# FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND

ORANICHA BUTHPHORM

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
2024

# FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND

ORANICHA  BUTHPHORM

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
2024

Thesis entitled "Fostering Factors to Rail Freight in Thailand"
By Oranicha Buthphorm

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

**Oral Defense Committee**

............................................................................ Chair
(Assistant Professor Rattapoohm Parichatprecha, Ph.D.)

............................................................................ Advisor
(Associate Professor Vatcharapol Sukhotu, Ph.D.)

............................................................................ Internal Examiner
( Jessada Pochan, Ph.D.)

............................................................................ Internal Examiner
( Sareeyapon Prasertsri, Ph.D.)

............................................................................ Internal Examiner
( Jaruwat Patmanee, Ph.D.)

**Approved**

............................................................................
(Professor Krongkarn Chootip, Ph.D.)
Dean of the Graduate School

| | |
|---|---|
| **Title** | FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND |
| **Author** | Oranicha Buthphorm |
| **Advisor** | Associate Professor Vatcharapol Sukhotu, Ph.D. |
| **Academic Paper** | Ph.D. Dissertation in Logistics and Supply Chain, Naresuan University, 2024 |
| **Keywords** | Rail Freight, Transportation System, Rail Freight Demand, Commodity Stakeholder, Railway Infrastruecture |

## ABSTRACT

Thailand's rail freight industry was expected to remain its backbone for the next fifteen years. Given the massive volume of rail freight, the government attempts to provide the conditions necessary to promote a modal shift from road to rail. The public is therefore left wondering about the large outlay given the ambitious goal. The major goal of this study is to reverse this scenario by examining what and where to increase demand for rail freight as well as fostering elements that promote the actual expansion of rail freight in Thailand. In order to address the goal of the first study, the researcher conducted a literature review and qualitative research.

In order to address the goal of the first study, the researcher conducted a literature review and qualitative research. To address issue number 2, 284 stakeholders answered questionnaires, and 8 focus groups were organized in addition to mixed-methods research. Commodity supplies and future product demand patterns are studied in order to estimate rising rail freight volumes, with the government's targets of 7%, 8%, and 10% in 2027, 2032, and 2037, respectively, serving as the foundation. It was found that 70.37%, 68.09%, and 61.07% of products will be transported, respectively, with an increase in the volume of things transported, comprising both currently transported goods and additional new commodities.

The primary factors influencing rail freight in Thailand, as shown by the stakeholders' conclusions, First, according to the key stakeholders, service, law, and public relations are the three most important aspects, followed by infrastructure and PR. The legislation, logistical facilities, infrastructure, public relations, and policy

were then disclosed by the secondary stakeholder. The primary stakeholders prioritize rail performance, infrastructure, legality, cost, mode choice, and technology.

Rail freight organizers can employ the elements that have been shown to be contributing to the growth of rail freight in Thailand as a useful guide to improve their policies, plans, and practices.

# ACKNOWLEDGEMENTS

Writing a dissertation is an extensive and tiresome process. I felt blessed and privileged to be under the guidance of such wonderful dissertation committee members as Assistant Professor Rattapoohm Parichatpreecha, Associate Professor Vatcharapol Sukhotu, Dr. Jessada Pochan, Dr. Sareeyapon Prasertsri, and Dr. Jaruwat Patmanee, who made my journey through research an exciting and fruitful venture.

This research project would not have been completed without the support of Dr. Thammanoon Hengsadeekul; it is impossible to imagine finishing this dissertation without his insight, feedback, invaluable advice, and thoughtful comments. He is a great mentor and a wonderful person who cares about his students and always provides as much as possible.

I would like to thank the following people, without whom I would not have been able to complete this research: The State Railway of Thailand, the association, and the business organization that returned survey feedback. Thank you to the experts, Associate Professor Chackrit Dungphastra, Associate Professor Wanchai Rattanawong, Assistant Professor Wachiraporn Chanponukul, Assistant Professor Ungul Laptaned, and Assistant Professor Thitima Wonginta, who helped me during the critical time of my research and gave me constructive suggestions.

Thank you to Burapha University for supporting the scholarship. Lastly, I would like to thank my family for their support since the beginning of my long journey.

Oranicha Buthphorm

# TABLE OF CONTENTS

**Page**

# LIST OF TABLES

**Page**

# LIST OF FIGURES

**Page**

# CHAPTER I

# INTRODUCTION

## 1.1 Background

Presently, a global economy which no frontier, economically robust by a development of strong transportation, which reduced costs in order to an economic enhancement together with social opportunities and benefits. Railways play an important role in many countries around the world because they are more cost effective than other modes of transportation (Bramo, 2014). In terms of long-haul and large-scale traffic movements, the railway has a potential benefit over road transport. Railway infrastructure has various benefits, including lower transportation costs, energy-efficient (Rodrigue, 2020), a cleaner climate (I. E. A. I. U. o. Railways, 2015), as well as being safe (I. R. S. Council, 2021), and social advantages from expanded positions. Developed nations, such as those in Europe, North America, Australia, Japan, and South Korea, all have high railway densities (UIC, 2017), since, railway is the foundation of an economical economy's transportation framework and railway understands as significant distance champs as significant distances cargo transport is continually developing (Rodrigue, 2020).

Both freight and passenger have declined significantly, freight operations on the State Railway of Thailand (SRT) are not considered a priority and traffic has been slowly lost to the competing road carriers (A. D. Bank, 2013). Although, SRT should improve the service quality of cargo bogies: locomotive trailer, loading yard, being on time, staff, coordination, safety, facilities, convoy vehicles, responsibility for any loss/damage, and freight rates (Bunsin, 2016). As compared to other modes of land transportation, such as road, Thailand's railway transport volume is very poor, 1.6 % of freight in 2019 (SRT, 2020) resulting in Thailand's low competitiveness. According to the OECD’s report mentioned that, well-functionally logistics both domestic all and internationally, is a mandatory precondition of national competitiveness (Arvis, 2014). In 2019, the global competitiveness reported, Thailand drops not only by World Economic Forum (WEF), from 38$^{th}$ to 40$^{th}$, but also with the IMD from 25$^{th}$ (2019) to 29$^{th}$ (2020), (Development, 2020). The key reason the ranking fell was the concentration of the railway transport system and the low efficiency of railway service (W. E. Forum, 2019). Owing to the relatively of low quality of Thailand’s infrastructure compared to other countries in the region is one of the major factors resulting in Thailand’s sinking competitiveness. To improve the country's competitiveness over the next 20 years and achieve the aim of becoming a developed country, it is important to concentrate on the growth of infrastructure to help and support the country's competitiveness building (N. E. a. S. D. Council, 2019). By the way, the result of the massive investment in transport infrastructure and relevant legal reforms, lead Thailand's logistics performance rank has greatly improved from 45$^{th}$ to 32$^{nd}$, in 2016 and 2018, accordingly (W. Bank, 2021). Railway's future will be dictated by how it responds to increasing transportation demand as well as competition from competing modes of transportation (IEA, 2019).

To be a regional transport hub, trade without borders with different nations in ASEAN, extend the percentage of railway freight, decrease transportation costs, meet railway freight needs, the quality of Thai infrastructure has extended, and have an effect on the country’s competitiveness enhancement, the important motives for the Ministry of Transport to create a Thailand's Transport Infrastructure Development Strategy 2015-2022. The government's main goal is to improve efficiency and upgrade international shipping standards in terms of speed, protection, and punctuality, as well as to promote economic growth within a system of regional cooperation and to reduce the country’s overall logistics cost, and it is used as a guideline for work plans and related departments. By building an intercity railway network and a double track, the aim of the projects to raise logistics performance rank to 25$^{th}$ or minimum score 3.50 and freight share volume from 1.6% to 4% within 2022 (N. E. a. S. D. Council, 2019).

The State Railway of Thailand (SRT) is a state-owned enterprise that runs a train service in Thailand for over 130 years, and there are both freight and passenger services. With the four main lines to each region, Thailand has a railway line network that interfaces 47 provinces and comprised of 4,337 kilometers of meter-gauge railway tracks (MOT, 2021). Over a century, the SRT has almost never progressed beyond 30 kilometers in length and distance per year. It's not popular with passengers or freight businesses because more than 90% of them are single track, which is a waste of time and just 62 percent of Thailand's provinces have a railway. The lack of serious investment in the railway system results in the service is unreliable as a result of the persistent lack of serious support, a revenue loss. As a result of the above, increasing the country's railway transportation service capability is critical. The government has created a master plan and a 20-year national strategy aimed at accelerating the development of logistical infrastructure and reduce logistics cost to enhance the nation competitiveness. As a result, the railway system is the country's primary mode of travel and transportation. The Master Plan is divided into three phases: an urgent plan (2017-2021), a medium-term plan (2022-2026), and a long-term plan (2027-2036), with 17 massive double-track lines totaling 2,936 kilometers, 14 new lines totaling 2,350 kilometers, and nine high-speed train projects totaling 2,506 kilometers. The overall length of the double-track railway increased to 3,157 kilometers, totaling 6,443 kilometers, and adding provinces spanning 61 provinces with the installation of 12 more railway lines (NESDC, 2019). The government has formed the Ministry of Transport: Thailand's Transport Infrastructure Development Strategy 2015-2022, the State Railways Enterprise Plan 2017-2021 has been made for direction and guidelines for the administration of the SRT as well. SRT’s strategy with the three main strategies: increasing railway transport capability, increasing revenue and lowering expenses, and driving and improving efficiency. An urgent plan double-track railway projects will be built, with seven parallel lines 993 km. with a budget around one hundred billion baht of the urgent period 2017-2021, the lines it is scheduled to operate around 2021-2023. Expansion of SRT's freight service, which could earn more money than the heavily subsidized passenger service, has been neglected for decades in favour of Thailand's roads (Janssen, 2017). SRT expects that the revenue from the double-track train's operating charges within 5-7 years after all double-track trains are completed in 2023, revenue from goods transportation is projected to rise from 2,000 million baht per year to 4,000 million baht per year (Manager online, 2019, para. 4). The massive investment in transport infrastructure will support the freight move from road to rail commencing in 2022, with 1.96% rising to 7%, 8%, and 10% in 2027, 2032, and 2037, respectively, in order to fulfill the goal of turning railway transportation the backbone of transportation.

The return on investment determines whether or not railway freight revenue will be generated as predicted. However, the business environment changed almost every year such as Coronavirus (COVID-19) pandemic, situation affecting the transportation of goods and consumer demand etc. While there is a scarcity of hard evidence, the entrepreneur has stated that he is willing to shift or pay for railway freight. It's a fascinating question that needs to be answered, furthermore, nobody has considered this previously. My research focus is to answering on how much the volume requirements shift from road to railway? What influence do external risks and uncertainties have on railway freight transportation in Thailand? How would the railway double track urgent project increment the railway freight volume? These studies were important because they revealed missing components that no one had yet discovered.

**1.2 Research Questions**

This investigation is guided by an interest in three questions:

RQ1: Can railway double-track urgent projects shift and boost railway freight demand to 10%?

The focus of Thailand's transportation infrastructure development plan for 2015-2022 is on developing the country's railway system to become the primary method of transportation throughout the country. The initial seven intercity railway networks that are experiencing congestion when transporting goods are scheduled to be built, with a total distance of 993 km. and the budget: 127,561.69 million baht. It was found that at the current construction status (February 2024), 3 lines are complete, 2 lines will be completed within this year (2024), 1 line within the next year (2025), and the final line in 2026. There are still doubts about whether construction these seven double-track railway lines will boost the share of domestic freight transport to achieves 10%, despite the government's objective to make railway freight transport the nation's primary mode of transportation.

RQ2: Which sources are driving the demand for railway freight transportation in Thailand?

Shipping is required in order to deliver the merchandise to the customer's specified location. Thus, consumers intend to choose the mode of transportation for their goods depending on several factors, such as overall cost of transportation, accessibility, level of service, and efficiency of the train system. Consequently, different needs for railway freight transportation result from different conditions or circumstances. Small company owners are unable to select from the SRT's current fleet of charter trucks for transport. Moreover, the transportation expense is not as attractive as anticipated. It will be interesting to see whether other factors cause a rise in the number of operators using railway networks for freight movements.

RQ3: What are the fostering factors of railway freight transport in Thailand?

This inquiry relates to what external environment factors could stimulate Thailand's railway freight transport industry to expand. The problem is that Thailand's freight train transportation industry is not very competitive, which has led to a steady decline in the amount of freight that is moved by train in the nation. The corporate environment of today is increasingly complex and uncertain due to its rapid change. External factor analysis is the only viable method. Utilizing this type of analysis is crucial in order for the company to adapt its policies and direction to the dynamic environment. What elements or circumstances needs to be altered by the company in order to boost productivity quickly? PESTEL analysis is being used since the railway freight transport system is a vast and expansive system. Both the public and private sectors have a variety of external stakeholders. Thus, it is highly suitable when used in trade and macro business systems.

Our results go some way towards answering these questions.

## 1.3 Purposes of the Study

The objectives of this research are:

1. To investigate the demand of railway freight boosting in order to shift mode from road to railway in Thailand.

2. To explore the fostering factors of railway freight transport growth in Thailand.

Overall aim of this study is to draw on the railway expertise, field experiences and the vision of key “expert” to help define the demand and foster factors for railway freight in Thailand, identify issues, needs and gaps, and make recommendations for further development in the implementation of factors in

Thailand. In according to achieve the nation’s transport strategy and boost economic in competitive advantage alternative way.

**1.4 Significance of the study**

The research will provide policy makers with relevant information on the origin sources to drive railway freight traffic and the influence level of factors. This is due to the relative importance of the factors that affect the amount of railway freight transport. The aim of this study is to determine the railway cargo demand to boost railway freight volume. What are some of the most significant demand factors? And a variety of issues to solve, avoid, and comprehend the different laws and regulations that will be imposed on operators. And how much of a match is there? As a result of the government sector's ability to respond well to freight demand, the country's GDP has decreased further. Reduced energy use benefits the environment, reduces emissions, and improves the community's quality of life, both economically and socially, as well as increasing the country's competitiveness. Rankings on the Logistics Performance Index have improved., by the reliability of the railway system, the country will be able to draw new investors and maintain existing ones.

Customers who use the suggested solution based on the study's findings will be able to get improved railway freight operation service. This is important for operators who are looking for more cost-effective transportation options. As a result of the government's policies encouraging the use of environmentally friendly, they could be eligible for a tax exemption in the future to help minimize $CO_2$ pollution in the air. Operators can also save money on transportation, by lower railway fares and higher competition are feasible as a result of lower production costs. Investments in public projects favor the private sector. Entrepreneurs, on the other hand, will be able to make better investment decisions. This study will serve as the foundation for future studies. The researcher will be able to perform research on Thailand's railway network. Extend the range of variables, the number of variables should be increased, and increase the variables' relative levels.

A survey of research documents that have been studied in the country has found that research has been carried out in the study for the last 38 years since 1982 as shown which serves as an informative guide for researchers and practitioners interested in this perspective. By using keywords; Fostering Factor, Influence Factor, Effect factors, Railway Freight, Railway Freight Demand, and Double Track, to classify domain of these, Table 1 is derived to assist us explore the research gap through keywords different perspectives.

**Table 1 Classification according research keywords categories**

| Research Keywords Categories | Paper (Author(s), (Year) |
|---|---|
| 1. Factors affect the success railway infrastructure | Peetawan & Suthiwartnarueout (2018) |
| 2. Railway Freight/ Demand | Limprasert (1982), Nuallaong, Wangapisit, & Limpattanasin (2020), |
| 3. Double Track | Phuvarojphibun & Chompun (2018) |
| 4. Fostering Factors to Railway Freight in Thailand | None |

In general terms, rows (1) to (4) in table 1 classify the selected research studies from six different elements to narrow down the research issues to fostering factors to railway freight in Thailand as a research gap. By using those keywords to classify domain of these, we found that there has been no research done on the demand to shift cargo transportation from road to railway. In addition, has no work was found to study the factors that fostering increased railway freight in Thailand.

We concluded that this research area is under-represented with insufficient study, which would be attributed to the problem’s higher level of complexity. Further, has not been deep elucidated of railway freight in Thailand yet, therefore, in this work of the study, we report investigation of the railway freight problems, current issues, and demand in Thailand. We also explore and report the influence of foster factors of railway freight which boost and guidance railway freight development plan.

**1.5 Scope of the study**

The purposes of this research are study on Thailand's railway freight in aspects of firstly, investigate the demand booster to railway freight transport, and secondly, explore the foster factors of railway freight transport. Then, the coverage of this study will be included as following: the population and sampling, the contents, the spatial, the period of research study.

**Scope of population**

By research purposes, we can identify the population as the stakeholder for the railway freight transport in Thailand as key stakeholder, primary stakeholder and secondary stakeholder as following;

1. The key stakeholder for the railway freight in Thailand are Ministry of Transportation (MOT), Department of Railway Transport (DRT), SRT, and Local SRT staff, since they are the high power to deploy railway strategy, budgetary, regulation, provides the railway transportation service, and high influence in this railway infrastructure projects.

2. The primary stakeholders are manufacturing or shippers, and the Logistics Service Provider (LSP), which high interested to use the railway transportation service, receives direct impact and requires to managed closely to the project.

3. The secondary stakeholder is the institution of education, the office of commercial affair, the chamber, the federation of Thai industries, community leader, local business, national environmental NGOs, and media, who will be interested and participants and give a richness information of this study.

**Scope of Contents**

In this study, we have focus on topics and theories of railway transportation, domestics freight in Thailand, commodity cargo, railway freight transport system, railway freight demand, and fostering factors influencing railway freight traffic.

**Spatial Scope of the study**

The railway freight lines in Thailand; Northern Line (Red Line), North Eastern, Line (Yellow Line), Eastern Line (Green Line), and Southern Line (Purple Line): as shown in Figure 1.

**1.6 Hypotheses**

To answer the research questions and research purposes, the research hypothesis has been generated by the researchers as follow:

Hypotheses 1(H1): The railway freight transportation system has a direct effect on railway freight demand.

Hypotheses 2(H2): The railway freight transportation system has a direct effect on the factors fostering railway freight transport in Thailand.

Hypotheses 3(H3): The railway freight demand has a direct effect on the factors fostering railway freight transport in Thailand.

Hypotheses 4(H4): The railway freight transportation system has an indirect effect of fostering factors of railway freight transport in Thailand via railway freight demand.


**Figure 1 The railway network of Thailand**

**Source:** https://thai-railway.fandom.com/wiki/Rail_transport_in_Thailand

**The hypotheses of research**

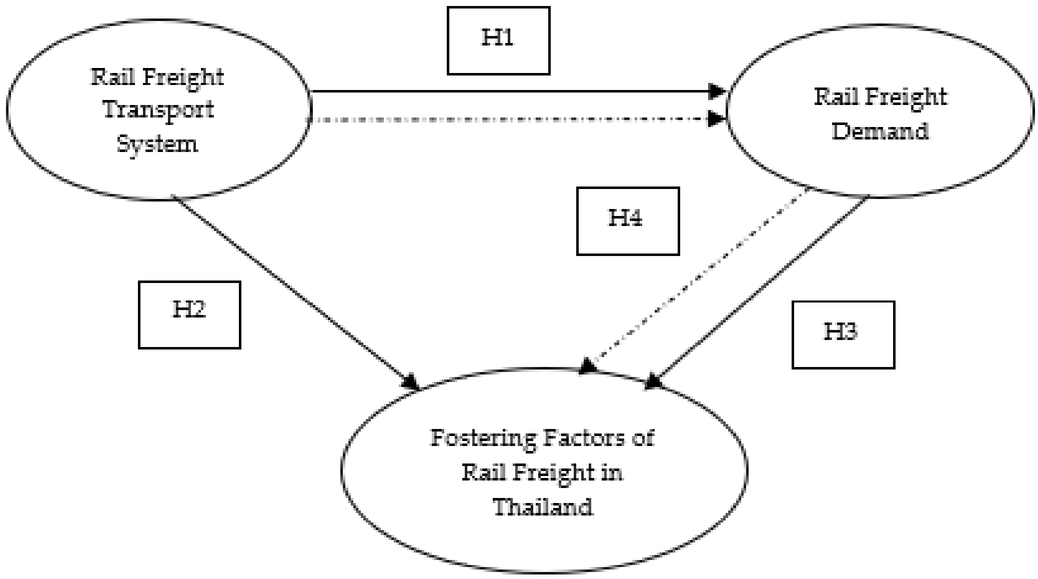



**Figure 2 Research hypotheses**

## 1.7 Research terms and definition

Some technical terminology will be used in this thesis, and they will now be formally defined:

1. Double railway track- Is a one-meter-wide track made up of two parallel tracks.
2. Urgent double-track railway project (7 lines) there consist of
    a. Chachoengsao - Kaeng Khoi
    b. Chira Road - Khon Kaen
    c. Mab Kabao - Chira Road
    d. Lop Buri - Pak Nampho
    e. Nakhon Pathom-Huahin
    f. Huahin-Prachuapkirikhan
    g. Prachaup kirikhan - Chumphon

3. Railway infrastructure development plan- Thailand’s Transport Infrastructure Development Strategy 2015-2022.
4. Railway Plan - The State Railways Enterprise Plan 2017-2021.
5. Key Stakeholders – SRT local officer, OTP
6. Primary stakeholders – Manufacturing, Logistics Service Provider
7. Secondary Stakeholders – The institution of education, the office of commercial affair, the chamber, the federation of Thai industries, community leader, local business, national environmental NGOs, and media,

**1.8 Structure of the thesis**

In order to investigate the demand of railway freight boosting to shift mode from road to railway, and explores fostering factors of railway freight in Thailand, this thesis is divided into five chapter as follows:

Chapter 1 is a general introduction to background, purposes of study, significances, research scope, hypotheses, terminology, and thesis structure.

Chapter 2 is a literature review is explored, an in introduction to railway transport system, including infrastructure, performance, and railway infrastructure development plans. A review of railway freight demand, including local economic requires, commodity, mode choice, demographic, pricing, and fuel price. A fostering factor with PESTEL analysis model, including political, economic, socio-cultural, technology, environment, and legal. Furthermore, the SEM, the mixed method research are review. The knowledge presented in this chapter will support the methodology (Chapter 3), results (Chapter 4), and conclusion (Chapter 5).

Chapter 3 provides a method to solve the research questions and research purposes set out in chapter 1, including the methodology and explanation of the tools used in order to collect and analyze the data. The qualitative method and the mixed method were employed to answer the first and second research objective in this study.

Chapter 4 demonstrates the results. Content analysis was employed for the first research objective, while the findings from the mixed method show that a statistical analysis of the data from the questionnaires is done using SPSS and AMOS and the validation of the hypothesis occurs. The results were derived from a careful regression analysis measuring the relationship between the predictors and the outcome, explaining the relationships between the hypotheses and the significant findings and deliverables from the study. Additionally, the results from the qualitative phase, the interview, and the focus group discussion were conducted. The analysis of this phase was carried out using content analysis. This phase was conducted to gain more insight into the railway freight demand and factors fostering railway freight development in Thailand.

Chapter 5 is an interpretation of the results and findings from three phase of the study and how it relates to existing literature. This chapter emphasizes and justifies the railway fright demand factors which boosting modal shift from road to railway. And the key fostering factors to develop railway freight in Thailand. Furthermore, this chapter concluded, which discusses the contribution of the research theory and practice, and the implications of the research approach. Finally, the propositions for the further studies to be carried out in the area.

# CHAPTER II

# LITERATURE REVIEW

The purposes of the research are to investigate the demand of railway freight boosting in order to shift mode from road to railway in Thailand and to explore the fostering factors of railway freight transport growth in Thailand. As a result, the researcher has studied relevant theory and literature including, the transportation modes, the railway transportation system, the railway freight demand, the Ministry of Transportation's plan, the 20-year national strategy, and the National Economic and Social Development Plan. Thailand's transportation for commodities of railway freight in Thailand.

For a broad overview of research problems and phenomenon studied regarding causal relationship of railway freight transportation demand, railway transportation system, and it with foster factors to boost the economic and would increase the nation's competitiveness. Theories and principles are explored in this section, and they will be used as a reference base in this research. The following is the reviews of literature confirms the situation and currents problems of railway freight system, firstly, determines the railway freight transport system factors; named, railway infrastructures, railway performance, and railway transport development infrastructure strategy, secondly, identifies the railway freight demand factors; named, railway freight by economic, commodity, mode choice, demographic, pricing, and fuel price; and lastly; establish the factors which effects to railway freight traffic in Thailand; from the business external environment analysis called; political, economic, socio-cultural, technology, environment, and legal.

## 2.1 Background: The Railway Transportation

In order to promote economic expansion, provide employment, and link people to vital amenities like healthcare and education, transportation is crucial (World Bank, 2024). The Latin words "trans," which means across, and "portare," which means carry, are the origin of the term "transport". It's also a system for moving cargo, people, and raw materials everywhere, frequently using machinery that runs on electricity (Adeniran, 2016). With regard to the many modalities that they take into account, geographers may be broadly classified into three groups: land, water, and air. Every mode is designed to fulfill the distinct needs of both freight and passenger traffic, and each has its own specifications and characteristics (Rodrigue, Claude, and Brian, 2006).

The importance of a properly and reliably infrastructure not only boost nation's economy supply chain but also global scale foster in supply chain., therefore in the economic cost saving of railway transportation and main element for logistics cost reduction to GDP in order to strengthen nation's competitiveness. As, depicted in Figure 3 the railway system is the backbone of long-distance freight transport in many countries. Railway underinvestment may be a major setback for economic growth (OECD, 2021).

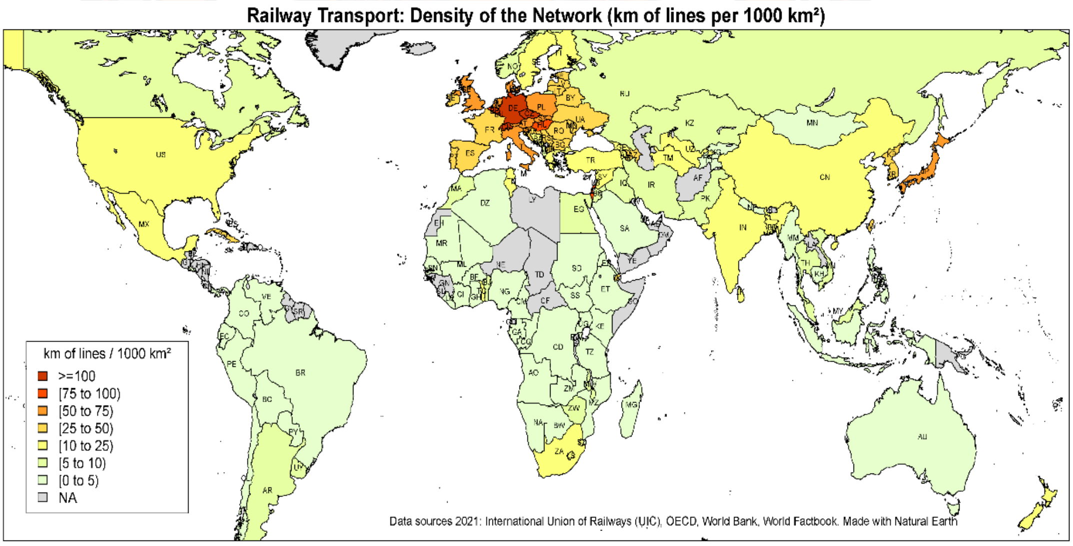



**Figure 3 Density of the network km of lines per 1000 km$^2$, 2021**

**Source:** International union of railways, 2021, OECD, and the World Bank

The indicator is available from 2009 to 2019, based on 7 nations (Table 2), Singapore had the highest score of 5.8 points, while the Philippines had the lowest score of 2.4 points. Actually, the Singapore's railway transportation consists primarily of a passenger urban railway transit system that runs around the city-state. While, the operating services have deteriorated in other countries, such as the Philippines, partially due to deteriorating infrastructure and lack of maintenance, and an improved highway system has given trucks a competitive advantage over railway.

**Table 2 Quality of railway infrastructure in South East Asia**

| Country | Quality of railway infrastructure | Scale (1(low) - 7(high) |
|---|---|---|
| Singapore | 5 | 5.80 |
| Malaysia | 12 | 5.10 |
| Indonesia | 18 | 4.70 |
| India | 28 | 4.40 |
| Vietnam | 52 | 3.60 |
| Thailand | 75 | 2.80 |
| Philippines | 86 | 2.40 |

**Source:** W. E. Forum, 2019

In Malaysia, railways transport only a small amount of final tonnage, accounting for only around 5% of total freight tonnage, according to the Asian Development Bank (A. D. Bank, 2017). From 2013 to 2019, the amount of freight transported on Indonesia's railway system increased due to a strong railway transportation system. In the 2017, the Vietnamese government has decided to increase investment in upgrading and modernizing the current railway system, as well as the development of new railway lines connecting seaports and railways, Trans-Asian railway, high-speed railway on the north-south axis, connecting with neighboring countries from the existing network 2,524 km. (Authority., 2017).

According to the Economist, Thailand fares relatively poorly in international rankings when it comes to the quality of railway infrastructure and facilities, limiting its overall logistics performance in the view of many industries. Eliminate transport capacity constraints to economic growth, increase customer responsiveness and improve services, including through efficiency gains so transportation charges can be reduced. Railways, especially state-owned railways, are powerful institutions; they are typically the largest single employer in a country and generally have a longstanding institutional life. Thailand has a railway line network that interfaces 47 provinces and comprised of 4,044 kilometers of meter-gauge railway tracks. The railway lines are making out of single track (3,687 kilometers or 91.17%), double track (250 kilometers or 6.18%), and triple track (107 kilometers or 2.65%) (SRT, 2019). The four main lines are the northern line 781 km., the Northeastern line, 1,094 km., the eastern line, 534 km., and the southern line, 1,570 km., and Mae Klong line, 65 km. The conversion of the country's long-distance railway network from single to dual track is an important policy that the SRT is pursuing to aid the country's long-term growth (SRT, 2019). The railway tracks of width of 1.00 meters and can carry cargo a most extreme weight of 15-18 tons with a most extreme speed of 80 km / hr. The greater part of the trains and wheels are exhausted and have a long assistance life, influencing the service's operation and the delay. In such manner, the proportion of locomotives that are available for use (availability) only about 64.1%. Since 2004, there are a number of availability locomotives., it has always been lower than the demand for the SRT's locomotive.

The main central of linkage between railway transport and road transport are Bangkok Port, Laem Chabang Port and ICD Ladkrabang. Whereas, Thai railways transport both bulk freight (primarily oil products and construction materials) and containerized freight, the most of the freight movement is between Bangkok and sea ports (particularly, between the Laem Chabang deep-water port and the Lad Krabang container terminal in Bangkok's eastern suburbs). Railway associations can connection to adjoining neighboring nation to Laos at Nong Khai station, to Cambodia at Aranyaprathet station, connecting to Malaysia at Padang Besar and Sungai Kolok stations (Figure 4).

Thai railway transport both mass cargo (essentially oil items and industrial product) and containerized cargo. The capacity to diminish transportation costs by multiple times from double track lessen costs however much as could reasonably be expected, making collaboration services and customer are directing their concentration toward railway cargo. Public arrangement on the improvement of the railway framework for seriousness and upper hand. While it is possible for freight trains to travel between Thailand and the neighboring countries (Malaysia and Laos), the amount of international railway freight presently constitutes only a minuscule portion of Thailand's foreign trade.

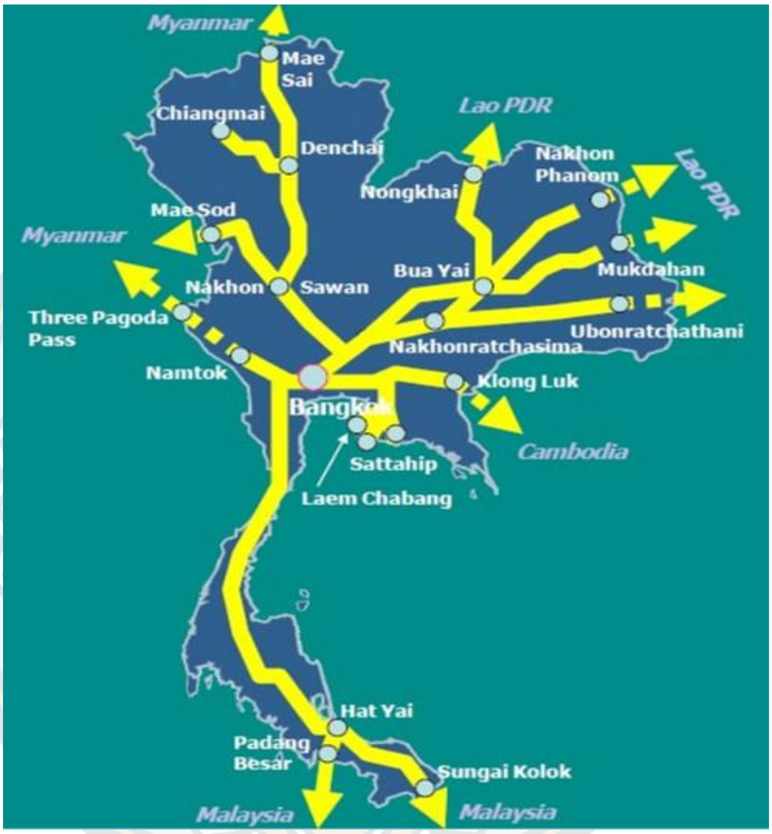



**Figure 4 Railway network in Thailand**

**Source:** Kasertsart University, 2017

**The domestic freight transport development in Thailand**

Between 2004 and 2022, road transportation accounted for around 80% of the total volume of freight transit in Thailand. Water transportation, which includes coastal and river transportation, came in second with about 18% of the total. In contrast, the share of railway and air freight transport is relatively small, at 2.07 percent and 0.2 percent, respectively. (Table 3 and Figure 5)

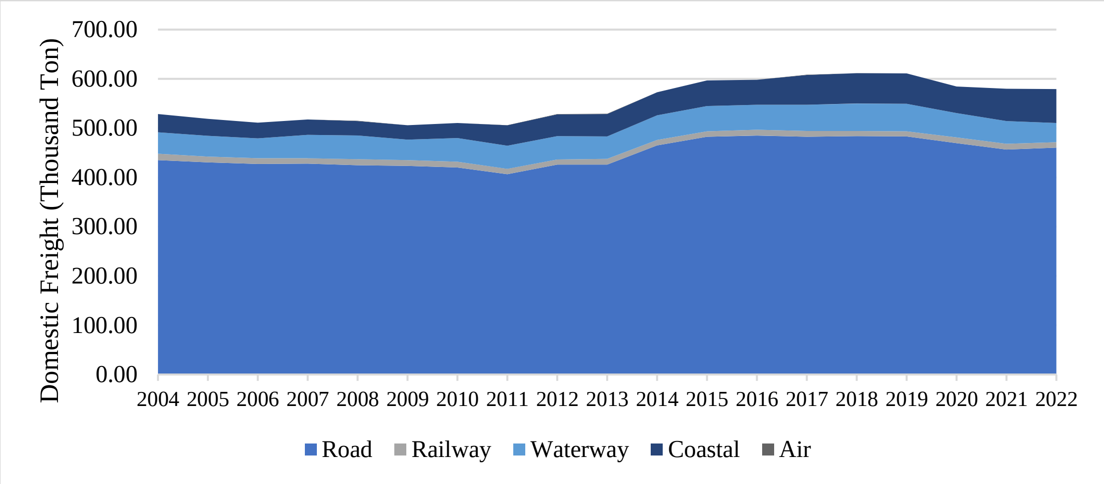



**Figure 5 The domestic Freight in Thailand**

**Source:** Ministry of Transport, 2023

**Table 3 Domestic Freight Volume 2004-2022**

| Year | Road | Railway | Waterway | Coastal | Air | Total |
|---|---|---|---|---|---|---|
| 2004 | 435,147.00 | 12,883.00 | 43,389.00 | 36,974.83 | 126.33 | 530,524.16 |
| 2005 | 430,289.00 | 11,760.00 | 42,306.00 | 34,253.51 | 129.97 | 520,743.48 |
| 2006 | 427,581.00 | 11,579.00 | 40,340.00 | 31,573.73 | 131.66 | 513,211.38 |
| 2007 | 428,123.00 | 11,055.00 | 47,229.46 | 31,216.47 | 121.93 | 519,752.86 |
| 2008 | 424,456.00 | 12,807.10 | 47,686.86 | 29,614.90 | 112.68 | 516,685.53 |
| 2009 | 423,678.00 | 11,133.00 | 41,561.06 | 29,311.37 | 104.17 | 507,796.61 |
| 2010 | 420,446.00 | 11,399.00 | 48,184.84 | 30,457.20 | 121.61 | 512,618.65 |
| 2011 | 406,536.00 | 10,864.00 | 46,932.22 | 41,272.76 | 133.69 | 507,749.67 |
| 2012 | 425,804.00 | 10,758.00 | 47,422.54 | 44,262.87 | 130.76 | 530,390.18 |
| 2013 | 426,086.00 | 11,889.24 | 45,412.90 | 45,441.02 | 120.18 | 530,962.34 |
| 2014 | 465,020.39 | 10,801.62 | 50,112.86 | 46,672.79 | 115.58 | 574,737.24 |
| 2015 | 482,357.79 | 11,387.58 | 50,907.43 | 51,872.48 | 117.52 | 598,657.80 |
| 2016 | 484,884.43 | 11,937.09 | 50,326.78 | 50,894.46 | 122.26 | 600,181.02 |
| 2017 | 482,596.07 | 11,694.90 | 53,025.58 | 60,850.40 | 115.63 | 610,299.58 |
| 2018 | 483,760.02 | 10,231.73 | 55,739.44 | 61,797.68 | 94.87 | 13,641.74 |

| Year | Road | Railway | Waterway | Coastal | Air | Total |
|---|---|---|---|---|---|---|
| 2019 | 483,167.99 | 10,261.85 | 55,999.36 | 61,772.32 | 77.82 | 13,298.34 |
| 2020 | 469,638.72 | 11,509.88 | 49,248.01 | 54,023.38 | 32.21 | 586,472.21 |
| 2021 | 456,489.28 | 11,455.84 | 46,404.68 | 65,447.08 | 20.48 | 581,838.35 |
| 2022 | 460,315.77 | 11,366.65 | 38,994.00 | 68,431.00 | 31.43 | 579,138.85 |

**Source:** Ministry of Transport, 2023

## 2.2 Railway Demand Forecasting

### Freight Demand Characteristics

The fact that transportation is derived is an essential characteristic. Transport is a means of fulfilling one or more wants; it is not an end in itself. To get credible forecasts, we have to initially determine the demand's when, where, and how (Ortuzar, & Willumsen, 2011). The physical process of transporting goods from one location to another is recognized as freight transport. In order to fulfill the demand driven on by industrial, agricultural, and personal demands, this physical migration occurs. Although these freight movements make up just a few percent of all traffic movements, they have a substantial impact on the transportation system (Middela et al., 2018). The four layers for freight movement are: decision on production, logistics, choice of transport modes, transport route, and multimodal transport. While the shipper, freight forwarder, carrier, and driver are the key players in the freight movement, there are other variables that also affect it, such as location, the variety of products needed to consolidate freight, commodity physical factors (such as cold, bulk, dangerous goods, packages, or high security), the size and geographical dispersion of operations, seasonality, and pricing factors (prices are generally not published to maintain the power of negotiation) (Boland, & Jourquin, 2018). We can see the variety impact the freight movement, so in the past, the researchers not give attention to freight modeling for following reasons; many aspects of freight demand make it harder to model than passenger movements. Next, the urban congestion is mainly caused by people movement. Lastly, the movement of freight involves many agents: producers, shippers, receivers, transporters, freight forwarders, storage facilitators, consumer, and receivers etc.

The master piece for freight demand forecasting in nationwide official start in the United States, in 2008, the National Cooperative Highway Research Program Report (NCHRP) 177, Freight Data Requirements for Statewide Transportation Systems Planning Research Report, was written by the Transport Research Board (TRB). The NCHRP Reports 177 were used as a foundational source of information for developing enhanced analytical approaches through subsequent planning and research attempts. An evaluation of freight data requirements, data availability, and unmet data needs with respect to existing concerns and challenges is provided in NCHRP report 177. For multiple planning phases, the data is shown according to mode, followed by data categories (for example, traffic flow) and planning activities (for example, economic evaluation). According to the TRB (1977), this is the most recent overview of methods for estimating demand, modal choice modeling, network analysis, economic evaluation, and effect estimation.

According to the NCHRP report, five approached are most commonly employed in freight demand forecasting methods as direct facility flow factoring method, O-D factoring method, Truck model, Four-step commodity model, and economic activity model. 1) direct facility flows factoring method; truck traffic volumes estimation used for short-term forecasting for freight truck (Cohen et al, 2008; Chow et al., 2010). 2) O-D factoring method is similar to the first method except that growth factors are being applied to the base year O-D trip table (Fisher et al., 2005). 3) Truck model, aggregate truck trip are generated separately for internal trips between zones and external trips between internal and external zones. 4) Four-step commodity model, the model develops forecasts of commodity flow and converts the commodity truck flow into daily freight truck trips as part of modeling process (Samimi et al., 2010). The method has been used as a statewide freight model framework by several states in U.S. (Cohen et al, 2008; Chow et al., 2010). While, this model generally not captured the commodity flow data sets or service trips (Fisher et al., 2005). 5) Economic Activity model, the two key components that work together; economic or land use and a freight transportation demand model. It is significant to catch the factors to estimating freight flow by this economic activity models.

Next, the researchers introduced to the four-step commodity model below.

**The Classic Four-Stage Transport Model**

It has been around 70 years since the first comprehensive urban transport studies took place in the United States. Transportation modeling is used to develop information to help make decisions on the future development and management of transportation systems, especially in urban areas. Mainly there are four stages (or four steps) model; trip generation, trip distribution, modal split, and trip assignment (Nkubiyaho, 2020).

**Trip Generation**

It is assessed based on to what proportion each discrete spatial unit serves as a movement's origin and destination. The number of trips that a specific geographical unit attracts and generates is often the output. When comparing economics, it might be considered to identifying demands; however, the desire to take a trip or go is being compared to the consumer's purchasing requirements. The purpose of the data survey is to estimate the number of trips. These data need to be surveyed in many types of areas, including residing and working areas. Statistics may be gathered in a variety of ways, including through the use of surveys, transportation statistics, land and real estate information, building, economic, and social data.

**Trip Distribution**

In order to determine the estimated amount of demand, we will divide the demand data from the first step among each origin and destination in step 2. This stage enables us to determine: What is the distribution of demands? This involves a number of variables, including barriers that will make it challenging to allocate requests with equality, particularly in terms of time significance. Typically, a spatial interaction model takes limitations like distance into account while estimating movements, or flows, between origins and destinations. A flow matrix interconnecting spatial units is the result.

**Modal Split**

Step 3 models the format that will be utilized or blended at each step using the prior origin and destination pair data. There is a difference in the likelihood of selecting a model. Other considerations to take into account include gas prices, travel and waiting times, safety, and accidents. Then, movements between origin points and destination points are organized down by modality. The availability of each option, their associated costs, and societal preferences all affect this function.

**Trip Assignment**

The estimated trips, split down by origin, destination, and mode, are then "loaded" onto the transportation network, primarily taking into account the fact that consumers may need to use pre-existing transit networks or prefer cutting down on travel time. Congestion arises when traffic volume surpasses the capacity of particular transportation segments, a situation that frequently happens and adversely impacts journey duration. This might then have an impact on trip distribution and creation through a feedback mechanism.

One example employed this theory lately is Chowdhury (2023), who carried out research on the development and application of freight demand models at the national urban scale. He established an urban commercial vehicle (CV) model for the Greater Toronto and Hamilton Area (GTHA), a carrier selection model, and a component of a national freight model in the US. Three components contribute up the trip-based GTHA CV model: traffic assignment, truck trip distribution, and truck trip generation. Off-peak model results imply that the GTHA may achieve daily commute time reductions of more than 5500 vehicle hours. When automated trucking is fully implemented, significant travel time reductions are expected, although partial adoption is expected to result in increased traffic.

**Forecasting**

The practice of projecting or anticipating the future is known as forecasting. It offers details about probable future occurrences and how they could affect a company. Although it might not eliminate future complexities and ambiguity, it gives management more confidence to make crucial decisions (Milenkovic & Bojovic, 2016). Many situations call for forecasting: a forecast of future demand is needed to determine whether to build another railway track within the next five years; a forecast of the volume of work required in a railway yard is needed to schedule staff; a forecast of train carriage requirements is needed to stock a train carriage. Both the medium-term (more than one year and up to five years) and long-term (greater than five years) forecasts should be developed. The next ten years should be the minimum length of a long-term forecast.

Every industry has to have a flow of information about what is expected demand for its product in order to plan for the future. In the case of the railway industry, precise forecasts of their freight traffic by commodity are vital because they determine not only the quantity and kind of cars to be used but also the expected total revenue based on the level and commodity composition of future rail freight traffic (Rao, 1978).

**Forecasting Methods**

There are two categories of forecasting techniques: qualitative and quantitative. Every kind offers a variety of forecasting forms as well as distinct advantages and disadvantages. To make judgments that are precise and timely, the decision-maker has to decide on the approach that best coincides with the demands and circumstances. The typical steps for forecasting are: 1) Establish goals. 2) Decide what you want to forecast. 3) Decide on the forecast period, such as a weekly, monthly, quarterly, yearly, or multi-year. 4) Select the forecast approach. 5) Gather the information required to make the forecast. 6) Assess the suitability of the employed forecasting techniques. 7) Create projections. 8) Apply the predicted outcomes.

One approach to categorize forecasting techniques for railway demand is by the future time horizon they grow long. Forecasts with a long-time horizon extend five to ten years. Short-term projections comprise prediction intervals of six to eighteen months, whereas medium-term forecasts cover two to five years into the future (Milenkovic & Bojovic, 2016). The time horizon affects the choice of forecasting method because of the availability and relevance of historical data, time available to make the forecast, cost involved, seriousness of errors, effort considered worthwhile (Waters, 2008).

Despite the wide range of problem situations that arise in the field of railway transportation (railway operations management, marketing, finance and risk management) there are only two types of forecasting techniques- qualitative and quantitative methods as mentioned earlier.

**Quantitative Methods**

The quantitative forecasting techniques It is a forecast that depends on the utilization of historical statistical and quantitative data as its basis. Consequently, this approach needs to be employed in situations where prior data is accessible, the volume of past data is sufficient, and historical events may be reproduced. Correlation analysis and time series are two distinct parts of the method. The time series methods, which they look at past patterns of data and attempt to predict the future based upon the underlying patterns contained within those data. While the casual methods, it assumes that the variable being forecasted is related to other variables in the environment. It tries to protect based upon those associations (Milenkovic, & Bojovic, 2016).

**Qualitative Methods**

The qualitative forecasting techniques are often subjective in nature and require judgment, experiences on the part of experts, and other qualitative factors. These techniques are often used in situations where there is little or accurate information cannot be collected, and or no historical data. The samples methods are Delphi Method, historical analogy, panel insight, panel consensus (experts), and consumer market survey. In addition, demand projection qualitative approaches can be applied in situations when there is little or no time-series data available, according to Bruck et al. (1974). Therefore, their primary use is when preference information is the only available and a prediction of any kind—especially long-range—is necessary. These techniques are frequently combined with discussions of potential future possibilities that an accomplished analyst might offer for a certain project. If these techniques can be coupled with one of the quantitative techniques covered earlier, they are considerably more potent. But demand forecasting shares the same fundamental drawback as all other future prediction techniques: no one can foresee the future with absolute precision. The forecast usefulness can be impacted by unanticipated circumstances, independent of the data quality (Milenkovic, & Bojovic, 2016).

**Freight Demand Forecasting**

There are many alternative ways to categories models of freight demand in transportation. Various scholar conducted study on freight forecasting using the quantitative method such as in Canada, the research on predicting the demand for freight transport: a new approach was carried out by Abdewahab, & Sargious (1992). They discussed how the greatest likelihood function for the simultaneous equation system must be formulated in order to use the approach. The benefit of this approach is that it estimates the model parameters all at once and simultaneously, allowing the analyst to place constraints on the calculated parameters. Two-stage estimation is a less computationally demanding approach in which the mode choice model is estimated using a maximum likelihood probit in the first phase and the shipment size equations are estimated using ordinary least squares in the second. Two-stage least squares (2SLS) is the name of this uncomplicated, reliable approach that is typically more recognizable to analysts with a less background in econometrics and mathematics.

Tsekeris, & Tsekeris (2011) conducted the study of demand forecasting in Transport: overview and modeling advances, mentioned that using new data sources from cutting-edge (web-based, for example) communication technologies might help overcome some of the current shortcomings in transport demand research. Furthermore, by creating links to dynamic travel demand estimates and conceptually consistently connecting aggregate travel needs to individual-level decision theory, current breakthroughs in modeling can further enhance the behavioral generality of these models. In the same year, Ortuzar, & Willumsen (2011) argued about models as reasonable simplifications of reality based on presumptions. They can never produce completely accurate results and always require to be interpreted.

