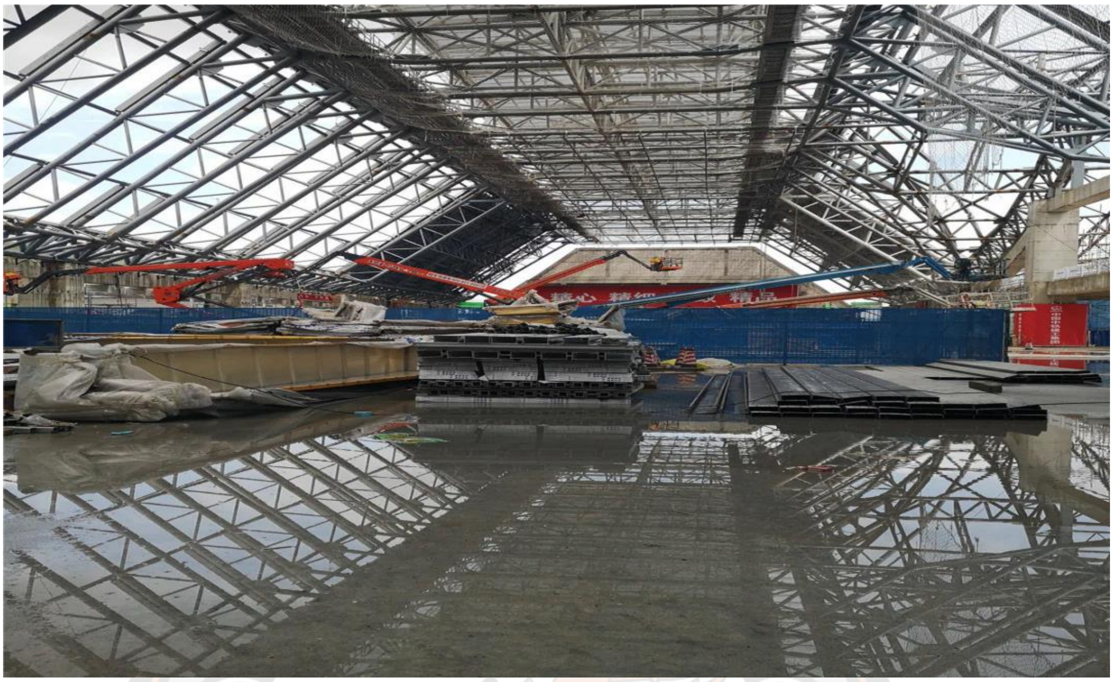

Figure 22 Jinghong Station (Waiting room)

Figure 23 Mohan Station

Figure 24 Mohan Station(inside)

Figure 25 Luang Prabang Raiway Station

BIOGRAPHY

BIOGRAPHY

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