Boland (2018) noted in his master's thesis that, despite the fact that freight contributes considerably to traffic traffics jams, noisy environments, and pollutants, there is comparably less research on freight demand than on passenger demand. In the transport literature, a number of techniques were developed that assist in decision-making in order to recognize, evaluate, and address this problem. Macroeconomic indicators like the gross domestic product should be connected to activity-based pricing. Commodity flows may be predicted using employment data. He stressed the need of understanding the connection between logistics and the economy, noting that the volume of cargo generated and consumed is intrinsically connected to economic activities, and that commodities flows frequently accompany monetary transactions.

Middela et al. (2018) conducted a study in India utilizing ordinary least squares regression models to simulate the generation and distribution of freight for interstate freight transportation throughout the country using secondary information. With regard to the variables associated with freight production (trip generation), these include: net state domestic product; total employment within the traffic analysis zone; employment across various sectors, such as primary, secondary, and tertiary; area and agricultural; consumption of petroleum and electricity; total road length; and the number of goods vehicles within the traffic analysis zone. When distributing freight in the traffic analysis zone using the gravity model. According to this study, the production of interregional freight is influenced by the following factors: workers in the secondary sector, area and agricultural area, net state domestic product, petroleum and power consumption. For infrastructure expansion to be done efficiently, the freight provide data is crucial.

The study on freight production in the agriculture sector was carried out by Dhulipala, & Patil (2020), who used multiple linear regression (MLR) and generalized additive modeling (GAM) at the regional level in India. Gross cropped area, gross irrigated area, employment in the agricultural industry, and population were the data inputs used in the model. With 47.9% and 67.5% less prediction error than the MLR model, the GAM model predicts more accurately. In addition to its ability to forecast production in the future, the GAM model aids in the accurate designation of priority areas for expansion of infrastructure. Sahu, & Pani (2020) studied freight generation and geographical impacts in India in the same year, controlling for area and employment. The employment better reflected freight generated in this stage of the study, but the area better represented freight attractiveness, according to the use of linear regression. They evaluate the geographic impacts and the major area interaction of freight generation across different industry sectors using ANCOVA and multiple classification analysis approaches. Each of these instrument’s aids in the provision of planning tools for freight transport.

In the United States, Hassan et al. (2020) conducted research to estimate freight demand with the goal of creating an effective system that minimizes prediction error by utilizing both machine learning and classical time series models to their maximum potential. They used a reinforcement learning framework implemented across a rolling horizon to integrate time series models and machine learning techniques. They discovered that the RL was a useful tool for forecasting freight demand. The direct long-term forecasts produced by standard time series techniques perform worse than the monthly-to-weekly long-term forecasts.

Tjandra et al. (2024) carried out the examination of the demand for transportation worldwide in the future. The population and gross domestic product per capita were the cluster-based transport model factors that had the most effects on transportation demand. In 2050, 395 trillion ton-km of transport demand—driven mostly by emerging nations, including China—will triple from 2020 levels, according to the six cluster-specific transport demand studies that were found to distinguish between each cluster.

**Railway Freight Demand Forecasting**

For the purpose of estimating railway demand, forecasting techniques can use both quantitative and qualitative data. The primary benefit of qualitative approaches is that their primary data source is the experiences of highly skilled executives and staff members. However, the accuracy of quantitative forecasting techniques' predictions depends on historical data (Milenkovic, & Bojovic, 2016).

Not many researchers conducted the rail freight demand forecasting, since it complicated, and contains various variables. Subsequently, many researchers used either a quantitative or qualitative technique to predict rail freight demand;

In Canada, Rao (1978) performed rail freight demand, employed the quantitative with econometric modelling and input-output analysis, using time series data from 1958-1973.

Vitosoglu et al. (2004) used Geographic Information Systems (GIS) tools to conduct an investigation of rail freight transit in Turkey. Transfer the metric containing commodities to GIS when given the origin-destination for 20 distinct commodities with an all-or-nothing assignment. Finally, this research makes use of the GIS, which is able to assist with the assignment of different commodities to linkages in the railway network.

Shen et al. (2009), use econometric time series models to forecasting the road freight and rail freight demand in Great Britain. In Europe, using the EU-TRANS-TOOLs modeling program, Islam et al. (2015) conducted rail freight forecasts for Europe 27 for the period up to 2050. They looked at three different scenarios. Two White Paper scenarios (High and Low) that adopt more upbeat perspectives of the White Paper policy objectives are taken into consideration alongside a reference scenario that assumes no significant changes to current rail freight policy, infrastructure, and trends. According to the analysis, the White Paper Low and Reference scenarios show comparable growth and modal split outcomes. The White paper High scenario results, in sharp contrast, indicate that, as compared to the Reference values, the demand for rail freight services nearly doubles.

Meng et al. (2022) carried out a study in China that outlined research on railway freight volume forecasting. They found that the methods used in this area are classified into two categories: intelligent forecasting methods based on machine learning and traditional forecasting methods based on statistics. Their application analysis is done with an emphasis on sorting and comparing the application scenarios, improvement concepts, and improvement effects of intelligent prediction methods.

Cebeci et al. (2022) conducted research in Turkey on the geographical distribution of rail freight demand using studies based on geographic information systems (GIS). They also discussed about the demand for production based in cities and stations as well as attractiveness values to significant load routes. They discovered that the link between GDP values and city-based rail freight demand indicated that the cities where shipments originate and end are either port- or mineral-ore-producing ones, rather than necessarily the most industrialized.

Research on railway freight demand forecasting based on several aspects was conducted by Liu et al. (2023). They reported that deep learning-based forecasting models may not be interpretable, while ordinary time series forecasting models frequently lack precision during extreme changes in demand. The combination of deep neural networks (DNN) and gray relational analysis (GRA) in this study provides a more comprehensible method for forecasting rail freight demand. An analysis of Chinese railway freight from 2000 to 2018 demonstrates the accuracy and interpretability of the tried-and-true GRA-DAE (Deep Automatic Encoders)-NN model. The performance of the GRA-DAE-NN models is further validated by comparative studies against traditional prediction models, such as GRNN, DNN, FNN (Feedforward Neural Network), FC-LSTM (Fully Connected Long Short-term Memory), SVR (Support Vector Regression), and ARIMA (Autoregression Integrated Moving Average). The choice of explanatory factors and increasing prediction accuracy are significantly impacted by the GRA.

Sultanbek et al.'s (2024) study examined methods for estimating Kazakhstan's demand for railways freight transportation. They applied the ARIMA model and time series methods. The results showed that the ARIMA model performed better than the neural nets and auto classifiers when different data analysis techniques were compared.

In conclusion, there are two categories of approaches for predicting the demand for railway freight: quantitative and qualitative. The former offers a variety of statistically-based methodologies for estimating rail freight demand. In any case, there is no ideal approach when using qualitative experience and judgment; each has pros and cons, and the operator may combine them together to get better demand outcomes.

## 2.3 Commodity and Thailand Commodity

### 2.3.1 Commodity

Within the framework of classical political economics, particularly in Karl Marx's criticism of political economy, a commodity is any item or services (sometimes referred to as "products" or "activities") (Marx, 1986) that is created by human labor (Marz, 2019) and made available for broad market sale (Marx and Engels, 1972). The theory of commodities explains consumer behavior when there are limitations on a good or service, a theory that suggests that the value of an item or service is determined by its availability. Products that are hard to get are frequently valued higher than those that are readily available. But a commodity's value is also influenced by the demand for it. It’s worth will be minimal if no one wants it, even though it can be uncommon (Brock, 1968).

The current commodity addressed by international organization as the International Monetary Fund (IMF) (2024) divided four categories of commodities as table below;

**Table 4 IMF Four Category Commodity**

| No. | Category | Commodity |
|---|---|---|
| 1 | Agricultural raw materials | Cotton, |
| | | Hard logs |
| | | Hard sawn wood |
| | | Hides |
| | | Natural rubber |
| | | Soft logs |
| | | Soft sawn wood |
| | | Wool |
| 2 | Energy | Coal |
| | | Crude oil |
| | | Natural gas |
| 3 | Food and Beverages | Bananas |
| | | Barley |
| | | Beef |
| | | Chicken |
| | | Cocoa |
| | | Coffee |
| | | Corn |
| | | Fish |
| | | Fish meal |
| | | Groundnuts |
| | | Lamb |
| | | Olive oil |
| | | Oranges |
| | | Palm oil |

| No. | Category | Commodity |
|---|---|---|
| | | Pork |
| | | Rapeseed oil |
| | | Rice |
| | | Shrimp |
| | | Soybean meal |
| | | Soybean oil |
| | | Soybean |
| | | Sugar |
| | | Sunflower seed oil |
| | | Tea |
| | | Wheat |
| 4 | Metals | Aluminum |
| | | Copper |
| | | Gold |
| | | Iron ore |
| | | Lead |
| | | Nickel |
| | | Tin |
| | | Uranium |
| | | Zinc |

**Source:** Commodity Terms of Trade: A New Database, 2019

On the other hand, the World Trade Organization (WTO) 's multilateral trade negotiations (MTN) categories use the commodity as part of their product categorization system for trade data and policy research. Trade negotiators, policy makers, and academics are permitted to examine policy measures, such as tariffs for different products, and interpret trade patterns using standard language. The primary product groupings that comprise the MTN Categories are specified in the Harmonized Commodity Description and Coding System (HS, also referred to as the Harmonized System), which is utilized for traded items. The categories were first used in the mid-1970s during the Tokyo Round and were specifically used in the Uruguay Round multinational trade discussions (WTO, International Trade Centre (ITC), United Nations Conference on Trade and Development (UNCTAD), 2023).

**Table 5 WTO's MTN Commodity Categories in HS2022**

| | MTN Categories | Subcategories |
|---|---|---|
| A | Live animals and meat | |
| | A01 | Live animals, excluding fish |
| | A02 | Meat |
| B | Dairy products | |
| | B00 | Dairy products |
| C | Fruits and vegetables | |
| | C01 | Fruits |
| | C02 | Vegetables |
| | C03 | Fruit and vegetable preparations |
| D | Coffee, tea, cocoa and spices | |
| | D01 | Coffee, tea, mate |
| | D02 | Cocoa and cocoa preparations |
| | D03 | Spices |
| E | Cereals and food preparations | |
| | E01 | Cereals |
| | E02 | Food preparations |
| F | Oilseeds, fats and oils | |
| | F01 | Oilseeds |
| | F02 | Animal fats and oils |
| | F03 | Vegetable fats and oils |
| G | Sugars and confectionery | |
| | G00 | Sugars and confectionery |
| H | Beverages and tobacco | |
| | H01 | Non-alcoholic beverages, including juices |

| | MTN Categories | Subcategories |
|---|---|---|
| | H02 | Alcohols |
| | H03 | Tobacco and tobacco products |
| I | Cotton, silk and wool | |
| | I01 | Cotton |
| | I02 | Silk and wool |
| J | Other agricultural products | |
| | J01 | Plants, parts, extracts and vegetal materials |
| | J02 | Chemicals from agricultural origin |
| | J03 | Residues of food processing industry |
| | J04 | Other products of animal origin |
| K | Fish and fish products | |
| | K00 | Fish and fish products |
| L | Minerals and metals | |
| | L01 | Mineral fuels, other than petroleum oils |
| | L02 | Other minerals |
| | L03 | Non-metallic mineral products |
| | L04 | Jewelry and related products |
| | L05 | Non-ferrous metals |
| | L06 | Iron and steel |
| | L07 | Metal products |
| M | Petroleum | |
| | M01 | Crude oils |
| | M02 | Petroleum oils, other than crude |
| N | Chemicals | |
| | N01 | Inorganic chemicals |
| | N02 | Organic chemicals |
| | N03 | Pharmaceuticals |
| | N04 | Plastics |
| | N05 | Fertilizers |
| | N09 | Other chemical products |

| | MTN Categories | Subcategories |
|---|---|---|
| O | Wood, paper, furniture | |
| | O01 | Wood and wood products |
| | O02 | Pulp, paper and printed matter |
| | O03 | Furniture |
| P | Textiles | |
| | P01 | Natural fiber, yarn and fabrics |
| | P02 | Man-made fiber, yarn and fabrics |
| | P09 | Other textile products |
| Q | Clothing | |
| | Q00 | Clothing |
| R | Rubber, leather and footwear | |
| | R01 | Rubber and rubber products |
| | R02 | Leather and leather products |
| | R03 | Footwear |
| S | Mechanical, office and computing machinery | |
| | S01 | General industrial machinery |
| | S02 | Machinery for specialized industries |
| | S03 | Power generating machinery |
| | S04 | Computers and office machinery |
| T | Electrical machinery and electronic equipment | |
| | T01 | Electrical machinery |
| | T02 | Electronic components |
| | T03 | Semiconductors |
| | T04 | Telecommunication equipment |
| | T05 | Audio-visual devices |
| | T06 | Domestic appliances |
| U | Transport equipment | |
| | U01 | Motor vehicles |
| | U02 | Railway vehicles |
| | U03 | Ships and floating structures |

| | MTN Categories | Subcategories |
|---|---|---|
| | U04 | Aircraft |
| | U05 | Bicycles, motorcycles and other transport equipment |
| V | Other Manufactures | |
| | V01 | Optical and photographic products |
| | V02 | Measuring instruments |
| | V03 | Medical equipment |
| | V04 | Clocks and watches |
| | V05 | Arms and ammunition |
| | V06 | Recreational and sports products |
| | V09 | Other manufactures |

### 2.3.2 Thailand Commodity

Currently, the three main economic sectors of the Thai economy are agriculture, industry, and services. If we consider the nature of product production in various countries, it may be divided into 2 types: industrial product production and production of agricultural products. For example, Thailand produces industrial products and agricultural products. Most of the industrial products will come from investment from foreign investors using Thailand as a production base and exporting them to sell around the world.

**Agricultural Commodity**

Thailand's economy has benefited immensely from the agricultural and service industries, which have given its people a wide range of employment opportunities. Thailand has maintained a strong agricultural economy throughout many economic downturns thanks to its wealth of natural resources, which include an extensive range of farms, fisheries, and crops. As for the production of agricultural products in Thailand produces a variety of agricultural products. It is produced so much that it can be exported to sell abroad. Thailand's strong food processing industry and international recognition for its quality control and standards make it one of the world's top suppliers of agricultural products. These factors allow Thailand to export value-added products to markets across the globe, including the EU, China, Japan, and the US. The food industry, which is the third largest in the country, contributes 21% of the GDP (gross domestic product). Among the main food exports are rice, canned pineapple, sugar, chicken meat, cassava products, and tinned tuna (USDA, 2020). Currently, export is the first main mechanism that brings income into the country. While, the agricultural sector is divided into crops, livestock, fisheries, agricultural services and forestry. (Ministry of Agriculture and Cooperatives, 2023), agricultural products can be brought to the consumption market in two important ways: 1) Consumer products are agricultural products that the buyer intends to consume. 2) Industrial agricultural products are agricultural products that the buyer has the objective of importing. Production process to create new products such as canned tuna and canned pineapple.

Some international organization given the major agricultural commodity for instance, the National Agro-Economic Zoning for Major Crops in Thailand (NAEZ) of Food and Agriculture Organization of the United Nations (2017) identified major crop in Thailand were: rice, paddy, maize, cassava, soybean, sugarcane, oil palm, para rubber, coffee, and tea. Though the nation also exports rice, vegetables, and fruit, rubber is Thailand's most well-known export. Thai beef, pork, and chicken are well recognized, as are its freshwater and marine fisheries (Statistic Yearbook Thailand, 2023). In this study the researcher will provides the information of five major agricultural commodity namely; rice, sugarcane, cassava, para rubber, palm oil, and maize, respectively.

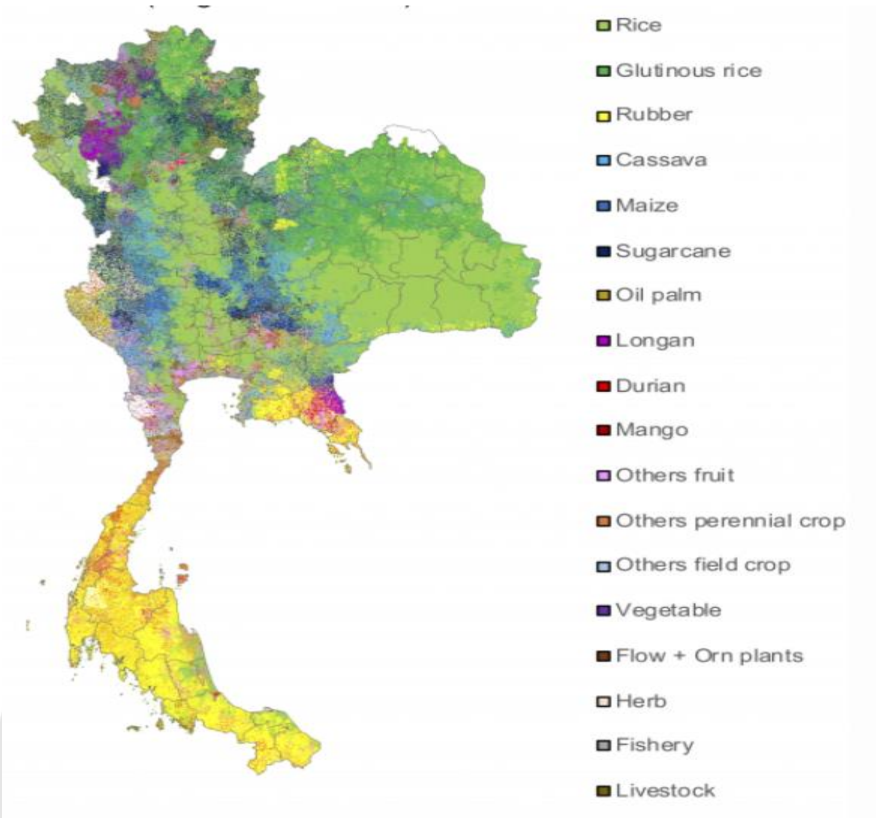



**Figure 6 Agricultural Commodity Area in Thailand**

**Source:** Chenphuengpawn et al., 2019

**Main crops in Thailand**

Approximately 52% of the 127 million acres of land may be used for farming. Despite the variety of crops cultivated there, rice has long been the foundation of Thai agricultural civilization and has been deeply ingrained in the country's customs. The country ranks in the top 10 worldwide rice producers in 2022, after Vietnam. The agricultural plantations of the country currently grow rubber, sugarcane, cassava, and other significant crops including onions, garlic, potatoes, and shallots, in addition to rice. Thailand has produced the most sugarcane among the other major crops in recent years (Statista, 2024). Rice, sugar, cassava, para rubber, and palm oil are still all considered "economic crops" and will be discussed in this section. Because, as stated previously, they generate certain amounts of the income that assists to strengthen Thailand's economy. in addition to continuously producing income for farmers and the country (Office of Industrial Economics (OIE), 2020). Rice For many individuals, like the Thai people, rice is a basic food. As a result, it must be conceded that it is still a crop with economic value today, drawing significant demand annually from trade partners. Especially rice varieties that are praised as the best in the world. “Jasmine rice”. As Thailand's primary export commodity in the agricultural product category, rice is a significant economic crop. Furthermore, the majority of Thai people eat rice as their primary meal. The majority of agricultural holdings are planted with rice. From 1981 to the present, Thailand has been the world's top exporter of rice. With an export value of 178,135 million baht, it shipped up to 8,763,265 tons in 2023, the rice export details for 2011 to 2023 shows in table below (Office of Agricultural Economics, 2024).

**Table 6 Rice Export Statistic 2011-2023**

| Year | Quantity (Kg.) | Value (Thai Baht) |
|---|---|---|
| 2011 | 10,711,548,988 | 193,842,525,443 |
| 2012 | 6,734,426,868 | 142,976,235,578 |
| 2013 | 6,607,552,376 | 133,797,188,434 |
| 2014 | 10,969,344,247 | 174,851,086,420 |
| 2015 | 9,795,780,638 | 155,912,016,318 |
| 2016 | 9,907,867,891 | 154,733,303,896 |
| 2017 | 11,674,331,363 | 175,160,779,227 |
| 2018 | 11,232,176,268 | 182,081,673,013 |
| 2019 | 7,583,661,548 | 130,584,562,060 |
| 2020 | 5,734,037,980 | 116,044,964,898 |
| 2021 | 6,296,680,597 | 109,771,150,044 |
| 2022 | 7,710,236,230 | 138,697,523,037 |
| 2023 | 8,763,265,509 | 178,135,655,432 |

**Source:** Office of Agricultural Economics, 2024

The Office of Agricultural Economics reported in 2019 that Thailand's rice-growing area was 68.72 million rai, with the northeastern region accounting for the majority of this area, followed by the northern and central areas, as seen in the figure below.

**Para Rubber**

One of Thailand's important commercial crops is rubber. Rubber is a plant that not only contributes significantly to Thailand's economic growth but also has social significance and yields great profits. Because rubber is a plant that strengthens communities by generating employment and vocations in rural areas. The planting area for rubber is 22.47 million rai. Natural rubber has an export volume of 4.4 million tons, of which 82 percent is exported and the remaining 18 percent is used domestically. Though some farms grow it in the East, Northeast, and North, it is mostly grown in the South (Rubber Authority of Thailand, 2018).

**Table 7 Para Rubber Production 2018-2022**

| Regions | Yield (Ton) | | | | |
|---|---|---|---|---|---|
| | **2022** | **2021** | **2020** | **2019** | **2018** |
| Northern | 265,841 | 245,012 | 238,784 | 217,688 | 193,303 |
| Northeastern | 1,326,919 | 1,311,533 | 1,273,928 | 1,207,569 | 1,151,053 |
| Central | 395,426 | 423,876 | 444,928 | 464,230 | 470,639 |
| Southern | 2,797,593 | 2,910,030 | 2,902,026 | 2,959,133 | 3,107,655 |
| **Total** | **4,785,779** | **4,892,451** | **4,859,666** | **4,848,620** | **4,922,650** |

**Source:** OAE, 2024

**Sugarcane**

The sugarcane business is a key piece of Thailand's provincial region and economy, giving work and pay to numerous people while also adding to the country's income. The primary ingredient used in the food and beverage sectors is sugar. One of the world's largest exporters of sugar is Thailand. The primary raw material used to bring sugar is sugarcane, which is mostly grown in the nation's central and northeastern areas. Thailand distributes sugar to several nations, including China, Malaysia, South Korea, Indonesia, and others. In Thailand, there are 58 sugar mills total; 20 of these facilities are found in the country's center and 22 in its northeast. (Pajampa, & Wongwuttanasatian, 2023). Post-guesses promote the year 2023–24 sugarcane creation to augmentation to 98.3 million metric tons. Upgrades in sugarcane yields will grow MY2023/27 creation by 1.5 percent from MY2022/23, as shown in the figure below (USDA, 2023).

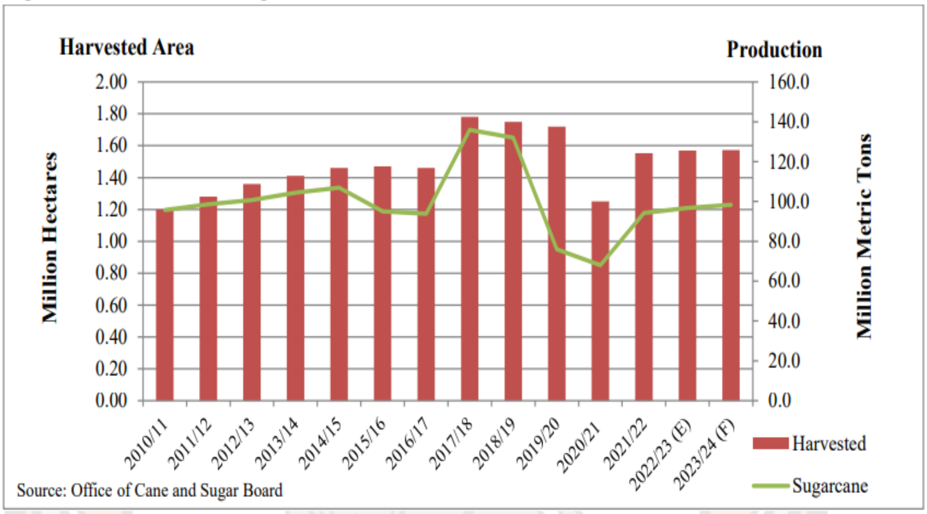



**Figure 7 Sugarcane Area and Production**

**Source:** Office of Cane and Sugar Board, and USDA-Foreign Agricultural Service, 2023

Inside Thailand, sugarcane advancement is accumulated in the Northeast (40.9% of all sugarcane bequest locales), followed by the North (28.8%), the West (15.1%), the Central Region (10.3%), and the East (5.0%). The primary sugarcane-creating districts are thus Kamphaeng Phet (7.5% of all Thai sugarcane farms), Nakhon Sawan (7.5%), Kanchanaburi (7.0%), Lopburi (6.3%), and Udon Thani (6.2%), as demonstrated by the figure 9 (Krungsri Research, 2023).

**Cassava (Tapioca)**

Thailand is the third-biggest maker of cassava on the planet, behind Nigeria and the Congo, with an established area of 10,861,975 rai in 2022 (OAE, 2024). Since the 1970s, Thailand has been the main exporter of cassava items. The fundamental merchant is China from the mid-2000s, yet previously, it zeroed in on trading to Europe for creature care. Thailand presently sends out around 10.4 metric tons of cassava items, mostly dried chips and starch power structures. The principal cassava-developing district is the Northeast, representing 60% of creation; however, the central and northern areas likewise develop cassava. The commodity cassava item volume from 2014 to 2023 is displayed in Table 8.

**Table 8 Thailand export cassava volume 2014-2023**

| Year | Volume (Ton) | Value (Million Baht) |
|---|---|---|
| 2023 | 8,583,311 | 126,651 |
| 2022 | 11,176,329 | 152,082 |
| 2021 | 10,357,333 | 123,061 |
| 2020 | 7,118,460 | 82,941 |
| 2019 | 6,595,170 | 80,776 |
| 2018 | 8,277,156 | 100,371 |
| 2017 | 11,172,324 | 95,072 |
| 2016 | 11,239,407 | 102,915 |
| 2015 | 11,682,313 | 117,325 |
| 2014 | 11,191,977 | 114,356 |

**Source:** Thai Tapioca Starch Association, 2024

**Palm Oil**

In 2022, the production volume of oil palm in Thailand amounted to approximately 18.6 million metric tons (OAE, 2024). The largest area of oil palm cultivation is in the southern region, followed by the central region and northeast; the least is in the northern region.

The amount of crude palm oil exported from Thailand reached almost one million tons in 2022, a notable rise over the around 619 thousand tons shipped the year before. In general, the amount of crude palm oil exported has changed throughout time. With an export value of almost 266 million Thai Baht, India ranked first among importers of oil palm from Thailand in 2023. Asia's demand is Thailand's main source of oil palm export revenue. Oil palm fruits are processed to make crude palm oil, which is used both for personal use and as a starting point for the creation of biodiesel.

**Maize**

One cereal variety that is crucial to the nation's economic growth is maize, often known as corn. In Thailand, maize is a significant crop that has long been utilized for both local and export markets. It is particularly useful in the animal feed sector, which supports farmers' livelihoods. Thailand's exports of animal feed have risen annually. Furthermore, ethanol and bioplastics made from animal feed maize are significant raw materials used in the sector. The total cultivated area in 2023 will be about 6.78 million rai. The northern area, with 4.5 million rai, the northeastern region, with 1.2 million rai, and the central region, with 0.87 million rai, are the main sources of maize cultivation and high output.

**Table 9 Maize Production and yield**

| Market Year | Area (1000 rais) | Production (1000 Tons) | Yield (kg/rai) |
|---|---|---|---|
| 2014 | 7,073 | 4,730 | 669 |
| 2015 | 6,275 | 4,029 | 642 |
| 2016 | 6,445 | 4,390 | 681 |
| 2017 | 6,553 | 4,821 | 736 |
| 2018 | 6,895 | 5,069 | 735 |
| 2019 | 6,522 | 4,535 | 695 |
| 2020 | 7,003 | 4,990 | 713 |
| 2021 | 6,661 | 4,848 | 728 |
| 2022 | 6,286 | 4,700 | 748 |
| 2023 | 6,667 | 4,954 | 743 |

**Source:** Centre for Agricultural Information, 2024

**Livestock and poultry**

In Thailand, chicken, duck, and swine are the three main animals that contribute more than 80% of livestock and poultry production income. The total number of chickens, ducks, and swine raised is higher (98% vs. 2%). The increasing number of goats, cattle, and buffalo reflects the rise in demand for domestic and neighboring countries markets (Nimsai et al., 2015), but chicken and pork are the two main exported products from Thailand (Department of Livestock Development, 2019). Apart from crops and livestock farming, fishery and aquaculture have also served as crucial parts of Thai food security and significantly contribute to GDP in Thailand. The production value of aquatic animals is forecast to amount to almost 86.4 billion Thai baht from fisheries and almost 104 billion Thai baht from aquaculture (Statista, 2024).

**Forestry**

In Thailand, the forestry sector contributed 2.5 percent of GDP growth in 2023. It was predicted that the subsector would develop by a maximum of 3.4%, therefore increasing the growth of the agricultural sector as a whole. The production volume of eucalyptus wood in Thailand reached around 78 thousand tons in 2022, making it the most produced timber product from the country's wood lot. Teak wood came after this. As a percentage of its overall land area, Thailand has around one-third forest area. The mountainous regions of northern and western Thailand are home to the majority of the country's forest territory (Royal Forest Department, 2022).

More than 63.5 percent of Thailand's total forest territory was found in the northern region in 2022. The two primary product categories that forests produce are wood commodities and non-wood forest products. Wood goods include sawn wood, fiberboard, wooden furniture, various types of fiber pulp, wood in chips or particles, plywood, veneer sheets, wood charcoal, flooring panels, logs, and other wood products available in Thailand (Royal Forest Department, 2022). Fiberboard exports from Thailand were valued at over 29.5 billion Thai baht in 2022. Wood in the form of chips or particles came second. Thailand exported around 4.4 billion kilos of wood chips or particles in that year. Pulpwood and wood charcoals were the main wood products imported into Thailand. As a result, according to Statista (2024), these two goods were among the wood items imported into Thailand with the highest value in 2022. These wood products are produced by a large number of wood-based enterprises around the whole country, some for export and others for home use. For domestic use, some timber products are imported (Royal Forest Department, 2022).

**Industrial Commodity**

Thailand's economy is largely dependent on foreign investment, travel, and exports. As such, the process of manufacturing goods for export is linked to the transportation of finished goods or raw materials. The Thai economy's producing sectors have been divided by the NESDB in order to plan for economic and social growth. It covers the fields of agriculture, livestock, services, and industry. The production branches include agriculture, food & beverage, and mining. Rubber, wood, paper, textile, chemical, and petroleum-based products Items and apparatus made of metal. Among the other necessary services and activities are more items, construction, plumbing, electricity and natural gas, retail and wholesale trade, transportation, and communications. (NESDB, 2024). In additionally, the Department of Industrial Promotion divides industries into 13 categories: clothing, textiles, rubber, leather, electronics, ceramics, plastics, services, metallurgy, food, handicrafts, gems, and nature conservation. and furniture (Department of Industrial Promotion, 2024). The industries that comprise iron and steel, electricity, electronics, motors and their components, motorcycles, pulp, paper and printing, ceramics, cement, textiles, and clothing are among the categories into which the Office of Industrial Economics (OIE) has been split. Wood, furniture, medicine, rubber, and rubber items food, accessories, footwear, and leather goods.

The ostensible value of the Thai commodities advertised is anticipated to be US$859.20 billion in 2024. A compound yearly development rate (CAGR) of 3.16% is anticipated for 2024–2028, meaning that by 2028, the full esteem ought to have come to US$973.00 billion. In 2024, the normal contract cost in Thailand's commodities showcase is anticipated to be US$0.09. Worldwide comparisons appear to indicate that by 2028, there will be 10,390.00k contracts in Thailand's commodities advertising, with the US enrolling the most elevated ostensible esteem (US$45,690.00bn in 2024). Investor interest in derivative trading is growing in Thailand's commodities market, as seen by the rise in the volume of options and futures contracts traded (Statista, 2024).

### 2.3.3 Population and Commodity Demand

Over the past 50 years, there has been a significant growth in the demand for commodities. Population and income growth are the two key long-term variables impacting the total demand for commodities. Since population expansion is frequently the main factor driving the rise of food commodities, money has less of an influence on them than it does on the rise of energy and metals. Along with the growth of the GDP, there has been a major four-fold increase in the demand for metals. A bit more quickly than the global population expansion, there was an increase in demand for agricultural and energy goods. Based on statistics on specific commodities, natural gas has increased the fastest among energy commodities, aluminum the fastest among metals, and soybeans the fastest among agricultural commodities. (World Bank, 2022).

From 6.9 billion in 2010 to 9.3 billion in 2050, the world's population is expected to increase by approximately one-third. However, the 13 geographical regions included in the model and individual nations have very different rates of population growth. Population estimates vary by global area and are based on the medium-fertility scenario used by the United Nations. Nonetheless, a sizable amount of this expansion is taking place in emerging nations. According to IMF projections, the population of Thailand is expected to grow by 0.1 million people (+0.14%) between 2024 and 2029. In 2029, there are projected to be 70.4 million people living in the country. Notably, throughout the previous years, the overall population has been steadily growing (IMF, 2024).

Thailand has roughly 66 million people, according to an announcement from the Registration Administration Office, Department of Provincial Administration, Ministry of Interior (MOI). This number can be broken down into the following regions: the Northern region approximately 11.5 million people; the Northeastern region has 22 million people; the Southern region has 9.44 million people; the Central region (including Bangkok) has 22.5 million people; and Bangkok has 5.4 million people (Office statistics registration systems, 2024). The following provinces have the greatest populations among those with a population of one million or more: Bangkok, Nakhon Ratchasima, Ubon Ratchathani, Chiang Mai, Khon Kaen, Chonburi, Buriram, Udon Thani, Nakhon Si Thammarat, Si Saket, Songkla, Surin, Samut Prakarn, Chiang Rai, Nonthaburi, Roi Et, Pathum Thani, Sakon Nakon, Chaiyaphum, Surat Thani, and Nakhon Sawan. In 2025, there will be 67.1 million people on the planet, according to NESDB population projections. It is anticipated that there would be 67.1 million people living in 2030, 66.6 million in 2035, and 65.4 million in 2040 (NESDC, 2019).

**2.4 Railway Commodity**

Basic rail systems for moving materials in quarries and mines existed before the 17th century, but the first significant rail transportation networks were not created until the early 19th century (Rodrigue, 2024). Over the past century, there have been significant changes to the commodity markets. Production and consumption habits have been impacted by technological advancements. The mix of commodity demand has radically changed as emerging markets and developing nations become more significant players in the global economy (World Bank, 2022). Following the researcher will introduce the nature of rail commodity of the top 5 of world largest rail freight volume, the US, China, Russia, India, and Canada. And the last the rail freight commodity of Thai.

**2.4.1 U.S.**

With over 140,000 miles of freight routes, the U.S. freight railways system is the largest in the world. Almost a third of all freight travels by rail, with an economic impact of about $80 billion (Fonseca et al., 2023). Each year, the six U.S. Class I railroads-BNSF, CN(GTC), CPKC, CSX, NS, and Up-provide Association of American Railroad (AAR) rail traffic data with weekly or monthly.

**Table 10 USA Rail Major Commodities**

| Commodities Name | Sub Categories |
|---|---|
| Chemicals | |
| Coal | |
| Farm Products | exclude grain, grain mill products, and food |
| Forest products | primary forest products, lumber and wood, pulp and paper |
| Grain | |
| Metallic Ores | Coke, primary metal products, iron and steel scrap |
| Motor vehicles and parts | |
| Nonmetallic mineral | crushed stone, sand and gravel, nonmetallic minerals, stone, clay, and glass |
| Petroleum & Petroleum products | |
| Other | waste and nonferrous scrap, all other carloads |

**Source:** Association of American Railroad, 2024

### 2.4.2 China

Nonetheless, bulk cargo rather than containerized goods has accounted for the majority of China's domestic rail freight traffic. With over 39% of the entire amount of goods moved by rail, coal is the most significant commodity. Given that China is the world's largest producer of energy, 58% of installed electricity producing capacity is accounted for by coal power plants (Wang & Ducruet, 2013).

**Table 11 China Freight by Commodity Types**

| Commodities | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| Coal, steel, iron | 52% | 54% | 56% | 58% | 60% | 59% | 59% | 60% | 57% | 55% |
| coal | 34% | 36% | 36% | 39% | 41% | 40% | 41% | 42% | 41% | 39% |
| other | 17% | 15% | 15% | 15% | 14% | 15% | 15% | 15% | - | - |

### 2.4.3 Russia

When considering the size of the network and the volume of freight and passenger traffic handled, the Russian rail system is among the biggest in the world. The Russian Railway, or Rossiyskie Zeleznye Dorogi (RZD) monopoly. As may be seen in the accompanying table, RZD divides freight volumes into export and domestic categories in the yearly report.

**Table 12 Russian Railway Commodity Traffic in 2019**

| Commodities | Domestic | Export |
|---|---|---|
| Hard Coal | 20.8 | 43.5 |
| Oil and Petroleum products | 17.0 | 20.5 |
| Construction Cargos | 15.5 | - |
| Iron and manganese ore | 12.4 | 7.5 |
| Ferrous metals | 5.7 | 6.1 |
| Chemical and mineral fertilizers | 3.1 | 4.7 |
| Timber | 2.4 | 4.7 |
| Other | 23.0 | 13.0 |

**Source:** Annual Report, 2019

### 2.4.4 India

India context, Indian railways has always focused on bulk freight transportation limiting the freight basket to raw materials for industries such as power, iron, and steel plants. Transportation of non-bulk commodities account for a small share in the rail freight movement (Bureau of Research on Industry and Economic Fundamentals, 2023).

**Table 13 India movement of bulk commodities 2018-19 to 2021-22**

| **Commodities** | 2018-19 Million Tonnes | % | 2019-20 Million Tonnes | % | 2020-21 Million Tonnes | % | 2021-22 Million Tonnes | % |
|---|---|---|---|---|---|---|---|---|
| Coal | 605.84 | 49.60 | 586.87 | 48.56 | 541.82 | 44.02 | 652.80 | 46.11 |
| Foodgrains | 39.31 | 3.22 | 37.53 | 3.10 | 62.82 | 5.10 | 73.38 | 5.18 |
| Iron & Steel | 53.99 | 4.42 | 53.13 | 4.40 | 60.06 | 4.88 | 68.50 | 4.84 |
| Iron ore | 137.34 | 11.24 | 153.37 | 12.69 | 159.13 | 12.93 | 168.36 | 11.89 |
| Cement | 117.34 | 9.61 | 110.10 | 9.11 | 120.40 | 9.78 | 137.19 | 9.69 |
| POL (Mineral Oils) | 43.01 | 3.52 | 44.68 | 3.70 | 42.48 | 3.45 | 44.46 | 3.14 |
| Fertilizers (Chemical manures) | 51.83 | 4.24 | 51.39 | 4.25 | 53.79 | 4.37 | 49.18 | 3.47 |
| Limestone and dolomite | 30.35 | 2.48 | 30.63 | 2.54 | 30.84 | 2.51 | 36.47 | 2.58 |
| Stones (including gypsum) other than marble | 21.58 | 1.77 | 18.24 | 1.51 | 27.30 | 2.22 | 24.20 | 1.71 |
| Salt | 4.86 | 0.40 | 4.30 | 0.36 | 5.88 | 0.48 | 8.03 | 0.57 |
| Sugar | 3.02 | 0.25 | 2.89 | 0.24 | 3.81 | 0.31 | 5.88 | 0.42 |
| Commodities other than above | 113.01 | 9.25 | 115.28 | 9.54 | 122.61 | 9.96 | 147.42 | 10.40 |
| Grand Total | 1,221.48 | 100.00 | 1,208.41 | 100.00 | 1,230.94 | 100.00 | 1,415.87 | 100.00 |

Source: Indian Railways Yearbook, Ministry of Railways

### 2.4.5 Canada

The Canadian National Railway Company (CN) annual report (2023) stated that Customers of CN have access to Canada, the United States, and Mexico through CN's vast network and effective links to all Class I railroads, which covers 18,800 route miles of track across these three countries. Every year, CN Rail moves over 300 million tons of manufacturing commodities, finished goods, and natural resources throughout North America, which is vital to the region's economy, consumers, and communities. Seven commodity groupings, which cover a diverse and broad range of origins and destinations, provide CN with its freight earnings. Based on the share of 2023 revenues, the top commodity category for CN at the end of 2023 is as following table:

**Table 14 Canadian National Railway Commodity 2023**

| Commodity | Revenue Percentage |
|---|---|
| Intermodal | 22 |
| Grain and fertilizer | 19 |
| Petroleum and chemical | 19 |
| Metals and mineral | 12 |
| Forest products | 12 |
| Automotive | 6 |
| other | 3 |

Source: CN 2023 Annual Report

### 2.4.6 Thailand

Thailand's demand for rail transportation has historically outpaced the SRT's capacity—the sole organization offering rail transportation services in Thailand. The goods that require transportation are the same as those in the other nations that were previously stated. However, in the past, service constraints such the lack of nationwide railway track connections prevented the railways from expanding their operations. At present, the most frequently transported commodities are eastern containers from ICD to Laem Chabang Port, followed by cement, general containers from other areas, petroleum, LPG, and crude oil, as well as other cargo and land bridge container transfer from Padang Besar to Malaysia.

Since the Lao-China railway network opened three years ago, it was discovered that containers were crossing into Laos; nevertheless, this has not resulted in a significant rise in the amount of rail freight trade. Roughly 10 million tons of cargo will be moved annually. Following the completion of the rail infrastructure, Thai trains will be able to carry more cargo—cars, chemicals, fertilizer, salt, sugar, and salt—as well as more seasonal fresh fruit for export, just like trains in other affluent nations. The Thai Railway commodity volume for 2015 to 2022 shows in Table 15, and Figure 6, respectively.

# Table 15 Thailand Railway Commodity Volume 2015-2022

Unit: Ton

| Commodities | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Total |
|---|---|---|---|---|---|---|---|---|---|
| Eastern Container | 7,285,125 | 7,350,239 | 6,420,566 | 3,941,109 | 4,732,503 | 5,121,871 | 6,388,149 | 6,151,561 | 47,391,123 |
| Cement | 758,821 | 1,306,426 | 1,750,998 | 1,820,257 | 1,951,330 | 2,093,428 | 1,952,361 | 1,570,647 | 13,204,268 |
| Container | 295,622 | 313,595 | 904,909 | 1,537,589 | 1,377,852 | 1,559,690 | 1,211,767 | 1,318,927 | 8,519,951 |
| Crude Oil | 1,212,655 | 1,192,481 | 1,156,581 | 803,551 | 866,931 | 1,016,518 | 1,029,187 | 965,208 | 8,243,112 |
| LPG | 829,920 | 776,448 | 694,272 | 630,672 | 503,712 | 406,800 | 312,240 | 248,160 | 4,402,224 |
| Petroleum | 493,722 | 544,008 | 570,856 | 549,363 | 519,873 | 342,987 | 402,820 | 359,735 | 3,783,364 |
| Landbridge Container | 134,019 | 195,723 | 329,731 | 359,827 | 435,490 | 338,363 | 405,561 | 384,876 | 2,583,590 |
| Other | 1,790 | 4,912 | 138,606 | 502,206 | 109,740 | 145,442 | 68,585 | 52,721 | 1,024,002 |
| Military & Police Stuff | 13,770 | 12,619 | 10,256 | 7,694 | 2,890 | 4,272 | 3,611 | 1,429 | 56,541 |
| Drink | 18,377 | 8,333 | 6,030 | 35 | | | | | 32,775 |
| Container Inter Lao PDR. | | | | | | | 2,288 | 28,530 | 30,818 |
| Rice vermicelli, Flour | 7,265 | 5,251 | 6,329 | | 2,404 | | | | 21,249 |
| Sugar | 750 | 660 | 665 | | | | | | 2,075 |
| Nut | 267 | 68 | 35 | 690 | 35 | | | | 1,095 |
| Wheeled vehicle part | 36 | | 90 | | | | | | 126 |
| Fertilizer | | 25 | | | | | | 56 | 81 |
| Furniture and items | | 44 | | | | | | | 44 |
| Total | 11,052,139 | 11,710,832 | 11,989,924 | 10,152,993 | 10,502,760 | 11,029,371 | 11,776,569 | 11,081,850 | |

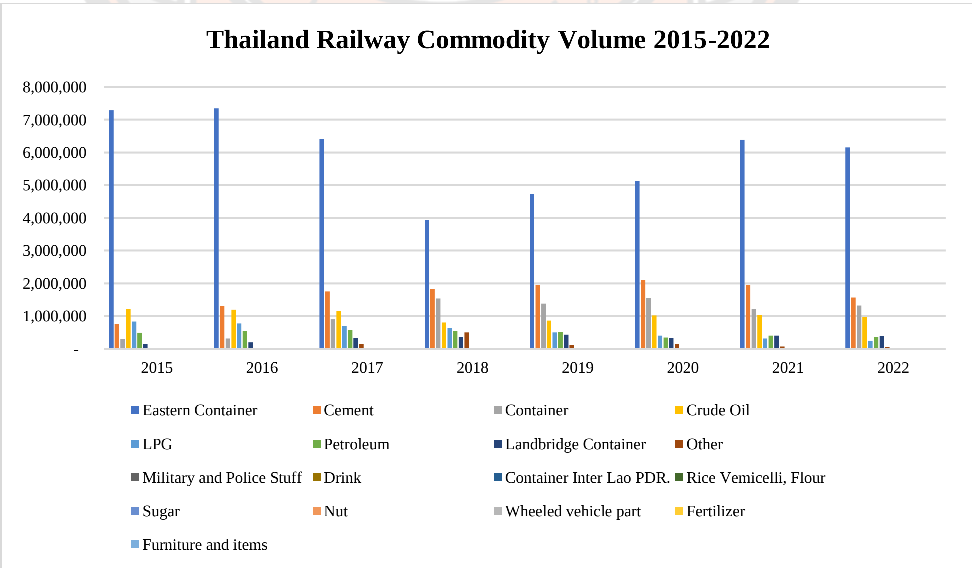



**Figure 8 Thailand Railway Commodity Volume 2015-2022**

## 2.5 Commodity Outlook

### 2.5.1 Thailand Economic Outlook

Thailand's Gross domestic product (GDP) is predicted to grow by 3.0 percent in 2025 and 2.6% in 2024 due to rising government expenditure, growing private consumption, and better tourism. In the meanwhile, exports should steadily increase (Bank of Thailand, 2023). Consist with the S&P Global Market Intelligence (2023) stated Thailand's economy will continue to be driven by the constantly growing number of tourists visiting the populous Asian emerging economies, particularly the Chinese mainland, India, and Indonesia. Over the next 10 years, Thailand's economy is anticipated to grow gradually, with a projected increase in total GDP from USD 500 billion in 2022 to USD 860 billion in 2032. One significant contributing aspect will be the swift rise in urban family earnings and private consumer spending.

The International Monetary Fund (IMF) was predicted that Thailand's gross domestic product (GDP) would rise steadily by a total of 161.5 billion US dollars (+29.42 percent) between 2024 and 2029 at current prices. The GDP is predicted to increase for the seventh year in a row to reach 710.43 billion dollars, setting a new record in 2029 (Figure 14). In other words, the figures are derived from the GDP in the local currency, which is then translated to US dollars using market exchange rates (averaged annually). The value of all finished goods and services produced in a given year is represented by the GDP (International Monetary Fund (IMF); Statistica, 2024).

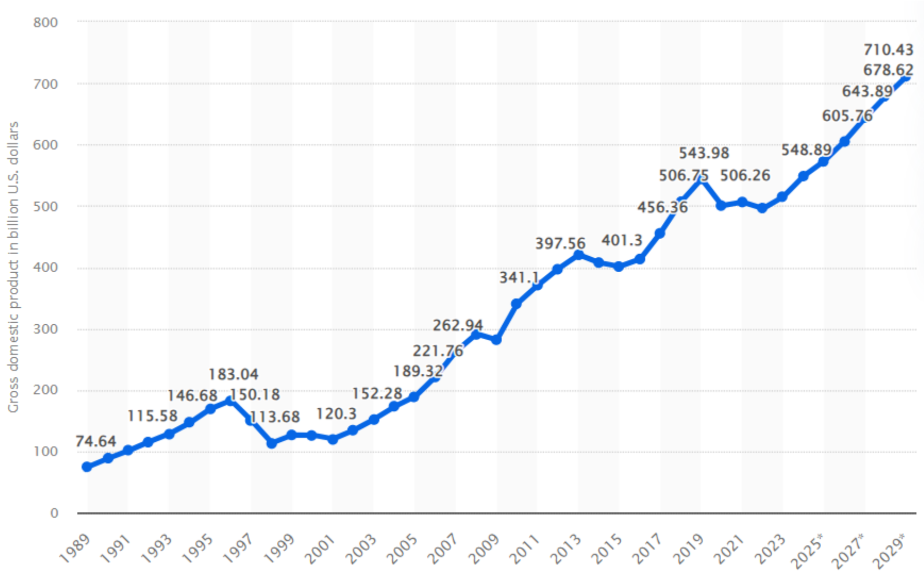



**Figure 9 Thailand: GDP in current prices from 1989 to 2029 (in billion U.S. dollars)**

**Source:** International Monetary Fund, 2024

### 2.5.2 Agricultural Commodity Outlook

The twenty-year agriculture and Cooperatives strategy (2017-2036) addressed the key issues for the next 20 - year agricultural commodity challenges and requires further tackled which concerned to the trend and directions of agricultural commodity in Thailand. As forecast by the United Nations (UN), the world population at the present trend of population growth will rise from 7,000 to 9,000 million in the next 20 years. This will substantially increase future world food demand. the enhancing of demand of healthy food and consumers tend to use the more convenient channel of on-line purchase of commodities including that of food (Ministry of Agriculture and Cooperatives (MOAC), 2017). Although it only makes up 6% of Thailand's GDP, the agricultural industry employs around 1/3 of the labor force in the nation. The greatest exporter of rubber, canned pineapple, tinned tuna, and tapioca products worldwide is Thailand (International Trade Administration, 2024).

**Rice Outlook**

The USDA forecasts Thailand’s rice and corn production to marginally increase in MY2024/25 along with expanded acreage in response to current attractive farm-gate prices. In 2025, Thailand will likely export 7.5 million metric tons of rice or well above its 5-year average. MY 2024/25 wheat imports will likely remain steady at 3.2 MMT due to high inventories and the expected recovery of MY2024/25 domestic corn production. In 2023, Thai rice exports expanded both in volume (by 14%), and value (by 28%) compared to 2022 (USDA, 2024).

**Para Rubber Outlook**

Thanks to the year-over-year expansion of the area where the yearling has increased the level and the year that the yield per RAI has increased in the country where the yearling has grown, the world's total rubber production has increased by 2.31 percent annually over the past five years, rising from 13.802 million tons in 2019 to 14.927 million tons in 2023. Furthermore, a portion of the tapped regions are in the stage where substantial yields of rubber are starting to occur. Due to the need for rubber in the rubber sector, rubber gloves, and other industries, Thailand's demand for rubber has grown by 20.26 percent annually over the last five years, particularly for mixed rubber. Thailand's exports have grown steadily over the last five years, averaging 2.75 percent annually, as a result of rising demand from allied industries. Block rubber and mixed rubber shipments rose by 2.43 percent and 100%, respectively, according to customs statistics. 10.08 annually, correspondingly.

In Thailand, it is anticipated that demand will rise from previous years and exports will also rise, following the pattern of increased global demand for rubber and higher exports than in the past (OAE, 2023).

**Sugar Outlook**

The growth of the food, beverage, pharmaceutical, and medical supply businesses, along with the expansion of the tourist sector, will either maintain or slightly enhance domestic consumer demand in 2023. The Krungsri research sees global production expanding by another 2.0-3.0% annually over 2024 and 2025. The sugar trend, as determined by market-enhancing variables such futures prices at the New York market, farmers, sugar factories, a sugar cane industry, and tourists have all increased planting areas and harvested more goods as a result of the Thai economy recovering, the need for sugar from linked sectors, and different related companies like restaurants and lodging. In actuality, the Thai sugar sector will follow worldwide patterns and become stronger as expansion penetrated both its national economy and export markets. The following is a perspective for the upcoming years. According to Krungsri Research (2023), the growth rate will increase to 3.0-4.0% between this year and 2025. The domestic demand for sugar is forecast to rise by 2.0-4.0 per year to 2.5-2.7 million tonnes, while the export of sugar and molasses is anticipated to rise by 2.5-3.5% to 9.5-10.5 million tonnes yearly.

**Cassava Outlook**

Potentially useful as a food supply, alternative energy source, and raw material for several other industries, including the food and beverage sector, cassava is a plant. among other things, feed for animals, paper, textiles, chemicals, energy, and cosmetics. Thailand concentrates mostly on exporting because local demand for about 30 to 35 percent of the country's output is met domestically. It is anticipated that global exports jumped by 14.55 percent annually in 2022 and 13.38 percent annually in 2023 (OAE, 2023). The Office of Industrial Economics has stated that production and sales circumstances have improved for all items, particularly cassava starch, as per the Thai Industrial Index overview report for March 2024. Farmers have been motivated to plant more cassava in order to provide industries with more considering the price of the crop has previously risen. Additionally, the market is still in demand, growing at a rate of 15.41% for exports and 8.58 percent for domestic sales (Office of Industrial Economic (OIE), 2024).

**Palm Oil Outlook**

The market is expected to develop between 2020 and 2025 due to rising consumer knowledge of the health advantages of palm oil, shifting consumer consumption patterns toward a more nutritious diet, and rising demand for biofuels. Concerns over the decline of petroleum reserves are driving up demand for biofuels. In light of this, the market for biofuels derived from food crops—like palm and rapeseed oil—has grown throughout the last several years. During the predicted period of 2020–2025, this is expected to fuel demand for palm oil and thus aid in market expansion. In Thailand, the demand for crude palm oil for consumption by people grew by 2.69 percent year between 2019 and 2023. The usage of palm oil for alternative energy climbed by 13.93 percent in 2023 due to policies encouraging tourism, while the demand for palm oil increased by 12.95 percent in 2022 (OAE, 2023). Oil palm prices rise in line with global oil prices. Due to the effects of the Russian-Ukrainian War, palm oil's value increased from 21% in 2015 to 36%, and in Surat Thani Province, it supplanted rubber as the primary crop. Oil palm bunches are produced and their weight drops as a result of the heat and limited water availability. The output of oil palm is predicted to fall from 18.2 million tons to 18.1 million tons, a 0.8% decrease from the previous year. The revenue of oil palm farmers will, however, somewhat improve to 3% from the previous year due to support from the price level, which is still high due to the price expansion of 4% from the previous year (ttb, 2024).

**Maize Outlook**

Post forecasts MY 2024/25 corn production will increase to 5.4 MMT, up 2 percent from MY 2023/24, in response to higher water supplies, greater MY 2024/25 acreage and higher average yield compared to MY 2023/24. The expected increase in water availability and better planting conditions in the second half of 2024 will encourage farmers to continue to grow off-season corn. In addition, an expected uptrend in feed consumption in 2024 will encourage corn farmers to continue with the corn production. The Thai Feed Mill Association (TFMA) anticipates an upward trend in 2024 feed consumption. TFMA expects Thailand’s total feed demand to increase to 21.3 MMT in 2024, up 7 percent from the previous year in anticipation of a gradual recovery in domestic swine production from the African Swine Fever (ASF) outbreak and the growing demand for poultry products. The increase in boiler production is driven by chicken meat exports, which TFMA expects will grow by 3-4 percent in 2024 (USDA, 2024).

**Seasonal Fruit**

Thai farmers rely mainly on the agricultural produce of fruit trees for their livelihood. There are currently at least 57 species farmed all across the nation, however the Thai Fruit Development Guidelines 2022–2027 place a strong focus on problem-solving and development for the seven primary commercial fruits, which include fruits with There are three fruit varieties with potential for local consumption—rambutan, longkong, and lychee—and four fruit varieties with potential for export: durian, mangosteen, longan, and mango. There are just three provinces in eastern Thailand: Rayong Province, Trat Province, and Chanthaburi Province. Four significant fruit trees, durian, mangosteen, rambutan, and longkong, are derived from it.

**2.5.3 Industrial Commodity Outlook**

**Petroleum Outlook**

Due to the combined impacts of tourism, jet fuel, gasoline, and cooking gas, sales volume climbed by 4.60 percent, in accordance with the trend of the ongoing growth in demand for trip fuel (Office of industrial economic, 2024).

**Cement Outlook**

Given that the total construction investment value is predicted to grow at a pace of 3.5–4.0 in 2024–2025, there will probably be a rise in demand for building materials. The volume of domestic cement sales tends to grow at a rate of 3.0-4.0 per year. With the steady recovery of the economy and increased investment in surrounding countries, exports will increase and benefit from further advancements in infrastructure investment. According to IMF predictions, GDP in CLM nations will keep declining, while exports to new markets like Australia and New Zealand will have possibilities to grow in order to diversify risk and promote market expansion.

**Steel (Steel bar and Structural Steel) Outlook**

Domestic sales volume is predicted to increase by 5.5-7.0% in 2024–2025 as a result of ongoing investments in projects, both public and private, that are growing faster than before. The amounts of exports will probably be going to recover gradually. One of the supporting elements is that, with the settlement of COVID-19, several countries—especially ASEAN, Thailand's primary export market—accelerated their investment in the development of fundamental projects (Krungsri Research, 2023). While the Worldsteel Association, (2023) address the region's steel demand is once again growing normally as a result of the rebound in tourism, particularly as China opens up, and the restart of postponed building projects. The demand for steel in ASEAN is predicted to rise by 6.2% in 2023 and then by 5.7% in 2024, following a 0.3% decline in 2022.

**Food and Drink Outlook**

**Ready to Eat Outlook**

The average annual growth rate for ready-to-eat food sales volume in Thailand is expected to be 3.0-4.0. This can be broken down into four categories: instant noodles, which will grow by 2.0–3.0 per year; ready-to-eat food, which will see sales increase by 5.0–6.0 per year; ready-to-eat cereals, which will grow by 4.0–5.0 per year; and ready-to-eat soup, which will either remain stable or grow by a tiny amount of 1.0 per year. The industry's slow but steady rebound, the growth of cities, the ease with which food is now available to customers, and the ingenuity of entrepreneurs creating more affordable, readily consumable, and healthful items are all contributing causes (Krungsri Research, 2024). Thailand's abundant natural resources, highly skilled labor force, and scientific expertise have earned it the moniker "the kitchen of the world" for quite some time. More than 23 percent of the country's GDP came from the food industry. Thailand's food industry, including exports and local consumption, is projected to be valued USD 102 billion in 2017. Thailand is among the world's largest net food exporters and the second-biggest in Asia, with a record food trade balance of USD 16.7 billion in 2016 (BOI, 2018).

**Food Processing Outlook**

The canned, processed, and prepared seafood, which has a greater added value to the processing of seafood, and chilled and frozen seafood processing make up the two main components of the Thai seafood processing business. Thailand holds the 8th rank in terms of volume and 14th rank in terms of value of processed seafood exports world The total projection for food production in 2024 is probably going to increase due to government initiatives to boost the economy and tourism. Product categories with significant growth potential are chilled fruits and frozen meals, which are still widely consumed in China. With the opening of new markets and the EU market, chilled and frozen chicken usually gets better, leading to a rise in consumption (FTI, 2024).

**Consumable Products Outlook**

The Thai retail business have a three major dominating in this sector, central group, TCC group, and CP group. The modern grocery outlets types were convenience stores, supermarkets, hypermarket/cash & carry, and online retailing (USDA, 2023). Below the top Thai retailers divided by categories;

**Table 16 Retail Categories**

| Categories | Name |
|---|---|
| Supermarkets | Central Food Retail, Gourmet Market, Villa Market, Foodland, UFM Fuji Super, Max Valu |
| Hypermarkets | Lotus's, Big C |
| Cash and carry | Makro |
| Convenience Stores | 7-Eleven, Family Mart, Lawson 108 |

**Source**: USDA, 2023

The majority of the revenue is made by the tourist industry, which also propels the national economy. The demand for fashion, clothes, and electrical items is being increased by tourists. Thai retailers' main clientele consists of Chinese travelers. Chinese customers purchase health items, herbs, handicrafts, cosmetics, and other things in large quantities. Clothes and herbs are the most popular things to buy and resale, followed by cosmetics. Thailand is a popular travel destination for people from China, Malaysia, India, South Korea, Laos, and Japan. Moreover, about 60% of all international tourists originate from these six nations alone (Mordor Intelligence, 2023).

In March 2024, Thailand's industrial production fell 5.13 percent compared to the same month the previous year. Thailand's industrial production is predicted by Trading Economics global macro models and analysts to be -1.90 percent by the end of this quarter. Our econometric models predict that, over the long run, Thailand's industrial production will trend between 5.00 percent in 2025 and 4.80 percent in 2026 (Trading Economic, 2024).

## 2.6 Railway Freight Transport System

The amount of railway freight has been up and down for the past 10 years, particularly in 2018, a railway freight volume are 10,232 thousand tons, decreased from 11,695 thousand tons in 2017, a 12.50 decreased, but 0.3 increased in 2019 (Figure 7). Due to limitations on various traditional factors, problems and obstacles of Thai railway transportation systems freight is still ineffective and unable to meet the users' expectation. As a result, it is critical to place a focus on freight transportation convenience, price incentives, and on on-time delivery service in order to increase the use of railway as the primary mode of multimodal transportation (N. E. a. S. D. Council, 2020).

**Rail Transport Infrastructure Concept**

As per the report by the European Commission (2011), the transportation industry contributes over 5% of the world's gross domestic product. Because it fosters the formation of industrial clusters and agglomerates, boosts productivity, lowers trade costs, and enhances the shipment of commodities, transportation infrastructure plays a significant role in economic growth (Donaldson, 2018). But for all its conveniences, the transportation industry has received a lot of attention for its effects on the environment. Furthermore, alternative uses of investment funds, including healthcare or social services, appears to be preferable given that it can take years or decades for the positive spillovers from investments in transportation infrastructure to materialize in the real economy (Herrendorf et al., 2012). The notion of transport infrastructure capacity is complex and includes a number of elements that are necessary for contemporary civilization to function and be generally well-off. Because it is so widespread, transportation infrastructure is essential to maintaining freight mobility, making delivery services more accessible, and allowing for the smooth transfer of commodities. Particularly at the regional and municipal levels, where spatial economic units are usually arranged, transportation facilities play a major role as accelerators for economic growth at various geographical extents (Polyzos, & Tsiotas, 2020). Global economies benefit from safe, dependable, and reasonably priced train services. Freight trains require lines and tracks, shunting yards, freight terminals, and associated equipment and facilities to handle rolling stock and freight/cargo shipments as part of its rail infrastructure (Teodorovic and Janic, 2016).

**Principles of Modal Shift**

According to Rodrigue (2020), the principles of modal shift often take places over three phases; Inertia phase, modal shift phase, and maturity phase. Firstly, the inertia phase, for a few users, the slow modal shift happens as part of a tax incentive. The tax incentive may be in the form of upfront funding for the development of related services. The actual modal share is often lower than the modal share expected. The underperformance of the modal shift is due to the accumulated investment and assets in the current mode and terminals. New transport ventures are likely to be the first to adopt a modal shift, as they are willing to take a chance on an untested distribution system for the opportunity to be the first. Secondly, the modal shift phase, as the industry realizes its benefits, this phase is a quick change from one mode to another. The new transportation method gradually moves from an underperform to an overperforming circumstance. Users and authorities may be caught off guard as they fight to deal with the additional infrastructure investments. Lastly, the maturity phase, a new modal share stability is reached when the market opportunities are realized. The incentives for modal shift are lessened and the disparity in comparative advantages has been identified.

### 2.6.1 Railway Infrastructure

The two main components of a railway transportation system are infrastructure (the permanent way, lines, stations, freight facilities, viaducts, tunnels, and so on) and rolling stock (the locomotives, passenger coaches, freight cars, etc.) The railway is operated by a control system, which was initially mechanical but is now more commonly electronic and computerized. The railway freight process is divided into two subsystems: firstly, train movement between yards and terminals; secondly train operations in yards and terminals (Silva, 2020).

In Thailand context, the low output of these two subunits is to blame for inefficiency, railway efficiency may be limited or increased depending on the subsystem, assets, and operational issues. The current railway network restricts the movement of goods. As a result, railway transportation is less dependable than other modes of transportation. In order to address the above issues, to boosting the domestic economy by investment, lowering transportation costs and to provide opportunities for maximizing the benefits of membership in the ASEAN community. As a result, the term has been established an eight-year period Thailand's Transportation Infrastructure Development Strategy (2015-2022).

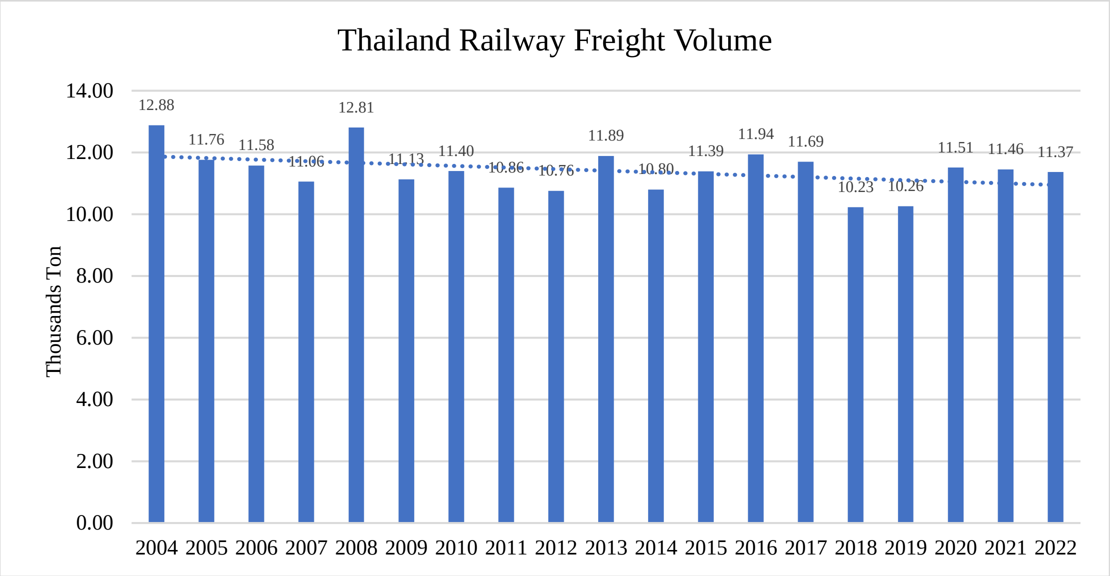



**Figure 10 Freight Carried by SRT**

**Source:** Ministry of Transport, 2023

### 2.6.2 Railway Performance

The difficulties properly measurement of the railway performance, or efficiency, of railway by benchmark with others railway and railway itself changed with exogenous factors. (I. T. Forum, 2019) International Transport Forum [ITF], (2019, p.11), stated that the efficiency is described as the ability to increase outputs from a collection of inputs (technical efficiency) or the ability to create an optimal mix of inputs to increase outputs (allocative efficiency). The railway performance or efficiency is difficult and complicated to describe in the railway industry, and it is up to the stakeholders; owners or operators, government, consumers, and the regulator. Operators will describe it in terms of infrastructure access and expense. Users care about availability, dependability, and speed. Both technological and allocative efficiency will be measured by the regulator. The implementation of various railway performance indicators, such as, (I. T. Forum, 2019) ITF (2019), reported that the quality of railway transportation services is measured in terms of productive efficiency, economic efficiency, and operational efficiency. However, (Europe., 2019), stated that the KPIs to measure railway performance are capacity, operation and market development. Whereas, the railway performance index (RPI), for measures and benchmark of railway operation efficiency with key elements of railway performance and intensity of use, quality of service and safety (Group, 2017). In other hand, the railways operator like CSX, focus that the railway performance measures, gross velocity, terminal dwell, and operational cars online are all important metrics, the length of the infrastructure, the number of vehicles, the number of transportation-related businesses, transportation-related jobs, vehicle and freight movements (Corporation., 2021). Normally, many researchers use to measures the perception and exception level of the passenger for the commuter service. Other studies, mentioned the TRANSQUAL model was used as an instrument to measure the railway operations' performance, the factors such as environment, responsiveness, reliabilities, physical facilities, and safety and security, to obtain the level of attractive of public transportation (Haron, 2016). The production, productivity, energy consumption, people, rolling stock, tracks, yard and terminal and train, are the KPIs measurement of railway performance stated by (Wanke, 2018).

In Thai context, punctuality is key part of quality of service, in Thailand. SRT's service quality popular for late arrival and departure for both services of passenger and freight. The inadequate of track and logistics facilities, the insufficient of rolling stock are effects to the railway performance. Nonetheless, the performance metrics are not defined by SRT. However, the annual report and other reports include a slew of metrics. Capacity strength of usage, punctuality, injury, speed, and freight movement are some of the indicators. Here the studied according State railway of Thailand's service quality and performance, the Balanced Scorecard (BSC) with financial, service quality, internal process and learning and development in order to evaluated the efficiency of organization management and study figure out how to improve service quality (Somchanmavong, 2018). The 5 perspectives to evaluation service quality, name; station and train, service process, staff, scheduling, and safety on state railways of Thailand's service: a case study of the southern line (Bangkok-Hua Hin), approached by (Sompracha, 2018). Some researcher, concentrates on railway operation, some found the factors impact to railways on-time operation performance were: marketing, technology, infrastructure and rolling stock, and mentioned that SRT can improve the performance by purchase new rolling stock and modern equipment (Ploenhad, 2015). The speed, economy, safety, convenience, and reliability are KPIs applied to measures the railway freight efficiency of the bulk cargos as crude oil (Sutthirak, 2016).

We could choose the KPIs by the stakeholder who you asking, the various indicators and the complicates can misleading the transfer understanding. As studied, we can divide the KPIs by two categories are tangibles KPIs, such as track length, number of vehicles, rolling stock, asset utilization, physical facilities, yard and terminal and station and train, and intangibles KPIs, such as financial, service quality, operational, marketing, technology and human resource utilization. The railway efficiency was calculated in a broad sense, taking into account factors such as frequency, punctuality, speed, and price, actually. Of course, this is a subjective measurement that ignores external, objective variables. The efficiency ratings, for example, do not appear to represent the density of railway networks or average levels of ridership (Mazareanu, 2019). Anyhow, in the business management, the financial or economy, service quality and reliability are most the KPIs applied for evaluated railway performance.

### 2.6.3 Thailand Railway Infrastructure Development Strategy

According to Rodrigue (2020), proposed that the transport policy is creating a collection of ideas and concepts that are designed to accomplish particular goals about the state of the social, economic, and environmental situations as well as the efficiency and effectiveness of the transportation system. Appropriating resources for transportation in an efficient manner, including overseeing and controlling current transportation operations, is the aim of transportation policy. But the necessity for the transportation system to lower its impact on the environment also gives us a chance to examine the equality results of the system and how they may be improved more closely. It is obvious that reforming transportation systems to more evenly share costs and benefits is essential to addressing transportation-related disparities and the consequences they cause (Randal et al. (2020).

Public sector theories clarify that efficiency is related to the seamless operation of public operations. Coordination, collection, and oversight of government revenue and spending in relation to service delivery to stakeholders are all aspects of efficiency (Ikubor et al., 2021). The appropriate functioning of economic operations is a social responsibility of the public sector. Furthermore, the objectives of the government could include various and involve several parties. Thus, efficiency and equality should direct public expenditure in order to prevent chaotic (Ewetan, 2012). An equitable share of public benefits among stakeholders is what equity is all about. The law of growing state spending, frequently referred to as Wagner's law, serves as the foundation for the relevant public expenditure theory used in this study. According to the theory, government expenditure typically increases as income growth does in any given nation (Ikubor et al., 2021).

`Academic interest in a stakeholder approach has expanded and increased since 1984. Four subfields have seen the majority of study on the stakeholder concept: corporate governance and organizational theory, corporate social responsibility and performance, normative theories of business, and strategic management (Jones et al., 2002). A new topic that has been connected to public sector project stakeholders is project governance. The notion of governance brings up concerns about social and economic accountability, collaborative attempts to reduce power imbalances across involved organizations, and accomplishing goals without relying on the government structure (Meso et al., 2009). Since the definition of a stakeholder is "any group or individual who can affect, or is affected by, the achievement of the firm's objectives" (Freeman, 1984, p. 46), the idea of a stakeholder has been introduced and used in a variety of academic fields, including construction project management. Stakeholder-related issues have been getting more attention as project success and performance criteria have evolved. This is because different stakeholders have different stakes in the projects that are being developed, and all stakeholders' opinions and concerns matter when decisions about the projects need to be made (Bryde, & Brown, 2005). This study employs stakeholder theory as a critical-diagnostic tool to pinpoint the stakeholders' points of view that are susceptible to a breakdown in the rail freight modal shift in order to increase rail freight volume on government targets, lower logistics costs to GDP, and increase competitiveness. The SRT officer and the OTP officer, for instance, are key stakeholders. The community, the chamber, the educational institution, the federal government of Thai industries, the media, and local government agencies represent the secondary stakeholders, who would want to know how rail infrastructure might increase Thailand's rail freight volume.

In logistics, capital budgeting decisions are frequently combined with capital assets, operating and market risks, regulatory interventions, and technological progress. These three criteria are considered, allowing for a more comprehensive decision-making process (World Bank, 2021). Because of a policy that encourages the construction of a broad, free-to-use highway network, freight enterprises are less interested in using railways. Furthermore, a railway policy that promotes passenger services above freight transport will lower the system’s profitability (Secretariat of the Cabinet, 2021). Railway transport in Thailand is a public service provided by the government. From there, the government annually allocates resources and support to many disciplines based on the policies of the state administration. The SRT is obliged to implement the strategy through various master plans consistent with the country's government and other development plans that affect railway services. According to a cabinet decision on December 4, 2017, national strategy and reform plans are divided into three levels. The 1$^{st}$ level is a national strategy, and the 2$^{nd}$ level is the National Economic and Social Development Plan (NESDP), a master plan within the framework of the federal system, national reform plans, and security plans. The 3$^{rd}$ level is a plan that supports the 1$^{st}$ and 2$^{nd}$ levels to achieve their goals (NESDC, 2022).

**Thailand’s 20-Year National Strategy (2018 - 2037)**

The 20-Year National Strategy is a long-term development strategy that lays frameworks and goals for all government sectors. The purpose of "Thailand, a nation of stability, prosperity, and sustainability, is a developed nation according to economic philosophy" and to realize the slogan of "Stability, Prosperity, and Sustainability." There are four frameworks in the strategy, and the following are the two most significant guidelines for railway transportation systems research and development, as well as investments in transportation infrastructure for security and energy. Thailand's promotion as a business base also includes connecting with the region and the world economy and forming development ties with other countries (NESDC, 2021).

**The National Economic and Social Development Plan (NESDP)**

Thailand’s National Economic and Social Development Plan (NESDP) has spanned over 70 years, with 12 editions. The 12$^{th}$ created a 20-year National Strategic Framework Plan (2017-2021) with sustainable development goals and Thailand 4.0 objectives. The development of railway and water transportation systems is a significant step forward, with the railway system being the country’s primary transit and transportation network [3]. Additionally, the Thai government has set the goal of promoting railway as a means of transforming Thailand into a regional logistics hub, with railway infrastructure development recognized as a trade gateway in the 13$^{th}$ edition of the Economic and Social Development Plan (2023–2027). It is the first edition to set the direction for establishing a framework plan under Thailand’s 20-Year National Strategy (2018–2037), and it will serve as a baseline for defining the master plan and action plan for the next five years of the 20-year strategy. It has 13 pins, with the fifth pin directly relevant to the operation of the SRT. It states that Thailand is a vital hub for regional trade, investment, and logistical initiatives (Ministry of Transport, 2021).

**The 20-year transportation system development strategy (2018-2037)**

The conceptual framework for developing transportation systems is green and safe transport, efficient transport to reduce the cost of transportation and logistics, and building a network connecting domestic and international transport systems and equal and equitable access to transportation systems. A vision for sustainable transportation that aligns with economic goals is designed to boost the economy and the country's competitiveness. The first strategy is to integrate transportation systems, infrastructure development, and management for efficiencies, such as building a linking railway system between an airport and a port (Ministry of Transport, 2021).

**The National Strategy on Infrastructure, Logistics, and Digital Systems (2018–2037)**

This plan focuses on infrastructure development to boost and support the country's competitiveness in transportation infrastructure and logistics systems capable of providing seamless multimodal mobility. Railway freight is predicted to rise at a 4% annual pace in 2022, up from 1.66% in 2019, far below the 4% target. Railways and waterways should take on the role of highways as the primary forms of transportation, with the government accelerating and pushing for more infrastructure use (NESDC, 2021). Thailand has focused on changing the mode of commodity transportation from a road to a low-cost carrier. As well as building infrastructure and transportation facilities for regional city centers around the country, the country's major transportation network will be the railway system.

The development of Thailand's transportation infrastructure, particularly the double-track railway, is seen together of the country's most vital methods for stimulate and promoting economic process and investment. The move from high-cost road transportation to less-expensive modes of transport. Transport infrastructure development similarly as facilities simple travel and transportation from the regional core cities. To be able to link the network with neighboring countries for commerce and border trade enhancement. Then we can see how the railway infrastructure supply can impact to be fostering the demand of railway freight transport in Thailand accordingly. Within the construction of railway foundation, the most is developing of railway, railway stations, signaling frameworks and the logistics facilities which joins the loading and unloading of commodities with a high development cost. The railway requires an expansive venture of capital. The cost of development, maintenance and overhead costs are very high as compared to other modes of transport. Those who contributed are governments who need to utilize railway transportation to diminish transportation costs, and increment the competitiveness of the nation.

**Thailand's Transport Infrastructure Development Strategy (2015-2022)**

In 2015, the government has established a strategy to Develop infrastructure in transport. Transport of the corresponding country with the concept of the 11th Development Plan, which will be used as a framework for investment develop infrastructure in transportation in the period of 8 years (2015-2022). There are four primary objectives and comprising five plans.

Data from the Railway Network Development Master Plan showed project development to increase railway freight with a double-track railway and a new double-track railway. Thailand's transport infrastructure development strategy for 2015–2022 is to improve the intercity railway network. The other 5 projects are still in progress; the first phase, Chachoengsao-Kaeng Khoi, was operated in 2019, while Chira Road-Khon Kaen was operated in 2020. With the expropriation of land in Khonkaen-Nong Khai, Denchai-Chiang Rai-Chiang Khong, and Ban Phai-Mukdahan-Nakhon Phanom, the EIA process is still ongoing for the other five projects of the medium phase (OTP, 2022), as shown in figure 4 and table 4. In addition, the government has long-term plans to construct 12 additional railway lines, totaling 1,588 kilometers, with a budget of over 300,000 million baht between 2028 and 2037 (State Railway of Thailand (SRT), 2019). In addition, transport and logistics activities such as Inland Container Depot: ICD, Dry Port, Transport Transformation Center, Truck Terminal, and Container Yard: CY were considered in the plan.

**State Railway of Thailand Enterprise Plan (2017 – 2021)**

The Strategy consists of 3 strategies following; first, to increase the capacity of the country's railway transport service, to manage of organizational development and management to be integrated, increasing income and reducing expenses, respectively. To increase the capacity of the country's railway transport service, with not only to build confidence in safety but also to increase the capacity of transport services by the projects as develop networks and stations to connect multiple modes of transport such as dual track, new railway, suburban commuter railway, and high-speed railway. Supporting the railway operation by increasing the number and maintain the quality of locomotives and wheels. In order to achieve of increasing income and reducing expenses, the SRT will gain more revenue from core business as passenger and freight transportation (SRT, 2017). Meanwhile, insight the 5th SRT's plan, (Thalerngpol, 2015), conducted studied on the strategic development in human resource management, the studied indicated the operational officer do not sure on execution of SRT's Plan 2012-2016, which focused on be excellent on railway service by human resource development, and the service quality on convenience, on time and safety.

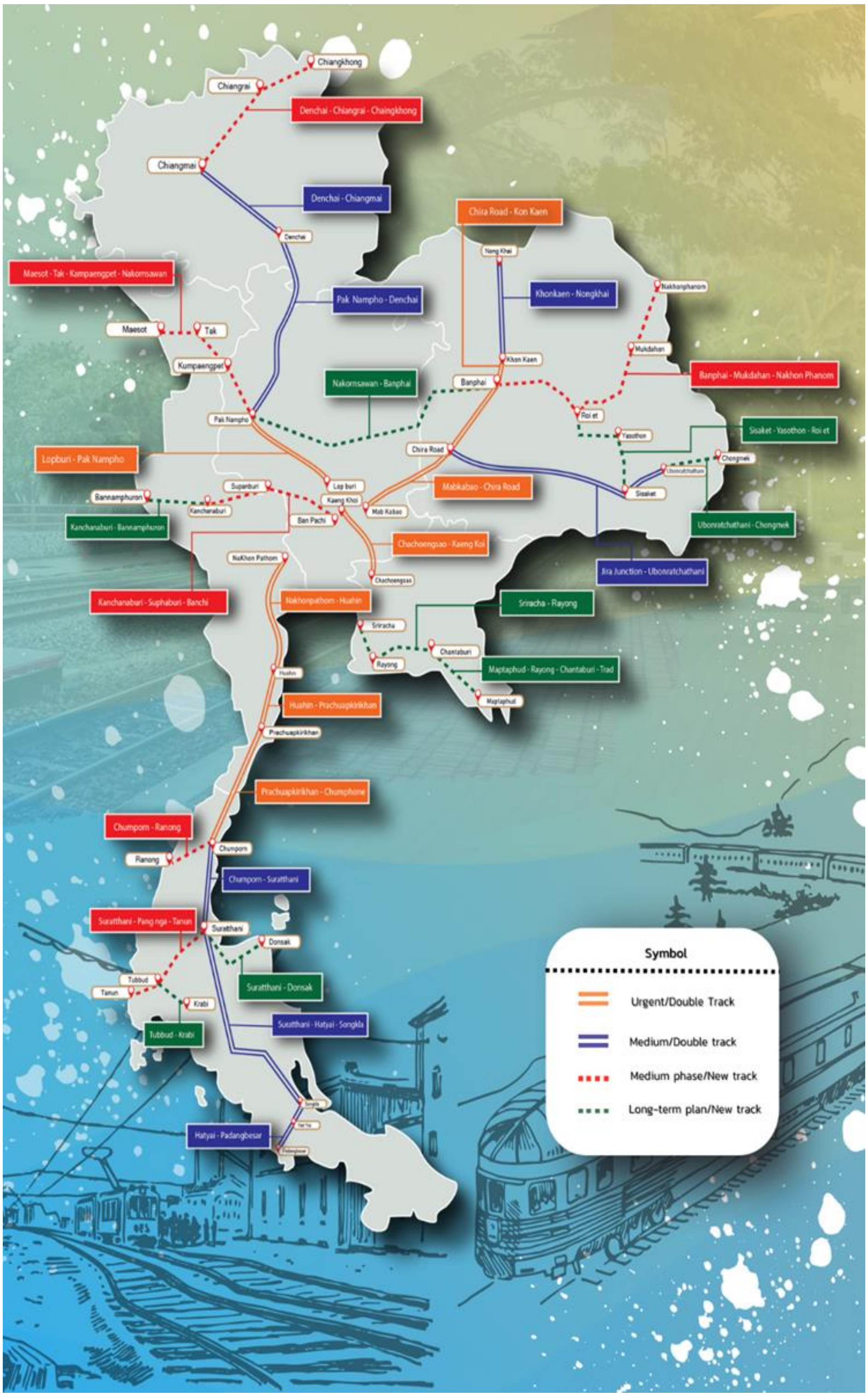



**Figure 11 The Double Track, and New Railway Lines Projects**

**Table 17 Thailand Intercity Railway Projects**

| Phase/Type | Line | Distance (Km.) | Budget (Million Baht) | Started Construction | Expected Completed |
|---|---|---|---|---|---|
| Urgent/Double | Chachoengsao - Kaeng Khoi | 106 | 11,348.35 | 2016 | 2019 |
| Track | Chira Road - Khon Kaen | 187 | 23,430.00 | 2016 | 2020 |
| | Mab Kabao - Chira Road | 132 | 32,347.50 | 2018 | 2026 |
| | Lop Buri - Pak Nampho | 148 | 22,990.13 | 2018 | 2025 |
| | Nakhon Pathom-Huahin | 169 | 20,038.00 | 2018 | 2024 |
| | Huahin-Prachuapkirikhan | 84 | 9,437.00 | 2018 | 2022 |
| | Prachaup kirikhan - Chumphon | 187 | 17,293.00 | 2018 | 2024 |
| | Total | 993 | 127,561.69 | | |
| Medium | Jira Junction-Ubonratchathani | 308 | 37,527.10 | 2024 | 2027 |
| phase/ | Khonkaen-Nong Khai | 167 | 29,748.00 | 2023 | 2027 |
| Double track | Chumphon-Surat Thani | 168 | 24,294.36 | 2023 | 2027 |
| | Hat Yai-Padang Besar | 45 | 6,661.37 | 2023 | 2027 |
| | Suratthani-Hatyai-Song kla | 321 | 57,375.43 | 2023 | 2028 |
| | Denchai-Chiangmai | 189 | 56,837.78 | 2023 | 2027 |
| | Pak Nam Pho-Denchai | 281 | 62,883.55 | 2024 | 2028 |
| | Total | 1,479 | 273,701.60 | | |
| Medium | Denchai - Chiang Rai – Chiang | 323 | 85,343.96 | 2023 | 2026 |
| phase/ | Khong | 355 | 66,846.53 | 2023 | 2026 |
| New track | Ban Phai - Mukdahan - Nakhon | | | | |
| | Phanom | | | | |
| | Maesot -Tak-Kampaengpet- | 250 | 108,498.00 | 2023 | 2026 |
| | Nakonsawan | | | | |
| | Kanchanaburi-Suphanburi-Ban | 221 | 41,771.00 | 2023 | 2026 |
| | Pachi | 116 | 18,748.00 | 2023 | 2026 |
| | Chumporn-Ranong | 197 | 34,649.00 | 2023 | 2026 |
| | Suratthani-Pang nga-Tanun | | | | |
| | Total | 1,462 | 355,856.49 | | |
| Long-term | Nakornsawan-Ban Phai | 291 | 47,712.00 | 2028 | 2032 |
| plan/ | Ubonratchathani-Chongmek | 87 | 9,197.00 | 2028 | 2032 |
| New track | Kanchanaburi-Ban namphuron | 36 | 6,497.00 | 2028 | 2032 |
| | Sriracha-Rayong | 70 | 13,357.00 | 2028 | 2032 |
| | Maptaphud-Rayong-Chantaburi- | 158 | 34,237.00 | 2028 | 2032 |
| | Trad | 76 | 17,147.00 | 2028 | 2032 |
| | Suratthani- Donsak | 68 | 15,223.00 | 2028 | 2032 |
| | Tubbud-Krabi | 162 | 20,435.00 | 2028 | 2032 |
| | Sisaket-Yasothon-Roi et | | | | |
| | Total | 948 | 163,805.00 | | |

**Source:** OTP, 2022

**Summary**

Looking for to change these issues, later government endeavors have solidified different independent developmental plans beneath one umbrella. As other countries modernize their railway infrastructure and operations, continued improved trade will also rely on Thailand improving its physical interconnectivity – both through enhanced traditional railway connections as well as potential highspeed railway connections - to other countries in the region. Government and SRT estimates the railway freight will increment to 20 million tons when the urgent plan double-track extend is completed and prepared for the operation in 2022, and to 30 million tons at the double track extend stage 2 is completed and prepared for a utilize in 2027. Also, Thailand can have efficiency transportation for a maintainability to drive the economy and increment the ability of the nation further.

## 2.7 Railway Freight Transportation Demand

The transport demand is derived demand, example, the railway freight services demand from the result of demand for transport raw material or finish goods to the distribution center or from the production facilities to the consumers. While, freight demand plays a very important role in determining vehicle fleet. As an obtained demand, the demand for freight is essentially impacted by the volume of goods manufactured and consumed. Growth in the national economy, or the economy of any region, results in expansion in overall demand for goods and services, while economic shrinkage result in demand cutting (Division, 2020).

Recently, Thailand carried out the mega railway double track projects, the first phase will be completed and commence on 2022, the 7 lines with 993 km. along the old track. To gain insight into what drivers to push demands of railways service transport on this routing and how these drivers can be influenced. To be answer this question, many scholars identified the drivers of freight transport demand in many perspectives. Here we summarize the driver of railway freight demand follows;

### 2.7.1 Local Economic

From an economic view any demand for which the willingness to pay is lower than the social effective trade existence, one important factor was the transport of goods and services. Railway freight's full economic and carbon benefits can only be realized if it can expand in key industries and reach its full potential. Railway freight – or the use of the railway network to transport goods on behalf of consumers in industry and trade, is a significant part of the overall freight industry. Economy, world trade, location of resources, and freight commodities are drives behind demand of railway freight transport (Lewis, 2012). Railway transport is an intelligent and sustainable driver of GDP (Chen, 2014). “This gives us a great boost and proves how the Railways has continued to be the driving force of the economy… despite the fact that the coronavirus crisis had pushed us into a deficit of 70 mt from April to July.” (Sharman, 2021, The Hindu “Railway freight usage surpasses FY20 level,” para. 3). Railway freight persevered to be considered via governments as key player in presenting integral commodities such as food, coal, and health-related material to communities throughout the lockdowns (I. U. o. Railways, 2020).

The link between economic development and the need for freight transport is depicted in the drawing below. The main final demand in an economy is determined by its level of economic development and income, which in turn determines exports, investment (or capital formation), including gross fixed capital formation and inventory change, and household and government consumption. These factors ultimately determine the relationship between the economy and freight. The upstream sectors generate energy, semi-finished items, raw materials, and other intermediate inputs for downstream production, while the downstream demand is conveyed to them (Figure 12) (Xu et al., 2021).

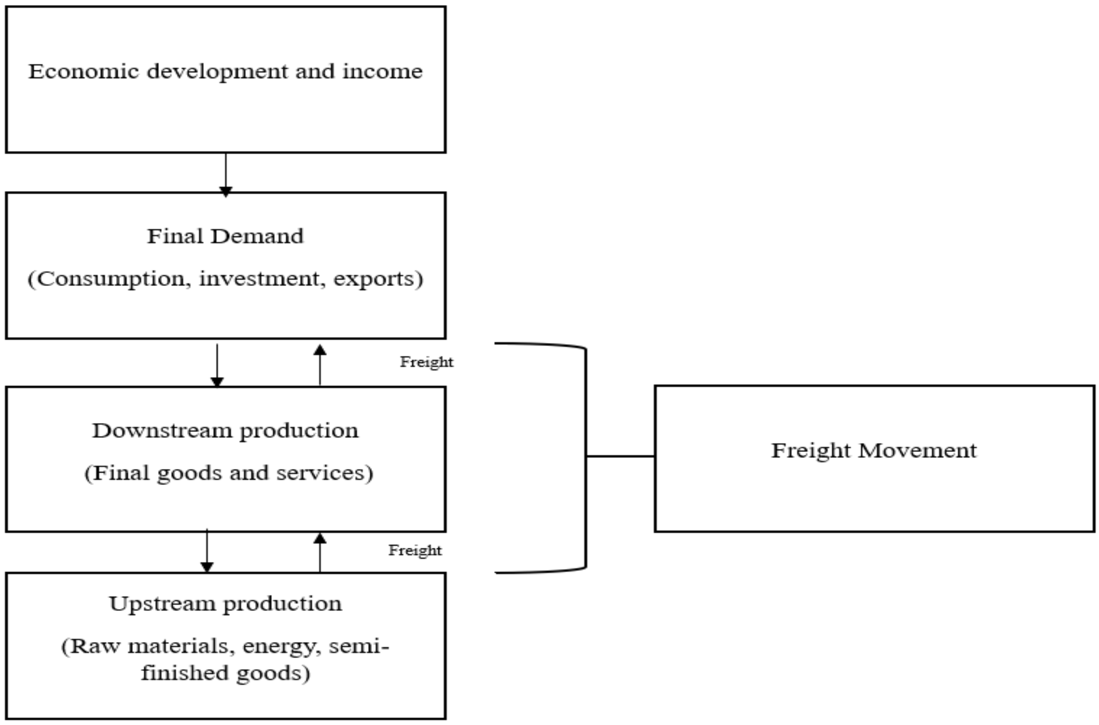



**Figure 12 The relationship between economic development and freight transport demand**

**Source:** Xu et al., 2021

### 2.7.2 Commodity

In economics, a commodity is an economic goods, commodities by railway are in many shapes and characteristics. Commodities, railway freight transport is used to ship cargo, such as consumer goods and bulk cargo. Many consumer products are shipped in containers, liquefied petroleum gas, cement product and agricultural products are also transported by railway. Customers typically use railway freight transport to transfer low-value, high-volume cargo such as coal (for power plants), steel (for shipbuilding), and other raw materials for industrial inputs (Zunder, 2018). Railways are normally the chosen mode for the long-haul transport of basic bulk commodities, railways are also effective as a mean of mass transport for industrial products and components, and some special materials in surface freight. Railway transportation is good for heavy, big and low value commodities, with long distance transportation, it dominated by bulk cargo, agricultural, and industrial raw materials in particular.

Coal remained the most popular product in the North American market in 2022, with about 3.8 million carloads being transported by railway. Chemicals were the second-largest product transported by railway across North America (Statista, 2022). Similar to China, where coal accounts for more than 39% of all products moved by railway, this is the most important commodity. The bulk of railway freight traffic in China has been related to bulk commodities transportation, not containerized cargo. (Kenderdine, & Bucsky, 2020).

The most common commodities carried by railway in Thailand are consumer goods which in the container, oil products, petroleum product, cement product, household product for construction (Transport, 2019). Railway transportation has a small market share, which has been declining in recent years, but this could change in the future due to ongoing investment in railway infrastructure improvements. The creation of railway infrastructure could influence sugar product transportation systems to move freight from the road to the railway system. Moreover, the advancement of motorways will diminish the measure of sugar item moved by the railway framework, (Luathep, 2018). The market's most serious problem is dwindling demand for bulk commodities. Loading of coal to steel plants and thermal power plants has declined essentially as development and energy businesses breakdown under the heaviness of falling energy utilization and halted economic activity. Railway transport has comparative advantages in carrying heavy bulk traffic on specific itineraries over long distances. To induces the demand of railway freight service in Thailand includes low or fare cost bulky cargos freight over long distance to keep cost reduction and maintain physical interconnectivity logistics to port, ICD production center and consumers (A. D. Bank, 2013).

### 2.7.3 Mode Choice

Mode choice is available transport modes for consumers’ preference to decision and choose moves the commodities. It is based on consumer choice behavior and consumers’ satisfaction to availabilities transport modes and their perception. The difference behavior and perception make difference satisfaction, hence difference level of satisfaction to choose differences transport modes. The effective transport mode is not only low transportation cost but related cost involved must be considered, the knowledge on freight transport will lead the consumer choose to use the appropriate and cost-effective transportation modes. Differ stakeholder choose differ mode choice criteria. Some depend on the product's characteristics. Cost appears to be the most important element for petroleum products, whereas it appears to be less important for agricultural and livestock products. Petroleum products, ores, and construction materials, however, transit time is less critical (Zeybek, 2019).

The review of relevant studies found that many factors affect freight mode choice. The consideration of previous studies, in Thailand, (Navavongsathian A., 2016), analyze the transport mode choice factors and factors elasticity of auto-parts, usages multinomial logit model choosing intermodal modes among truck, truck-ship, and truck-air. The commodity product characteristics is sometimes influenced to the decision maker to making choice, the quality of agricultural products is sensitive with travel time and temperature, in the studies by (Insomtua, 2020), point out the mode choice factors are transportation cost, travel time and damage of products during transportation.

### 2.7.4 Demographics

Population growth key factor will impact the nation's transportation. Railways were mainly used to stimulate the economies of cities that were served early on, were clustered at intersections, and had populations of more than 10,000 people. In Europe, (Bogart, 2017), mentioned that without railways, population growth would have been considerably lower in parishes near stations and in those likely to gain new occupations in England and Wales. A long-standing body of research aims to understand the interactions between the spread of railways and settlement trends, population change, and urban growth (Baron, 2015). Railways foster spatial concentration, resulting in major changes in the city network's structure and hierarchy (Mojica, 2011).

Transportation is both push and a pull for migrants. If the distance is close to its maximum, further distances will decrease. Railway, on the other hand, is more likely to have given stable or limited-development rural areas a second chance and opened up new cultural and economic horizons for them. As a result, areas that couldn't be reached by train were progressively oppressed, causing regional inequalities to widen. In additional, (Baron, 2015), mentioned that railway and migration, railways as a contributor to rural desertification, railways account for around 40% of migration, and statistical regression reveals a broad range of interactions between demographic change, railway connectivity, and the rural environment.

### 2.7.5 Pricing

The rule of demand says that at higher price, buyer will demand less of an economic commodity, cargos and raw material. In the transportation, competition and trade off needs to be made, if the freight rates are lower, the demand of mode would be higher. The capability to serve to service as soon as consumer requires, as to meet transport demand in transportation charge. In railways freight transportation, the pricing policy, determines by the prime cost, transportation enterprise, customer, market and competition (Jarocka, 2016). The attractive prices policies are often adjusted by the company's pricing strategy, based not only costs, demand, competition but also government policy in terms of setting prices.

Not only must railway freight be reduced, but all associated costs must be reduced as well. To induces the demand of railway freight service in Thailand includes low or fare cost bulky cargos freight over long distance to keep cost reduction and maintain physical interconnectivity logistics to port, ICD production center and consumers (A. D. Bank, 2013). The railway transportation is competitive by prices, the railway freight price list was influenced to railway operation performance (Ploenhad, 2015) (Ploenhad, 2015). In order to gain more competitive, SRT can reduce railway freight, by operation collaborative with ICD's private sector, it is can lower shipper's cost (Bunsin, 2016).

### 2.7.6 Fuel Price

For all modes of freight, fuel is a significant and relatively volatile component of cost, as well as a significant portion of most consumers' cost of living. Fuel is key factor for vehicle to operate and to move the raw material, cargos or commodities in all types of transportation. Fuel prices account for more than half of the transportation industry's gross operating costs (Gohari, 2018). Then, the cost of fuel consumption in Thailand impact to transportation cost and logistics costs, with the evidence present, in 2019, Thailand has a logistics cost of 13.4% of GDP with 6.7% of transportation costs, with the global average at 10.7,while North America, Europe and Asian pacific with minimum logistics cost to GDP at 8.4,8.5, and 12.7, respectively.

As other transportation mode, the railway freight charges refer to the STR's price tariff, and it is combines with a freight charge and fuel surcharge. The carrier normally splits the charge due to the fluctuation of fuel price lead the cost of railway operation and efficiency. By the way, the average fuel consumption for locomotive engine about 4-5 litres per kilometres, and consumption the fuel about 91 million litres per annual or 2,621 million baht annually (Thailand, 2010) (SRT, 2010). Railways consume up to 3.7 times less energy per tonne miles travel than trucks (Corporation., 2021), moreover the significance of fuel and the advantage of energy saving, fuel efficiency of railway transportation is the factor that consumers would make the decision to choose, accountability for 9 percentages of world motor passenger and 7 percentages of freight move, but the consumption of energy only 3 percentages (Tattini, 2020). The government can seldom promote the transition from energy-inefficient modes of freight transportation to energy-efficient modes of freight transportation simply by raising fuel prices. More time and lines for railway freight traffic, as well as lower railway freight taxes, could increase railway freight volume and, as a result, reduce overall energy use, the case in China, (Zou, 2019).

**2.8 Fostering Factors to railway freight traffic**

In its market world, the enterprise is not alone, it is encircled by and functions within a broader context. Strategic management provides senior management with a wider perspective of the organization's future. This can enable the business lower its risk in the future. examination of the environment It's a crucial step in strategic planning. This assures that the plan is correct and appropriate for the modern environment. To effectively establish the direction and strategy of a business, it is very vital to comprehend the relationships and patterns of the environment. The Macro Environment is the name given to this setting. Many forms of strategic analysis tools can infer elements from the study of information elements affecting the operations of the company from various perspectives, including: Porter's Five Forces Model, Diamond model, SWOT Analysis, and PESTEL analysis.

Porter’s Five Forces Model, it is commonly used to assess the attractiveness of various industries for business. Companies which operate in the business or are considering entering it must assess a number of variables that, in Porter's opinion, characterize the industry's attractiveness (Cherkashin, 2018). New competitors, customers, replacement products, raw material suppliers, and industry competition are all part of the Five Forces Model, which assesses the environment and five competitive forces of a corporation. This tool can be used by businesses to examine their business structure and industry to decide the best countermeasures. The threat of new entrants is defined by the industry's capital intensity, entry restrictions, licenses, and other government laws that may prohibit new players from entering. For example, train operating businesses must get permission to run a franchise in the railway business (Road, 2016). To sum up, the Porter’s Five Forces Model is a technique that may be used to aid tactical perception of where a corporate organization's competitive is located.

Diamond model or Porter’s diamond version consists of following 4 interacting determinants of aggressive advantages. 1) Factor conditions: it refers back to the elements of production, which could have an impact on the industry’s comparative gain withinside the worldwide market. 2) Demand situations: describe the form of local demand for services or products of an industry. 3) Related and supported logistics industries: Regarded as complementary services or products providers. 4) Firm strategy, shape and rivalry: Determine the situations of a cluster, how agencies are prepared and led, as they cooperate and how the regional competition look like (Tsai, 2021).

SWOT Analysis is usually to confirm the business strategy in an exceedingly company or cluster and consists of 4 elements; strengths, weaknesses, opportunities, and threats—and could be a structured analysis tool to evaluate those four parts of a project or business structure (Ahi, 2018). The examination of the weak usage of railway freight in Belgium and Europe, both as a sustainable mode of land transportation in itself, in addition as part of the intermodal chain. These scenarios can be developed based on a SWOT evaluation indicating the contemporary strengths and weaknesses and the future traits and boundaries for railway freight transport (Troch et al., 2015). SWOT Analysis is a tried-and-true management paradigm that allows a company like BNSF Railway to evaluate its business and performance to that of competitors and the industry (Team, 2020).

The PESTEL analysis' goal is to get you to look around and see what's going on in the larger economic and commercial environment. A PESTEL study allows you to consider all relevant elements that could influence your company's success or failure. Analysis of data from macro factors for the purposes of company operations and reorganization, as well as for rivalry. The factors that influence the macro climate, the useful and worldwide analysis tool called PESTEL, the acronym PESTEL stands for the following factors; political, economic, social and cultural, technological, environment and legal, it is used in business reengineering or create competition, and to gain more competitive advantage. This structure permits us to more readily survey most significant outer components that are impacting organizations in the railway business. The network railway in UK, successful managers require a broad view and understanding of the external world in order to make decisions. In the case of Network Railway, there are numerous external factors that have an impact on the company. As a result, the company uses the setting of a PESTEL analysis to demonstrate the need of considering all external environmental factors (UKEssays, 2018). Summary, PEST Analysis is a tool used by strategic planners to examine the future outlook of a firm, marketing trends, and variables that will influence important changes in the business sector.

In Thailand context, the study of “Guidelines for developing Thailand's State Railway”, examine the SRT's current state and administrative issues, as well as future growth opportunities. The researcher implies the external influences to analysis include policy and politics, the economy, society and cultural, technology and innovation, as well as the environment and laws, are all things to consider (Bura, 2016). Although, (Peetawan, 2018), stated that, in transportation project planning, investment, and assessment, the five dimensions were found to be used: administration, economics, logistics platform, social, and technological. Soonest, (Kelly, 2020), focused on the massive construction of impact of the railway on the geographic, economic and political future of the US., railway even helped shape the physical growth of cities and towns and made suburban living feasible.

The distinction between the five strategies is that the 5 forces model looks at corporate competition, whilst the diamond model focus on corporate competition in industry clusters at the national level. SWOT analysis considers both internal and external elements, whereas PESTEL analysis only considers external aspects.

**2.9 Structural Equation Modeling (SEM)**

During the last 20 years, structural equation modeling (SEM) has emerged as a robust variable information analysis tool in science analysis settings, particularly within the fields of social science, psychology, and education. SEM are sophisticated data processing techniques. They allow analyses in the social sciences that would not be possible using other methods. SEM is a statistical analytic system that enables researchers to define and evaluate models with observed and latent (or unobservable) variables, as well as their typically linear relationships (Westland, 2019). This model is a series of equations for the analyzed system with corresponding assumptions, in which the parameters are calculated using statistical data. Theory can be defined as a set of relationships that provide consistent and comprehensive explanations of observed phenomena. SEM is combination of two models; measurement model; confirmatory factor analysis (CFA) and structural model; path analysis.

Measurement model: the measurement model represents the theory that specifies how measured variables come together represent the theory, and a measurement part, linking the constructs to observed measurements. Confirmatory factor analysis (CFA) is a multivariate statistical technique for determining whether calculated variables accurately reflect the number of constructs. Confirmatory factor analysis (CFA) is a method for confirming or disproving a measurement theory (Solutions, 2021). The initial step in running most types of SEM models is to do confirmatory factor analysis (CFA). In a priority specified, theory-derived model, the study tool of causal links among latent and observable variables. A latent construct (sometimes called a factor or scale) is a variable that cannot be assessed directly. It's calculated using a set of observable variables (indicators) that are weighted according to their variance/covariance structure. CFA, by given ability to bridging the observed gap between theory and observation. CFA, offers a measurement model based on

SEM, it is executed on the means and variance-co variance matrix instead of the correlation matrix. To identify the observation variables, which one is the most important and given priority of variables.

Structural Model: represents the theory that show how constructs are related to other constructs; usually, this part expresses the endogenous or dependent constructs as linear functions of the exogenous or independent constructs. It is type of various relapse factual examination that is utilized to assessed causal model (relationship) by concentrate on the connections between a needy variable and at least two autonomous factors. A statistical technique for analysis and testing relationships between a series of observed variables is path analysis. Path analysis allows for the simultaneous investigation of several direct and indirect relationships between variables. It is now considered a form of SEM, a more general statistical technique (Valenzuela, 2017). Path analysis is a form of multiple regression statistical analysis that is used to evaluated causal model (relationship) by examining the relationships between a dependent variable and two or more independent variables. The advantages of path analysis are; to better understand the causal relationship between difference variables and to study causal relationship structural with the study size and the effect direction, for total effect, direct effect and indirect effect. Showing causal mechanisms through which independent variables produce both direct and indirect effects on a dependence variable.

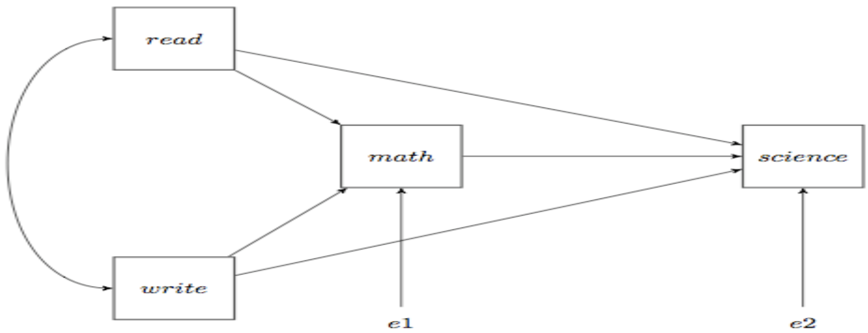



**Figure 13 The sample of structural model**

**Source:** UCLA, 2006

When conducting a path analysis, given construct path analysis illustrate the hypothesized relationship, to use arrows shows how different variables related to each other. After the statistical analysis has been completed, by construct an output path diagram, with illustrates the relationships as they actually exist. If the hypothesis is correct, the input path diagram and output path diagram will show the same relationships between variables.

SEM is put to the test by proposing causal interactions, with the following assumptions: multivariate normal distribution, a linear relationship is assumed between endogenous and exogenous variables, data should be free of outliers, there should be a cause-and-effect relationship between endogenous and exogenous variables and a cause has to occur before the event, non-spurious relationship, and observed covariance must be true. With the model identification: equations must be greater than the estimated parameter or models should be over identified or exact identified, under identified models are not considered. Furthermore, the sample size is 10 to 20 times the number of cases as variables (Kline, 2015), the error terms are considered to be uncorrelated with other variables, and interval data is used.

There are five logical steps in SEM: model specification, model identification, model estimation, model testing, and model modification (Suksawang, 2014).

1. Model specification defines the hypothesized relationships among the variables in an SEM based on one's knowledge. Model formation, to investigate theories-related hypotheses as well as applicable literature reviews. Defining the conceptual framework (Path Analysis) for the hypotheses. The corresponding hypotheses, which explain the potential effects and interrelationships between the latent factors, must then be precisely described. Defining individual constructs, as well as the constructs as a whole. Theoretically, CFA is used to perform a confirmatory test of the measurement model.

2. Model identification is to check if the model is over-identified, just-identified, or under-identified. Model coefficients can be only estimated in the just-identified or over-identified model.

3. Parameter estimation of the model, create the overall measurement model; path analysis is a collection of relationships between exogenous and endogenous

variables depicted by an arrow that connects the measured variable to the constructs. The measurement model is based on the unit-dimensionality assumption. Based on the assumption that latent structures affect the measured variable and that the error term is uncorrelated within the measured variables. Maximum likelihood (ML), robust maximum likelihood (RML), unweighted least squares (ULS) and weighted least squares (WLS) are some employ to estimate item parameters in a SEM. Even though there are several available options for a SEM solution, maximum likelihood (ML) estimation is one of the most commonly used SEM estimation procedures (Davcik, 2014); (Green, 2016).

4. Model testing, measures of the model fit, examine the underlying model legitimacy; a model is viewed as a solid match if the estimation of the chi-square test is huge and at any rate one gradual fit list (CFI, GFI, TLI, AGFI, and so forth) and one disagreeableness of fit file (RMR, RMSEA, SRMR, detective) meet the foreordained rules.

5. Model modification adjusts the model to improve model fit, From the start, the process of testing model conformity was implemented. The hypothesis model was found to be inconsistent with the empirical data based on the hypothesis and the empirical data. Or a hypothetical model that is empirically consistent with the evidence. However, certain model parameters are not statistically important, which is incompatible with the theoretical principles and research findings. The model needs to be adjusted by the researchers, (Prachanban, 2015).

SEM has three significant benefits over conventional multivariate strategies: (1) express appraisal of estimation mistake; (2) assessment of dormant (unseen) factors by means of noticed factors; and (3) model testing where a construction can be forced and evaluated as to attack of the information.

## 2.10 Related Works and Studies

Related works and studied of “Fostering factor of railway freight in Thailand” are below;

Chalongpop (2012), conducted research on the facilitating the international railway network to promote Thailand as an economic and tourism hub of the region. Railway transport will play a large part in enhancing the Asian connection and bringing about a jump increment in exchange volumes. Railway transport is the main form of transport and roads are utilized to support distribute products to various areas of the ASEAN. From the assessment of the quantity of goods transported by the model, discovered that in the event that the expense of transportation is decreased, the volume of freight will in general be higher in value and volume and more potential. That shows that the advancement of railway transport infrastructure has helped stimulate the growth of the Asian trade.

Lewis (2012), conducted the researched on the Railway Freight Traffic: An Analysis to Better Understand the Industry and the Factors that Influence Traffic. The variables that impact railway activity volume is partitioned into four categories: product request, product production/supply, modular competition, and railway benefit. because it was the railway has ward over one amongst these four categories: operation. Others are portion of an even bigger advertise, and also the railway must offer to that in decide to draw clients.

Wijeweera (2014), studied on An Econometrics Analysis of Freight Railway Demand Growth in Australia, the results demonstrate that the Australian dollar's instability has a significant effect on freight railway demand within Australia. For example, a 1% depreciation of the dollar raises the growth rate of non-bulk freight railway demand by about a quarter of a percent. It is common knowledge that favorable international economic conditions encourage the market for bulk freight. Our findings suggest that such factors have an effect on the non-bulk freight railway market as well. Furthermore, while freight rates and macroeconomic activities show the expected relationship with freight railway demand, the relationships are not strong enough to make clear statistical inferences, according to the report.

Feo-Valero (2016), they conducted the study on Railway freight transport and demand requirements: an analysis of attribute cut-offs through a stated preference experiment. The findings obtained in relation to the transportation cost variable indicate that rises in transportation cost above the cut-off were heavily penalized by decision-makers. When attribute cut-offs are implemented, the non-significance of its coefficient means that, although its level remains below the cut-off, decision-makers do not consider this variable during the modal choice process. The statistics demonstrate the presence of strongly polarized positions for the frequency variable, illustrating the shortcomings of conventional requirements that average extreme positions and result in erroneous subjective value figures. Choosing to ignore the nature of cut-offs and/or segments of the population with polarized valuations can lead to incorrect assumptions about the true capabilities of railway to absorb quota from the road.

Charoenpanyaying (2017), the studied on the government policy and legal factors affecting development of railway freight transportation in Thailand, found that problems of early national economic and social development plans focused strongly on the development of road transport, the outdated regulations, the operational constraints including the lack of measures to promote and encourage the use of railway freight transportation and the poor public image of railway freight services. The new scenario for development plan of the railway freight which not based on policy management but offered continuity with clear direction. Regulatory laws require improvement to modernize railway transportation, the government must amend legislation pertaining to the control of railway administration and empower the SRT to operate and provide services for Thai citizens.

Peetawan (2018), worked to identified the factors affecting the success of railway infrastructure development projects contributing to Thailand's logistics platform. AHP and fuzzy AHP had been deployed and main fulfillment elements had been identified. Researched have focused on double track and new line only. They found that influence of railway development master plan has highest influence on projects success.

Ahi and Yildiz (2018), they worked on a case reflect on consideration on Turkish railway clusters allowing research of competitiveness execution standards counting the development functionality of corporations thru various models. Porters' industries Life Cycle Evolution, Diamond, Five Forces Models and SWOT Analysis are carried out to discover which standards have an effect on at maximum at the cluster companies' competitiveness performances and innovation functionality primarily based totally on operational conditions.

Commission (2019), analysis of the potential of the development of railway container transport market in Poland, The PESTEL analysis was used to identify the external environment elements that affect container business. Global megatrends, macroeconomic trends, technical advances, global and European transport trends, as well as the competitive Polish railway market environment and railway infrastructure development, all influence the development of railway container transport in Poland.

Khan (2020), estimating the demand for railway freight transport in Pakistan: A time series analysis, using the Johansen co-integration and error correction model, the study estimates the demand for railway freight transport in Pakistan. The findings reveal that the freight rate and gross value added are the two most significant factors influencing railway freight demand. Railway freight demand has a positive long-run cross-price elasticity, indicating that railway freight and trucking are substitutes. The findings have significant consequences for railway authorities in terms of how freight rates are used to handle freight operations. It also provides a potential mechanism for switching road freight to railway mode through fuel price taxes.

None of the studies in the literature consider railway freight demand, railway freight transportation system, with PESTEL analysis and apply the SEM at the same time to compare the consistency of these models on a real observed data. Also, none of the researches focus on a railway freight demand in Thailand.

## 2.11 Conceptual Framework

From the purpose of to investigate the railway freight demand boosting in Thailand, researcher has done a review of documents, studies, publications, and analysis and found that, economic factors were discovered to have an effect on railway freight demand. For instance, consider the study of Lewis (2012), conducted researched on railway freight traffic, according to the study, the economy, global trade, resource place, and freight commodities are the driving forces behind railway freight transport demand. The characteristics of commodity products can often influence a decision maker's decision; for example, the quality of agricultural products is affected by travel time and temperature. The studied by (Bunsin, 2016), conduct the research survey for SRT’s efficiency improvement, suggested SRT to reduce railway freight, by operation collaborative with ICD’s private sector, can lower shipper’s cost accordingly. Ploenhad (2015), addressed that the impact of railway freight price list on railway activity performance was discussed in relation to railway efficiency and marketing strategy on pricing.

In addition, the causes of the railway transportation system were discovered. As a result, the amount of freight transported by railway and the components of railway transportation increased. Railway lines have enormous political clout due to their scale and importance, which is an important factor to consider when preparing reform initiatives (ICT., 2017). To boost the capacity of Thailand's transport infrastructure and interregional trade, more railway and water transport facilities, such as transfer points between truck and train (and port), as well as a road network linking the center of freight transshipment and port, should be strengthened (Luathep Jaensirisak, & Saengpradab, 2016).

The external environment factors affecting railway freight demand were identified using the PESTEL analysis, the driving forces of railway freight transportation in Thailand will be examined as economic, socio-cultural, political, technology, environment and legal.  The external environment is tumultuous now and in the future. Under the circumstances, it's critical to highlight the most significant changes that could impact railway freight demand markets.

As a result, a conceptual framework has been developed in this research study as a guideline for conducting research on “Fostering factors to railway freight in Thailand”. Figure 14, a conceptual structure can be written to represent the relationships between the variables. Has the following characteristics.

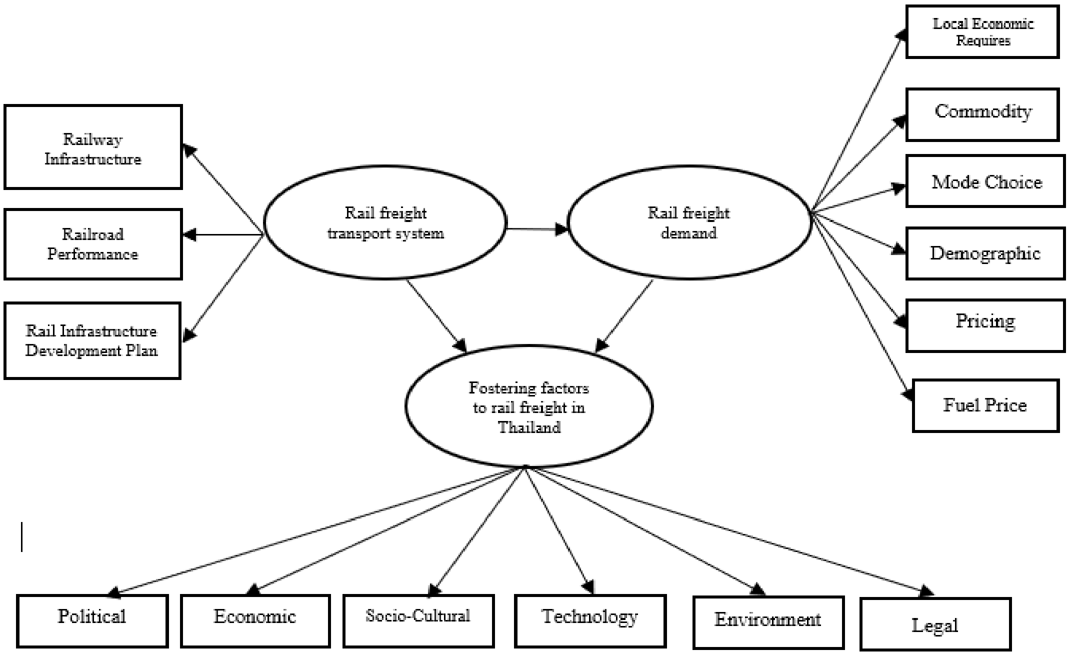



**Figure 14 Conceptual Framework**

# CHAPTER III

# RESEARCH METHODOLOGY

## 3.1 Research Design

The research design employs a combination of qualitative and quantitative methods to address the research issues, research questions, and research objectives, as well as to obtain complete access, assurance, precision, and completeness of data, in line with the objective of this study.

The first objective, to investigate the demand for railway freight boosting in order to shift modes from road to railway in Thailand. A qualitative method with literature approach was used by the researcher.

While the second research objective, the researcher employed the mixed method to gain the completeness data; the first phase employed a quantitative approach and collected information via questionnaires. The open-ended questionnaires were used to collect opinions from the key stakeholder and the secondary stakeholder, while the structured questionnaire with suggestions was used with the primary stakeholder. The second phase examined the results from the first phase and arranged a group discussion with the primary stakeholder to explain and verify the details of the factors fostering railway freight growth in Thailand. The methodology framework of this research is shows in Figure 15.

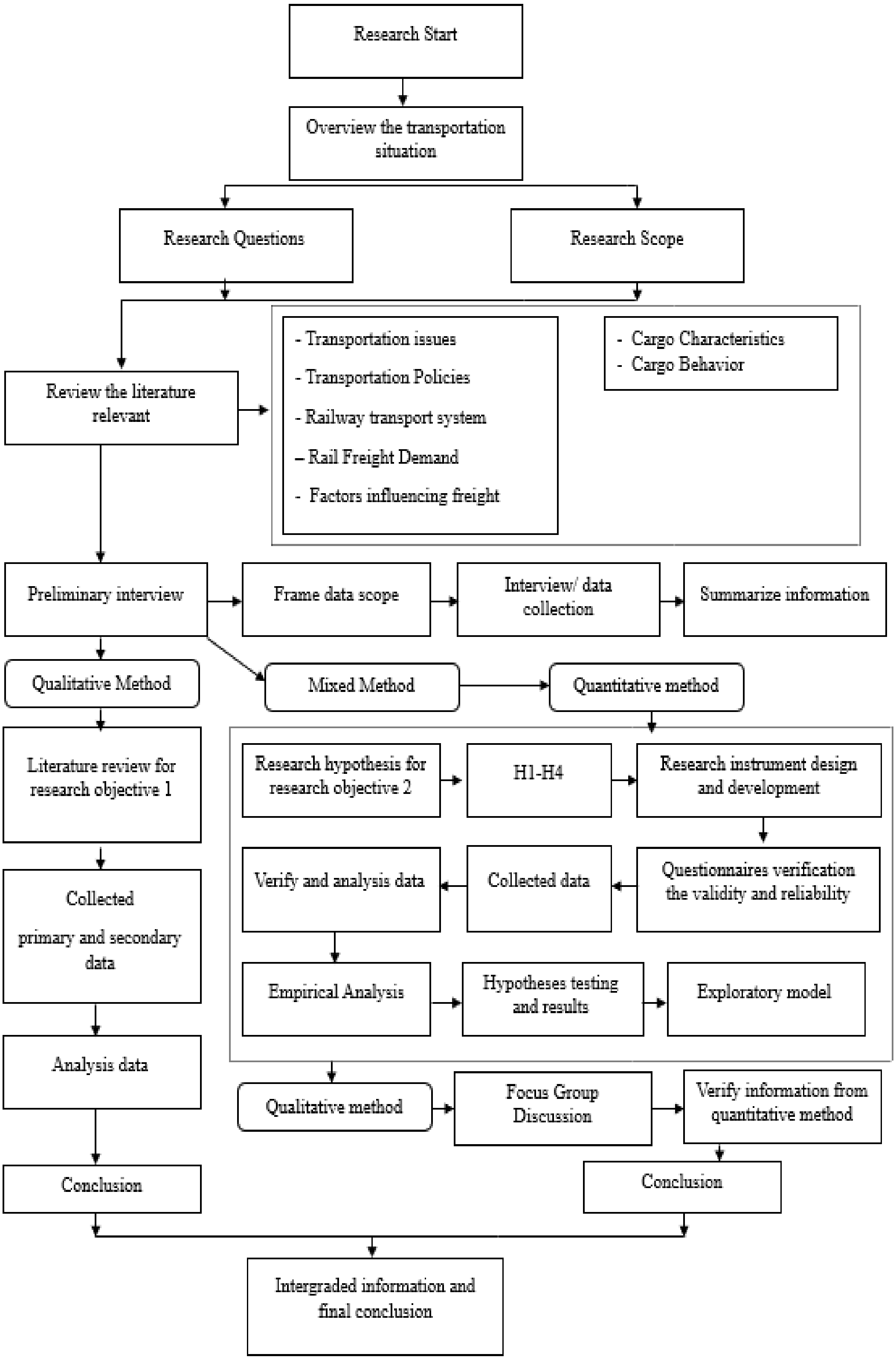



**Figure 15 Research Methodology Framework**

## 3.2 Research instrument and development

### 3.2.1 Qualitative Method

Examine how railway freight commodity cargo demand in Thailand has shifted from road to railway. In order to address the study aim, the research used the literature approach, in-depth interview with SRT's rail Cargo Service Department, Northern Line, Uttaradit Station), and combined information from the focus group discussion results. There were three processes of the future rail freight commodity cargo analysis as data input, data processing, and output (Figure 16). The researcher conducted studied on the source's commodity cargo in Thailand. The various resources for the commodity cargo moves from the NESDC, the Ministry of Transportation, SRT, the Office of Transport and Traffic Policy and Planning. The National Statistics Report, the Office of Industrial Economics, the Office of Agricultural Economics, government office agencies, and associations etc. involved in order to understand potential demand in the future. The researcher combined the information and viewpoints from other empirical studies. A comprehensive examination of the literature can reveal research issues and objectives in a way that is not achievable with a single study. Furthermore, it can offer a summary of the many and multidisciplinary domains within which the research is conducted.

Table 18 shows the topics and goods that were investigated along with the secondary data sources that were examined through and assessed. This literature review provides information on commodities produced, the origin and destination in the nation to the researcher, this means that the data was authenticated and trustworthy, and the organization was certified. Potential export and consumption trends for predicting the volume of freight that will be transported by railway during the next five, ten, and fifteen years. However, NESDB's target data for boosting railway freight transport is the basis for forecasting the volume of commodities that will shift from road to railway transportation.

**Table 18 The relevant sources for railway freight commodity cargo in Thailand**

| Topic | References sources |
|---|---|
| Transportation strategy, volume and sharing | Ministry of Transport (MOT), NESDC |
| Transportation Policy | MOT |
| The product origin and destination | Office of Transport and Traffic Policy and Planning (OTP) |
| The list of manufacturing type | National Statistical Office (NSO) |
| Industrial commodity, statistics, situation, index, trends | The office of industrial economics (OIE), Ministry of Industry (MOI) |
| Agricultural commodity, statistics, situation, index, trend | Office of Agricultural Economics (OAE), Food Intelligence Center (FIC) |
| Rubber | OAE, The federation of Thai industries (FTI), Rubber Division, Department of Agriculture (DOA), Rubber Authority of Thailand (RAOT) |
| Sugar | Office of the Cane and Sugar Board (OCSB), OIE |
| Cement | OIE, Thai Cement Manufacturers Association (TCMA), Department of Primary Industries and Mines (DPIM) |
| Tapioca (Cassava) | OAE,<br>Thai Tapioca Starch Association,<br>The Tapioca Products Factory Association,<br>The Thai Tapioca Trade Association,<br>North Eastern Tapioca Trade Association,<br>Thailand Cassava Centre,<br>ASEAN Cassava Centre |
| Petroleum Products | Energy policy and planning office (EPPO), The Office of Industrial Economics (OIE) |
| Crude oil | EPPO |

| Topic | References sources |
|---|---|
| Fertilizer | Thai Fertilizer and Agricultural Supplies Association, OIE |
| Salt | The Department of International Trade Promotion (DITP), Thai Refined Salt Co., Ltd., Pimai Salt Co., ltd. |
| Plastic pellets | Thai Plastic Industries Association, OIE |
| Food processing | MOI, FIC, OIE<br>National Food Institute (NFI), Eastern Economic Corridor Office (EEC) |
| Drink | OIE, MOI,<br>Thai Beverage Industry Association (TBA), DITP |
| Rice | Bureau of Rice Policy and Strategy (BRPS), FIC, DITP, OAE,<br>Thai Rice Mills Association, Thai Rice Exporters Association, |
| Steel and product | The Association of Thai Steel Industries, TFI, DIT, OIE,<br>Iron and Steel Institute of Thailand |
| Wood product | OIE,<br>Royal Forest Department, Ministry of Natural Resources and Environment,<br>Thai Hevea Wood Association,<br>Rubber Intelligence Unit |
| Motor vehicle and parts | The Thai Automotive Industry Association (TAIA), OIE, DITP |
| Machinery and part | NSO |
| Metal product | NSO, OIE |
| Animal Feed | NSO, OIE |
| Seasonal fruit | OIE |

| Topic | References sources |
|---|---|
| Electronic product | NSO, OIE |
| Consumer product | NSO, OIE |
| Motorcycle and parts | TAIA, OIE |
| Plastic product | OIE |
| Palm oil | OAE, OIE |
| The Royal Agricultural Product | SRT (Cargo Service Department, Northern Line, Uttaradit Station) |

The information gained from the focus group discussions and the interview with the SRT freight service officer (Northern Line) is combined with the findings of the secondary data analysis. The future commodity analysis procedure is shown in Figure 16.

**The Future Rail Freight Commodity Cargo Analysis Processes**

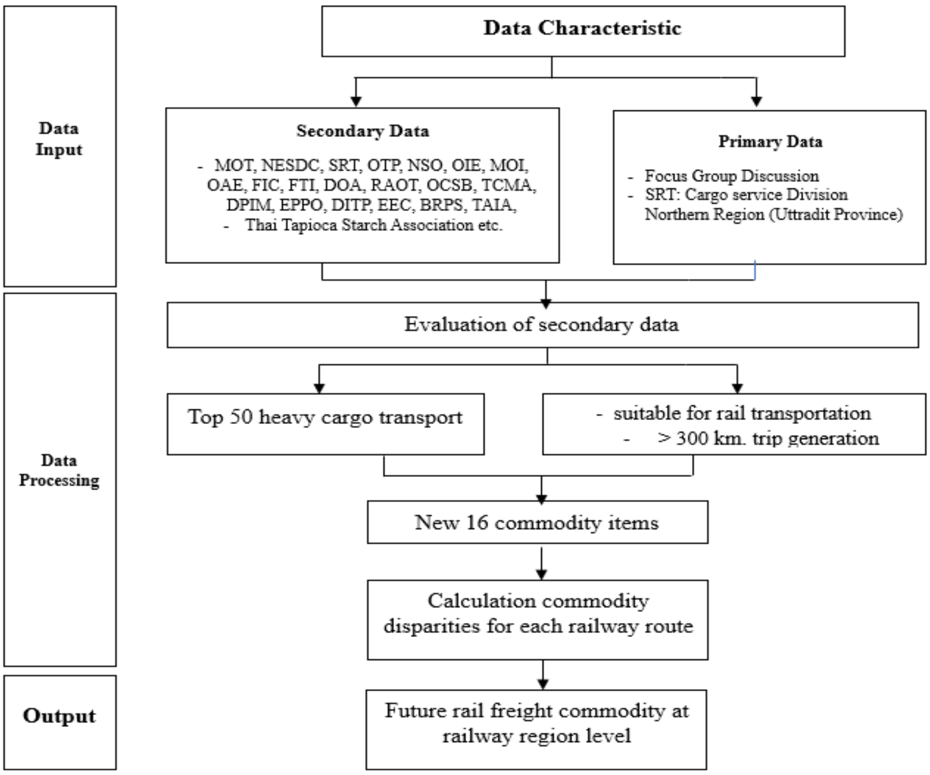



**Figure 16 Future Rail Commodity Analysis Process**

**Freight Demand Forecasting Technique**

Since flexibility and adaptability were paramount considerations, the structure of the technique was purposely generalized. In this study, the researcher was employed the national development strategies, the NESDC target was aimed for the volume for achieves for each target year such as the rail freight reach 7%, 8%, and 10%, in 2027, 2032, and in 2037 respectively. Please be noted that, in this study, we are going to replace the current method of transporting goods by road with rail transportation, based on the previously stated assumptions. Thus, the estimations of commodity output and area may be employed to begin the volume forecasting process. There are two types of demand forecasting, as we previously mentioned in chapter 2: quantitative and qualitative. In this study, we employ a range of forecasting techniques in our forecast process; no technique is perfect; each method has advantages and disadvantages. We combined these techniques to shift the mode from road to rail in order to improve demand outcomes. The forecasting and selection procedures are based on the behavior of the relevant market.

For instance, both the qualitative approach and the in-depth interview with a specialist in bulk railway cargo are appropriate for use with bulk commodities. We combine the trend of commodities from the literature review mentioned in the chapter for agricultural and industrial commodities with data from the national statistical office, various government and private as well as in-house studies, international institutes, trade associations, enterprises, and the trade press as a basis for evaluating volume. We also employ pertinent relationships that are particular to a certain nation, such the population in each area.

**3.2.2 Mixed method**

As mentioned earlier and depicted in Figure 15, this mixed method was employed to answer RQ1, RQ3, and research objective 2; the fostering factor for railway freight growth in Thailand. The researcher started the quantitative phase by focusing on research question and research objectives. With the relevant literature and relevant information, the researcher can summarize the four hypotheses. The study uses the structural equation model (SEM) as the statistical method to examine the research questions and hypotheses. Before getting into details about the method of examining items, the re-introduction of research questions and corresponding hypotheses is very relevant. The research questions for this study are as follows:

RQ1: Can double-track railway urgent projects shift and boost railway freight demand to 10%?

RQ2: Which sources are driving the demand for railway freight transportation in Thailand?

RQ3: What are the fostering factors of railway freight transportation in Thailand?

**Research Hypotheses**

According to the researcher's hypothesis, the impacts of railway service, railway infrastructure, and railway development strategy could enhance customer usage while promoting the shift from road to railway, which will boost the demand for railway freight.

H1: A railway freight transportation system has a direct effect on railway freight demand.

H2: The railway freight transportation system has a direct effect on factors development of railway freight transport in Thailand.

H3: The railway freight demand has a direct effect on the development factors of railway freight transport in Thailand.

H4: The railway freight transportation system has an indirect effect on the development factors of railway freight transport in Thailand via railway freight demand.

**Population and sampling**

Since it is difficult to research the entire population, one must make do with a sample. The population and samples were performed as follows to achieve the aim of the research of the "Fostering Factors to Railway Freight in Thailand", we could define those people who were stakeholder of railway freight in the area of the Thailand railway projects. The sample in this study are the stakeholders, which are key stakeholder, primary stakeholder and secondary stakeholder, the amount was unknown. A preliminary data collection was collected through four expertise in railway freight in Thailand, with face-to-face interviewed and the data for pilot study was collected through the primary stakeholder. The research was carried out between

October 2022 and January 2024. As mentioned earlier in this mixed method approach, the researcher was conducted with the quantitative and information verify with the qualitative.

The sampling in this study is divided to three categories of stakeholder, the key stakeholder, the primary stakeholder, and the secondary stakeholder. While the primary stakeholder, the sample size was important for Structural Equation Model (SEM), as this size there were various opinions and several guiding rules of thumb, as Kline (2005). The recommended sample size between 100 and 200 is the minimum for structural modeling, and the minimum sample size should be 100 to 200 (Anderson and Gerbing (1988); Boomsma (1985): Ding et al. (1995). The sample size should be 5 to 10 times the number of variables (Bentler and Chou (1987); Bollen (1989); Hair et al. (2010); Schumacher (2017). Therefore, the number of distinct parameters to be estimated by the SEM model of this study is 15, yielding a minimum sample size of 75.

**Table 19 Samples size of stakeholder**

| **Population** | **Samples** |
|---|---|
| Key Stakeholder | |
| OTP | 2 |
| SRT Local staff | 13 |
| Sub Total | 15 |
| Primary Stakeholder | |
| Manufacturer | |
| Private sector collective transport operators | |
| Sub Total | 420 |
| Secondary Stakeholder | |
| The Institution in education | 6 |
| The office of commercial affair | 6 |
| The Chamber | 6 |
| The Federation of Thai Industries | 6 |

| Population | Samples |
|---|---|
| Community leader, Local business | 8 |
| National Environmental NGOs | 2 |
| Media | 2 |
| Sub Total | 36 |
| **Grand Total** | **471** |

**Research Instruments and Instrument Development**

To collect data from the samples, the researcher was used the questionnaires to transfer the research particular questions, as a result to collect the data rapidly and efficiency. The questionnaires development begins with the literature review to specific the questions for particular research questions and research objectives. The following questions and references show the rational why the researcher select the question.

RQ1: can double-track railway urgent projects shift and boost railway freight demand from to 10%?

**Table 20 RQ1 and the references sources**

| Topic | References sources |
|---|---|
| Boost railway freight demand for SRT to 10%. | NESDC<br>The 20th year national strategy,<br>The competitiveness of infrastructure,<br>Logistics and transportation infrastructure (7.1)<br>The master plan,<br># To increasing of volume of freight transported by railway as a proportion of total freight transported (average percentage)<br># Railway freight transport volume is the amount of freight transported via the domestic railway network (Unit: million tons). |

| Topic | References sources |
|---|---|
| | # The total amount of freight transported within the nation is the product of the volume of freight transported by road, railway, water, and air (Unit: million tons). |

RQ2: Which sources are driving the demand for railway freight transportation in Thailand?

The references in Table No. 18 above, as well as other pertinent sources, allow researchers analyze the demand for railway freight in Thailand.

RQ3: what are the fostering factors of railway freight transportation in Thailand?

**Table 21 RQ3 and the references sources**

| Research questions | References sources |
|---|---|
| Factors impact to railway freight transportation system | |
| Railway Infrastructure | OECD (2021), Li and Zhang (2020), Wangai et al., (2020), UNESCAP (2017), Woodburn (2017) |
| Railway Freight Performance | CSX (2021), ITF (2019), Goya et al. (2018), Wanke et al. (2018), BCG (2017), Haron et al. (2016), Sutthirak (2016), Ploenhad (2015) |
| Railway Infrastructure Development Plan | Kinsokon and Suwanpot (2019), Peetawan and Suthiwartnarueput (2018), SRT (2017), MOT (2015), OTP (2014), MOT (2014) |
| Factors impact to railway freight demand | |
| Local Economic requires | Wangai et al., (2020),<br>Blanquart and Koning (2017)<br>Lewis (2012) |
| Demographics | Towsend (2022), Berger (2019), |

| Research questions | References sources |
|---|---|
| | Bogart et al. (2017), Baron (2015), Mojica and Marti-Henneberg (2011) |
| Commodity | Zhang et al. (2019), OTP (2019), Zunder and Islam (2018), Luathep et al. (2018), ADB (2013) |
| Mode Choice | Insomta and Kasikitwiwat (2020), Zeybek (2019), Zhang et al. (2019) |
| Pricing | Li and Zhang (2020), Khan and Khan (2020), Jarocka and Ryciuk (2016), ADB (2013) |
| Fuel Price | Tattani and Peter (2020), Zou and Chau (2019), Gohari et al. (2017), CSX (2016), SRT (2010) |
| External Environment Impact to railway freight transportation in Thailand | |
| Political | Kelly (2020), Gangwar (2020), Winkler and Mocanu (2020), Kinsokon and Suwanpot (2019), Bura (2016) |
| Economic | Wangai et al. (2020), Kelly (2020), Peetawan and Suthiwartnarueput (2018), Bura (2016) |
| Socio cultural | Wangai et al. (2020), Peetawan and Suthiwartnarueput (2018), Bura (2016) |
| Technology | Tulupovet al. (2020), Peetawan and Suthiwartnarueput (2018), Bura (2016) |
| Environmental | Preonas (2022), Sun et al. (2022), Bura (2016) |
| Regulation, Rules, and Law | Krzesniak et al. (2022) Grimm and Pittman (2018), Bura (2016) |

**Research Instrument**

1. The literature approach with forecasting techniques for answer research objective 1.

2. Research instrument for mixed method consist of the questionnaires and the semi-structure questions as follows;

2.1 Questionnaires for collect data from the primary stakeholder

There were five parts to the questionnaires (Close ended question), specifically:

1) The general participants data such as company types, location, outbound transportation, inbound transportation, cargos characteristics, transportation modes, and cargos volume per month.

2) The railway freight demand, which included 6 factors based on the literature review as economic, commodities, mode choice, demographic, pricing, and fuel price.

3) The railway freight transportation system which included 3 factors based on literature review as railway infrastructure, railway performance, and Thailand's infrastructure development strategy.

4) The factor fostering factors, which included 6 factors based on literature review as political, economic, socio-cultural, technology, environment, and legal.

Each question is answered on a scale of 1 to 5, with the text in the question being either positive or negative. The following are the scores for both types of questions:

| **Level of influences** | **Positive Scores** | **Negative Scores** |
|---|---|---|
| Strongly nothing important | 1 | 5 |
| Nothing important | 2 | 4 |
| Important | 3 | 3 |
| Very important | 4 | 2 |
| Strongly important | 5 | 1 |

5) This is a free-form survey for additional feedback.

The interpretive criteria used by the researcher to classify the mean into the following ranges have been defined.

| | |
|---|---|
| The average of 4.50-5.00 is set to be in the highest criteria. | or promote / influence the most |
| The average of 3.50-4.49 is set to be in the high criteria. | or promote / influence a lot |
| The average of 2.50-3.49 is set to be in the moderate criteria. | or promote / influence moderate |
| The average of 1.50-2.49 is set to be in the low criteria. | or promote / influence the little |
| The average of 1.00-1.49 is set to be in the lowest criteria. | or promote / influence the least |

**Variables in the research**

In this research, researchers have studied the variables related to "Fostering Factors to Railway Freight in Thailand," including exogenous variables and endogenous variables below.

Exogenous Variables are railway freight transport system and, railway freight demand each variable includes observed variables following;

1. Railway freight transport system with observed variables as railway infrastructure and railway performance, and Thailand infrastructure development strategy, measuring with interval scale.

2. Railway freight demand with observed variables; economic, commodities, mode choice, demographic, pricing, and fuel price, measuring with interval scale.

Endogenous variables are Foster Factors of railway freight transport in Thailand with observed variables as political, economic, socio-cultural, technology, environment, and legal measuring with interval scale.

**Instrument Development**

The measures for improving the efficiency of data collection tools are as follows:

1) Identifying the knowledge to be studied by survey at ideas and principles in documents and texts. And literature review on the demand for railway

freight, as well as factors that encourage and facilitate increased freight traffic, both in Thailand and abroad.

2) Compiled some preliminary data, from an interview with the operation director of the SRT and railway private transportation entrepreneurs.

3) Investigated the questionnaire, interview and observation’s design.

4) Define the questions and their scope with the research goals.

**Inspection of the tool's consistency**

The validity, discriminatory control, and reliability of questionnaire tools are used to determine their quality in this study. The questionnaire's validity, the following is how the researcher performed the questionnaire:

1) Create a questionnaire and send it to the thesis supervisor for review, advice, and suggestions about how to make it more relevant.

2) Take the revised and modified questionnaire to an expert who will assess the instrument's consistency, vocabulary, message suitability, validity, and material accuracy.

3) Present to the dissertation supervisor for the final time to consider changes and modifications, as well as to determine the validity of the questionnaire (Content Validity Ratio : CVR)

**Content validity**

The questionnaires used in this research were check inter-reliability by index of concordance = IOC. To verify a connection between the questions and the research objectives. Also, the consistency between each question and each of the research purposes must be evaluated (Tuntavanitch, 2018). Experts conducted a criterion-based evaluation by scoring +1,0 or -1. When +1 indicates that the question is compatible with the objective, 0 indicates that the question is unclear, and -1 indicates that the question is not associated with the objective, (Srisatidnarakul, 2012), Items with scores greater than or equal to 0.5 were deemed appropriate; those with scores less than 0.5 were deemed unacceptable and had to be updated based on expert recommendations. The questions that choose to use should have a value ranging from 0.50 (IOC$\geq$ .50), Srisatidnarakul (2012).

**Output from questionnaires IOC**

In this study, there are five expertise from diverse education institute to proof the questionnaire IOC. Chulalongkorn University, University of the Thai Chamber of Commerce**,** Prince of Songkla University, Sripatum University and Burapha University. All experts critically gave value feedbacks to some of the questions and the summary of the score evaluation is attached in Appendix F. All items were rated higher than 0.50 on IOC index, indicating they were acceptably congruent with objective set.

**Questionnaire Pilot Test**

This pilot study aims to ensure the applicability and responsiveness of the questionnaire by assessing its validity and reliability. In actuality, a pilot survey is a copy and trial of the primary survey. The primary objective of doing a pilot study is to identify any potential flaws in the measurement device (Srinvasan et al., 2015).

In this study, a questionnaire is the measuring instrument we are utilizing in this investigation. Pilot study in this research was proceeded in May 2022 via online questionnaire survey. The reliability and Cronbach's Alpha value of dimension were ranged from 0.70 to 0.92, indicating they were acceptably congruent with the objectives set. The questionnaire as the defined discrimination value, to analysis the value of Alpha coefficient of Cronbach, (Cronbach, 1990), for reliability value with more than 0.70 is ideal for an item (Nunnally, 1970). Furthermore, the instrument design examined various issues, such as language that was easy to understand and a user-friendly setting.

2.2 Open-ended Questions for collect data from the key stakeholder and secondary stakeholder

Recognize their perspectives on the issues and circumstances surrounding the need for railway transportation in Thailand based on their experiences. With open-ended questionnaires, 15 key stakeholders and 69 secondary stakeholders.

1) The expectations of the urgent double-track railway project (7 lines).

2) The views on the demand increasing after complete the urgent double-track or not?

3) The view on, the government will achieve the railway freight volume/proportion as targeted or not?

4) The fostering factor in order to shift from road to railway modes.

The fostering factor in order to shift from road to railway modes. The three questions were asked in open-ended form as follows:

1) Will railway freight transport increase to 10% after the double-track railway project is completed or not?

2) Where does the railway freight demand to shift from road to railway come from?

3) What are the fostering factors for encouraging and motivating long-term growth in railway freight transportation in Thailand?

2.3 Research instrument for focus group

It is credible and fair to obtain deep interview content. To refer the study's findings to the appropriate agencies. For data collection, as interviewing, the researchers have chosen to use a semi-structured interview method. It will be used for debating and inquiring in focus group. Which is a deliberate interrogation to learn more about related topics, it can be modify to make the responses of key informants more clearly. And capable of directing content to reach research goals.

Create a semi-structured interview questions style based on the conceptual framework of the study, which is divided into three areas: first, factors affecting to railway freight demand in Thailand, secondly, the railway freight transport system in Thailand. Finally, the external environment impact to increase railway freight traffic in Thailand.

While the focus group is a method of gathering research data by discussion in groups of main informants. A single focus group is a conversation between a researcher or a group moderator and group participants in this study. Where the discussion participants are informed and experienced on the topic of "Fostering factors of railway freight in Thailand", with the process of organizing focus group follows; identifying the problems or factors that will be investigated, the researcher choose to conduct focus group with 8 persons of the primary stakeholder: manufacturing and logistics service provider Then, the focus group agenda will be moderated by the researcher and there are also assistants who write down notes during conversations, to capture data, and use of two voice recorders. The main questions in 3 main areas; first, the demand factors affecting to railway freight demand in Thailand, second, the railway freight transport system in Thailand. Last, the external environment impact to increase railway freight traffic in Thailand. The key informants for focus group of 8 person as follows:

**Table 22 The key informants: focus group**

| Stakeholder | Expertise | Participants | Qualification |
|---|---|---|---|
| Primary | manufacturing and logistics service provider | 8 | Is the most qualified person in terms of experience, expertise, and comprehension, and is able to provide in-depth information on the subject. |

**Data Collection**

In order to meet the objectives, the data collected and used both primary and secondary data. Secondary data, which is studied from the government agencies report, thesis, books, and publications related to the factors that support railway freight transportation at the local, national and international levels. Both domestically and internationally including the study of relevant theories as a reference and data base to support the concepts in this study. It is required by both the researcher and the reader in order for the researcher to design the research in a positive manner and for the reader to comprehend the research result more thoroughly.

The primary data was collected in three ways. Firstly, questionnaires survey was conducted with primary stakeholder, by mailed to 420 participants filled out and sent back to the researcher. Secondly, the key stakeholder and secondary stakeholder with open ended questionnaire form. Lastly, after receiving the study results from the key, primary and secondary stakeholder, the researcher was held a focus group to obtain additional insights. The focus group was conduct with some of primary stakeholder; with the manufacturing and logistics service provider organizations with 8-person (Escalada, 2014).

### 3.3 Data Analysis and Statistical

3.3.1 Data analysis for the qualitative method, the purpose of this study is to examine the demand for railway freight boosting in Thailand in order to mode shift from road to railway transportation. The research findings will be compiled and developed into theoretical conclusions, and data on the extent of this shift in freight transport from road to railway will be presented. The primary data will be collected from literature and focus group, the most important part of data analysis and management is to be true to the participants.

Qualitative data from focus group, that a semi-structured guide or module of questions elicits verbal responses from subjects, one to two hours on average, from recordings then transcribed, with no names or identifying information. Transcribed text is also cleaned, quality reviewed against the original audio. Finalized content is stored in word processing files on password protected computers. Files can be securely uploaded into a variety of qualitative analysis programs. The process will be conduct with data preparation and basic data analysis and analysis methods and statistics.

Data Preparation and Basic Data Analysis

1) Getting familiar with the data and start looking for basic observations or patterns. This also includes transcribing the data.

2) Revisiting research objectives and identifies the questions that can be answered through the collected data.

3) Developing a framework as coding or indexing, by identifies broad ideas, concepts, behaviors, or phrases and assigns codes to data. Coding is helpful in structuring and labeling the data.

4) Identifying patterns and connections that can answer research questions, and finding areas that can be explored further.

**Analysis Methods and Statistic**

The content analysis method will be used for qualitative method, to analyze the field data from literature approach and focus group. With the following guidelines for synthetic analysis:

1) Sort the information into groups. Check the data accuracy and completeness.

2) Gather information and rate it according to the research topics.

3) Synthesize data.

4) Summarize and discuss the findings of the analysis, as well as make recommendations.

3.3.2 For the purpose of conducting research on the research objective "Fostering factors in railway freight in Thailand", the following quantitative method was analyzed as follows:

**Descriptive Statistics Analysis**

1) The participants general data, will analysis with percentage.

2) Rail freight Demand, Rail freight transportation system and fostering factors in rail freight in Thailand, will analysis with mean, and standard deviation.

3) The relative level of correlation values of the demand for rail freight and rail freight systems by Pearson Correlation Coefficient.

The sample mean formula is:

$$\bar{x} = (\Sigma x_i) / n$$

Where

$\bar{x}$ = the "sample mean"

$\sum$ = summation notation

$x_i$ = all of the x-values

n = the number of items in the sample

The standard deviation formula (Srisaard, 2002, p. 106-108)

$$S.D. = \sqrt{\frac{n\sum X^2 - (X)^2}{n(n-1)}}$$

Where

S.D. = Standard deviation

x = the x-values

n = the number of items in the sample

Σx = total values

Examining the characteristics of measurable variables It is composed of the average ($\bar{x}$), Standard deviation (SD), skewness, and kurtosis, with the results interpreted according to the Likert 5-point scale, reflecting the extent of performance from low to high.

This scale has five ranges:

| | |
|---|---|
| 1-1.80 | for strongly disagree |
| 1.81-2.60 | for disagree |
| 2.61-3.40 | for neutral |
| 3.41-4.20 | for agree |
| 4.21-5.00 | for strongly agree |

The relative level of correlation values of the demand for railway freight and railway freight systems by Pearson Correlation Coefficient. To analyze information on the demand for railway freight and railway freight systems, that they are related or not by the relative level of correlation values (Wetchasarn, 2002) are detailed below.

| | |
|---|---|
| 0.81-1.00 | Very Strong |
| 0.61-0.80 | Strong |
| 0.41-0.60 | Moderate |
| 0.21-0.40 | Weak |
| 0.00-0.20 | Very weak |

**Inferential Statistics Analysis**

1) Analysis of structural equations by using AMOS program with a structural equation model based on conceptual framework. Where, RFrghtDnd, RFrghtTpt and Fstfctr are stands for the latent variables, and res1 and res2 stands for error estimation for latent. While, X1 through X9 and Y1 through Y6 stand for the items in the test, and e1 through e15 stand for measurement errors (unreliability) in each item. The factor is assumed to cause the observed correlation among the items. as seen in the example, and can be written as a symbol as well.

An examination of how effectively the causal connection model reflects the elements that are contributing to the development of railway freight transport in Thailand. use the packaged computer software AMOS, which includes statistical metrics such as chi-square, comparative fit index (CFI), goodness of fit index (GFI), and adjusted goodness of fit index (AGFI), and root mean square error of approximation (RMSEA).

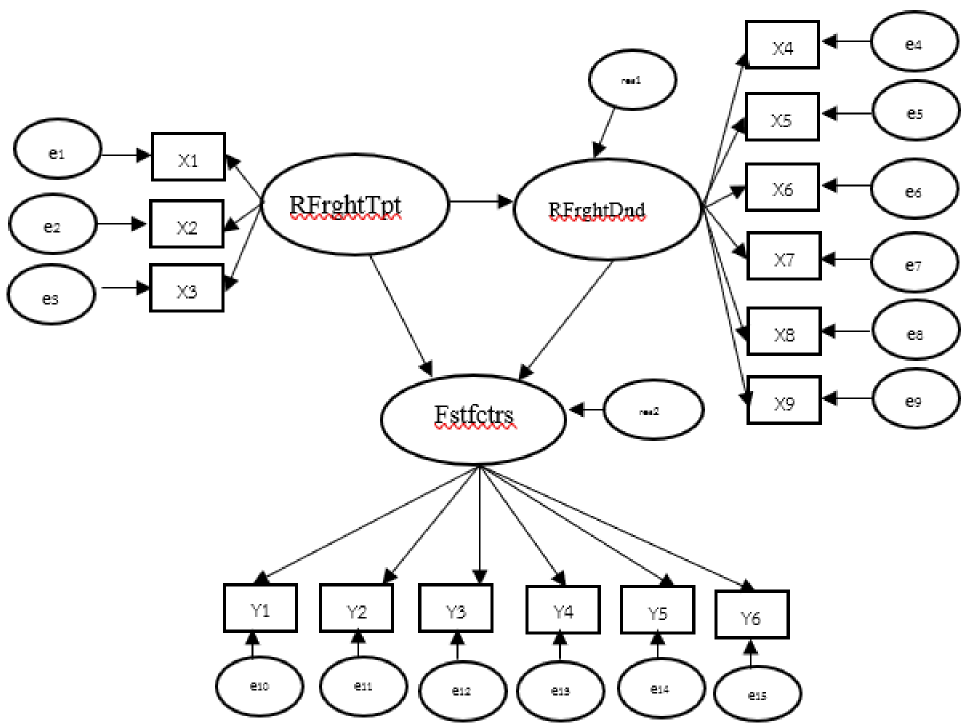



**Figure 17 SEM by research hypothesis**

2) Confirming Model Consistency (Measurement model)

The model consistency check was to confirm that the model the analysts made was is it reliable with the solicitation that has been gathered or not? If consistent, it is called model fit (Kraiwan, 2013). To predict the test's factor structure and comparing it to the factor structure—which is experimentally derived from the item scores—is a crucial test of the test's construct validity, content validity, and theory supporting the prediction. For the past 20 years, the most widely used method for doing such types of tests has been confirmatory factor analysis (CFA). Primary factor loadings and modification indices provide some item-level feedback, whereas CFA in $\chi 2$ and "goodness of fit" (GOF) indices reflect the degree of difference between the actual and predicted component structures (Prudon, 2014). To verify a model fit, the program uses a variance and covariance matrix from model-based estimation or $\sum (\boldsymbol{\theta})$, subtract from the variance and co-variance metrics of the sample or data collected (sample covariance matrix: $\sum$) or $\sum$-$\sum (\boldsymbol{\theta})$, The resulting value is surplus or residual metrics, or residual covariance matrix. The test statistic is $x^2$-test. The following hypotheses were tested:

$$H_0: \sum (\boldsymbol{\theta})$$
$$H_1: \sum \neq \sum (\boldsymbol{\theta})$$

If $\sum$ and $\sum (\boldsymbol{\theta})$, they vary or $x^2$ are significance, the researcher's conceptual framework model based on empirical evidence is inconclusive. To make the $x^2$ not statistically important, the researcher had to change the model. When the researcher modifies the model and analyzes the new model until it is consistent with the empirical evidence, the criteria are then taken into consideration. In order to write a paper, follow the model. There are other indices that can be used as a statistical indicator of consistency.

**Table 23 Symbols and statistics**

| Symbol | Statistic | Objective | Criteria | Consideration |
|---|---|---|---|---|
| CMIN-p | Chi-square probability level | To check the value should be of chi square, must be insignificant statistical | ρ >.05 | - ρ value must be more than 0.05<br>- Value of ρ, the more the better |
| CMIN/df | Relative chi-square | To check the factors consistency with empirical data | <3 | - CMIN/df must be less than <3<br>-CMIN/df value approaches 0, the better |
| GFI | Goodness of fit index | To measure the fit comparative level with the value between 0-1.00 | >0.90 | -GFI must be more than >0.90<br>-GFI value approaches 1, the better |
| RMSEA | Root mean square error of approximation | To determine the worth of something the subject's error, in the form of the root discrepancy's squared mean approximate value in the context of 0-1.00 | <0.08 | -RMSEA must be less than <0.08<br>-RMSEA value approaches 0, the better |
| CFI | Comparative Fit Index | To check model’s consistency with empirical data | 0 CFI 1 | -CFI value approaches 1, the better fit |

3) SEM Adaptation

In the case of the structural equation model test, it was discovered that the theory's accuracy did not match the empirical evidence. The researcher may consider adjusting the parameters in conceptual framework research. In order to enhance the statistical acceptability of structural equations, the researchers' method for modifying the model structure of that equation is as follows (Raengssungnaen, 2011).

1) Reducing the number of variables in the model. Based on recommendations from the AMOS program, according to the error of the dependent variable (Modification Indices: MI)

2) Combining variables and creating new latent factors

3) Connecting two arrows between the tolerance of the dependent variable that the program recommends to align the model with the empirical data, which considered the model modification indices.

4) Calculation of direct and indirect influences

The researchers determined the degree of influence of direct and indirect influences as follows.

**Table 24 Direct and indirect influences value**

| **Direct and indirect influences value** | **Degree of influence** |
|---|---|
| influences value ≤0.30 | Very Low |
| 0.30 < influences value ≤ 0.50 | Low |
| 0.50 < influences value ≤0.70 | Moderate |
| 0.70 < influences value ≤ 0.90 | High |
| 0.90 < influences value | Very High |

# CHAPTER IV

# RESULTS

In this chapter, the results of the data analyses are employed to investigate the two research objectives used for the current study. In order to comprehend, well understand circumstance and learn more about this study. To gain complete access, assurance, accuracy and completeness of data, according to the purpose of this study, this research was designed with combination of quantitative method and qualitative method with cross-sectional study.

Regarding the first research objective, *to investigate the demand of railway freight boosting in order to shift mode from road to railway in Thailand*, the researchers employed the literature review and analysis approach to answer this research objective.

While the second research objective, *to explore the foster factors of railway freight transport growth in Thailand,*

Results of the data analysis are presented. The presentation was divided into three phases by the researcher in accordance with the Mixed Method research approach, which emphasizes the value of gathering and evaluating both quantitative and qualitative data. The researcher used a variety of data collection techniques and was practice-oriented in the real world (Creswell & Plano, 2011) Subsequently, information was gathered by the simultaneous distribution of open-ended and closed-ended questionnaires. Qualitative methodologies were used during the latter phase of the study.

## 4.1 The Demand of domestic freight shift mode from road to railway in Thailand

**The first research objective** "*to investigate the demand of railway freight boosting in order to shift mode from road to railway in Thailand*"

To answer objective number 1, with the investigation of the volume of cargo that will shift transportation modes from road to railway, the forecasting was made under the following assumptions:

1. Domestic transportation of goods is expanding by 3% each year.

2. Beginning in 2022, the proportion of domestic goods transportation by air, sea, and water will remain unchanged (Figure 18).

3. Establishing an objective to raise the percentage of freight transported by railway by 1% year to 7% in order to align with the NESDC's aim of 2023–2027. The objective is that it will rise progressively to 8% in the years 2028–2031. And in accordance with the goal, rise progressively from 2032 to 2037, reaching 10% in that year.

4. The first phase of the double track railway project, 7 lines; the second phase of the double track project, 7 lines; the new railway project, 6 lines; and the new long-term railway project, 8 lines, have been completed according to the time period specified by the government.

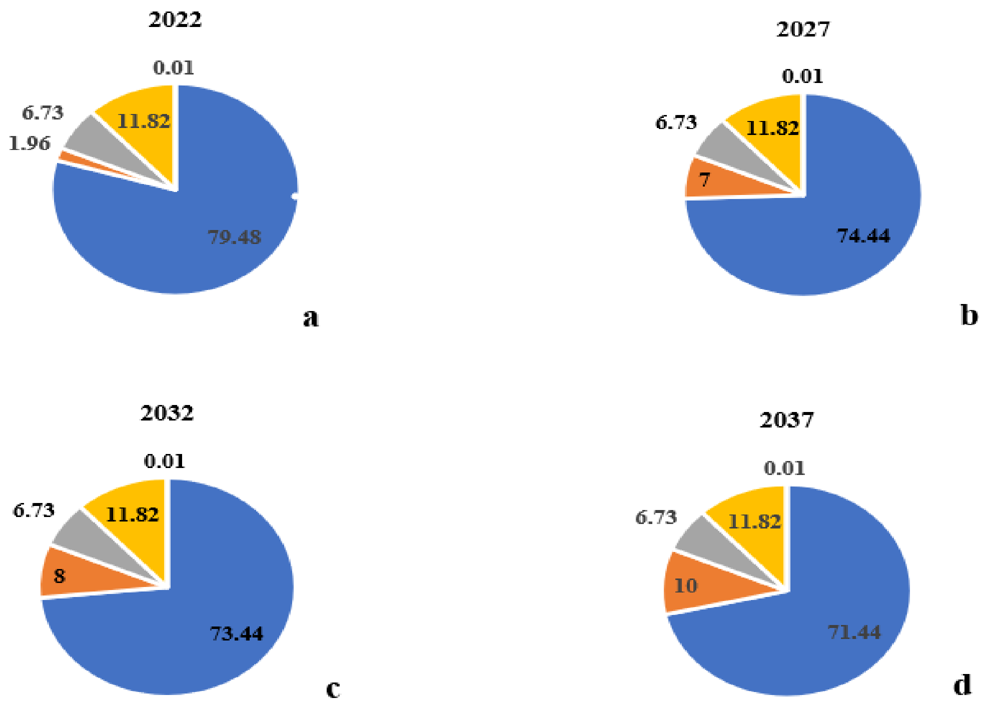



**Figure 18 The assumption shares of domestic freight in future**

In Thailand, the road is the primary means of freight transportation. About 80% of Thailand's freight was moved by road between 2004 and 2022, according to Table 18 on domestic transport. In contrast, the percentages of domestic railway, waterway, coastal, and air are around 2%, 7%, 11%, and 0.01%, respectively, which results in high logistics and transportation costs.

**Table 25 The domestic transportation volume and proportion 2004-2022**

Unit: Thousand tons

| Year | Road | Railway | Waterway | Coastal | Air | Total | Road | Railway | Waterway | Coastal | Air | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 435,147.00 | 12,883.00 | 43,389.00 | 36,974.83 | 126.33 | **530,524.16** | 82.02 | **2.43** | 8.18 | 6.97 | 0.02 | **100** |
| 2005 | 430,289.00 | 11,760.00 | 42,306.00 | 34,253.51 | 129.97 | **520,743.48** | 82.63 | **2.26** | 8.12 | 6.58 | 0.02 | **100** |
| 2006 | 427,581.00 | 11,579.00 | 40,340.00 | 31,573.73 | 131.66 | **513,211.38** | 83.31 | **2.26** | 7.86 | 6.15 | 0.03 | **100** |
| 2007 | 428,123.00 | 11,055.00 | 47,229.46 | 31,216.47 | 121.93 | **519,752.86** | 82.37 | **2.13** | 9.09 | 6.01 | 0.02 | **100** |
| 2008 | 424,456.00 | 12,807.10 | 47,686.86 | 29,614.90 | 112.68 | **516,685.53** | 82.15 | **2.48** | 9.23 | 5.73 | 0.02 | **100** |
| 2009 | 423,678.00 | 11,133.00 | 41,561.06 | 29,311.37 | 104.17 | **507,796.61** | 83.43 | **2.19** | 8.18 | 5.77 | 0.02 | **100** |
| 2010 | 420,446.00 | 11,399.00 | 48,184.84 | 30,457.20 | 121.61 | **512,618.65** | 82.02 | **2.22** | 9.40 | 5.94 | 0.02 | **100** |
| 2011 | 406,536.00 | 10,864.00 | 46,932.22 | 41,272.76 | 133.69 | **507,749.67** | 80.07 | **2.14** | 9.24 | 8.13 | 0.03 | **100** |
| 2012 | 425,804.00 | 10,758.00 | 47,422.54 | 44,262.87 | 130.76 | **530,390.18** | 80.28 | **2.03** | 8.94 | 8.35 | 0.02 | **100** |
| 2013 | 426,086.00 | 11,889.24 | 45,412.90 | 45,441.02 | 120.18 | **530,962.34** | 80.25 | **2.24** | 8.55 | 8.56 | 0.02 | **100** |
| 2014 | 465,020.39 | 10,801.62 | 50,112.86 | 46,672.79 | 115.58 | **574,737.24** | 80.91 | **1.88** | 8.72 | 8.12 | 0.02 | **100** |
| 2015 | 482,357.79 | 11,387.58 | 50,907.43 | 51,872.48 | 117.52 | **598,657.80** | 80.57 | **1.90** | 8.50 | 8.66 | 0.02 | **100** |
| 2016 | 484,884.43 | 11,937.09 | 50,326.78 | 50,894.46 | 122.26 | **600,181.02** | 80.79 | **1.99** | 8.39 | 8.48 | 0.02 | **100** |
| 2017 | 482,596.07 | 11,694.90 | 53,025.58 | 60,850.40 | 115.63 | **610,299.58** | 79.08 | **1.92** | 8.69 | 9.97 | 0.02 | **100** |
| 2018 | 483,760.02 | 10,231.73 | 55,739.44 | 61,797.68 | 94.87 | **613,641.74** | 78.83 | **1.67** | 9.08 | 10.07 | 0.02 | **100** |
| 2019 | 483,167.99 | 10,261.85 | 55,999.36 | 61,772.32 | 77.82 | **613,298.34** | 78.78 | **1.67** | 9.13 | 10.07 | 0.01 | **100** |
| 2020 | 469,638.72 | 11,509.88 | 49,248.01 | 54,023.38 | 32.21 | **586,472.21** | 80.08 | **1.96** | 8.40 | 9.21 | 0.01 | **100** |
| 2021 | 456,489.28 | 11,455.84 | 46,404.68 | 65,447.08 | 20.48 | **581,838.35** | 78.46 | **1.97** | 7.98 | 11.25 | 0.004 | **100** |
| 2022 | 460,315.77 | 11,366.65 | 38,994.00 | 68,431.00 | 31.43 | **579,138.85** | 79.48 | **1.96** | 6.73 | 11.82 | 0.01 | **100** |

**Source**: MOT, 2023

Thus, based on the aforementioned assumptions, Table 25 and Figure 18 illustrates the amount of freight transport that the NESDC has set 7% for 2027, 8% for 2032, and 10% for 2037 for the railway transportation. It was analyzed that in 2027, the railway system would need to carry 46,996.65 thousand tons of cargo—a rise of more than 35,630 thousand tons from 2022—when shifting from road to railway transportation. Subsequently, in 2032, more than 15,265.49 thousand tons additional freight will need to be transported—62,265.14 thousand tons. Additionally, 46,996.65 thousand tons of cargo—or 90,227.95 thousand tons—must be transported by the railway transportation system in 2037, an increase of more than 27,962.81 thousand tons.

**Table 26 Forecasting the domestic proportion transportation, 2027, 2032 and 2037**

Unit: Thousand tons

| Year | Road | Railway | Waterway and Coastal | Air | Total |
|---|---|---|---|---|---|
| 2022 | 460,315.77 | 11,366.65 | 107,425.00 | 31.43 | 579,138.85 |
| 2027 | 499,775.76 | **46,996.65** | 124,541.11 | 67.14 | 671,380.66 |
| 2032 | 571,593.94 | **62,265.14** | 144,377.28 | 77.83 | 778,314.19 |
| 2037 | 644,588.45 | **90,227.95** | 167,372.84 | 90.23 | 902,279.46 |

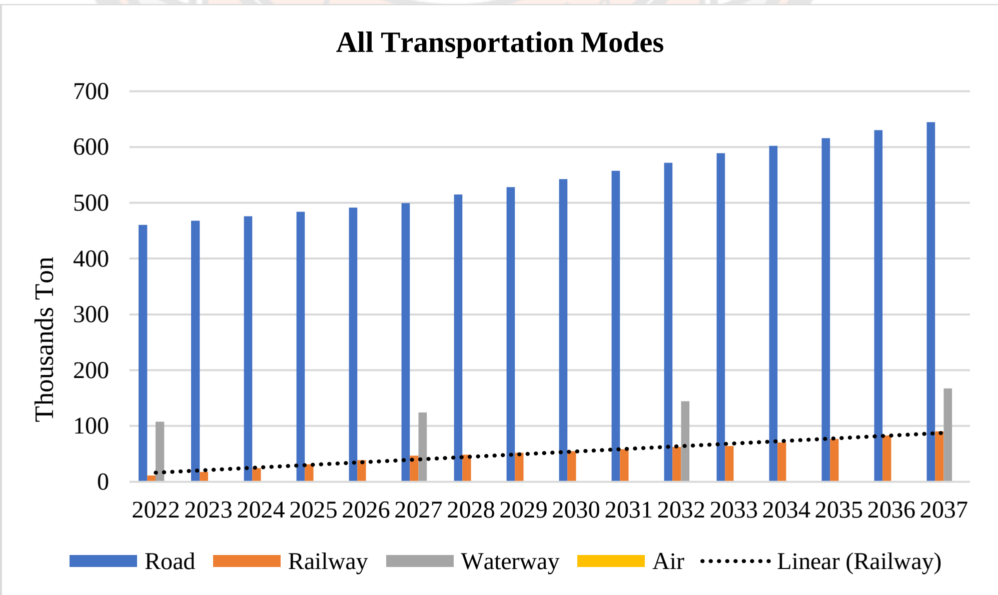



**Figure 19 The trend of shift mode from road to railway freight**

As indicated by Table 27 and Figure 19, the railway system is anticipated to be able to carry 33,073.12 thousand tons of commodities by 2027, which equates to 70.37% of the NESDB target. By 2032, the railway system will be able to carry 42,647.97 thousand tons, or 68.49% of the goal set by the NESDB. In the end, the railway system will be able to transport 55,106.50 thousand tons of commodities by 2037, which is 61.07% of the target that was set (Table 28).

**Table 27 The railway volume forecasting on railway lines, 2027, 2032 and 2037**

Unit: Thousands Ton

| Lines/Year | 2022 | % | 2027 | % | 2032 | % | 2037 | % |
|---|---|---|---|---|---|---|---|---|
| Northern | 1,011.34 | 9.12 | 5,935.47 | 17.95 | 7,679.33 | 18.00 | 10,259.50 | 18.62 |
| North Eastern | 2,747.10 | 24.78 | 11,004.47 | 33.27 | 14,278.52 | 33.48 | 18,682.13 | 33.90 |
| Eastern | 6,899.56 | 62.24 | 12,347.39 | 37.33 | 15,125.90 | 35.47 | 18,965.26 | 34.42 |
| Southern | 426.85 | 3.85 | 3,785.71 | 11.45 | 5,564.22 | 13.05 | 7,199.61 | 13.06 |
| **Total** | **11,084.85** | **100** | **33,073.12** | **100** | **42,647.97** | **100** | **55,106.50** | **100** |

**Table 28 Comparison targeted and forecasting commodity volume**

Unit: Thousands Ton

| Year | 2027 | 2032 | 2037 |
|---|---|---|---|
| Targeted | 46,996.65 | 62,265.14 | 90,227.95 |
| Forecasting | 30,073.12 | 42,647.97 | 55,106.50 |
| Achieves (%) | 70.37% | 68.49% | 61.07% |

The goods to be transported come from the food & beverage, agricultural, and Agro-food industries. The industrial sector includes steel and metal products, automobiles, petrochemical and chemical, industrial materials and machinery, and steel. As an instance, the technology sector produces electronic components. All those are bases along the four railway lines have been examined by the researcher. Throughout this analysis, we commonly referred to the railway routing in Thailand used for the transporting of commodities as the Northern, North Eastern, Eastern, and Southern lines.

The volume of commodity cargo output within the region along each railway line will be discovered leading to an unequal amount of increased freight movement each year. Upon assessing the percentage, it is discovered that in 2027, the following freight transport volumes will be considered part of the overall proportion: 17.95%, 33.27%, 37.33%, and 11.45% for the Northern Line, Northeast Line, Eastern Line, and Southern Line, respectively. And in 2032, over the next five years, the following types of freight will be transported by railway percentages were 18.00%, 33.48%, 35.47%, and 13.05%, in that order. Finally, by 2037, the percentage of the railway freight that will be transported 18.62%, 33.90%, 34.42%, and 13.06%, on the Northern Line, Northeast Line, Eastern Line, and Southern Line, respectively.

Figure 20, shown the trend of each railway line, we found that the northern line forecasting, the percentage of freight transported by railway in 2027, 2032, and 2037 will be 17.95%, 18.00%, and 18.62%, respectively. Furthermore, the forecast for the Northeastern line in 2027, 2032, and 2037, the proportion of freight transport by railway will be 33.27%, 33.48%, and 33.90%, respectively. According to the eastern line prediction, the percentage of freight transported by railway in 2027, 2032, and 2037 will be 37.33%, 35.47%, and 34.42%, respectively. In additionally, based to the southern line estimation, the percentage of freight transported by railway in 2027, 2032, and 2037 will be 11.45%, 13.05%, and 13.06%, respectively.

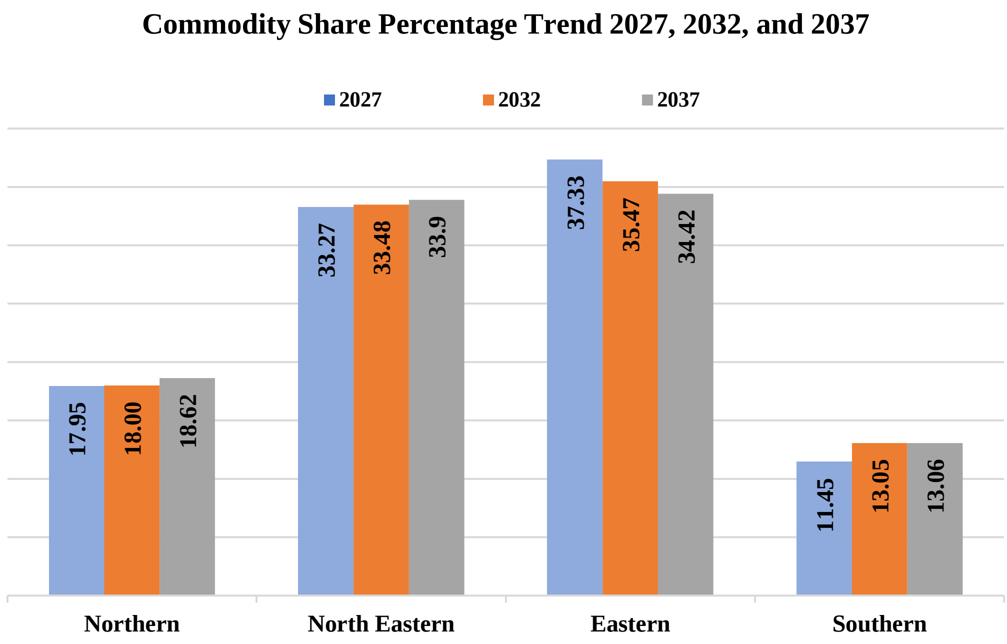



**Figure 20 Commodity share percentage trend 2027, 2032 and 2037**

In 2022, 11,084.85 thousand tons of freight was transported by railway, constituting 6.459 thousand tons of rubber, 1.57 thousand tons of sugar, 0.965 thousand tons of crude oil, 0.791 thousand tons of cassava, etc. Then by performed the study, data collected, and literature review on the production, origin and destination of agricultural products, agricultural industrial products, and industrial products on all railway lines, the researcher discovered that the State Railway of Thailand already transported 12 products (number 1-12) and that there were another 16 products (number 13-28) that could be the new potential commodity cargo transported, for a total of 28 products. The dynamics of the existing and future potential cargo of commodities are depicted in Table 29 and Figure 21. Presently, rubber leads the cargo, followed by crude oil, petroleum products, sugar, cement, casava, and containers. While food cans and food processing lead the way in terms of new potential commodity cargo, the key new items that might be transported by railway in the future are drink, rice, steel, and wood products.

The following table shows the share of commodity cargo by railway transport 2022, 2027, 2032, and 2037.

**Table 29 The railway cargo volume by commodity cargo forecasting, 2027, 2032 and 2037**

Unit: Ton

| No. | Cargo | 2022 | 2027 | 2032 | 2037 |
|---|---|---|---|---|---|
| 1 | Rubber | 6,459,907.67 | 7,071,785.53 | 8,195,974.12 | 9,500,024.11 |
| 2 | Container | 58,097.00 | 2,177,220.56 | 2,872,889.13 | 3,458,640.97 |
| 3 | Sugar | 1,570,647.00 | 1,841,813.27 | 2,036,304.16 | 2,168,115.97 |
| 4 | Cement | 16,531.00 | 1,627,500.00 | 2,077,148.24 | 2,651,026.00 |
| 5 | Cassava | 791,580.00 | 1,085,940.23 | 1,625,012.75 | 2,337,995.99 |
| 6 | Petroleum Products | 359,735.00 | 845,656.09 | 1,474,922.71 | 2,507,398.98 |
| 7 | Crude Oil | 965,208.00 | 1,118,940.61 | 1,297,158.84 | 1,503,762.61 |
| 8 | Fertilizer | 56.00 | 660,220.00 | 768,592.06 | 891,428.61 |
| 9 | Salt | 366,034.00 | 441,416.81 | 475,531.27 | 512,282.24 |
| 10 | Miscellaneous | 70,910.00 | 169,222.10 | 421,078.19 | 1,025,353.11 |
| 11 | Plastic pellets | 177,983.69 | 251,323.28 | 404,758.65 | 651,867.86 |
| 12 | LPG | 248,160.00 | 280,770.26 | 317,665.78 | 359,409.67 |
| 13 | The royal agricultural product | - | 34,479.25 | 50,448.71 | 187,312.53 |
| 14 | Seasonal fruit | - | 758,603.00 | 1,063,979.95 | 1,434,795.36 |
| 15 | Rice | - | 907,500.00 | 1,461,537.83 | 2,353,821.28 |
| 16 | Palm oil | - | 261,170.00 | 402,192.55 | 513,310.95 |
| 17 | Consumer product | - | 884,688.00 | 1,062,785.82 | 1,232,060.06 |
| 18 | Food can and food processing | - | 1,823,315.00 | 2,936,467.05 | 4,562,415.58 |
| 19 | Drink | - | 1,733,000.00 | 2,791,013.84 | 4,345,622.06 |
| 20 | Animal Feed | - | 983,650.00 | 1,230,652.59 | 1,426,663.63 |
| 21 | Wood product | - | 1,083,408.50 | 1,447,453.86 | 1,937,257.11 |
| 22 | Machinery and part | - | 1,070,170.00 | 1,246,827.00 | 1,445,414.22 |
| 23 | Steel and product | - | 1,313,855.00 | 1,571,335.66 | 1,821,608.68 |
| 24 | Electronic product | - | 918,405.00 | 1,064,683.11 | 1,234,259.52 |
| 25 | Metal product | - | 1,039,682.00 | 1,215,207.05 | 1,408,758.03 |
| 26 | Plastic product | - | 694,889.50 | 811,774.04 | 941,068.61 |
| 27 | Motor vehicle and parts | - | 1,166,990.00 | 1,359,067.92 | 1,575,532.20 |
| 28 | Motorcycle and parts | - | 827,502.00 | 965,508.29 | 1,119,288.67 |
| | Total (Ton) | **11,084,849.36** | **33,073,115.99** | **42,647,971.17** | **55,106,494.61** |
| | Thousands Ton | **11,084.85** | **33,073.12** | **42,647.97** | **55,106.49** |
| 1-12 | Current cargo (incremental) | | **17,571,808.74** | **21,967,035.90** | **27,567,306.12** |
| 13-28 | New potential commodity cargo | | **15,501,307.25** | **20,680,935.27** | **27,539,188.49** |
| | Total | | **33,073,115.99** | **42,647,971.17** | **55,106,494.61** |

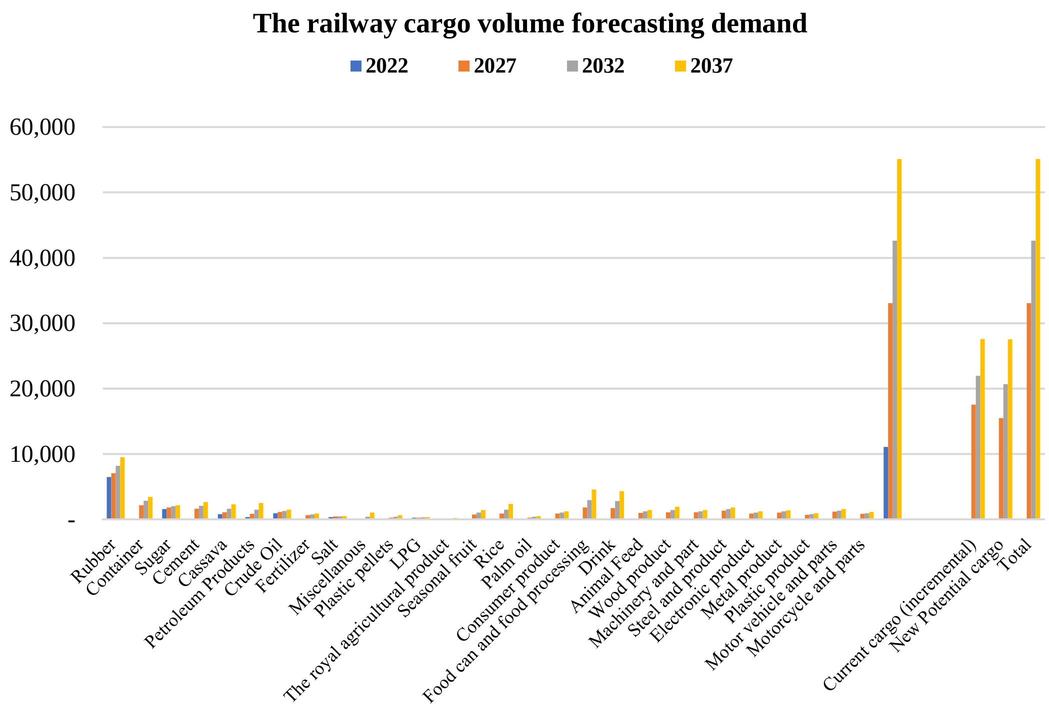



**Figure 21 Thailand railway commodity cargo volume forecasting demand**

We provided the anticipated volume for each railway route as well as the total amount of freight cargo. Subsequently, the investigator will exhibit the commodities freight corresponding to each railway line. Please be noted that, in this study, we are going to replace the current method of transporting goods by road with rail transportation, based on the previously stated assumptions. Thus, the estimations of commodity output and area may be employed to begin the volume forecasting process. We use a variety of forecasting approaches in our forecast process. The relevant market's behavior serves as the basis for the forecasting and selection processes. For instance, both the qualitative approach and the in-depth interview with a specialist in bulk railway cargo are appropriate for use with bulk commodities. We combine the trend of commodities from the literature review mentioned in the chapter for agricultural and industrial commodities with data from the national statistical office, various government and private as well as in-house studies, international institutes, trade associations, enterprises, and the trade press as a basis for evaluating volume. We also employ pertinent relationships that are particular to a certain nation, such the population in each area.

**Northern Line Demand Forecasting**

With the commodity analyses that have been conducted for transit period between 2027, 2032, and 2037, the commodity volume for northern line have been identified and shown in Table 30 below.

**Table 30 The commodity cargo forecasting of Northern Line, 2027, 2032 and 2037**

Unit: Ton

| No. | Cargo | 2022 | 2027 | 2032 | 2037 |
|---|---|---|---|---|---|
| 1 | Rubber | 33,220.00 | 38,511.08 | 44,644.90 | 51,755.68 |
| 2 | Container | 8,166.05 | 11,530.94 | 18,570.69 | 29,908.28 |
| 3 | Sugar | - | 973,440.00 | 1,184,338.60 | 1,440,929.00 |
| 4 | Cement | - | 551,250.00 | 703,550.21 | 897,928.16 |
| 5 | Cassava | - | - | - | - |
| 6 | Petroleum Products | - | - | - | - |
| 7 | Crude Oil | 965,208.00 | 1,118,940.61 | 1,297,158.84 | 1,503,762.61 |
| 8 | Fertilizer | | 318,270.00 | 368,962.16 | 427,728.27 |
| 9 | Salt | - | - | - | - |
| 10 | LPG | - | - | - | - |
| 11 | Plastic pellets | - | 10,609.00 | 12,298.74 | 14,257.61 |
| 12 | Miscellaneous | 4,748.00 | 10,850.51 | 26,999.54 | 67,183.49 |
| 13 | The royal agricultural product | - | 34,479.25 | 50,448.71 | 187,312.53 |
| 14 | Seasonal fruit | - | 194,633.00 | 272,982.85 | 382,872.57 |
| 15 | Rice | - | 302,500.00 | 487,179.28 | 784,607.09 |
| 16 | Palm oil | - | - | - | - |
| 17 | Consumer product | - | 190,962.00 | 221,377.30 | 256,636.96 |
| 18 | Food can and food processing | - | 423,500.00 | 682,050.99 | 1,098,449.93 |
| 19 | Drink | - | 605,000.00 | 974,358.55 | 1,569,214.19 |
| 20 | Animal Feed | - | 53,045.00 | 61,493.69 | 71,288.04 |
| 21 | Wood product | - | 159,135.00 | 184,481.08 | 213,864.13 |
| 22 | Machinery and part | - | 212,180.00 | 245,974.77 | 285,152.18 |
| 23 | Steel and product | - | 106,090.00 | 122,987.39 | 142,576.09 |
| 24 | Electronic product | - | 159,135.00 | 184,481.08 | 213,864.13 |
| 25 | Metal product | - | 212,180.00 | 245,974.77 | 285,152.18 |
| 26 | Plastic product | - | 58,349.50 | 67,643.06 | 78,416.85 |
| 27 | Motor vehicle and parts | - | 106,090.00 | 122,987.39 | 142,576.09 |
| 28 | Motorcycle and parts | - | 84,872.00 | 98,389.91 | 114,060.87 |
| | Total (Ton) | 1,011,342.05 | 5,935,552.89 | 7,679,334.49 | 10,259,496.93 |
| | Thousands Ton | 1,011.34 | 5,935.55 | 7,679.33 | 10,259.50 |

| No. | Cargo | 2022 | 2027 | 2032 | 2037 |
|---|---|---|---|---|---|
| 1-12 | Current cargo (incremental) | | **3,033,402.14** | **3,656,523.68** | **4,433,453.10** |
| 13-28 | New potential commodity cargo | | **2,902,150.75** | **4,022,810.81** | **5,826,043.83** |
| | Grand Total | | **5,935,552.89** | **7,679,334.49** | **10,259,496.93** |

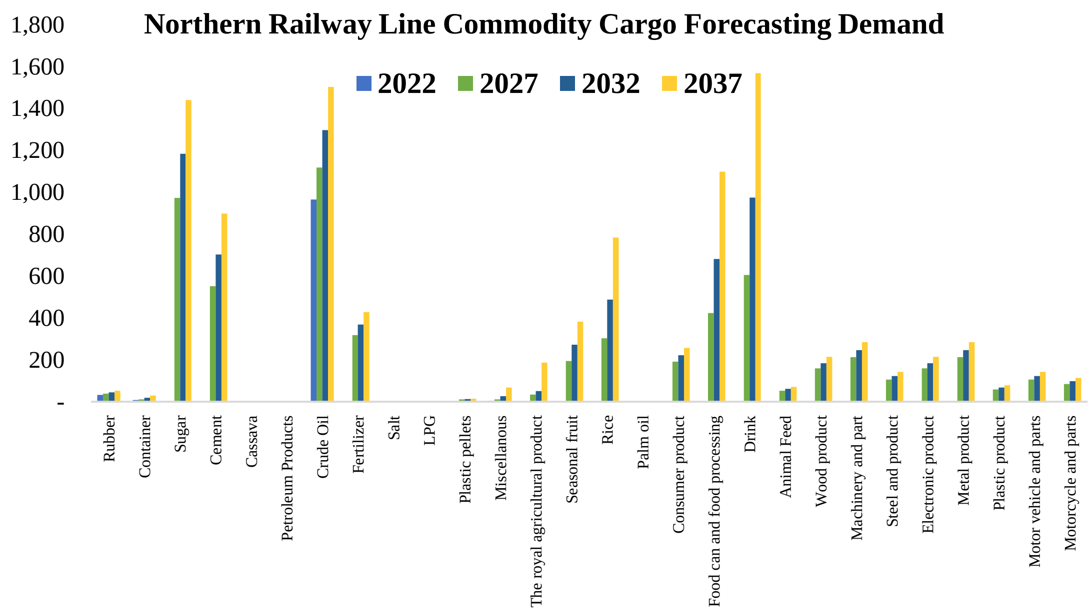



**Figure 22 Northern railway line commodity cargo forecasting demand**

The net amount of cargo transported for each of the 28 commodities is displayed in the northern line forecasted volume (Figure 22). Similar to the previous time, crude oil and sugar have the highest railway freight mobility in terms of transported net tons throughout the transit time for existing commodity cargo. Nevertheless, it's also expected that the new potential commodity cargo—which includes rice, seasonal fruit, food cans and food processing, drink and machinery and parts—will draw in the most net tons.

**North Eastern Line Demand Forecasting**

With the commodity analyses that have been conducted for transit period between 2027, 2032, and 2037, the commodity volume for north eastern line have been identified and shown in following table below.

**Table 31 The commodity cargo forecasting of North Eastern Line, 2027, 2032 and 2037**

Unit: Ton

| No. | Cargo | 2022 | 2027 | 2032 | 2037 |
|---|---|---|---|---|---|
| 1 | Rubber | 370,484.00 | 597,774.56 | 1,006,481.99 | 1,620,949.31 |
| 2 | Container | - | - | - | - |
| 3 | Sugar | 55,105.00 | 551,250.00 | 639,049.83 | 740,833.90 |
| 4 | Cement | 16,531.00 | 551,250.00 | 703,550.21 | 897,928.16 |
| 5 | Cassava | 1,570,477.00 | 1,820,613.27 | 2,010,104.16 | 2,138,915.97 |
| 6 | Petroleum Products | 359,735.00 | 580,431.09 | 1,167,454.24 | 2,150,958.76 |
| 7 | Crude Oil | - | - | - | - |
| 8 | Fertilizer | 56.00 | 330,750.00 | 383,429.90 | 444,500.34 |
| 9 | Salt | 342,867.00 | 414,951.03 | 447,020.11 | 481,567.62 |
| 10 | LPG | - | - | - | - |
| 11 | Plastic pellets | 28,551.67 | 31,121.32 | 35,404.07 | 39,686.82 |
| 12 | Miscellaneous | 3,293.00 | 14,698.10 | 36,573.58 | 83,671.48 |
| 13 | The royal agricultural product | - | - | - | - |
| 14 | Seasonal fruit | - | - | - | - |
| 15 | Rice | - | 605,000.00 | 974,358.55 | 1,569,214.19 |
| 16 | Palm oil | - | - | - | - |
| 17 | Consumer product | - | 484,000.00 | 561,088.65 | 650,455.53 |
| 18 | Food can and food processing | - | 544,500.00 | 876,922.70 | 1,288,487.14 |
| 19 | Drink | - | 544,500.00 | 876,922.70 | 1,288,487.14 |
| 20 | Animal Feed | - | 400,155.00 | 463,889.32 | 537,774.86 |
| 21 | Wood product | - | 484,000.00 | 561,088.65 | 650,455.53 |
| 22 | Machinery and part | - | 486,675.00 | 564,189.71 | 654,050.50 |
| 23 | Steel and product | - | 424,360.00 | 491,949.55 | 570,304.35 |
| 24 | Electronic product | - | 441,000.00 | 511,239.87 | 592,667.12 |
| 25 | Metal product | - | 424,360.00 | 491,949.55 | 570,304.35 |
| 26 | Plastic product | - | 371,315.00 | 430,455.85 | 499,016.31 |
| 27 | Motor vehicle and parts | - | 477,405.00 | 553,443.24 | 641,592.40 |
| 28 | Motorcycle and parts | - | 424,360.00 | 491,949.55 | 570,304.35 |
| | Total (Ton) | 2,747,099.67 | 11,004,469.37 | 14,278,515.96 | 18,682,126.14 |
| | Thousands Ton | 2,747.10 | 11,004.47 | 14,278.52 | 18,682.13 |
| 1-12 | Current cargo (incremental) | | **4,892,839.37** | **6,429,068.09** | **8,599,012.36** |
| 13-28 | New potential commodity cargo | | **6,111,630.00** | **7,849,447.87** | **10,083,113.78** |
| | Grand Total | | **11,004,469.37** | **14,278,515.96** | **18,682,126.14** |

The net amount of cargo moved for each of the 28 commodities on the northeastern line is shown (Figure 23). As in the past, the commodities with the highest railway freight mobility for existing commodity cargo throughout the transit period are petroleum products and cassava. However, it's also anticipated that the new potential commodity cargo would bring in the greatest net tonnage, comprising beverage, consumer goods, food processing, and food cans.

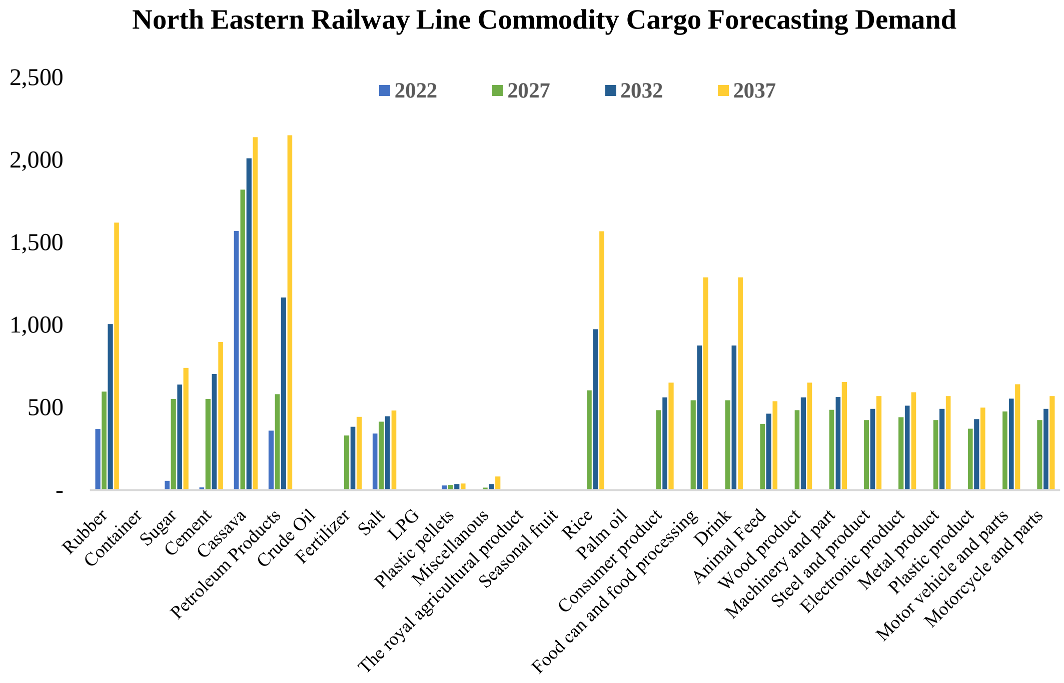



**Figure 23 North Eastern railway line commodity cargo forecasting demand**

### Eastern Line Demand Forecasting

The commodity volume for the eastern line has been determined using the commodities assessments that have been carried out for the transit periods between 2027, 2032, and 2037. This is displayed in Table 32 below.

**Table 32 The commodity cargo forecasting of Eastern Line, 2027, 2032 and 2037**

Unit: Ton

| No. | Cargo | 2022 | 2027 | 2032 | 2037 |
|---|---|---|---|---|---|
| 1 | Rubber | | | | |
| 2 | Container | 6,396,210.00 | 6,989,311.36 | 8,102,527.46 | 9,393,050.02 |
| 3 | Sugar | 2,992.00 | 3,570.56 | 4,344.13 | 5,285.30 |
| 4 | Cement | - | | | |
| 5 | Cassava | - | 525,000.00 | 670,047.82 | 855,169.68 |
| 6 | Petroleum Products | - | 265,225.00 | 307,468.47 | 356,440.22 |
| 7 | Crude Oil | - | | | |
| 8 | Fertilizer | - | - | - | - |
| 9 | Salt | 23,167.00 | 26,465.78 | 28,511.16 | 30,714.62 |
| 10 | LPG | 248,160.00 | 280,770.26 | 317,665.78 | 359,409.67 |
| 11 | Plastic pellets | 169,817.64 | 239,792.34 | 386,187.96 | 621,959.58 |
| 12 | Miscellaneous | 59,214.00 | 135,320.57 | 336,720.88 | 837,869.30 |
| 13 | The royal agricultural product | - | - | - | - |
| 14 | Seasonal fruit | - | 343,470.00 | 481,734.44 | 675,657.48 |
| 15 | Rice | - | - | - | - |
| 16 | Palm oil | - | 55,125.00 | 70,355.02 | 89,792.82 |
| 17 | Consumer product | - | 127,308.00 | 147,584.86 | 171,091.31 |
| 18 | Food can and food processing | - | 484,000.00 | 779,486.84 | 1,255,371.35 |
| 19 | Drink | - | 363,000.00 | 584,615.13 | 941,528.51 |
| 20 | Animal Feed | - | 159,135.00 | 184,481.08 | 213,864.13 |
| 21 | Wood product | - | 15,913.50 | 18,448.11 | 21,386.41 |
| 22 | Machinery and part | - | 318,270.00 | 368,962.16 | 427,728.27 |
| 23 | Steel and product | - | 371,315.00 | 430,455.85 | 499,016.31 |
| 24 | Electronic product | - | 318,270.00 | 368,962.16 | 427,728.27 |
| 25 | Metal product | - | 318,270.00 | 368,962.16 | 427,728.27 |
| 26 | Plastic product | - | 212,180.00 | 245,974.77 | 285,152.18 |
| 27 | Motor vehicle and parts | - | 530,450.00 | 614,936.93 | 712,880.44 |
| 28 | Motorcycle and parts | - | 265,225.00 | 307,468.47 | 356,440.22 |
| | Total (Ton) | 6,899,560.64 | 12,347,387.38 | 15,125,901.66 | 18,965,264.36 |
| | Thousands Ton | 6,899.56 | 12,347.39 | 15,125.90 | 18,965.26 |
| 1-12 | Current cargo (incremental) | | **8,465,455.88** | **10,153,473.67** | **12,459,898.40** |
| 13-28 | New potential commodity cargo | | **3,881,931.50** | **4,972,427.99** | **6,505,365.96** |
| | Grand Total | | **12,347,387.38** | **15,125,901.66** | **18,965,264.36** |

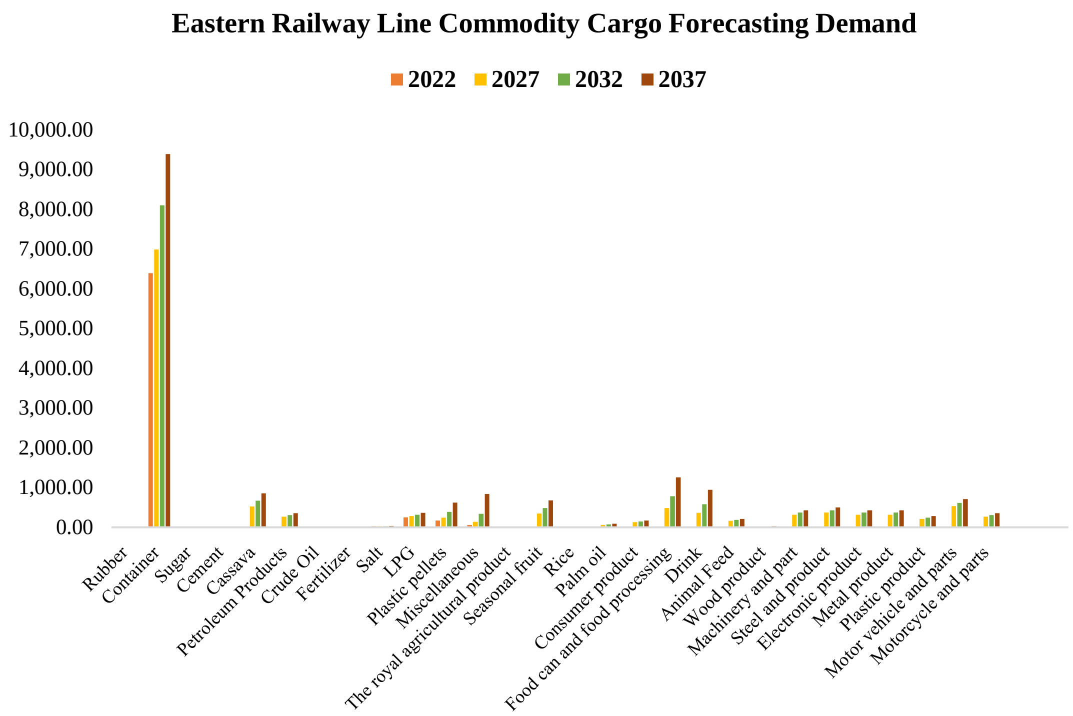



**Figure 24 Eastern railway line commodity cargo forecasting demand**

The net amount of cargo moved for each of the 28 commodities on the eastern line is shown (Figure 24). As in the past, the commodities with the highest railway freight mobility for existing commodity cargo throughout the transit period are container. However, it's also anticipated that the new potential commodity cargo would bring in the greatest net tonnage, comprising of food processing, and food cans, drink, and motor vehicle and parts.

**Southern Line Demand Forecasting**

Table 33 shows the commodity evaluations performed for the transit periods of 2027, 2032, and 2037 that have been used to calculate the commodity volume for the southern line.

**Table 33 The commodity cargo forecasting of Southern Line, 2027, 2032 and 2037**

Unit: Ton

| No. | Cargo | 2022 | 2027 | 2032 | 2037 |
|---|---|---|---|---|---|
| 1 | Rubber | 387,876.00 | 449,654.59 | 573,885.86 | 665,291.00 |
| 2 | Container | 35,146.00 | 40,743.85 | 45,743.85 | 53,029.66 |
| 3 | Sugar | - | 648,960.00 | 1,045,156.57 | 1,271,592.77 |
| 4 | Cement | - | - | - | - |
| 5 | Cassava | 170.00 | 21,200.00 | 26,200.00 | 29,200.00 |
| 6 | Petroleum Products | - | - | - | - |
| 7 | Crude Oil | - | - | - | - |
| 8 | Fertilizer | - | 11,200.00 | 16,200.00 | 19,200.00 |
| 9 | Salt | - | - | - | - |
| 10 | LPG | - | - | - | - |
| 11 | Plastic pellets | - | - | - | - |
| 12 | Miscellaneous | 3,655.00 | 8,352.70 | 20,784.19 | 36,628.84 |
| 13 | The royal agricultural product | - | - | - | - |
| 14 | Seasonal fruit | - | 220,500.00 | 309,262.66 | 376,265.31 |
| 15 | Rice | - | - | - | - |
| 16 | Palm oil | - | 206,045.00 | 331,837.53 | 423,518.13 |
| 17 | Consumer product | - | 82,418.00 | 132,735.01 | 153,876.26 |
| 18 | Food can and food processing | - | 371,315.00 | 598,006.52 | 920,107.16 |
| 19 | Drink | - | 220,500.00 | 355,117.46 | 546,392.22 |
| 20 | Animal Feed | - | 371,315.00 | 520,788.50 | 603,736.60 |
| 21 | Wood product | - | 424,360.00 | 683,436.02 | 1,051,551.04 |
| 22 | Machinery and part | - | 53,045.00 | 67,700.36 | 78,483.27 |
| 23 | Steel and product | - | 412,090.00 | 525,942.87 | 609,711.93 |
| 24 | Electronic product | - | - | - | - |
| 25 | Metal product | - | 84,872.00 | 108,320.57 | 125,573.23 |
| 26 | Plastic product | - | 53,045.00 | 67,700.36 | 78,483.27 |
| 27 | Motor vehicle and parts | - | 53,045.00 | 67,700.36 | 78,483.27 |
| 28 | Motorcycle and parts | - | 53,045.00 | 67,700.36 | 78,483.27 |
| | Total (Ton) | 426,847.00 | 3,785,706.14 | 5,564,219.02 | 7,199,607.21 |
| | Thousands Ton | 426.85 | 3,785.71 | 5,564.22 | 7,199.61 |
| 1-12 | Current cargo (incremental) | | **1,180,111.14** | **1,727,970.47** | **2,074,942.27** |
| 13-28 | New potential commodity cargo | | **2,605,595.00** | **3,836,248.56** | **5,124,664.94** |
| | Grand Total | | **3,785,706.14** | **5,564,219.02** | **7,199,607.21** |

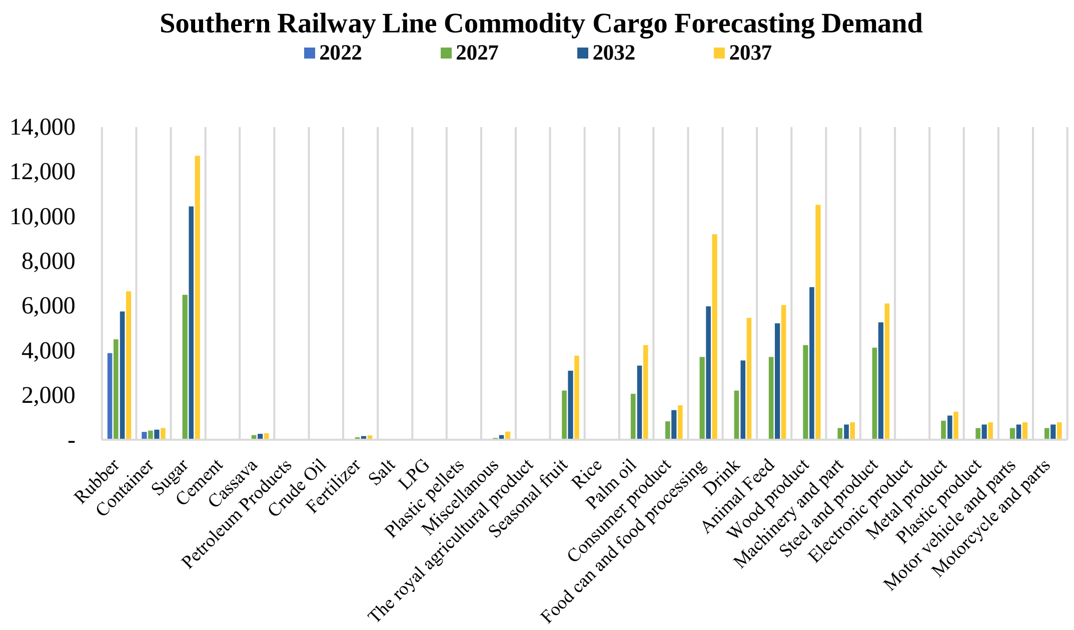



**Figure 25 Southern railway line commodity cargo forecasting demand**

Figure 25 displays the net amount of freight moved for each of the 28 goods on the southern line. Sugar and rubber have the highest railway freight mobility for current commodity cargo during the transit duration in 2027. But it's also expected that the new potential commodity cargo, which would include wood products, food processing, and food cans, would bring in the most net tonnage.

## 4.2 The Fostering Factors of railway freight in Thailand

**The second research objective**, "*to explore the foster factors of railway freight transport growth in Thailand*"

### 4.2.1 Background

This section's mixed-methods research design involved distributing postal mail to 420 participants, conducting a quantitative survey with primary stakeholders, and using an open-ended questionnaire to gather data from key and secondary stakeholders. However, a focus group discussion was used to conduct the qualitative technique in order to get more information from eight of the primary stakeholders (Escalada, & Heong, 2014, p. 5).

The findings of the quantitative study are arranged according to the methods by which statistical techniques—such as confirmatory factor analysis, inter-item correlations, reliability analysis, preliminary data analyses, and model-fit—were applied to the data. This chapter's outcome is to interpret the data that has been gathered and managed using tables and realistic outlines. The research objectives of this study were applied to the greatest extent possible in order to interpret the findings and adapt them to the body of existing literature concerning the relationship value, which serves as the study's focal point.

#### 4.1.2 The key stakeholders

A total of 15 key stakeholders and completing this part of the survey. The key stakeholders including the OTP, and the SRT. With the open-ended questionnaires, concludes the questions below:

**The expectations of the urgent double-track railway project (7 lines)**

**Table 34 Key stakeholder opinion on double-track expectation**

| No. | Point of view |
|---|---|
| 1 | Railway transportation of commodities is becoming more and more popular among entrepreneurs. |
| 2 | Reduce road accidents, and pollution |
| 3 | Reduce logistics costs to GDP |
| 4 | SRT is able to deliver services more quickly, conveniently, safely, and on schedule |
| 5 | Have more income |
| 6 | Attract more agriculture and industry commodity |
| 7 | As of yet, not all train lines have been double-tracked, so don't expect much. |

**The views on the demand increasing after complete the urgent double-track or not?**

**Table 35 Key stakeholder point of view on boosting demand after complete project**

| No. | Point of view |
|---|---|
| 1 | Will rise, but there has to be coordinated development of transportation policies and infrastructure, such operator-specific tax laws, private sector involvement and operation, CY/ICD SRT development, and locomotives and carriages that are prepared for service. |
| 2 | It should continue to increase because trains will take less time to transport. However, there must also be a sufficient number of containers and trucks to use the service. |
| 3 | It takes time and publicity. |
| 4 | It will undoubtedly rise as operators could reduce expenses and transit is less expensive than through road or other forms of transportation. |

**The view on, the government will achieve the railway freight volume/proportion as targeted or not?**

**Table 36 Key stakeholder point of view on will achieve railway freight targeted or not?**

| No. | Point of view |
|---|---|
| 1 | It may take longer than the government has targeted. |
| 2 | It should continue to increase because trains will take less time to transport. However, there must also be a sufficient number of containers and trucks to use the service. |
| 3 | Other components, such a defined government strategy for the acquisition of locomotives, trailers, and staff, are necessary in order to expect to reach the |

| No. | Point of view |
|---|---|
| | intended amount. |
| 4 | It is reasonable to assume that the railway will be more accessible and have more locomotives and freight containers if the project is finished on schedule. |
| 5 | Have to do things step by step and examine the train's management system for the locomotive and trailer transfer. |
| 6 | If the railway system is ready and completed within the time frame, the transportation of goods will increase as expected. |
| 7 | If the issue of time can be managed and the confidence of the shippers can be gained, it may be possible. |
| 8 | As expected, but in a gradual manner with construction not yet 100% complete as planned. |
| 9 | It may be as expected. |
| 10 | Some increase |
| 11 | Not expecting it yet |

**The fostering factor in order to shift from road to railway modes.**

**Table 37 Key stakeholder point of view on fostering factor to railway freight**

| No. | Key Factor | Sub Factor |
|---|---|---|
| 1 | Legislation | - Increase liberation<br>- Encourage the private sector to the railway industry |
| 2 | Infrastructure | - Railway transportation network in all regions<br>- Investing in a new locomotive<br>- Accessibility and inclusive<br>- Spur line |
| 3 | Public Relations | - Advantages of railway transportation<br>- The government’s Strategic and transparent |
| 4 | Logistics Facilities | - Railway network systems of linked locations (nodes) |

| No. | Key Factor | Sub Factor |
|---|---|---|
| | | |
| 5 | Operation | - Fast and cost-effective |
| 6 | Customer | - MOU with large enterprise |
| 7 | Policy | - The budget to be supported by the government |
| 8 | Service | - Reliability in service efficiency |

### 4.1.3 The secondary stakeholders

The 69 secondary stakeholders, including as the institution of education, the Office of Commercial Affairs, the chamber, the federal government of Thai industries, the community, the media, and other government agencies. With the open-ended questionnaires, concludes the questions below:

**The views on, the expectations once the express double track railway project (7 lines) is completed.**

**Table 38 Secondary stakeholder opinion on the urgent double-track expectation once completed**

| No. | Point of view |
|---|---|
| 1 | Able to deliver more items in a vehicle as it has a larger service capacity. |
| 2 | Reduced transit times and free private sector involvement to foster competition. |
| 3 | It should only be appropriate for shipping cargo to the Den Chai-Chiang Rai and Den Chai-Lamphun lines on the R3A line, which features an industrial park |
| 4 | When contrasted with road transportation, it is not yet widely used. |
| 5 | The train station is far from Singburi province, which is closer to Lopburi. It is more convenient to use land by car. |
| 6 | Provide options for higher product distribution, more shipping, and a decrease in "loss" and damage from domestic to international trade. |
| 7 | It is more beneficial for transporting goods. Shipping is faster and prices are lower. |
| 8 | In the transportation industry, double handling is an issue. |
| 9 | I would want to see greater advancements made in railway transportation. It is anticipated to be less likely to cause accidents than transportation. |

| No. | Point of view |
|---|---|
| 10 | Reduce congestion in travel/transportation |
| 11 | The province of Roi Et will have a transportation hub, and the region's GDP will rise overall and in terms of development. |
| 12 | In order to minimize the number of trucks moving cargo on the road, the majority of inter-city freight movement occurs by railway. |
| 13 | Goods transportation will be more cost-effective and quicker, and it will be much more advantageous if there are connections with nearby nations. |
| 14 | When the goods arrive at their destination, the transportation is prompt, safe, quick, and affordable without diminishing the quality of the goods. In addition to crossroads and intersection points, there are other safety features for people and their belongings, such as electric lights, warning signs, barriers, and CCTV cameras that are connected to local organization. |
| 15 | It is expected that the transportation of agricultural products will be faster and there will be more distribution of agricultural products to various regions, which will affect the income of farmers, which will result in a better quality of life indicator. |
| 16 | It ought to foster transportation that is 100% more efficient than car. |
| 17 | It is expected that it will replace more trucking systems. |
| 18 | The number of railway customers has increased. |
| 19 | I would want to see more commodities transported by train as soon as possible. |
| 20 | It is good to transport large quantities in industry and oil. |
| 21 | Products have to be more affordable in order to be transported in huge quantities. |
| 22 | By arranging the truck system to have a smaller proportion, you may increase the percentage from the road to the railway system and lower national logistics expenses. |
| 23 | Improve both the nation and pollution levels. |
| 24 | It allows farmers and others to make more money by accelerating the sale of their domestic goods to foreign nations and raising buying power. |
| 25 | increases the potential and capacities of the nation, enabling it to create new sectors, raise economic value, and provide earning for its citizens. |
| 26 | In order to enable passengers to use all eight double track railway lines to go where they're going more quickly, it is projected that they will all be finished and constructed perfectly in accordance with the plans. |

**The views on the demand increasing after complete the urgent double-track or not?**

**Table 39 Secondary stakeholder opinion on boosting demand after complete project**

| No. | Point of view |
|---|---|
| 1 | Increased, but not immediately as transportation businesses need to make adjustment |
| 2 | It should continue to increase because trains will take less time to transport. However, there must also be a sufficient number of containers and trucks to use the service. |
| 3 | It takes time and publicity. |
| 4 | It will undoubtedly rise as operators could reduce expenses and transit is less expensive than through road or other forms of transportation. |
| 5 | Although it has increased, the percentage is not significant since the railway has an aggressive marketing department. |
| 6 | It is possible depending on the company, the context of the area and the product. |
| 7 | Raise whether the expenses and period of transportation satisfy the demands of entrepreneurs. |
| 8 | Will it increase or not? It depends on the price and various transportation steps. |
| 9 | Railway transport will be the primary option for moving products if the cost of transportation is not excessive and the structural components are prepared. |
| 10 | Increased because train trips can be added to transportation. |
| 11 | Increased as a result of the fully operational railway infrastructure, which lowers down on time and delivers goods to their destination fast and affordably. |
| 12 | Whether railway transport will increase or not remains to be seen based on |

| No. | Point of view |
|---|---|
| | the needs of people in the area. If nothing changes, if it is the current agricultural society, railway transport will definitely increase unless social conditions change. |
| 13 | It will increase if related transportation components and infrastructure are developed to support railway transport at the same time. |
| 14 | There will probably be more ongoing projects to develop and stimulate more railway transport. |
| 15 | It is not likely to increase if the double track train still uses normal or low speed and the demand for it is reduced. |
| 16 | It must definitely increase because at present the cost of car transport is higher and it is not cost-effective. Railway transport must definitely be better. |
| 17 | Probably not in the near future, but once the necessary components are created, it is going to become a transportation staple. |
| 18 | It should be added, but I still don't have confidence in the system administration whether it can respond to the smooth flow of logistics or not. |
| 19 | I think that railway freight transportation must definitely increase after this double track project. Because this project is like the development of transportation in Thailand and within the railway organization. If transportation in the country improves, people travel more, causing the economy in Thailand to increase. |
| 20 | Definitely increased agricultural products will be fresh and new. |
| 21 | Expected to be possible |

**The views on, the double-track will lead the government to achieve railway freight targeted or not?**

**Table 40 Secondary stakeholder opinion on the double-track will lead the government to achieve railway freight targeted or not?**

| No. | Point of view |
|---|---|
| 1 | As the government expected |
| 2 | In the long term, the short term will still not be able to perform as expected. |
| 3 | There is continuous loss and the government must compensate 5 times like the current railways. |
| 4 | Depends on the SRT administration. |
| 5 | If it is promoted, its use will increase. |
| 6 | Operators are likely to change if railway transportation services meet the needs of those products and services. |
| 7 | It is expected that it will go in the direction that the government has estimated. |
| 8 | It is possible because it has potential. There must be good support in terms of regulations, maintenance, etc. |
| 9 | This is as expected because the economy tends to expand. |
| 10 | The government expected this as entrepreneurs are reaping the benefits and concentrating on expanding their opportunities. |
| 11 | Less than expected |
| 12 | As the trains around Thailand begin to develop and invest more in railway infrastructure, it will create more connections to each other and train services will be the country's mainstay of transportation and tourism as well. |
| 13 | Depending on the circumstances, railway freight shifting may or may not satisfy regulatory requirements. If another model is more accessible and quicker, that model may be changed if the public wants it but the government is taking its time to act. |
| 14 | Yes, if the basic outline and related elements are developed to be ready to support the railway transport system at the same time. |
| 15 | Shifting the approach that entrepreneurs operate will take time. Policies that are favorable, such as tax reductions, are required. |

| No. | Point of view |
|---|---|
| 16 | I think it is still not as expected by the government. It may increase but it hasn't reached the target yet. |
| 17 | It should exceed expectations because it's convenient, fast / on time / safer. |
| 18 | In the initial stages, changes may not be seen until the government has statistics confirming that railway transport is more economical and can reach destinations faster and safer. |
| 19 | It would not be as expected because of the delayed construction as promised if Chiang Rai is completed in another 10 years. In the next 10 years, the delivery operators will have already changed models and operators. |
| 20 | Agricultural items are more likely to be used by Thailand's railway transportation system. As a result, using railway transportation is essential. The state has a duty to provide for citizens when their needs are acknowledged. |
| 21 | It's unlikely because at present B2B transportation has decreased and increased to B2C. Delivery to the hands of customers is important. Coming by railway must be connected to another road. |
| 22 | Not without rapid development and a clear timeline. |
| 23 | In terms of speed and safety—ensuring that the commodities are not damaged—railway freight transit has significantly improved since its inception, leading the government to believe that everything is as intended. As such, railway freight transit is a potential shipping another option. |

**The fostering factor in order to shift from road to railway modes.**

**Table 41 Secondary stakeholder point of view on fostering factor to railway freight**

| No. | Key Factor | Sub Factor |
|---|---|---|
| 1 | Legislation | - Reform the law to enable more private enterprises to offer train services<br>- Eliminate SRT's monopoly<br>- Strengthen market competition and fairness price<br>- Build restrictions on-road transportation<br>- Tax incentives and privileges |
| 2 | Infrastructure | - Enhance capacity<br>- Availability of wagons<br>- Accessibility<br>- Connectivity |
| 3 | Public Relations | - Advantages of railway transportation<br>- Shared goals and value<br>- Information sharing |
| 4 | Logistics Facilities | - Logistics facilities center connectivity<br>- Sufficient container yards and transshipment yards<br>- Distribution center |
| 5 | Operation | - Invest in technology and innovation systems for cost reduction<br>- SRT’s flexible system<br>- Strengthen freight workforce and development technical equipment |
| 6 | Customer | - Customer-oriented<br>- Improving data and research<br>- Partnering with stakeholders across the supply chain |

| No. | Key Factor | Sub Factor |
|---|---|---|
| | | - Logistics service provider oriented on cost reduction |
| 7 | Policy | - Clear and prompt policy<br>- Partial transportation expenses by government subsidy<br>- Trade promotion<br>- Terminal oriented development<br>- Integrated policy |
| 8 | Service | - Reliability<br>- Technology and innovation involve |

**4.2 The results of developing a causal relationship model of factors promoting railway freight transport in Thailand**

The results are organized in the way statistical techniques were used to analyze the data which includes the preliminary data analyses, descriptive statistics, framework of SEM, and hypotheses testing and results.

**Preliminary Analyses**

The questionnaires were distributed to the primary stakeholders, who are manufacturing, logistics service providers, and container delivery service. The 420 sets of questionnaires contributed to the sampling mentioned. The returned rate is 47.62%, where 200 sets of the questionnaire are returned. Based on the 200 valid questionnaires, 65% of valid questionnaires are manufacturing, and logistics service providers 35% (Figure 26).

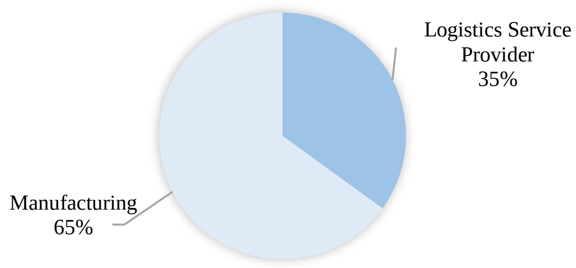



**Figure 26 Percentage of respondent on business type**

In order to ensure the quality of collected data, the region location, the import-export destination, the commodity characteristics, the mode of transportation, and the transportation volume of respondents are asked. Figure 27 shows that the highest proportion of respondents relies on Central, Bangkok, Southern, Northeastern, Eastern, and Northern with 55%, 44%, 41%, 24%, 22%, and 14% respectively.

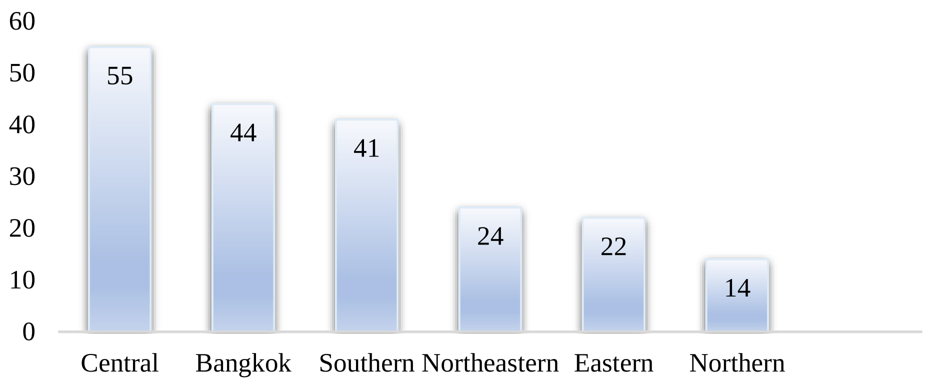



**Figure 27 Region location of respondents**

According to the survey, over 50% of participants transport general commodities (41.50%), followed by dry bulk (35.50%), other industrial items (14%), and liquid bulk (9%) (Figure 28).

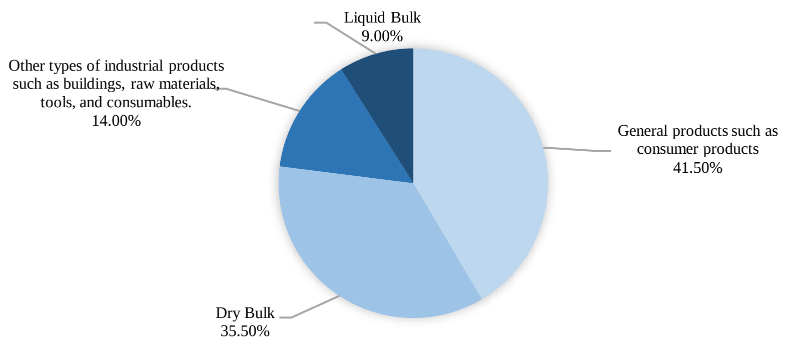



**Figure 28 Types of commodities cargo**

The study also gathered information on its means of transportation. According to the survey, 86.14% of transportation was carried out by road, 9.96% by railway, 2.60% by waterways and coastal, and 1.30% through pipe, as Figure 29 illustrates.

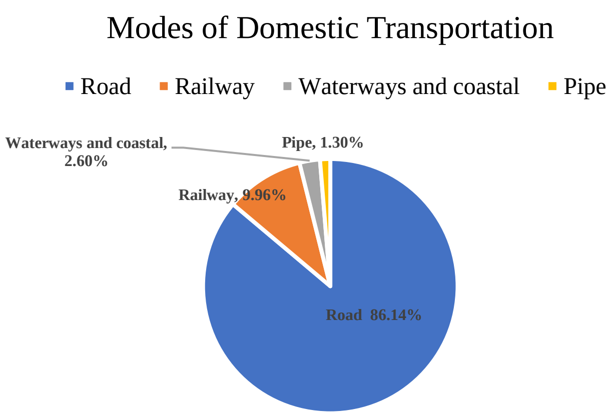



**Figure 29 Modes of Domestic Transportation**

**Table 42 Demographic data of respondents**

| Demographic Data | | Frequency | Percentage |
|---|---|---|---|
| Business Type (N=200) | | | |
| | Manufacturing | 130 | 65.00 |
| | LSP | 70 | 35.00 |
| Location (N=200) | | | |
| | Central | 55 | 27.50 |
| | Bangkok | 44 | 22.00 |
| | Southern | 41 | 20.50 |
| | Northeastern | 24 | 12.00 |
| | Eastern | 22 | 11.00 |
| | Northern | 14 | 7.00 |
| Commodities | | | |
| | General products | 83 | 41.50 |
| | Dry bulk | 71 | 35.50 |
| | Other types of industrial products | 28 | 14.00 |
| | Liquid bulk | 18 | 9.00 |
| Modes Transportation | | | |
| | Road | 199 | 86.14 |
| | Railway | 23 | 9.96 |
| | Waterways and coastal | 6 | 2.60 |
| | Pipe | 3 | 1.30 |

**Descriptive Statistics**

The study's findings, which are presented in Table 43 - Table 45, are the outcome of an investigation of the factors fostering railway freight transport in Thailand among 200 primary stakeholders.

**Table 43 The $\bar{x}$, the standard deviation, and the level of the railway freight Transport System**

| Railway Freight Transport | $\bar{x}$ | S.D. | Promote or Influence |
|---|---|---|---|
| Railway Infrastructure ($x_1$) | 3.93 | 0.83 | A lot |
| Railway Performance ($x_2$) | 3.83 | 0.92 | A lot |
| Thailand's Infrastructure Development Strategy ($x_3$) | 3.80 | 0.91 | A lot |
| **Total** | **3.85** | **0.89** | A lot |

Table 43 indicates that there is a significant level of influence from the Railway Freight Transport variables on the fostering factor of railway freight transportation ($\bar{x}$ =3.85, S.D. = 0.89). The study revealed that, when Railway Freight Transport was taken into account for each factor, Railway Infrastructure had the highest average value. This factor has the potential to promote railway freight transport at a high level ($\bar{x}$ =3.93, S.D. = 0.83), Railway Performance has the potential to perform the identical ($\bar{x}$ =3.83, S.D. = 0.92), and Thailand's Infrastructure Development Strategy has the potential to conduct the same ($\bar{x}$ =3.80, S.D. = 0.91), respectively.

**Table 44 The $\bar{x}$, the standard deviation, and the level of Railway Freight Demand**

| **Railway Freight Demand** | $\bar{x}$ | **S.D.** | **Promote or Influence** |
|---|---|---|---|
| Local Economic (x4) | 3.71 | 0.84 | A lot |
| Demographic (x5) | 3.70 | 0.80 | A lot |
| Commodities (x6) | 3.44 | 0.84 | Moderate |
| Mode Choice (x7) | 3.68 | 0.95 | A lot |
| Pricing (x8) | 3.82 | 0.84 | A lot |
| Fuel price (x9) | 3.60 | 0.85 | A lot |
| **Total** | **3.66** | **0.85** | A lot |

Table 44 shows that the fostering factor of railway freight transportation is significantly influenced by the railway freight demand factors ($\bar{x}$ =3.66, S.D. = 0.85). According to the study, when the factors of local economics, demographics, mode choice, fuel price, and commodity were taken into consideration, pricing had the highest average value when it came to promoting railway freight transport at a high level ($\bar{x}$ =3.82, S.D. = 0.84). The other factors included ($\bar{x}$ =3.71, S.D. = 0.84), ($\bar{x}$ =3.70, S.D. = 0.80), ($\bar{x}$ =3.68, S.D. = 0.95), ($\bar{x}$ =3.60, S.D. = 0.85), and ($\bar{x}$ = 3.44, S.D. = 0.84), respectively.

**Table 45 The $\bar{x}$, the standard deviation, and the level of the Fostering Factors of Railway Freight Transport in Thailand**

| Factors | $\bar{x}$ | S.D. | Promote or Influence |
|---|---|---|---|
| Political (Y1) | 3.70 | 1.00 | A lot |
| Economic (Y2) | 3.73 | 0.83 | A lot |
| Sociocultural (Y3) | 3.32 | 0.76 | Moderate |
| Technology (Y4) | 3.65 | 0.97 | A lot |
| Environmental (Y5) | 3.54 | 0.89 | A lot |
| Legal (Y6) | 3.91 | 0.84 | A lot |
| **Total** | **3.64** | **0.88** | A lot |

Table 45 demonstrates how the PESTEL components have a considerable impact on the fostering factor of railway freight transportation ($\bar{x}$ =3.64, S.D. = 0.88). The study found that when it comes to promoting railway freight transport at a high level, legal variables had the greatest average value ($\bar{x}$ =3.91, S.D. = 0.84). Then come sociocultural, political, technical, economic, and environmental variables. The remaining components were as follows: $\bar{x}$ = 3.73, S.D. = 1.00; $\bar{x}$ = 3.65, S.D. = 0.97; $\bar{x}$ = 3.54, S.D. = 0.89; and $\bar{x}$ = 3.32, S.D. = 0.76.

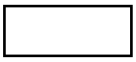
**Casual relation of fostering factor to rail freight in Thailand**

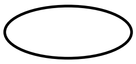
The researcher given the statistic symbols for the analyzed as followings;

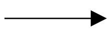
**Table 46 Statistics Symbol**

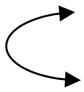
| **Symbols** | **Statistics Value** |
|---|---|
| n | Sampling |
| $\bar{x}$ | Mean |
| S.D. | Standard Deviation |
| Skewness | Skewness |
| Kurtosis | Kurtosis |
| r | Pearson Product Moment Correlation Coefficient |
| $X^2$ | Chi-square |
| df | Degree of Freedom |
| GFI | Goodness of Fit |
| CFI | Comparative Fit Index |
| RMSEA | Root Mean Square Residual |
| AGFI | Adjusted Goodness of Fit Index |
| DE | Direct Effect |
| IE | Indirect Effect |
| TE | Total Effect |
| $\alpha$ | Cronbach's alpha ($\alpha$) |
| AVE | Average Variance Extracted |
| CR | Composite Reliability |
| $\lambda$ | factor loading |
| $R^2$ | Coefficient of Determination |

The model symbols are below;

 Observed (Indicator) variable

 Latent variable

 Causal relationship



Correlation or covariance relation

 Error estimation for observed (indicator)

 Error estimation for latent

**Table 47 Symbol and variables**

| | | |
|---|---|---|
| RfrtDmnd | stand for | Rail Freight Demand |
| RfrtTpt | stand for | Rail Freight Transport System |
| Fstrfctrs | stand for | Fostering factors to rail freight in southern of Thailand |
| X1 | stand for | Railway Infrastructure |
| X2 | stand for | Railway Performance |
| X3 | stand for | Thailand's Railway Infrastructure Development Strategy |
| X4 | stand for | Local Economic Requires |
| X5 | stand for | Commodity |
| X6 | stand for | Mode choice |
| X7 | stand for | Demographic |
| X8 | stand for | Pricing |
| X9 | stand for | Fuel Price |
| Y1 | stand for | Political |
| Y2 | stand for | Economic |
| Y3 | stand for | Socio-cultural |
| Y4 | stand for | Technology |
| Y5 | stand for | Environment |
| Y6 | stand for | Legal |

**Order of Operation**

Variables related to this study were defined by constructs, explaining the concept the variable is attempting to capture, and secondly, variables were defined by how these variables will be measured. Therefore, the order of operation is Table 48 – 49 below.

**Table 48 Order of operation**

| | | |
|---|---|---|
| Railway Freight Transport System (RrtTpt) | Railway Infrastructure($x_1$) | X1.1 X1.2 X1.3 X1.4 X1.5 X1.6 X1.7 X1.8 X1.9 |
| | Railway Performance ($x_2$) | X2.1 X2.2 X2.3 X2.4 |
| | Thailand's Railway Infrastructure Development Strategy ($x_3$) | X3.1 X3.2 X3.3 X3.4 X3.5 |
| Railway Freight Demand (RfrtDmnd) | Local Economic (x4) | X4.1 X4.2 X4.3 |
| | Demographic (x5) | X5.1 X5.2 X5.3 |
| | Commodities (x6) | X6.1 X6.2 X6.3 X6.4 X6.5 |
| | Mode Choice (x7) | X7.1 X7.2 X7.3 X7.4 |
| | Pricing (x8) | X8.1 X8.2 X8.3 X8.4 |
| | Fuel price (x9) | X9.1 X9.2 X9.3 X9.4 X9.5 |

**Table 49 The Dependent (Y) variables**

| | | |
|---|---|---|
| Foster Factors of railway freight transport in Thailand | Political (Y1) | Y1.1 Y1.2 Y1.3 Y1.4 Y1.5 |
| | Economic (Y2) | Y2.1 Y2.2 Y2.3 Y2.4 Y2.5 Y2.6 |
| | Sociocultural (Y3) | Y3.1 Y3.2 Y3.3 Y3.4 Y3.5 |
| | Technology (Y4) | Y4.1 Y4.2 Y4.3 Y4.4 |
| | Environmental (Y5) | Y5.1 Y5.2 Y5.3 Y5.4 Y5.5 |
| | Legal (Y6) | Y6.1 Y6.2 Y6.3 Y6.4 Y6.5 |

**Extreme Cases of Skewness and Kurtosis**

This part, the objective was to understand the concept of skewness and to recognize its symptoms in a general manner as to whether the data can be interpreted as reliable and valid. It was evaluated that all variables with absolute values of the skew index greater than 3.0 (>3.0) seem to be described as "extremely" skewed, and the kurtosis index where absolute values greater than 10 is (>10.0) considered "extreme" kurtosis. Based on this study's frequency distributions for extreme skewness and kurtosis, all ratios are less than 3.0 (<3.0), therefore considered to be within acceptable range of normality (Table 50).

**Table 50 Frequency distribution**

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation | Skewness | | Kurtosis | |
|---|---|---|---|---|---|---|---|---|---|
| | | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Std. Error |
| X1 | 200 | 2.00 | 5.00 | 3.9256 | 0.82880 | -0.498 | 0.172 | -0.729 | 0.342 |
| X2 | 200 | 2.00 | 5.00 | 3.8313 | 0.92118 | -0.289 | 0.172 | -1.131 | 0.342 |
| X3 | 200 | 1.80 | 5.00 | 3.7980 | 0.91223 | -0.394 | 0.172 | -0.759 | 0.342 |
| X4 | 200 | 2.00 | 5.00 | 3.7133 | 0.84476 | -0.052 | 0.172 | -0.742 | 0.342 |
| X5 | 200 | 2.00 | 5.00 | 3.6983 | 0.79614 | 0.061 | 0.172 | -0.654 | 0.342 |
| X6 | 200 | 1.80 | 5.00 | 3.4400 | 0.83516 | 0.223 | 0.172 | -0.706 | 0.342 |
| X7 | 200 | 1.75 | 5.00 | 3.6825 | 0.95295 | -0.168 | 0.172 | -1.010 | 0.342 |
| X8 | 200 | 2.00 | 5.00 | 3.8238 | 0.83643 | -0.103 | 0.172 | -1.066 | 0.342 |
| X9 | 200 | 1.40 | 5.00 | 3.5980 | 0.84544 | -0.222 | 0.172 | -0.655 | 0.342 |
| Y1 | 200 | 1.00 | 5.00 | 3.6970 | 1.00371 | -0.873 | 0.172 | 0.192 | 0.342 |
| Y2 | 200 | 2.00 | 5.00 | 3.7333 | 0.82601 | 0.034 | 0.172 | -0.778 | 0.342 |
| Y3 | 200 | 2.00 | 5.00 | 3.3240 | 0.76364 | 0.442 | 0.172 | -0.135 | 0.342 |
| Y4 | 200 | 1.75 | 5.00 | 3.6538 | 0.96733 | -0.152 | 0.172 | -1.013 | 0.342 |
| Y5 | 200 | 1.40 | 5.00 | 3.5370 | 0.88915 | -0.226 | 0.172 | -0.616 | 0.342 |
| Y6 | 200 | 2.00 | 5.00 | 3.9050 | 0.83634 | -0.311 | 0.172 | -0.987 | 0.342 |

**Correlations**

The association (strong or weak) between two or more variables is referred to as correlation (Hair Jr et al., 2010). The statistical indicator of the strength of the linear link between paired variables was Pearson's correlation coefficient (r) (Table 51). For example, the significant level of technology (y4) and demographic (x7) is at the 0.01 level and the r value is 0.925, representing there is a significant positive high correlation relationship between technology and demographic. The higher the technology, the higher the demographic vice versa.

**Table 51 Correlation**

| | X1 | X2 | X3 | X4 | X5 | X6 | X7 | X8 | X9 | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X1 | 1 | | | | | | | | | | | | | | |
| X2 | .739** | 1 | | | | | | | | | | | | | |
| X3 | .694** | .714** | 1 | | | | | | | | | | | | |
| X4 | .300** | .403** | .463** | 1 | | | | | | | | | | | |
| X5 | .346** | .468** | .525** | .882** | 1 | | | | | | | | | | |
| X6 | .370** | .428** | .311** | .151* | .178* | 1 | | | | | | | | | |
| X7 | .702** | .712** | .630** | .291** | .345** | .516** | 1 | | | | | | | | |
| X8 | .688** | .719** | .727** | .425** | .496** | .462** | .675** | 1 | | | | | | | |
| X9 | .601** | .619** | .556** | .320** | .379** | .570** | .744** | .629** | 1 | | | | | | |
| Y1 | .561** | .446** | .729** | .544** | .578** | .211** | .596** | .517** | .493** | 1 | | | | | |
| Y2 | .279** | .395** | .497** | .881** | .848** | .167* | .306** | .413** | .355** | .544** | 1 | | | | |
| Y3 | .336** | .426** | .230** | .174* | .176* | .671** | .496** | .394** | .585** | .196** | .144* | 1 | | | |
| Y4 | .714** | .693** | .593** | .303** | .318** | .455** | .925** | .633** | .693** | .603** | .249** | .518** | 1 | | |
| Y5 | .609** | .586** | .480** | .313** | .343** | .474** | .741** | .604** | .872** | .542** | .276** | .643** | .796** | 1 | |
| Y6 | .774** | .779** | .774** | .415** | .474** | .422** | .720** | .893** | .641** | .506** | .402** | .372** | .708** | .604** | 1 |

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

**Data analysis and model testing to answer research hypotheses**

**The Measurement Analysis of Construct Validity**

The two-step procedure was used to test the proposed structural regression model. According to the two-step rule, in order to evaluate a structural regression model, it is necessary to first identify the measurement factor of the model and then the structural aspect.

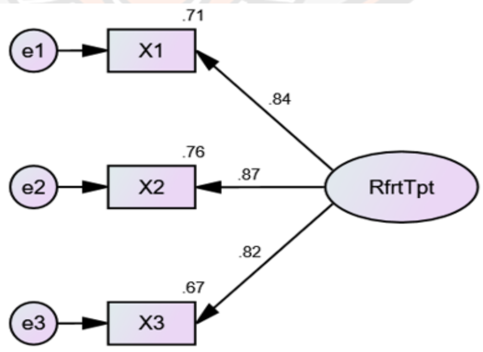
In order to verify that the model is consistent with empirical data, this research aims to construct a model by examining the structural connection patterns of each aspect that support rail freight transportation in Thailand. Examine the following elements that have a direct, indirect, and overall impact on the promotion of rail commodities in Thailand. This is a variable that has unobserved features and cannot be measured.

**Measurement Model**

An assessment of the measurement model to determine whether the indicators can theoretically explain the latent variables that emerge from measuring construct variables. There are things to be considered: reliability of variables, construct validity, convergent validity, and differential validity of the analysis of factors promoting rail freight transport in Thailand. This study used the Confirmatory Factor Analysis (CFA) technique of factor analysis since it enabled the author to test the hypothesis that there is, in fact, a relationship between the observed variables and their underlying latent constructs (Schreiber, Nora, Stage, Barlow & King, 2006). This section will provide and explore more information on CFA.

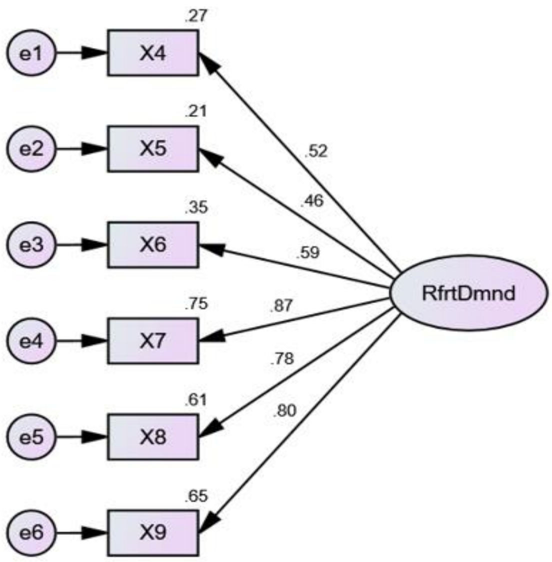
Following, the author presents the depicts the construct model of the rail freight transport system, the rail freight demand, the fostering factors to rail freight of Thailand, and the summary of the model.

Figure 30 depicts the model for the construct of rail freight transport system. The standard regression weight between 0.82 -0.87. Between three items, the item X2 (Railway Performance) was the item most highly loading on this construct, with confidence in one's factor influence aspect defining the rail freight transport system. Then, it is mean the conceptual framework is consistent with empirical data.




Chi-square = .094, df = 1, P-value = .759, Chi-square/df = .094,
CFI = 1.000, GFI = 1.000, AGFI = .998, IFI = 1.003, NFI=1.000, TLI=1.008,
RMR=.015 , RMSEA = .000

**Figure 30 The measurement model for rail freight transport system**




Chi-square = .106, df = 1, P-value = .745, Chi-square/df = .106,
CFI = 1.000, GFI = 1.000, AGFI = .996, IFI = 1.001, NFI=1.000, TLI=1.018,
RMR=.008 , RMSEA = .000

**Figure 31 The measurement model for rail freight demand**

Figure 31 depicts the model for the construct of rail freight demand. The standard regression weight between 0.46 -0.87.

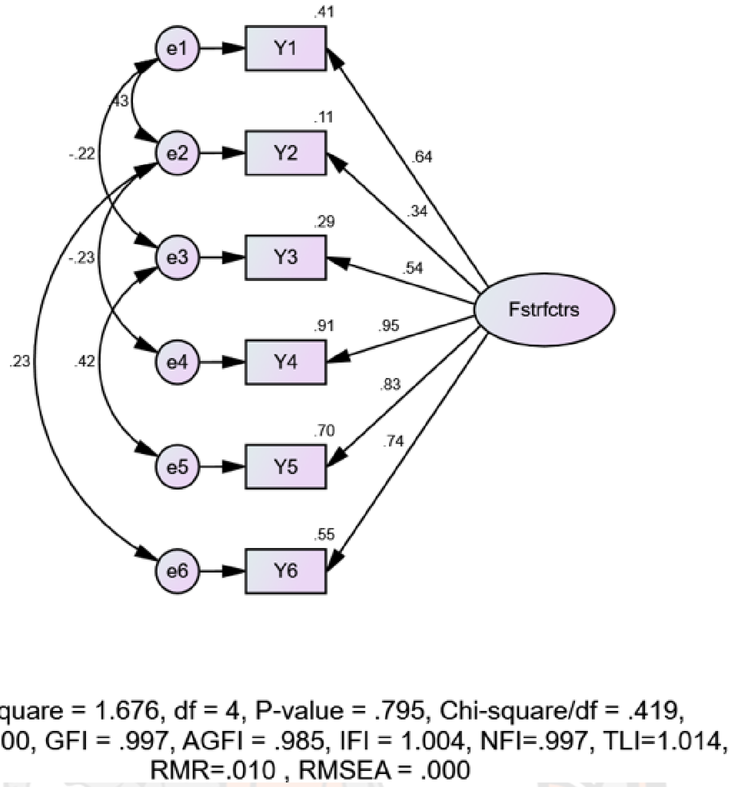



**Figure 32 The measurement model for fostering factors to rail freight in Thailand**

Figure 32 depicts the model for the construct of fostering factors to rail freight in Thailand. The standard regression weight between 0.34 -0.95.

The fit indices, as shown in Table 52, indicates that for the fit indices, the number of latent variables is directly related to degrees of freedom (df). The values of three indices-CFI, GFI and RMSEA-include the df term that penalizes their values. This study 0.9 or above for CFI and GFI and .05 or below for RMSEA.

**Table 52 Confirmatory Factor Model Fit Indices**

| | Chi-square | df | CFI | GFI | RMSEA |
|---|---|---|---|---|---|
| Railway Freight Transport System | .094 | 1 | 1.000 | 1.000 | .000 |
| Railway Freight Demand | .106 | 1 | 1.000 | 1.000 | .000 |
| Fostering Factors of Railway Freight in Thailand | 1.676 | 4 | 1.000 | 1.000 | .000 |

**Construct Validity and Reliability**

The first stage in ensuring the validity and reliability of the construct is to assess internal consistency using Cronbach's alpha (α) and composite reliability (CR). Table 40 illustrates that the α values range from x1 to y6, and the CR spans from 0.814 to 0.887, both of which are over the acceptable standards. The validity of the construct was evaluated using convergent validity and discriminant validity techniques, the CFA factor loading range from 0.431 to 0.881, and the AVE values range from .539 to .724, with all being greater than 0.5 (Ab Hamid, Sami, & Mohmad Sidek, 2017). Additionally, the factor loading (λ) for all constructs in the measurement model were found to be highly significant ($p<0.001$) and surpassed 0.3 (As general rule of thumb>0.3). The coefficient of determination ($R^2$) values represents the effect size, which is the strength between dependent and independent variables. Therefore, the model's strength is further established with $R^2$ values of 0.148 to 0.983. As regards the model, all the variables' coefficients are statically significant at the 95% confidence level.

**Table 53 The Analysis Results of Construct Indicators Validity**

| Constructs | Indicators | α | AVE | CR | $R^2$ | λ |
|---|---|---|---|---|---|---|
| Railway Freight Transport System | | 0.960 | 0.724 | 0.887 | - | |
| | X1: Railway Infrastructure | | | | | 0.858 |
| | X2 Railway Performance | | | | | 0.871 |
| | X3: Thailand's Railway Infrastructure Development Strategy | | | | | .823 |
| Railway Freight Demand | | 0.950 | 0.539 | 0.814 | 0.875 | |
| | X4: Local Economic | | | | | 0.431 |
| | X5: Demographic | | | | | 0.484 |
| | X6: Commodity | | | | | 0.493 |
| | X7: Mode Choice | | | | | 0.820 |
| | X8: Pricing | | | | | 0.826 |
| | X9: Fuel Price | | | | | 0.785 |
| Fostering Factors of Railway Freight | | 0.958 | 0.591 | 0.844 | 0.983 | |
| | Y1: Political | | | | | 0.568 |
| | Y2: Economic | | | | | 0.432 |
| | Y3: Socio-cultural | | | | | 0.497 |
| | Y4: Technology | | | | | 0.880 |
| | Y5: Environment | | | | | 0.881 |
| | Y6: Legal | | | | | 0.799 |

*Note* all values (*p<0.001)

$X^2$=37.168, df=27, Chi-square/df = 1.377, CFI=.997, GFI=.976, AGFI = .895, TLI = .988, RMR = .029, RMSEA=.044

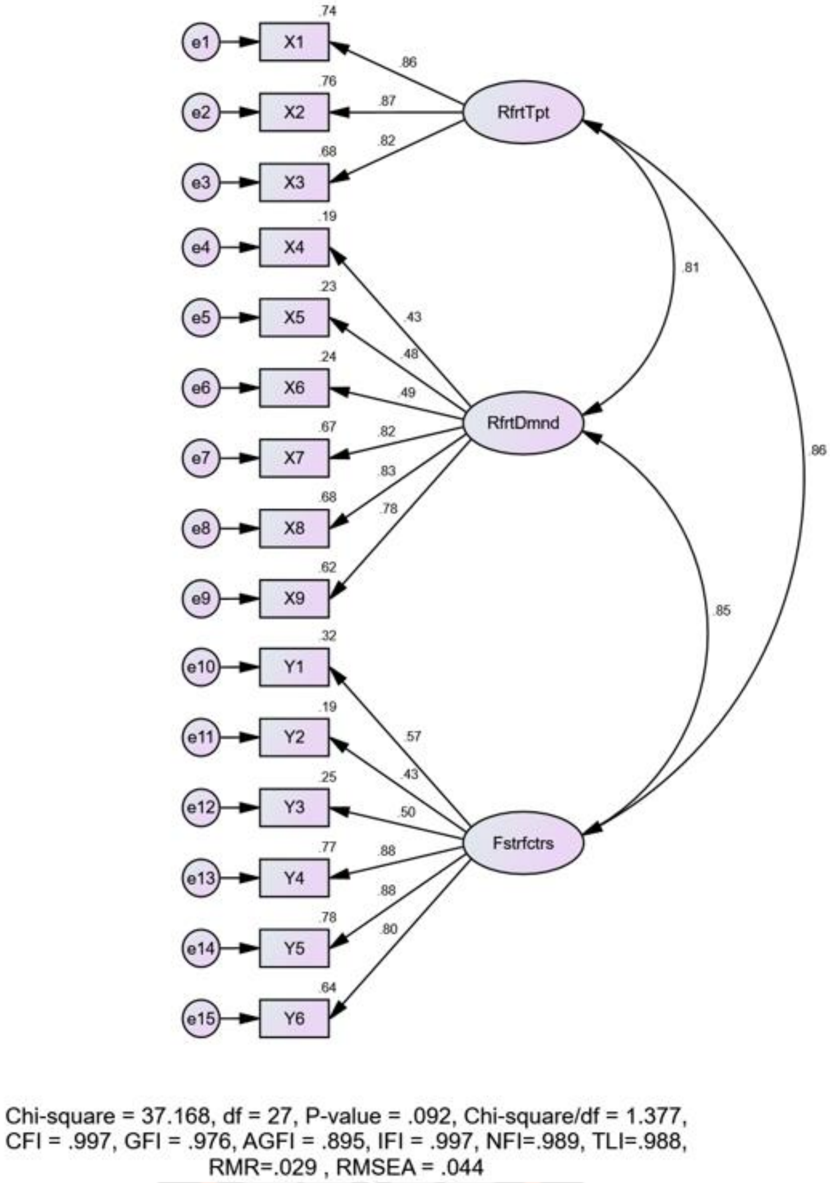



**Figure 33 The Construct Measurement Model**

**Data analysis according to research hypotheses**

The researcher has analyzed the pattern of causal relationships between the causal factors of the railway freight transport system and the demand for railway freight transport and factors that promote railway freight transport in Thailand, including qualitative research results. Therefore, the researcher can develop a model in the form of structural equations using a ready-made statistical analysis program as shown in the illustration below.

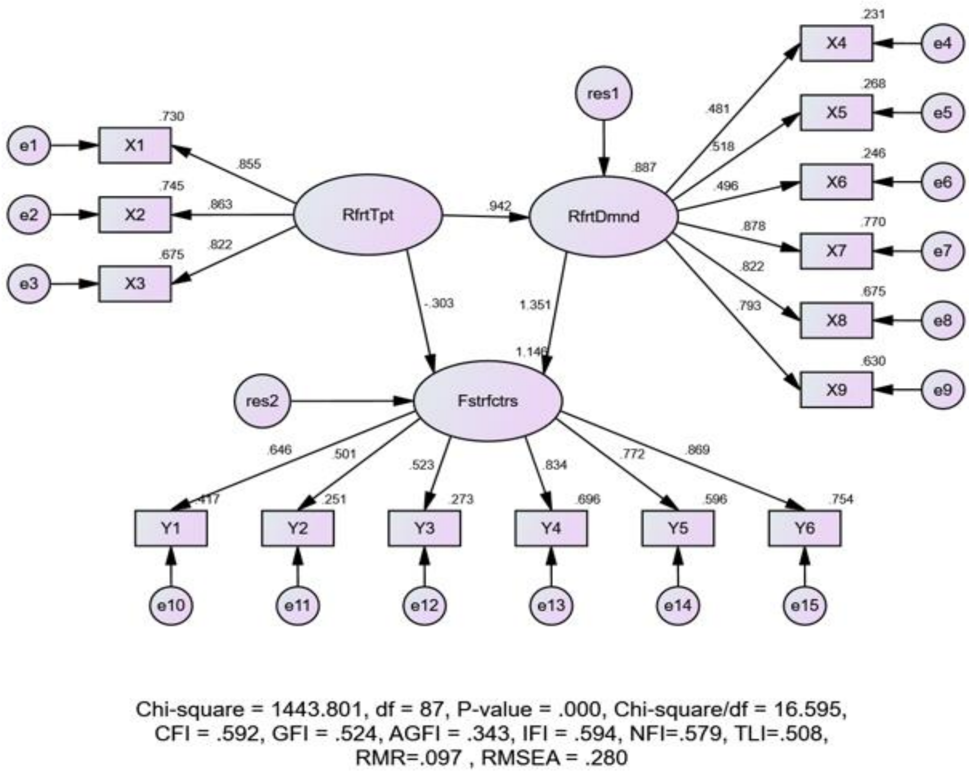



**Figure 34 SEM before modification**

From Figure 34, analysis of the model before adjusting the model and the harmony of the overall model found that the proportion of sanity, square file statistic, and degree of freedom were equal to the point, which did not pass the specified criteria. is less than 3 group indexes set at a level greater than or equal to 0.9. It was found that every index, namely NFI equal to 0.91, CFI = 0.592, passed the criteria but the index GFI = 0.77, AGFI= 0.343 which did not pass the criteria, while the index that set at a level less than 0.08, it was found that the model before adjustment had an index value of RMR = 0.097 and an index value of RMSEA = 0.280, which did not pass the criteria specified to have a value of not less than 0.08. It can be concluded that the structural model of causal factors: the factor structure model that fostering factor to rail freight in Thailand before adjusting the developed model is not as harmonious with the empirical data as it should be.

The researcher proceeded with adjusting the model to make it more harmonious by considering the index values, recommending adjustments and allowing the error values of the observed variables in the structural equation model to be related to each other. considering theoretical principles and it is possible to discuss the results, which from adjusting the model has added relationships and cut data until the proportion of the qui square statistic if the degree of freedom is less than 3. The results of the analysis can be displayed as in the table below.

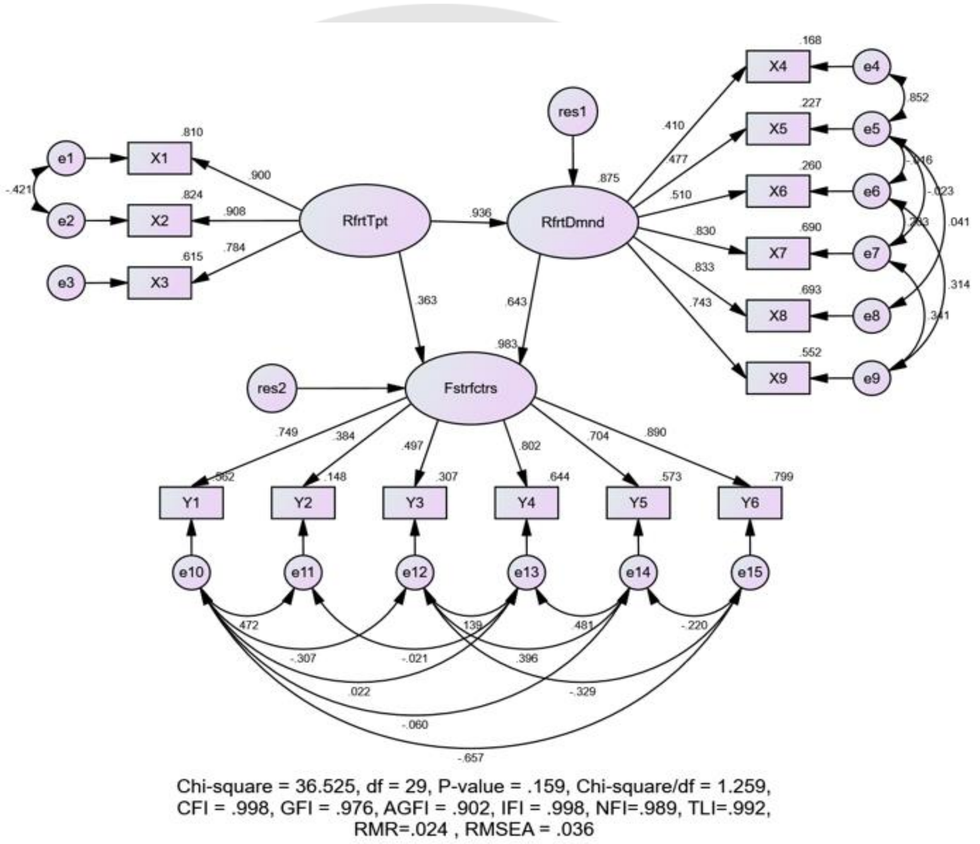



**Figure 35 SEM After modification**

From the illustration of the structural equation model of factors that affect the factors that promote railway freight transport in Thailand after adjusting the model for the harmony of the overall model, it is found that the proportion of the Chi-square statistic if the degree of freedom is equal to 1.29. which is less than 3,000 criteria that set the group index at a level greater than or equal to 0.90. It was found that every index was CFI = 0.998, GFI equal to 0. 902, IFI = 0.998, NFI = 0.989 and TLI = 0.992 and found that RMR = 0.24 and RMSEA = 0.032, which is less than 0.08, pass the same criteria. Therefore, it can be concluded that the structural equation model of causal factors, the structural equation model of fostering factor to rail freight in Thailand, as shown in the figure above.

Consideration of the structural equation model of factors affecting rail freight transport in Thailand by considering the harmony of the results in the structural model. It was found that the efficiency of the factors promoting railway freight transport.

It was found that the efficiency of the railway transport system and the demand for rail transport of goods to the fostering factor to rail freight in Thailand has a $R^2$ of 0.983 or 98.3%, which has a value from 80% or more, and it was also found that the demand for on railway freight transport and the railway freight transport system are accurate because there is a relationship value of $R^2$ equal to 0.875, or 87.5%, with the ability to predict demand for transporting goods on railway and the fostering factor to rail freight in Thailand.

After we found the harmony of the structural equation model, next, we predict the variables in the model.

The objective of this quantitative portion of the study is to examine the predicted connections between the variables. Which independent factors have a direct impact on the dependent variable and which intervening variables have an indirect impact on the dependent variable are investigated. The dependent variable may be positively or negatively affected by the independent variable. Depending on how significant the variable is in a cause-and-effect connection, it might be completely distinct. For this reason, a causal influence analysis model is used in this situation analysis. Whereas, the path analysis is the statistic used to examine the direct and indirect effects of independent factors on the dependent variable. The study makes utilizes a broad range of statistics. Four hypotheses have already been established for this study based on the idea analysis and examination of relevant literature and research theories below.

Hypotheses 1(H1): The railway freight transportation system has a direct effect on railway freight demand.

Hypotheses 2 (H2): The railway freight transportation system has a direct effect on the factors fostering railway freight transport in Thailand.

Hypotheses 3 (H3): The railway freight demand has a direct effect on the factors fostering railway freight transport in Thailand.

Hypotheses 4 (H4): The railway freight transportation system has an indirect effect of fostering factors of railway freight transport in Thailand via railway freight demand.

Table 54 depicts the path coefficients for the hypothesized relationships within the proposed research model.

**Table 54 Hypotheses Test Results**

| Path/ Hypotheses | | Path Coefficients ($\beta$) | Direct Effect (DE) | Indirect Effect (IE) | Total Effect (TE) | Degree of Influence | Result |
|---|---|---|---|---|---|---|---|
| RfrtTpt → RfrtDmnd | H1 | 0.936 | 0.936 | - | 0.936 | Very high | Supported |
| RfrtTpt → Fstrfctrs | H2 | 0.363 | 0.363 | - | | | Supported |
| RfrtTpt → RfrtDmnd → Fstrfctrs | H4 | 0.602 | | 0.602 | 0.965 | Very high | Supported |
| RfrtDmnd → Fstrfctrs | H3 | 0.643 | 0.643 | - | 0.643 | Moderate | Supported |

Table 54 shows the correlation coefficients, all paths were significant at $p < 0.05$, and the test results showed that the Rail Freight Transport (RfrtTpt) had a positive very high influence and statistically significant on Rail Freight Demand (RfrtDmnd) ($\beta$ =0.936) supporting H1.

The influence of Rail Freight Transport (RfrtTpt) had a positive influence and statistically significant on Fostering Factor to Rail Freight in Thailand (Fstrfctrs) ($\beta$ =0.363) supporting H2.

In additional, the Rail Freight Transport (RfrtTpt) had a significant indirect effect on the Fostering Factor to Rail Freight in Thailand (Fstrfctrs) indirect via the Rail Freight Demand (RfrtDmnd) with ($\beta$ =0.602) supporting H3.

Lastly, the Rail Freight Demand (RfrtDmnd) were positively and statistically significant for the Fostering Factor to Rail Freight in Thailand (Fstrfctrs) ($\beta$ =0.643) Supporting H4. Then, all four hypotheses were supported in the model.

In summary, all of the indices were within an acceptable range following model refining. In addition, the structural model's results showed that each relationship that had been proposed were supported.

**Results of hypothesis testing according to SEM**

The researcher discussed the results of data analysis based on the following assumptions.

*Hypotheses 1(H1) The railway freight transportation system has a direct effect on railway freight demand.*

The results show that the railway freight transport system has a positive direct influence on railway freight demand with a standardized influence coefficient equal to 0.936. When testing the economic significance of the influence coefficient, it was found that the influence coefficient was Statistically significant at the 0.05 level, this research result therefore supports research hypothesis number 1.

*Hypotheses 2(H2) The railway freight transportation system has a direct effect on fostering factors of railway freight transport in Thailand.*

The railway transport system has a positive direct influence on the factors promoting railway freight transport in Thailand with a standard coefficient of influence equal to 0.363. When testing the statistical significance of the coefficient of influence, it was found that the coefficient The influence is economically significant at the 0.05 level. Therefore, the results of this research support research hypothesis number 2.

*Hypotheses 3(H3) The railway freight demand has a direct effect on fostering factors of railway freight transport in Thailand.*

The results of the research found that the demand for railway freight transport has a positive direct influence on the factors promoting line freight transport in Thailand with a statistical influence coefficient of 0.643 and a statistical significance coefficient of influence at the level of 0.05. The results of this research therefore support research hypothesis number 3.

*Hypotheses 4(H4) The railway freight transportation system has an indirect effect on fostering factors of railway freight transport in Thailand via railway freight demand.*

The results show that the railway freight transport system has a positive indirect influence on factors promoting railway freight transport through railway freight demand with a standardized influence coefficient equal to 0.602 when testing the significance of railway freight. Statistics on the influence coefficient reveal that the influence coefficient is statistically significant at the 0.05 level. Therefore, the results of this research support Hypothesis 4.

**Suggestion from respondents**

To request additional suggestions from respondents in the research, which was an open question, content analysis was used. There was a total of 32 respondents expressing opinions from a sample of 200 people, which can be shows according to each aspect as shown in Table 55.

**Table 55 Comments or Suggestions from the respondents**

| Number | Business Type | Comments or Suggestions |
|---|---|---|
| 1 | LSP | The economy and national competitiveness depend on the acceleration of international railway connection, which has an impact on the amount of railway freight movement. |
| 2 | Manufacturing | For suppliers, railway transportation ought to be an attractive option provided it offers competitive pricing, high quality, temperature-controlled containers, and a reliable access system. |
| 3 | Manufacturing | Railway networks generally have the potential to reduce transportation costs, especially for long-distance trips. In addition to having more environmental standards and fewer limitations than |

| Number | Business Type | Comments or Suggestions |
|---|---|---|
| | | vehicles, railway transportation can also lower overall accident rates, particularly when it comes to the transportation of big products. |
| 4 | Manufacturing | 1. The ICD station, which includes the distance between the ICD and the customer, and the quantity of containers (carriages) in accordance with the transit volume.<br>2. The work force at the destination and the transport machinery, such as the crane and forklift. |
| 5 | Manufacturing | Sea transportation is used by the majority of our organization. since the transportation is decided upon by the client directly. As such, our expertise with railway transportation is somewhat limited. When it comes to reservations in and out, sea transportation can accommodate big volumes of products at once. Sometimes a product issue may be fixed, even if it doesn't deliver the goods as soon as the consumer bought it or has other issues. There is not much need for railway transportation. The product may not be compatible due to different transportation considerations. |
| 6 | Manufacturing | Road transportation will be reduced since operators can transport massive loads by railway. However, the way train services operate at the moment makes it unattractive. When the high-speed or double-track railway is completed, transportation will be more convenient. To be able to convey a range of items, it could be required to enhance the flow of goods from each station. |

| Number | Business Type | Comments or Suggestions |
|---|---|---|
| 7 | Manufacturing | The method for transporting freight by railway is not yet widely used. An association for freight transport network management should be formed (railway transport), and the network should be explicitly controlled. |
| 8 | LSP | The staff at SRT seldom meets deadlines and infrequently gives advice or support. It's not always easy to get in touch and ask questions. |
| 9 | LSP | In our roles as a freight forwarder, ship agency, and airline, we operate on two railway systems:<br>1. BKK-MY, which is now unutilized since it takes roughly the same amount of time as a ship and has more complicated customs processes than a ship.<br>2. LCB-ICD Lat Krabang, we truly appreciate this service, but there aren't enough trains to accommodate the quantity of containers, so we also have to utilize expensive road transportation. In order to lower the cost of transportation—both domestically and internationally—our manager is interested in using railway. The railway might develop ICD for multimodal transportation, or it could contract with private businesses to distribute goods and offer ICD services in that province. |
| 10 | LSP | SRT has to update its infrastructure and change the way it provides services in order to continue being useful. It's not akin to there are no rivals, advancements, or efforts being made against national objectives. Any initiative taken is comparable to burning straw and not being taken |

| Number | Business Type | Comments or Suggestions |
|---|---|---|
| | | seriously. There will be a large number of attendees at the press conference, but very little and slowly will happen in the real world. Foreign systems and a variety of rules take time to change. Railway transportation is the primary mode of transportation used worldwide; nevertheless, what is the proportion of railway transportation in Thailand? It's tiny. Why? Further research on this is required. |
| 11 | Manufacturing | The cost of transportation should be addressed by railway and sea; however, their viability will rely on the nature of the commodities and the mode of transportation that best matches them and facilitates convenient access to minimize the need for road traffic. |
| 12 | Manufacturing | Because our business mainly focuses on transportation by ship and road. It may lead to little knowledge and understanding about railway transportation. |
| 13 | LSP | Like the Highway Department, ask the SRT to handle just the hardware-related station repairs and track maintenance system. Allow the private sector for rental a locomotive and operate it on its own, manage its own marketing, and maintain the lines for the advantage of the private sector. Because government agencies are highly corrupt and ineffective, stop marketing railway operations through the Railway Department, Department of Railways, or other agencies of the government. |
| 14 | LSP | There are major issues with train transit at the |

| Number | Business Type | Comments or Suggestions |
|---|---|---|
| | | border, including operational delays and inadequate CY equipment to support the development of railway transport, which frequently results in a three- to four-day wait. Taking the ship is more economical than traveling by land, allows you to plan your arrival time precisely, and receives less media attention. |
| 15 | Manufacturing | Is transporting steel 6 meters, 9 meters, 12 meters by railway really worth it? Is it less of a hassle than the road? |
| 16 | Manufacturing | A piggyback transportation system should be in place, which allows for the option to load an entire vehicle onto a train. The products can be transported straight to the recipient's hands without needing to be unloaded from the car when it gets to the destination station. |
| 17 | Manufacturing | Let the government truly address the border transit issue in Sadao District, including both the Sadao Checkpoint and Padang Besar. Politicians are not doing their duties, they have no voice, and they are only interested in making money, which is why there are a lot of traffic jams and problems for people. |
| 18 | Manufacturing | Like China and other nations, I want Thailand to support railway freight transportation. It is also stable as it will let people to travel wherever in Thailand and, concurrently, foster a strong logistics network and a robust economy. |
| 19 | LSP | 1. To utilize railway transportation, there has to be |

| Number | Business Type | Comments or Suggestions |
|---|---|---|
| | | significant support from the government and transportation providers.<br>- A set up, contemporary infrastructure that reaches every major city or area in every region.<br>- Discounts and freight costs to entice business owners to utilize big amounts without the government having to invest or suffer initial losses. It is preferable to have few participants or not turn a profit right away than to have fixed expenses, like the railway's upkeep, that need to be covered.<br>- Indirect advantages might include lower pollution levels and total product cost savings. 2. During the initial phase, only Thai businesses could operate; foreigners may not utilize this to support Thai companies. 3. Restructure the SRT by transferring services from officials to a fast-moving, decision-making private sector model. There have been a lot of delays and disgustingly high levels of politics inside the corporation. |
| 20 | LSP | The management of truck and railway transportation currently involves a number of work processes, such as loading goods onto trucks, unloading it at the station, placing it on the railways, and discharging it from the vehicles. Small business owners are less interested in this since some operations require careful consideration of time, and the overall costs of each point are the same as if they were carried out by truck alone. Railway transport makes sense for those operators who am able to accumulate enough |

| Number | Business Type | Comments or Suggestions |
|---|---|---|
| | | goods for a single train. |
| 21 | Manufacturing | Railway freight delivery contributes to time management, lower traffic accident rates, and increased safety. |
| 22 | Manufacturing | Since railway transit is more cost-effective than other modes of transportation and is incredibly safe and convenient, it should have explicit transportation regulations. |
| 23 | Manufacturing | It is crucial to select a container yard location before putting cargo onto trains as it will impact how long it takes to load cargo. For instance, if the site is poorly designed and the access line is problematic. |
| 24 | LSP | This is due to the fact that there is still very little railway-based cargo transportation. The loading and unloading process takes time, and there aren't many connecting points. In addition, prices are still inconsistent with the shipping system. It is not consistent with the customer group of Barge Port, a private port that may have one-stop service in the same place with CFS cargo, containers, and barges in one place. This is more convenient than taking a train to catch the mother ship at Laem Chabang Port. |
| 25 | LSP | - Assistance from the government is required.<br>- The railway system has to be updated to be more contemporary.<br>- The private sector requires to contribute together. |
| 26 | Manufacturing | For operators, railway transportation significantly lowers transport costs. However, a significant |

| Number | Business Type | Comments or Suggestions |
|---|---|---|
| | | barrier to the viability of railway transportation is the SRT's incapacity to deliver services. |
| 27 | LSP | It could be able to enhance the railway transport point by connecting with the current land transport point to build a comprehensive link and make use of existing resources if the effort to lower the cost of moving products in the suburbs (auto transport) is not as successful as it should be. Maximum efficiency since there is no traffic on the railways when automobiles are not allowed to enter or exit the city. |
| 28 | LSP | Railway transport system<br>- Reduce freight costs.<br>- Accelerate the completion of the double-track project.<br>- Improve Road transport laws, such as increased cargo weight specifications, to reduce transport costs.<br>- Change from gasoline-powered cars to EV cars.<br>- The government provides funding and has a policy to reduce interest rates for logistics businesses.<br>- Hurry and push for the creation of the Department of Railways faster.<br>- SRT's service provision from executives to employees should be improved.<br>- Should push for a policy to change to high-speed locomotives. |
| 29 | Manufacturing | To reduce expenditures, a research and effective railway system development are necessary. Cutting |

| Number | Business Type | Comments or Suggestions |
|---|---|---|
| | | back on government spending and establish a local economy. |
| 30 | Manufacturing | - To lower corporate expenses, a more developed economy and more tangible progress are required.<br>- The railway system is causing reluctance among the private sector. The target station's arrival time is still unpredictable and slow.<br>- The private sector favors using reputable shipping firms like Thailand Post for transportation.<br>- Chiang Mai need inexpensive railway service for visitors. |
| 31 | Manufacturing | It is very appropriate to use 5 layers (main factors) to determine the construction of future infrastructure. |
| 32 | LSP | - Increase the number of locomotives, railway cars, and personnel for freight cars.<br>- It cannot compete with ships due to high freight charges. |

**Focus Group Discussion**

In this section, overall quantitative research findings from the key stakeholders, primary stakeholder and secondary stakeholders will be discussed to answer the research questions below:

Our investigation is answering the research questions below:

1. Will railway freight transport increase to 10% after the double-track railway project is completed or not?

2. Where does the railway freight demand to shift from road to railway come from?

3. What are the fostering factors for encouraging and motivating long-term growth in railway freight transportation in Thailand?

Finding from this phase of the study will be merged with the results derived from the quantitative study to give a sounder explanation of the opinions of the railway freight demand factors which boosting the railway freight traffic in Thailand.

**Profile of the focus group participants**

Table 56 shows that a total of eight key informants in focus group discussions were conducted, with three from manufacturing and five from LSP, two from Bangkok, three from Eastern, and one each from Northern, Northeastern, and Southern. No real name will be used throughout the study as part of the agreement before the discussion.

Conducting the focus group with the following primary goals in mind was to thoroughly examine the study questions and objectives. In addition, to get feedback on the railway freight transportation infrastructure, the need for railway freight, and the factors that support railway freight growth in Thailand.

**Table 56 Participants from focus group discussion**

| Number | Business Type | Location/Region | Gender |
|---|---|---|---|
| 1 | Manufacturing: Rubber | Southern | Male |
| 2 | Manufacturing: Sugar | Northeastern | Female |
| 3 | Manufacturing: General product | Bangkok | Male |
| 4 | LSP | Bangkok | Male |
| 5 | LSP | Northern | Female |
| 6 | LSP | Eastern | Male |
| 7 | LSP | Eastern | Male |
| 8 | LSP | Eastern | Female |

**1. Will railway freight transport increase to 10% after the double-track railway project is completed or not?**

This is a collection of information providers who have and have not utilized railway freight transportation. The majority agreed that more freight transportation would be possible if the seven urgent double-track railway lines were built, but not sure if it will reach 10% or not.

…If you do it to your full potential, it will work because the train makes better time than the ship. It will make product stock management better. It should increase, but it may not reach 10%.

(Focus Group Participant, No. 1, January 25, 2024)

…If the government can follow the plan to increase the double-track railway. It will be another choice mode to choose in choosing the transportation of goods. Because in the end it depends on what the customer wants. And if demand arises, we can adjust in the future. Must according to customer requirements. It might not be door-to-door. "I'm not sure if it will receive 10% or not, but maybe it will increase.

(Focus Group Participant, No. 2, January 25, 2024)

…We have to wait and see the efficiency of railway freight transport first.

(Focus Group Participant, No. 3, January 25, 2024)

…Should be added if connection mode isn't a problem.

(Focus Group Participant, No. 6, January 25, 2024)

…Freight operators must make new preparations to keep up with train operations. I am not sure if it will increase or not, but definitely not in the next 1-2 years.

(Focus Group Participant, No. 7, January 25, 2024)

The others said there may be an increase, but they needed to wait and see since they weren't sure. *Then the researcher continues asking,*

**“So how do we increase it up to 10%?”.**

> …It's not possible to accommodate a lot of containers in time. Bring in a lot of containers, and you won't be able to get the ships out in time. There is not enough train carriage, and there is no problem with the tractor or locomotive. There is only a notification that the line will be closed.
>
> (Focus Group Participant, No. 1, January 25, 2024)

> …Nong Ruea has no train passing through, only container trucks. "This kind of policy creates more connections if you go to Nong Ruea or closer." "Customer needs are important; they want door-to-door. By continuing to pilot the train, customers may have the opportunity to use it.
>
> (Focus Group Participant, No. 2, January 25, 2024)

**2. Where does the railway freight demand to shift from road to railway come from?**

Verification of information gathered in the past from key stakeholders, primary stakeholders, and secondary stakeholders on the circumstances that led to the shift from road to railway as the mode of freight transportation.

> …Cheaper costs are highly possible. If the structure is full, the performance will be better. Importantly, it's cheaper than the road and the ship will shift the mode more.
>
> (Focus Group Participant, No. 1, January 25, 2024)

> …"Infrastructure" The existence of a network that connects to Nong Ruea is crucial. Efficiency, no delays, and more double tracks are available. Customers from traffic jams into central Bangkok, in my opinion, will utilize it because of its restricted hours. The railway has a limited amount of time,

minimal accidents, and ready-to-use equipment, then more clients will start embracing it."

(Focus Group Participant, No. 2, January 25, 2024)

…By railway transport, transportation costs should be cheaper than by road, reducing the cost of transporting goods and transporting large quantities, reducing the cost of product prices, and increasing competition.

(Focus Group Participant, No. 3, January 25, 2024)

…Railway service channels are quite limited. If you invest, you must invest to meet your needs. Both in terms of transporting goods and mass transit because of the high cost of construction. Transportation is not convenient for common people. Will be suitable for B2B businesses

(Focus Group Participant, No. 4, January 25, 2024)

…Price and time

(Focus Group Participant, No. 5, January 25, 2024)

…Price, total cost, time, connections in each mode, connection at SRTO.

(Focus Group Participant, No. 6, January 25, 2024)

…Road congestion, time and total cost.

(Focus Group Participant, No. 7, January 25, 2024)

…Customers see the importance of saving money and time and reducing global warming.

(Focus Group Participant, No. 8, January 25, 2024)

**3. What are the fostering factors for encouraging and motivating long-term growth in railway freight transportation in Thailand?**

PESTEL was utilized in this investigation. a model for data analysis on outside variables that promotes Thailand's railway freight transport volume to grow.

> …Focusing on the advantages, many customers will place more importance on saving the world. Rubber customers like Michelin will look at the process from upstream to downstream. How much substance is added to the water process? Until the release of gas was his organization's green book. Well, it's a good thing if it can actually be done.
>
> Among the 6 factors in PESTEL, one environmental issue is important. The country's economic issues cause rubber production to decline. The price of rubber in our country is higher than neighboring countries such as Malaysia and Indonesia. The whole world will turn to buy in Malaysia and Indonesia. In terms of quality, they are not different, but they are different in price. On the customer side, quality measures are already in place. The grade of rubber is clear, but the price will be higher, causing us to have less market share.
>
> (Focus Group Participant, No. 1, January 25, 2024)

> …Think of the factors mentioned above if the organization reduces pollution. Improved image and CSR in itself, reduce railway pollution and reduce accidents. When the law is supported, it is thought that it is a good thing to use.
>
> (Focus Group Participant, No. 2, January 25, 2024)

> …The clarity of the policy, concrete transportation plan will be a factor in the success of railway transportation. It can share market share in choosing the services of those interested in the logistics business.
>
> (Focus Group Participant, No. 6, January 25, 2024)

> …The most important thing is government policy and law, if it is not there, it will allow the private sector or related agencies to play a role in investing in road transportation development. And if there are no factors in proper rules and regulations, other factors will hardly be possible in Thailand. Therefore, laws that create important policies and cooperation between the public and private sectors will not be able to emerge and succeed. Therefore, government policies and laws should benefit the private sector that can play a role in investing in transportation to make the country have a railway transportation system.
>
> (Focus Group Participant, No. 7, January 25, 2024)

The others said the expansion of railway freight transport in Thailand is seen to be dependent on several factors. Including transportation efficiency, time, frequency, safety, comprehensive structure, connection, and regulations that foster competition while promoting this means of transportation.

# CHAPTER V

# CONCLUSIONS

The goal of this chapter is to go over the summary results from both the research objectives. The study's contributions will be examined in terms of their implications for theory and practice, going beyond the overview. Lastly, it will be explored where future research should go in order to keep improving the current state of progress. Therefore, firstly the researcher would like to present a summary of the research results summary according to the following research objectives.

## 5.1 Railway Freight modal shift from road to railway in Thailand

The study investigating into the demand for railway freight boost in Thailand in order to shift from road to railway transportation. Following an analysis of the demand for railway freight along Thailand's four railway lines, data collection and literature review revealed that the government's objective, which is to transfer from road to railway freight transportation in 2027, 2032, and 2037, can be summed up as follows:

1. The NESDB and government have set goals of boosting railway freight transportation volume to 7%, 8%, and 10% in 2027, 2032, and 2037. According to the study findings, the railway system is required to transport 46,996.65 thousand tons, 62,265.14 thousand tons, and 90,227.95 thousand tons of cargo, in that order.

2. The study's findings revealed that, of the top 50 items with the largest volume of goods transported in Thailand and the list of goods appropriate for railway transportation, the railway system could carry 16 more items in addition to the initial 12 that it transported

3. It is possible to calculated the number of products transported annually by examining each commodities cargo item in terms of its location of production, domestic distribution, and export. Beyond the NEDSC and the Thai government’s target, in 2027, 2032, and 2037, the railway system will be able to carry 70.37%,

68.49%, and 61.07% of goods, respectively. The average percentage of freight transit volume for the northern, northeast, eastern, and southern lines was determined to be 13%, 35%, 18%, and 34%, accordingly (Table 12, Page 50).

4. The following is a list of key items that will be extra-transported on each line:

*Northern Line*: Two major items that are currently being delivered along the northern line are rubber and crude oil. In the foreseeable future, goods such sugar, cement, and fertilizers may be transported.

*Northeastern Line:* The Northeastern Line, Salt, petroleum products, and cement are important items being carried. In the near future, additional goods that could be carried are rice, machinery and parts, and motor vehicles and parts.

*Eastern line*: Food cans and food processing, drinks, motor vehicles and parts are among the commodities that may be carried in the near future. Currently, the majority of the cargo being transported is containers.

*Southern line:* A significant commodity that is now being transported via the southern line is rubber. Other commodities that could be delivered soon include wood products, food cans and food processing, and steel products.

**5.2 Fostering Factors to railway freight growth in Thailand**

The following was discovered by mixed study examining the factors that promote the growth of railway freight in Thailand with the participation of key, primary, and secondary stakeholders:

*The* key stakeholders prioritized railway freight transport infrastructure, which was followed by the railway service providers' public relations about the construction of new railway infrastructure, and the services provided by the various railway services. Furthermore, it was shown that key stakeholders valued the relevance of rules and regulations.

Although the primary stakeholder considers that rail infrastructure has the greatest impact on the growth of rail freight, other factors that will support the shift from road to rail from their perspective include legal issues, rail performance, pricing, and an active and appropriate strategy for developing railway infrastructure. Furthermore, it was discovered during the focus group interviews that the focus group members prioritized the cost of transportation. The infrastructure for railway-based cargo transportation comes next, followed by the efficiency of the railway transportation.

Nonetheless, recognizing that the regulation has the greatest impact on Thailand's expansion in rail freight is the secondary stakeholder at stake. Facilities for logistics are ranked second, followed by railway infrastructure, public relations, and policy, in that order.

## 5.3 Contribution

**Theoretical Implications of the resent work**

These results added to the library of knowledge on domestic variables for the development of railway freight. The implications listed below are as follows:

- A broad variety of interrelated railway freight development elements to support the modal shift from road to railway.

- Future researchers may use this work as a baseline to conduct a more thorough examination of SRT advancements

- The analysis of the components' relationships from the point of view of the stakeholders is novel to this research, and it provides a substantial contribution to the body of knowledge on stakeholders' theories.

- The current work framework can serve as a basis for future advancements in railway freight transportation.

**Management and Policy Implications**

This study has significant management and policy implications for the development of railway freight in Thailand. The present work involves the primary stakeholders’ views on the development of railway freight in Thailand. The study highlights the following implications:

- Policies to enhance the volume of freight transport on each line may be set based on the findings of the demand analysis of increasing the volume of railway freight transport on each train line and commodity cargo list.

- The perspective's findings place a strong emphasis on railway infrastructure, whereby the SRT can increase freight volume by enhancing railway infrastructure through accelerated transit times, increasing train capacity through double stacking, better train maintenance, increased availability of wagons, customized services, and increased safety.

- The discoveries recognize that the requirements for railway framework improvement prevent the advancement of railway commodity cargo in Thailand. In this manner, government policymakers at SRT could propose sufficient engineering and innovation to draw in new clients in the SRT cargo transport business.

- By approving new laws to liberalize services, we would allow competitors and newcomers to freely participate in the railway freight transport industry. New railway freight operators were made possible by the prompt realization of the separation of the functions within the state's own monopolies into infrastructure management and railway undertakings.

- In order to be competitive, especially with regard to road freight, it is important to adopt a tariff policy and a truck $CO_2$ emission tax in order to promote railway freight traffic.

- Develop a pricing dynamic strategy. In order to form prices for railway freight transport, it is necessary to fully liberalize the market, ensure fair competition, and conduct more successful acquisitions using incentives based on price origin and destination.

The factors that have been identified as contributing to the growth of railway freight in Thailand can serve as a practical guide for railway freight organizers to optimize their policies, strategies, and practices. The study highlights the importance of investing in the improvements of facilities to develop railway operators’ services to meet the increasing demand for railway freight. These factors play a significant role in attracting new customers, retaining existing ones, and maintaining a competitive edge in the railway freight sector for both the State Railway of Thailand (SRT) and policymakers such as the government and the Department of Railway (DRT).

Furthermore, the study emphasizes the need for the SRT, government, and DRT to focus on strengthening the demand for mode shift among manufacturing and logistics service providers. This can be achieved by improving the quality of railway services in terms of logistics facilities, network, liberalization, competitive pricing, and choice of mode choice. Given the relatively low volume of railway freight in

Thailand at present, it is crucial to take practical steps to support railway freight customers, practitioners, and policymakers, especially as the industry begins to recover. The study recommends that SRT and DRT carefully plan and implement these measures in their operations. Additionally, SRT and DRT should prioritize railway freight pricing, as this significantly encourages a shift from road to railway transportation. They should incorporate pricing policies and legal considerations into their railway freight strategies to attract existing customers and tap into new potential markets. Moreover, the study suggests that SRT and the government should embrace technology and innovation to improve railway performance and promote sustainable transportation for railway freight in Thailand, respectively. The success of railway freight traffic demand relies on achieving a sustainable competitive advantage, which stems from both financial and marketing success.

**5.4 Future Research**

Based on the study's findings, the researcher intends to carry out more research through investigating the development of a transportation network linking raw material producers and customers. Spatial studies in industry and agriculture will be the main emphasis of this to research the network's potential to lower logistical costs, satisfy present clients' demands, and attract in new ones soon. A potential shift from road trailer or road container shipment to rail transportation is something else the researcher is interested in investigating.

# REFERENCES

# REFERENCES


Abdelwahab, W., & Sargious, M. (1992). Modelling the demand for freight transport: a new approach. *Journal of Transport Economics and Policy, 26*(1), 49-70.

Ahi, M., Yildiz, K. . (2018). Determining performance criteria of railway market: a case study. *Journal of Open Innovation: Technology, Market, and Complexity 4*(6), 15. doi:https://doi.org/10.1186/s40852-018-0084-5

Adeniran, A. O. (2016). “Impacts of the Fourth Industrial Revolution on Transportation in the Developing Nations”. *International Educational Scientific Research Journal, 2*(11), 56-60.

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological bulletin, 103*(3), 411.

Arvis, J. F., Saslavsky, D., Ojala, L., Shepherd, B., Busch, C., & Raj, A. (2014). *Connecting to Compete 2014: Trade Logistics in the Global Economy--The Logistics Performance Index and Its indicators*. Retrieved December 2, 2022, from Washington DC: http://www.worldbank.org/content/dam/Worldbank/ document/Trade/ LPI2014.pdf

Asian Development Bank. Thailand. (n.d.). *Supporting Railway Sector Reform Final Report.* Retrieved December 2, 2022, from https://www.adb.org/sites/default/files/ project-document/75722/46246-001-tha-tacr-01.pdf (accessed on February 15, 2023).

Authority., U. V. R. (2017). *Current status and strategy to development Vietnam Railway by vision to 2050.* Retrieved December 2, 2022, from https://www.unescap.org/sites/default/files/Viet%20Nam%20country%20report-TAR%20WGM-5.pdf

Bank, A. D. (2013). *Thailand: Supporting Railway Sector Reform Final Report.* Retrieved December 2, 2022, from https://www.adb.org/sites/default/files/ project-document/75722/46246-001-tha-tacr-01.pdf

Bank, A. D. (2017). *Unlocking the Potential of Railways: A Railway Strategy for CAREC, 2017–2030*. Retrieved December 2, 2022, from

Bank, W. (2021). *International LPI, Global Rankings.* Retrieved December 2, 2022, from https://lpi.worldbank.org/international/global

Bank of Thailand. (2023). *Economics Trend.* Retrieved December 2, 2022, from https://www.bot.or.th/th/thai-economy.html

Baron, N. (2015). Railways and demographic change. *Railway economics, policy and regulation in Europe.*

Bentler, P. M., & Chou, C. P. (1987). Practical issues in structural modeling. *Sociological methods & research*, *16*(1), 78-117.

Berger, T. (2019). Railroads and rural industrialization: Evidence from a historical policy experiment. *Explorations in Economic History*, *74*, 101277.

Bhawan, S. & Puram, R.K. (2023). *Draft "Guideline for meduim and Long term power plant Demand Forecast", Central Electricity Authority, Government of India, Ministry of power.* Retrieved December 2, 2022, from https://cea.nic.in/wp-content/uploads/news_live/2023/04/Forecast___Guidelines__upload_CEA_website-1.pdf

Blanquart, C., & Koning, M. (2017). The local economic impacts of high-speed railways: theories and facts. *European Transport Research Review*, *9*, 1-14.

Board of Investment. (2018). *Thailand Food Industry.* Retrieved December 2, 2022, from https://www.boi.go.th/upload/content/Food%20industry_5aa7b40bd758b.pdf

Bogart, D., Alvarez, E., Satchell, M., Shaw-Taylor, L., & You, X. (2017). *Railways and growth: evidence from mid-nineteenth century England and Wales.*

Boland, S., & Jourquin, B. (2018). Freight demand forecasting models: the different approaches. *A master's thesis presented to Louvain School of Management (LSM), Belgium*.

Bollen, K. A. (1989). *Structural equations with latent variables* (Vol. 210). New York: John Wiley & Sons.

Boomsma, A. (1985). Nonconvergence, improper solutions, and starting values in LISREL maximum likelihood estimation. *Psychometrika*, *50*, 229-242.

Bramo, F. (2014). Relationship between railway transport and economic & Social life of a country (Case Albania). *International Journal of Development and Economic Sustainability*, *23*(2).

Brock, T. C. (1968). Implications of commodity theory for value change. *Psychological foundations of attitudes*, 243-275.

Bryde, D. J., & Brown, D. (2005). The influence of a project performance measurement system on the success of a contract for maintaining motorways and trunk roads. *Project Management Journal*, *35*(4), 57–65.

Bunsin, S. (2016). An Analysis of the State Railway of Thailand's Service Quality and Effectiveness in Meeting Customer Needs. *Journal of Public and Private Management*, *23*(2).

Bura, K. (2016). Alternatives for improvement of the State Railway of Thailand. *Journal of Humanities and Social Sciences Valaya Alongkorn 11*(2).

Canadian National Railway. (2023). *CN 2023 Annual Report.* Retrieved December 2, 2022, from https://www.annualreports.com/HostedData/AnnualReports/PDF/TSX_CNR.TO_2023.pdf

Chalongpop, S. (2012). *Facilitating the international railway network to promote Thailand as an economic and touristic hub of the region*. December 2, 2022, from https://www.researchgate.net/publication/327688816_Rail_network_development_and_economic_growth_in_Thailand

Charoenpanyaying, S. (2017). A study of government policy and legal factors affecting development of railway freight transportation in Thailand. *Journal of Transportation and Logistics*, *10*(1).

Chen, H.-L. & Qin, T. (2014). *Contribution Analysis of Railway Freight Transportation to Logistics Industry*. Paper presented at the International Conference on Management Science and Management Innovation Changsha, China.

Chenphuengpawn, J., Chantarat, S., Attavanich, W., & Sa-ngimnet, B. (2019). *Thai agricultural dynamics and implications for returns and risks for agricultural households.* (aBRIDGEd No. 14/2019). Puey Ungphakorn Institute for Economic Research. December 2, 2022, from https://www.pier.or.th/abridged/ 2019/14/

Cherkashin, N. A. (2018). *Analysis of the British Passenger Railway Transportation Market in the Post-Privatisation Era.*

Chow, J. Y., Yang, C. H., & Regan, A. C. (2010). State-of-the art of freight forecast modeling: lessons learned and the road ahead. *Transportation*, *37*, 1011-1030.

Chowdhury, T. A. (2023). *Freight Demand Model Development and Application at the National and Urban Scale* (Doctoral dissertation, University of Toronto (Canada)).

Commission, E. (2019). *Analysis of the potential of the development of railway container transport market in Poland*. Retrieved from

Cohen,H. Horowitz, A. & Pendyala,R. (2008). *NCHRP Report 606: Forecasting Statewide Freight Toolkit. Transportation Research Board of the National Academies, Report by Cambridge Systematics, Inc., and Global Insight (formerly Reebie Associates),* Washington, D.C., 5-15.

Corporation., C. (2021). *Performance Measures.*

Council, I. R. S. (2021). *Railway Safety.*

Council, N. E. a. S. D. (2019). *The 20-year National Strategy Framework (2017 - 2036).* Retrieved December 2, 2022, from http://nscr.nesdb.go.th

Council, N. E. a. S. D. (2020). *NESDC Economic Report, Thai Economic Performance in Q1 and Outlook for 2020*. N.P.: n.p.

Cronbach, L. (1990). *Essential of psychological testing.* New York: Harper Collins Publishers.

Davcik, N. (2014). The use and misuse of structural equation modeling in management research: A review and critique. *Journal of Advances in Management Research, 11*(1).

Department of Agricultural Promotion. (2023). *The Eastern Freiut Situation*. Retrieved December 2, 2022, from https://doaenews.doae.go.th/ archives/18251

Department of Industrial Promotion. (2024). *Industrial Sector*. Retrieved December 2, 2022, from https://www.dip.go.th/en/case-study

*Department of Livestock Development. Livestock Statistic*. (n.d.). http://ic t.dld.go.th/th2/ index.php/th/report/11-report-thailand-livestock

Department of Rail Transport. (2023). T*he existing railway network.* Retrieved December 2, 2022, from https://www.facebook.com/photo.php?fbid=663222922668840&set=pb.100069434130040.-2207520000&type=3

Development, I. I. f. M. (2020). *The IMD World Competitiveness Ranking.* N.P.: n.p.

Dhulipala, S., & Patil, G. R. (2020). Freight production of agricultural commodities in India using multiple linear regression and generalized additive modelling. *Transport Policy*, *97*, 245-258.

Ding, L., Velicer, W. F., & Harlow, L. L. (1995). Effects of estimation methods, number of indicators per factor, and improper solutions on structural equation modeling fit indices. *Structural Equation Modeling: A Multidisciplinary Journal*, *2*(2), 119-143.

Division, N. E. a. S. D. C. M. S. a. P. (2020). NESDC Economic Report, Thai Economic Performance in Q1 and Outlook for 2020. Retrieved December 2, 2022, from https://www.nesdc.go.th/nesdb_en/article_attach/article_file_20200525140723.pdf

Donaldson, D. (2018). Railroads of the Raj: Estimating the Impact of Transportation Infrastructure. *American Economic Review, 108* (4-5): 899-934.

EC-European Commission. (2011). Roadmap to a Single European Transport Area-Towards a competitive and resource efficient transport system. *White Paper, Communication*, *144*.

Escalada, M. H., K.L. (2014). *Focus group discussion*. N.P.: n.p.

Europe., R. (2019). *RNE Guidelines-Key Performance Indicators of Railway Freight Corridors-Version 3.0*. Retrieved December 2, 2022, from https://rne.eu/wp-content/uploads/RNE_Guidelines_KPIs_of_RFCs.pdf

Ewetan, O. O. (2012). Fiscal federalism in Nigeria: Theory and practice. *International journal of development and sustainability*, *1*(3), 1075-1087.

Feo-Valero, M., García-Menéndez, L., & Saz-Salazar, SD. (2016). Railway freight transport and demand requirements: an analysis of attribute cut-offs through a stated preference experiment. *Transportation, 43*(1).

Fischer, M. J., Outwater, M. L., Cheng, L. L., Ahanotu, D. N., & Calix, R. (2005). Innovative framework for modeling freight transportation in Los Angeles County, California. *Transportation research record*, *1906*(1), 105-112.

Food and Agriculture Organization of the United Nations. (2017). *National Agro-Economic Zoning for Major Crops in Thailand (NAEZ) (Project TCP/THA/3403) NAEZ MODEL IMPLEMENTATION AND RESULTS* Retrieved December 2, 2022, from https://openknowledge.fao.org/server/api/core/bitstreams/7b71ea9b-4fec-4486-818a-9b13af4ca363/content

Fonseca, C., Zeerak, R., Napoline, K., & Zhao, J. (2023). Best Types of Commodity Flow Data for Freight, Railroad, and Ports and Waterways Studies.

Forum, I. T. (2019). *Efficiency in Railway Operations and Infrastructure Management*. N.P.: n.p.

Forum, W. E. (2019). *Global Competitiveness Report 2019: How to end a lost decade of productivity growth*. N.P.: n.p.

Gangwar, R. (2020). Railways in India: challenges and opportunities. *Handbook on Railway Regulation*, 146-164.

Gohari, A., Matori, N., Yusof, K-W., Toloue, I., & Myint, K- C. (2018). *Effects of the Fuel Price Increase on the Operating Cost of Freight Transport Vehicles*. N.P.: n.p.

Goya, J., De Miguel, G., Arrizabalaga, S., Zamora-Cadenas, L., Adin, I., & Mendizabal, J. (2018). Methodology and key performance indicators (KPIs) for railway on-board positioning systems. *IEEE Transactions on Intelligent Transportation Systems*, *19*(12), 4035-4042.

Great Minster House, D. f. T. (2016). *Railway Freight Strategy, Moving Britain Ahead.* N.P.: n.p.

Green, T. (2016). A methodological review of structural equation modelling in higher education research. *Studies in Higher Education, 41*(12).

Grimm, C. M., & Pittman, R. (2018). Policy in the deregulated and newly competitive railroad industry: A global analysis. In *Transportation Policy and Economic Regulation* (pp. 105-127). Elsevier.

Group, B. C. (2017). *The 2017 European Railway Performance Index.* N.P.: n.p.

Hair, J. F., Black, W. C., Babin, B. J. & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). New Jersey USA: Pearson Prentice Hall.

Haron, S., Nasir, M.S.B., & Mohamad, S.S. . (2016). Railway transport service performance indicators in Klang Valley. *Paper presented at the AIP Conference Proceedings* 1774.

Hassan, L. A. H., Mahmassani, H. S., & Chen, Y. (2020). Reinforcement learning framework for freight demand forecasting to support operational planning decisions. *Transportation Research Part E: Logistics and Transportation Review*, *137*, 101926.

Havenga, J., Simpson, Z., & de Bod, A. (2014). Havenga, J., Simpson, Z., & de Bod, A. *Journal of Transport and Supply Chain Management*, *8*(1).

Herrendorf, B., Schmitz, Jr, J. A., & Teixeira, A. (2012). The role of transportation in US economic development: 1840–1860. *International Economic Review*, *53*(3), 693-716.

Hilmola, O. P. (2007). European railway freight transportation and adaptation to demand decline: Efficiency and partial productivity analysis from period of 1980-2003. *International Journal of Productivity and Performance Management*, *56*(3), 205-225.

Howell, D. C. (1992). *Statistical methods for psychology*. Boston: PWS-Kent.

ICT., T. a. (2017). *Railway Reform: Toolkit for Improving Railway Sector Performance.* Washington, DC: World Bank.

IEA. (2019). The future of railway. Opportunities for energy and the environment.

Ikubor, J. O., Jibir, R. C. O. A., & Hassan, A. A. (2021). Impact of Government Infrastructural Expenditure on Economic Growth: Evidence from Nigeria. *International Journal of Economics and Development Policy*, *4*(1), 26-39.

Insomtua, N., & Kasikitwiwat, P. (2020). *Time valuation in the transportation of agricultural products. Paper presented at the the 25th National Convention on Civil Engineering*. Chonburi, Thailand.

Islam, D. M. Z., Jackson, R., & Zunder, T.H. (2015). Assessing the impact of the 2011 EU Transport White Paper - a railway freight demand forecast up to 2050 for the EU27. *European Transport Research Review, 7*.

International Monetary Fund. (2024). *World Economic Outlook Database- Thailand.* Retrieved December 2, 2022, from https://www.imf.org/en/Publications/WEO/weo-database/2024/April/weo-report?c=578,&s=NGDP_R,NGDP_RPCH,NGDP,NGDPD,PPPGDP,NGDPRPC,NGDPRPPPC,NGDPPC,NGDPDPC,PPPSH,&sy=2022&ey=2029&ssm=0&scsm=1&scc=0&ssd=1&ssc=0&sic=0&sort=country&ds=.&br=1

International Trade Administration. (2024). *Thailand – Country Commercial Guide.* Retrieved December 2, 2022, from https://www.trade.gov/country-commercial-guides/thailand-agriculture

International Transport Forum. (2019). *Efficiency in Railway Operations and Infrastructure Management, ITF Roundtable Reports, No. 177*. OECD Publishing, Paris.

Janssen, P. (2017). *Thailand's expanding state' threatens future growth.* N.P.: n.p.

Jarocka, M., & Ryciuk, U. (2016). Pricing in the Railway Transport. In P*aper presented at the 9th International Scientific Conference "Business and Management 2016*. Vilnius, Lithuania.

Jones, T., Wicks, A. & Freeman, R. E. (2002). Stakeholder theory: The state of the art. In Norman E. Bowie (ed.), *The Blackwell Guide to Business Ethics*. Blackwell. pp. 19-37.

Kasertsart University, E. F. (2017). *Railway network in Thailand.* N.P.: n.p.

Kelly, M. (2020). *Effect of Railroads on the United States.* Retrieved December 2, 2022, from https://www.thoughtco.com/effect-of-railroads-on-the-united-states-104724

Kane, L., & Behrens, R. (2002). Transport planning models–an historical and critical review. *SATC 2002*.

Khan, M. Z., & Khan, F.N. (2020). Estimating the demand for railway freight transport in Pakistan: A time series analysis. *Journal of Railway Transport Planning & Management, 14*, 100176.

Kinsukon, C., and Suwanpot, S. (2019). *Insight into the benefits of double-track trains to the transportation of Northeastern processed agricultural products.* N.P.: n.p.

Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York, USA.: The Guilford Press.

Kline, R. B. (2015). Principles and practice of structural equation modeling. *Review, 29*(2).

Kraiwan, Y. (2013). *Structural Equation Model Analysis with Amos*. Bangkok: Chulalongkorn University Press.

Krześniak, M., Jacyna, M., Wasiak, M., Lasota, M., & Wawryszczuk, R. (2022). Technical, legal, and business conditionings of the functioning of rail operators in the freight transport market. *WUT Journal of Transportation Engineering*, *135*, 101-114.

Krungsri Research. (2023). *Business/industry trends 2023-2025: Construction materials business.* Retrieved December 2, 2022, from https://www.krungsri.com/th/research/industry/industry-outlook/construction-construction-materials/construction-materials/io/construction-materials-2023-2025.

Krungsri Research. (2024). *Business/industry trends 2024-2026: Ready-to-eat food industry*. Retrieved December 2, 2022, from https://www.krungsri.com/th/research/industry/industry-outlook/food-beverage/ready-to-eat-food/io/io-ready-to-eat-food-2024-2026

Kungwon, S. (2014). A Structural Equation Model of Factors Affecting Decisions Making for Organic Rice Production in Chiang Mai. *Journal of Agricultural and Extension, 36*(3).

Laurino, A., Ramella, F., & Beria, P. (2015). The economic regulation of railway networks: A worldwide survey. *Transportation Research Part A: Policy and Practice, 77*(c), 202-212.

Lewis, P. (2012). Railway Freight Traffic: An Analysis to Better Understand the Industry and the Factors that Influence Traffic. In *Paper presented at the 53rd Annual Transportation Research Forum.* Florida: Tampa.

Li, L., & Zhang, X. (2020). Reducing CO2 emissions through pricing, planning, and subsidizing rail freight. *Transportation Research Part D: Transport and Environment*, *87*, 102483.

Liu, C., Zhang, J., Luo, X., Yang, Y., & Hu, C. (2023). Railway Freight Demand Forecasting Based on Multiple Factors: Grey Relational Analysis and Deep Autoencoder Neural Networks. *Sustainability*, *15*(12), 9652.

Lu, M. (2016). *Evaluation of Railway Performance through Quality of Service.* N.P.: n.p.

Luathep, P., Klungboonkrong, P., Bhonsattayawong, N., & Jaensirisak, S. (2018). Impact of Transport Infrastructure Development on Sugar Transportation Modal Shift in Northeastern Thailand. *International Journal of GEOMATE, 14*(46), 156-163.

Mazareanu, E. (2019). *Railwayroad services - most efficient countries 2019.* N.P.: n.p.

Marx, K. (1973). Outlines of the critique of political economy. *Trans. Martin Nicolaus, London: Penguin*.

Marx, K. (2019). *Capital: volume one*. Courier Dover Publications.

Marx, K. & Engels. F., (1972). Karl Marx and Frederick Engels. *Collected Works*, *12*.

Meso, P., Musa, P., Straub, D., & Mbarika, V. (2009). Information infrastructure, governance, and socio-economic development in developing countries. *European Journal of Information Systems,18*(1), 52-65.

Middela, M. S., Pulipati, S. B., & Prasad, C. S. R. K. (2018). Modelling freight generation and distribution for nationwide interstate freight movement. *Transportation in Developing Economies*, *4*, 1-13.

Milenkovic, M., & Bojovic, N. (2016). *Railway Demand Forecasting, Handbook of research on emerging innovations in rail transportation engineering, IGI Global book series Advances in Civil and Industrial Engineering (ACIE).* Hershey PA, USA

Ministry of Transport. (2014). *Thailand's Transport Infrastructure Development Strategy (2015-2022)*. Retrieved February 20, 2023, from https://www.mot.go.th/mot_strategy/index.php

Ministry of Agriculture and Cooperatives. (2017). *The Twenty-Year Agriculture and cooperatives strategy (2017-2036) and the five-year agriculture development plan under the twelfth national economic and social development plan (2017-2021)*. Retrieved December 2, 2023, from https://www.moac.go.th/moaceng-magazine-files-422991791792

Meng, J., Chen, P., Li, D., & Xu, R. (2022). Summary of Research on Railway Freight Volume Forecast. *Railway Standard Design*, *66*(10), 18-26.

Mojica, L., & Marti-Henneberg, J. (2011). Railways and population distribution: France, Spain, and Portugal. *Journal of Interdisciplinary History, 42,* 15-28.

Mordor Intelligence. (2023). *Thailand Retail Industry Size & Share Analysis - Growth Trends & Forecasts (2024 - 2029)*. Retrieved December 2, 2022, from https://www.mordorintelligence.com/industry-reports/retail-industry-in-thailand

Motana, K. (2015). Thailand's Transport Infrastructure Development Strategy 2015-2022. *The National Defence College of Thailand Journal, 4*(58), 91-125.

Navavongsathian A., J., S. Vuthpadadorn, D., Farangthong, S., Sothiwan, T., & Pomsa, C. (2016). An Analysis of Transportation Mode Choice Factors and Factors Elasticity of Autoparts Industries in Samutprakarn Province. *NIDA Development Journal*, *56*(1/2016), 109-135.

NetworkRailway. (2016). *Anglia Route Study. Long Term Planning Process*. Retrieved December 2, 2022, from https://www.networkrailway.co.uk/wp-content/uploads/2016/12/Anglia-Route-Study-March-2016.pdf

Nimsai, S., Tansuchart, R., Mikmalairak,P. & Fakkong K. (2015). *Market Opportunities and Value ChainDevelopment of Thai Cattle in Asian Market*: Case S tudy of Laos, Vietnam and China(Yunnan) Markets (RDG5720058). TRF Report.

Nunnally, J. C. (1970). *Introduction to psychological measurement.* New York: McGraw-Hill.

OECD. (2021). *Infrastructure investment (indicator).* Retrieved December 2, 2022, from https://www.oecd-ilibrary.org/transport/infrastructure-investment/indicator/english_b06ce3ad-en doi: 10.1787/b06ce3ad-en

*Office of the National Economic and Social Development Council*. (2024). Retrieved December 2, 2022, from https://www.nesdc.go.th/ewt_news.php?nid=9712&filename=io_page

Office of the National Economic and Social Development Council. (2019). *Report of the Population Projections for Thailand 2010-2040.* N.P.: n.p.

Office of Agricultural Economics. (2024). *Export Statistic*. Retrieved December 2, 2022, from https://impexpth.oae.go.th/export

Office of Agricultural Economics. (2024).*Cassava*. Retrieved December 2, 2022, from https://www.oae.go.th/view

Office of Industrial Economics. (2020). *Study of basic information on important pilot economic crops of Thailand-Value Chain: Rice*. Retrieved December 2, 2022, from https://bioinnovationlinkage.oie.go.th/ReadCV_Plant.aspx?

Office of Industrial Economics. (2024). *Overview of Thai Industrial Index for the month of March 2024*. Retrieved January 2, 2024, from https://i.index.oie.go.th/Read_industrial.aspx?idContent=3157

Office of Transport and Traffic Policy and Planning. Ministry of Transport. (n.d.). Cargo transportation volume by cargo category. Retrieved December 2, 2022, from http://mistran.otp.go.th/MIS/Data/Content/55/25630624_cargo%20Rail%202562%20(Fiscal%20Y-Calendar%20Y)-format.pdf (accessed on February 20, 2023).

Office statistics registration systems. (2024). *Population.* Retrieved December 2, 2022, from https://stat.bora.dopa.go.th/stat/statnew/statMenu/newStat/home.php

Ortúzar, S. J. D., & Willumsen, L. G. (1990). *Modelling transport* (4th ed.). Chichester, West Sussex, England: John Wiley & Sons.

Palšaitis, R., and Ponomariovas, A. (2012). Assessment of Railway Freight Transport Service Quality. *Transport and Telecommunication Journal,13*(3), 188-192.

Peetawan, W., & Suthiwartnarueput, K. (2018). Identifying factors affecting the success of railway infrastructure development projects contributing to a logistics platform: A Thailand case study. *Kasetsart Journal of Social Sciences, 39*, 320-327.

Pajampa, K., & Wongwuttanasatian, T. (2023). A trial of filter cake pellets and bagasse co–combustion in a sugar mill steam generator: Thermal and economical assessments. *Energy Reports*, *9*, 422-430.

Ploenhad, J. (2015). Study on the approach to improve the performance of demonstration trains from the suburbs the route Bangkok-chachoengsao-Bangkok. *Journal of Logistics and Supply Chain College*, *1*(1), 101-112.

Poopat, C., & Chaingraen, P. (2011). National Logistics Development Strategies A case study of Development Transportation by railway. *Suan Dusit University Graduate School, 7*(2), 98-110.

Prachanban, P. (2015). *Structural Equation Modeling Analysis.* Retrieved December 2, 2022, from http://www.bec.nu.ac.th/cutwebb/

Preonas, L. (2023). Market power in coal shipping and implications for US climate policy. *Review of Economic Studies*, rdad090.

Prudon, P. (2014). Confirmatory factor analysis: A brief introduction and critique. *Qualtrics, P. UT, USA, 10*(1.476).

Raengsungnaen, K. (2011). *Factor analysis with SPSS and AMOS for Research.* . Bangkok: SE-Education.

Rail transport in Thailand. (2024). The railway network of Thailand is managed and operated by the State Railway of Thailand (SRT). Retrieved December 2, 2022, from https://thai-railway.fandom.com/wiki/Rail_transport_in_Thailand

Railnet Europe. (n.d.). *RNE Guidelines-Key Performance Indicators of Rail Freight Corridors-Version 3.0*. Retrieved February 12, 2023, from https://rne.eu/wp-content/uploads/RNE_Guidelines_KPIs_of_RFCs.pdf

Railways, I. E. A. I. U. o. (2015). *Railway Handbook 2015 Energy Consumption and CO2 Emissions, .*

Railways, I. U. o. (2020). UIC Covid-19 Task Force, RAILWAYsilience: How the railway sector fought Covid-19 during lockdowns. Retrieved December 2, 2022, from https://uic.org/IMG/pdf/railwaysilience__how_the_railway_sector_fought_covid-19_during_lockdowns.pdf

Rao, P. S. (1978). Forecasting the demand for railway freight services. *Journal of Transport Economics and Policy, 12*(1), 7-26.

Randal, E., Shaw, C., Woodward, A., Howden-Chapman, P., Macmillan, A., Hosking, J., ... & Keall, M. (2020). Fairness in transport policy: A new approach to applying distributive justice theories. *Sustainability, 12*(23), 10102.

Road, O. o. R. a. (2016). *Licensing guidance on how to apply for operator licences and licence exemptions*. Retrieved December 2, 2022, from http://orr.gov.uk/__data/assets/pdf_file/0011/2216/licensing-guidance.pdf>

Rodrigue, J. (2020). *The geography of transport systems* (5th ed.). New York. NY: Routledge.

Rodrigue, J. P., Claude, C., & Brian, S. (2006). *Geography of Transport Systems.* New York. NY: Routledge.

Rodrigue, J. P. (2024). *Geography of Transport Systems* (6th ed.). New York. NY: Routledge.

Rodrigue, J. P. (2020). *The geography of transport systems* (5th ed.). London, Routledge.

Rubber Authority of Thailand. (2018). *Academic information-para rubber 2018.* Retrieved December 2, 2022, from https://www.raot.co.th/download/ technical_data_of_rubber_61.pdf

Russian Railway. (2019). *Analysis of operating results*. Retrieved December 2, 2022, from https://ar2019.rzd.ru/pdf/ar/en/performance-overview_analysis-operating-results_transportation-logistics.pdf

Samimi, A., Mohammadian, K., & Kawamura, K. (2010). Behavioral Paradigms for Modeling Freight Travel Decision-Making. In *The 12th International Conference on Travel Behaviour Research*. N.P.: n.p.

Schumacher, R. G. & Lomax, R. G. (2010). *Beginner's guide to Structural Equation Modeling* (3rd ed.). New York, USA: Routledge.

Silva, F. G., Oliveira, R., & Marinov, M. (2020). An Analysis of the Effects on Railway Operational Efficiency Due to a Merger between Brazilian Railway Companies: The Case of RUMO-ALL. *Sustainability*, *12*, 4827.

Sirisoponsilp, W. (2016). *Approaches to Successful Implementation of Transport Infrastructure Development Plans*. Retrieved December 2, 2022, from http://www.dsdw2016.dsdw.go.th/doc_pr/ndc_2560-2561/PDF/8522e/%E0%B8%A3%E0%B8%A7%E0%B8%A1.pdf

Srinvasan, R., Lohith, C. P., Kadadevaramth, R. S., & Shrisha, S. (2015, August). Strategic Marketing and Innovation Performance of Indian MSMEs. In *2015 Portland International Conference on Management of Engineering and Technology (PICMET)* (pp. 127-133). IEEE.

Solutions, S. (2021). *Confirmatory Factor Analysis.* Retrieved December 2, 2022, from https://www.statisticssolutions.com/confirmatory-factor-analysis/

Somchanmavong, M. (2018). Evaluation of Organizational performance using the Balanced Scorecard Case study of Thanalaeng Railway Station, Lao PDR. . *Journal of Management Science Nakhon Pathom Rajabhat University*, *5*(1), 79-90.

Sompracha, A., & Wararatchai, P. (2018). Services of the State Railway of Thailand: A Case Study of The Southern route (Bangkok - Hua Hin). *Journal of Logistics and Supply Chain College*, *2*(1), 102-114.

Srisaard, B. (2002). *Preliminary research* Bangkok: Suveeyasarn.

Srisatidnarakul, B. (2012). *Development and validation of research instruments: psychometric properties.* Bangkok: Chulalongkorn University Printing House.

Statista. (2024). *Commodities - Thailand.* Retrieved December 2, 2022, from https://www.statista.com/outlook/fmo/commodities/thailand#volume

Statista. (2024). *Thailand: Gross domestic product (GDP) in current prices from 1989 to 2029 (in billion U.S. dollars).* Retrieved December 2, 2022, from https://www.statista.com/statistics/332234/gross-domestic-product-gdp-in-thailand/

Trading Economic. (2024). *Thailand Industrial Production*. Retrieved December 2, 2022, from https://tradingeconomics.com/thailand/industrial-production#:~:text=In%20the%20long%2Dterm%2C%20the,according%20to%20our%20econometric%20models.&text=In%20Thailand%2C%20industrial%20production%20measures,manufacturing%20sector%20of%20the%20economy.

Worldsteel Association. (2023). *Worldsteel Short Range Outlook April 2023.* Retrieved December 2, 2022, from https://worldsteel.org/media/press-releases/2023/worldsteel-short-range-outlook-april-2023/#:~:text=After%20falling%20by%200.3%25%20in%202022%2C%20ASEAN%20steel%20demand%20is,then%20by%205.7%25%20in%202024.

Suksawang, P. (2014). The basics of structural equation modeling. *Princess of Naradhiwas Journal*, *6*(2), 136-145.

Sultanbek, M., Adilova, N., Sładkowski, A., & Karibayev, A. (2024). Forecasting the demand for railway freight transportation in Kazakhstan: A case study. *Transportation Research Interdisciplinary Perspectives*, *23*, 101028.

Sun, X., Ma, M., Jiang, B., & Cao, R. (2022). Ground vibration from freight railway: environmental impact and potential mitigation measure at propagation path. *Environmental Science and Pollution Research*, *29*(29), 44364-44377.

Sutthirak, T. (2016). *Efficiency of crude oil transportation by railway management* (Master' s Thesis). Chonburi: Burapha University.

S&P Global Market Intelligence. (2023). *Thailand's economy faces headwinds from manufacturing sector downturn.* Retrieved December 2, 2022, from https://www.spglobal.com/marketintelligence/en/mi/research-analysis/thailands-economy-faces-headwinds-from-manufacturing-sector-downturn-sep23.html

Tattini, J., & Peter, J. (2020). *Railway is one of the most energy-efficient transport modes*. Retrieved December 2, 2022, from https://www.iea.org/reports/railway

Team, M. S. (2020). *SWOT Analysis.* N.P.: n.p.

Thailand, S. R. o. (2010). *State Railway of Thailand Annual Report 2010.* N.P.: n.p.

Thai Tapioca Starch Association.(2024). *Export Tapioca Products.* Retrieved December 2, 2022, from https://www.thaitapiocastarch.org/en/information/statistics/export_tapioca_products

Thalerngpol, R., & Dhebpanya, P. (2015). The Strategic Development in Human Resource Management of The State Railway of Thailand. *Journal of Management Science Chiangrai Rajabhat University, 10*(1), 49-66.

Tjandra, S., Kraus, S., Ishmam, S., Grube, T., Linßen, J., May, J., & Stolten, D. (2024). Model-based analysis of future global transport demand. *Transportation Research Interdisciplinary Perspectives*, *23*, 101016.

Townsend, J. (2022). Community Rail: Helping our Railways to Deliver Social, Environmental and Economic Sustainability. In *Sustainable Railway Engineering and Operations* (Vol. 14, pp. 41-60). Emerald Publishing Limited.

Transport, O. o. T. a. T. P. a. P. M. o. (2014). *Strategies to Improve Transportation Infrastructure in Thailand (2015 - 2022).* Retrieved December 2, 2022, from https://www.otp.go.th/post/view/772

Transport, O. o. T. a. T. P. a. P. M. o. (2019). Cargo transportation volume by cargo category. Retrieved December 2, 2022, from http://mistran.otp.go.th/MIS/Data/Content/55/25630624_cargo%20Railway%202562%20(Fiscal%20Y-Calendar%20Y)-format.pdf

Transport., M. o. (2015). Thailand's Transport Infrastructure Development Strategy (2015-2022). Retrieved December 2, 2022, from https://www.mot.go.th/mot_strategy/index.php

Transportation Research Board. (1977). *Freight data requirements for statewide transportation systems planning.* Washington, D.C.: National Research Council.

Tsai, P.-H., Chen, C.-J., & Yang, H.-C. (2021). *Using Porter's Diamond Model to Assess the Competitiveness of Taiwan's Solar Photovoltaic Industry.* N.P.: n.p.

Tsekeris, T., & Tsekeris, C. (2011). Demand forecasting in transport: Overview and modeling advances. *Economic research-Ekonomska istraživanja*, *24*(1), 82-94.

TTBBank. (2024). *ttb analytics expects agricultural income of 5 main crops in 2024 to recover to reach 900 billion baht.* Retrieved December 2, 2022, from https://www.ttbbank.com/th/newsroom/detail/ttba-agro-business-2024

Tulupov, A. V.; Beloshitsky, A. V.; Shitov, E. A.; Shitova, Y. A. Innovative, Scientific and Technological Priorities of Railway Freight Transport. *WORLD. 2021*, *19*, 186-195.

Tuntavanitch, P. J., P. (2018). The real meaning of IOC. *Journal of Educational Measurement, 24*(2), 3-12.

UCLA. (2006). *Statistical Consulting Group. Introduction to SAS.* Retrieved December 2, 2022, from https://stats.idre.ucla.edu/sas/modules/sas-learning-moduleintroduction-to-the-features-of-sas/

UKEssays. (2018). *Railway Industry Plays A Key Role Management Essay.* Retrieved December 2, 2022, from https://www.ukessays.com/essays/management/ railway-industry-plays-a-key-role-management-essay.php?vref=1

U.S. Department of Transportation, Bureau of Transportation Statistics. (2022-5-10). *Comparison of Commodity Flow Survey and Freight Analysis Framework for 2017 Domestic Freight Flows. Technical Repo*rt. Washington, DC.

United States Department of Agriculture. (2020). *Food Processing Ingredients-Thailand.* Retrieved December 2, 2022, from https://apps.fas.usda.gov/ newgainapi/api/Report/DownloadReportByFileName?fileName=Food%20Processing%20Ingredients_Bangkok_Thailand_03-30-2020

United States Department of Agriculture. (2024). *Country Summary-Thailand.* Retrieved December 2, 2022, from https://ipad.fas.usda.gov /countrysummary/default.aspx?id=TH&crop=Corn

United States Department of Agriculture. (2023). *Retail Foods-Thailand.* Retrieved December 2, 2022, from https://apps.fas.usda.gov/newgainapi/api/ Report/DownloadReportByFileName?fileName=Retail%20Foods_Bangkok_ Thailand_TH2023-0039.pdf

Valenzuela, S. B., I. . (2017). *Path Analysis. The International Encyclopedia of Communication Research Methods.* N.P.: n.p.

Vanichbuncha, K. (2009). *Statistics for research.* Bangkok: Dhamasarn.

Wanke, P., Chen, Z., Liu, W., Antunes, J. J.M., Azad, & Md. A. K. (2018). Investigating the drivers of railway performance: Evidence from selected Asian countries. *Habitat International, 80*, 49-69.

Wangai, A. W., Rohacs, D. & Boros, A. (2020). Supporting the sustainable development of railway transport in developing countries. *Sustainability, 12,* 3572.

Wang C., & Ducruet C. (2013). Transport Corridors and Regional Balance in China: The Case of Coal Trade and Logistics. *Journal of Transport Geography*. *40.* 3-16.

Waters, D. (2008). *Quantitative Methods for Business* (5th ed.). Pearson Education.

Westland, J. C. (2019). *Structural equation models: From paths to networks.* Cham: Springer.

Wetchasarn, K. (2002). *Marketing Research* Bangkok: Chulalongkorn University Printing House.

Wijeweera, A., To, H., & Charles, M. (2014). An empirical analysis of Australian freight railway demand. *Economic Analysis and Policy, 44*(1), 21-29.

Winkler, C., & Mocanu, T. (2020). Impact of political measures on passenger and freight transport demand in Germany. *Transportation Research Part D: Transport and Environment*, *87*, 102476.

Woodburn, A. (2017). The impacts on freight train operational performance of new rail infrastructure to segregate passenger and freight traffic. *Journal of Transport Geography*, *58*, 176-185.

World Bank. (2022). *Commodity Markets: Evolution, Challeges, and Policies.* Washington, DC: World Bank.

World Bank. (2024). *Transport.* Retrieved December 2, 2022, from https://www.worldbank.org/en/topic/transport/overview

World Trade Organization. (2022). *WTO ITC UNCTAD, World Tariff PRofiles 2023, 2. Product classification for WTO trade statistics and policy analysis – Multilateral Trade Negotiations (MTN) Categories*. Retrieved December 2, 2022, from https://www.wto.org/english/res_e/statis_e/ wtp2023_special _topic2_e.pdf

Wongsapai, W., Achawangkul, Y., Thepsaskul, W., Daroon, S., & Fongsamootr, T. (2020). Biomass supply chain for power generation in southern part of Thailand. *Energy Reports*, *6*, 221-227.

Xu, X., Chase, N., & Peng, T. (2021). Economic structural change and freight transport demand in China. *Energy Policy*, *158*, 112567.

Zhang, R., Jian, W., & Li, L. (2019). Effects of travel time reliability and commodity characteristics on hinterland leg transportation of export containers. *Transportation Research Record*, *2673*(7), 204-214.

Zeybek, H. (2019). Analysis of freight mode choice decisions of shippers and forwarders: pre-liberalisation survey. *World Review of Intermodal Transportation Research*, *8*(3), 209-221. doi: 10.1504/WRITR.2019.102357

Židová, Z., & Zitrický, V. (2023). The impact of the use of technology in international rail freight transport on transport processes. *Promet-Traffic&Transportation*, *35*(2), 243-254.

Zou, G. C., K.W. (2019). Long- and Short-Run Effects of Fuel Prices on Freight Transportation Volumes in Shanghai. *Sustainability*, *11*(8), 5017. doi:doi:10.3390/su11185017

Zunder, T. H., & Islam, D.M.Z. (2018). Assessment of existing and future railway freight services and Technologies for low Density High Value Goods in Europe. *European Transport Research Review*, *10*, 9. doi:doi.org/10.1007/s12544-017-0277-1

# APPENDIX

## APPENDIX A LETTER FOR PRELIMINARY INTERVIEW

ที่ อว ๐๖๐๓.๓๑/๐๓๗๒

คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
มหาวิทยาลัยนเรศวร
อำเภอเมืองพิษณุโลก
จังหวัดพิษณุโลก ๖๕๐๐๐

๒๗ สิงหาคม ๒๕๖๓

เรื่อง ขอความอนุเคราะห์ข้อมูลและสัมภาษณ์

เรียน ผู้อำนวยการฝ่ายปฏิบัติการเดินรถ

ด้วยนางสาวอรณิชา บุตรพรหม นิสิตระดับปริญญาเอก สาขาโลจิสติกส์และโซ่อุปทาน คณะโลจิสติกส์และดิจิทัลซัพพลายเชน มหาวิทยาลัยนเรศวร ได้ทำวิทยานิพนธ์เรื่อง ปัจจัยที่สนับสนุนการขนส่งสินค้าทางรถไฟในภาคใต้ของไทย (Foster Factors to Rail Freight in Southern of Thailand) ซึ่งเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปรัชญาดุษฎีบัณฑิต สาขาโลจิสติกส์และโซ่อุปทาน

เพื่อให้การดำเนินการวิจัยสำเร็จลุล่วงไปด้วยดี จึงใคร่ขอความอนุเคราะห์จากท่านผู้อำนวยการฝ่ายปฏิบัติการเดินรถให้ข้อมูลและสัมภาษณ์แก่ นางสาวอรณิชา บุตรพรหม โดยมีหัวข้อสัมภาษณ์ตามเอกสารแนบ ทั้งนี้นิสิตผู้วิจัยจะเป็นผู้ติดต่อประสานงานในรายละเอียดกับท่าน โดยตรงต่อไป

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์ด้วย จักเป็นพระคุณยิ่ง และขอขอบคุณมา ณ โอกาสนี้

ขอแสดงความนับถือ

(ดร.บุญทรัพย์ พานิชการ)
คณบดีคณะโลจิสติกส์และดิจิทัลซัพพลายเชน

งานบริการการศึกษา สำนักงานเลขานุการ
คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
โทร. ๐ ๕๕๙๖ ๘๗๔๗
โทรสาร ๐ ๕๕๙๖ ๓๗๕๖

ที่ อว ๐๖๐๓.๑๑/๑๐๓๕๑

คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
มหาวิทยาลัยนเรศวร
อำเภอเมืองพิษณุโลก
จังหวัดพิษณุโลก ๖๕๐๐๐

๑๘ กันยายน ๒๕๖๓

เรื่อง ขอความอนุเคราะห์ข้อมูลและสัมภาษณ์

เรียน กรรมการบริษัท
บริษัท อาร์ แอนด์ ซี อินเตอร์ทรานส์ จำกัด

ด้วยนางสาวอรณิชา บุตรพรหม นิสิตระดับปริญญาเอก คณะโลจิสติกส์และดิจิทัลซัพพลายเชน มหาวิทยาลัยนเรศวร ได้ทำวิทยานิพนธ์เรื่อง ปัจจัยที่สนับสนุนการขนส่งสินค้าทางรถไฟในภาคใต้ของไทย (Foster Factors to Rail Freight in Southern of Thailand) ซึ่งเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปรัชญาดุษฎีบัณฑิต สาขาโลจิสติกส์และโซ่อุปทาน

เพื่อให้การดำเนินการวิจัยสำเร็จลุล่วงไปด้วยดี จึงใคร่ขอความอนุเคราะห์จากท่านให้ข้อมูลและสัมภาษณ์แก่ นางสาวอรณิชา บุตรพรหม โดยมีหัวข้อสัมภาษณ์ตามเอกสารแนบ ทั้งนี้นิสิตผู้วิจัยจะเป็นผู้ติดต่อประสานงานในรายละเอียดกับท่าน โดยตรงต่อไป

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์ด้วย จักเป็นพระคุณยิ่ง และขอขอบคุณมา ณ โอกาสนี้

ขอแสดงความนับถือ

(ดร.บุญทรัพย์ พานิชการ)
คณบดีคณะโลจิสติกส์และดิจิทัลซัพพลายเชน

งานบริการการศึกษา สำนักงานเลขานุการ
คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
โทร. ๐ ๕๕๙๖ ๔๗๔๗
โทรสาร ๐ ๕๕๙๖ ๔๗๙๕

ที่ อว ๐๖๐๓.๑๗/ ๑๓๓๕๑

คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
มหาวิทยาลัยนเรศวร
อำเภอเมืองพิษณุโลก
จังหวัดพิษณุโลก ๖๕๐๐๐

๑๘ กันยายน ๒๕๖๓

เรื่อง ขอความอนุเคราะห์ข้อมูลและสัมภาษณ์

เรียน กรรมการบริษัท
บริษัท ตรังฮท ชิปปิ้ง จำกัด

ด้วยนางสาวอรณิชา บุตรพรหม นิสิตระดับปริญญาเอก คณะโลจิสติกส์และดิจิทัลซัพพลายเชน มหาวิทยาลัยนเรศวร ได้ทำวิทยานิพนธ์เรื่อง ปัจจัยที่สนับสนุนการขนส่งสินค้าทางรถไฟในภาคใต้ของไทย (Foster Factors to Rail Freight in Southern of Thailand) ซึ่งเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปรัชญาดุษฎีบัณฑิต สาขาโลจิสติกส์และโซ่อุปทาน

เพื่อให้การดำเนินการวิจัยสำเร็จลุล่วงไปด้วยดี จึงใคร่ขอความอนุเคราะห์จากท่านให้ข้อมูลและสัมภาษณ์แก่ นางสาวอรณิชา บุตรพรหม โดยมีหัวข้อสัมภาษณ์ตามเอกสารแนบ ทั้งนี้นิสิตผู้วิจัยจะเป็นผู้ติดต่อประสานงานในรายละเอียดกับท่าน โดยตรงต่อไป

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์ด้วย จักเป็นพระคุณยิ่ง และขอขอบคุณมา ณ โอกาสนี้

ขอแสดงความนับถือ

(ดร.บุญทรัพย์ พานิชการ)
คณบดีคณะโลจิสติกส์และดิจิทัลซัพพลายเชน

งานบริการการศึกษา สำนักงานเลขานุการ
คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
โทร. ๐ ๕๕๙๖ ๔๗๔๗
โทรสาร ๐ ๕๕๙๖ ๔๗๗๕

ที่ อว ๐๖๐๓.๓๗/๐๓๓๙

คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
มหาวิทยาลัยนเรศวร
อำเภอเมืองพิษณุโลก
จังหวัดพิษณุโลก ๖๕๐๐๐

๓๑ สิงหาคม ๒๕๖๓

เรื่อง ขอความอนุเคราะห์ข้อมูลและสัมภาษณ์

เรียน กรรมการบริษัท โชคฉัตรชัย จำกัด

ด้วยนางสาวอรณิชา บุตรพรหม นิสิตระดับปริญญาเอก คณะโลจิสติกส์และดิจิทัลซัพพลายเชน มหาวิทยาลัยนเรศวร ได้ทำวิทยานิพนธ์เรื่อง ปัจจัยที่สนับสนุนการขนส่งสินค้าทางรถไฟในภาคใต้ของไทย (Foster Factors to Rail Freight in Southern of Thailand) ซึ่งเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปรัชญาดุษฎีบัณฑิต สาขาโลจิสติกส์และโซ่อุปทาน

เพื่อให้การดำเนินการวิจัยสำเร็จลุล่วงไปด้วยดี จึงใคร่ขอความอนุเคราะห์จากท่านให้ข้อมูลและสัมภาษณ์แก่ นางสาวอรณิชา บุตรพรหม โดยมีหัวข้อสัมภาษณ์ตามเอกสารแนบ ทั้งนี้นิสิตผู้วิจัยจะเป็นผู้ติดต่อประสานงานในรายละเอียดกับท่าน โดยตรงต่อไป

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์ด้วย จักเป็นพระคุณยิ่ง และขอขอบคุณมา ณ โอกาสนี้

ขอแสดงความนับถือ

(ดร.บุญทรัพย์ พานิชการ)
คณบดีคณะโลจิสติกส์และดิจิทัลซัพพลายเชน

งานบริการการศึกษา สำนักงานเลขานุการ
คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
โทร. ๐ ๕๕๙๖ ๘๗๔๗
โทรสาร ๐ ๕๕๙๖ ๘๗๗๕

## APPENDIX B LETTER FOR QUESTIONNAIRES QUALITY

ที่ อว ๐๖๐๓.๐๒ / ว ๓๖๒๖

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
ตำบลท่าโพธิ์ อำเภอเมืองพิษณุโลก
จังหวัดพิษณุโลก ๖๕๐๐๐

๒๑ ธันวาคม ๒๕๖๔

เรื่อง ขอความอนุเคราะห์ตรวจแก้ไขเครื่องมือที่ใช้ในการวิจัย

เรียน รองศาสตราจารย์ ดร.จักรกฤษณ์ ดวงพัสตรา

สิ่งที่ส่งมาด้วย ๑. โครงร่างวิทยานิพนธ์ จำนวน ๑ ฉบับ
๒. เครื่องมือที่ใช้ในการวิจัย จำนวน ๑ ฉบับ

ด้วย นางสาวอรณิชา บุตรพรหม รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก หลักสูตรปรัชญาดุษฎีบัณฑิต สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง "ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)" โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เองษฎิกุล เป็นประธานที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร พิจารณาแล้วเห็นว่าท่านเป็นผู้ที่มีความรู้ความเชี่ยวชาญในเนื้อหาสาระของวิทยานิพนธ์เรื่องนี้เป็นอย่างดียิ่ง จึงใคร่ขอความอนุเคราะห์ท่านเป็นผู้เชี่ยวชาญตรวจแก้ไขเครื่องมือที่ใช้ในการวิจัยดังเอกสารที่แนบมาพร้อมนี้ บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดี และขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
โทร. ๐ ๕๕๙๖ ๘๗๐๓
โทรสาร ๐ ๕๕๙๖ ๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร. ๐๘ ๖๒๓๑ ๓๔๗๔

ที่ อว ๐๖๐๓.๐๒ / ว ๓๖๒๖

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
ตำบลท่าโพธิ์ อำเภอเมืองพิษณุโลก
จังหวัดพิษณุโลก ๖๕๐๐๐

๒๓ ธันวาคม ๒๕๖๔

เรื่อง ขอความอนุเคราะห์ตรวจแก้ไขเครื่องมือที่ใช้ในการวิจัย

เรียน รองศาสตราจารย์ ดร.วันชัย รัตนวงษ์

สิ่งที่ส่งมาด้วย ๑. โครงร่างวิทยานิพนธ์ จำนวน ๑ ฉบับ

๒. เครื่องมือที่ใช้ในการวิจัย จำนวน ๑ ฉบับ

ด้วย นางสาวอรณิชา บุตรพรหม รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก หลักสูตรปรัชญาดุษฎีบัณฑิต สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง "ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)" โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เองษฎีกุล เป็นประธานที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร พิจารณาแล้วเห็นว่าท่านเป็นผู้ที่มีความรู้ความเชี่ยวชาญในเนื้อหาสาระของวิทยานิพนธ์เรื่องนี้เป็นอย่างดียิ่ง จึงใคร่ขอความอนุเคราะห์ท่านเป็นผู้เชี่ยวชาญตรวจแก้ไขเครื่องมือที่ใช้ในการวิจัยดังเอกสารที่แนบมาพร้อมนี้ บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดี และขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
โทร. ๐ ๕๕๙๖ ๘๗๐๓
โทรสาร ๐ ๕๕๙๖ ๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร. ๐๘ ๖๒๓๑ ๓๔๗๔

ที่ อว ๐๖๐๓.๐๒ / ว ๓๖๒๖

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
ตำบลท่าโพธิ์ อำเภอเมืองพิษณุโลก
จังหวัดพิษณุโลก ๖๕๐๐๐

๒๑ ธันวาคม ๒๕๖๔

เรื่อง ขอความอนุเคราะห์ตรวจแก้ไขเครื่องมือที่ใช้ในการวิจัย

เรียน ผู้ช่วยศาสตราจารย์ ดร.วชิราภรณ์ จันทร์โพธนุกุล

สิ่งที่ส่งมาด้วย ๑. โครงร่างวิทยานิพนธ์ จำนวน ๑ ฉบับ
๒. เครื่องมือที่ใช้ในการวิจัย จำนวน ๑ ฉบับ

ด้วย นางสาวอรณิชา บุตรพรหม รหัสประจำตัว ๕๙๐๓๒๘๓๓ นิสิตระดับปริญญาเอก หลักสูตรปรัชญาดุษฎีบัณฑิต สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง "ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)" โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เฮงษฎีกุล เป็นประธานที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร พิจารณาแล้วเห็นว่าท่านเป็นผู้ที่มีความรู้ความเชี่ยวชาญในเนื้อหาสาระของวิทยานิพนธ์เรื่องนี้เป็นอย่างดียิ่ง จึงใคร่ขอความอนุเคราะห์ท่านเป็นผู้เชี่ยวชาญตรวจแก้ไขเครื่องมือที่ใช้ในการวิจัยดังเอกสารที่แนบมาพร้อมนี้ บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดี และขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
โทร. ๐ ๕๕๙๖ ๘๗๐๓
โทรสาร ๐ ๕๕๙๖ ๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร. ๐๘ ๖๒๓๑ ๓๔๗๔

ที่ อว ๐๖๐๓.๐๒ / ว ๓๖๒๖

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
ตำบลท่าโพธิ์ อำเภอเมืองพิษณุโลก
จังหวัดพิษณุโลก ๖๕๐๐๐

๒๓ ธันวาคม ๒๕๖๔

เรื่อง ขอความอนุเคราะห์ตรวจแก้ไขเครื่องมือที่ใช้ในการวิจัย

เรียน ผู้ช่วยศาสตราจารย์ ดร.อังกูร ลาภธเนศ

สิ่งที่ส่งมาด้วย ๑. โครงร่างวิทยานิพนธ์ จำนวน ๑ ฉบับ
๒. เครื่องมือที่ใช้ในการวิจัย จำนวน ๑ ฉบับ

ด้วย นางสาวอรณิชา บุตรพรหม รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก หลักสูตรปรัชญาดุษฎีบัณฑิต สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง "ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)" โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เฮงษฎีกุล เป็นประธานที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร พิจารณาแล้วเห็นว่าท่านเป็นผู้ที่มีความรู้ความเชี่ยวชาญในเนื้อหาสาระของวิทยานิพนธ์เรื่องนี้เป็นอย่างดียิ่ง จึงใคร่ขอความอนุเคราะห์ท่านเป็นผู้เชี่ยวชาญตรวจแก้ไขเครื่องมือที่ใช้ในการวิจัยดังเอกสารที่แนบมาพร้อมนี้ บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดี และขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
โทร. ๐ ๕๕๙๖ ๘๗๐๓
โทรสาร ๐ ๕๕๙๖ ๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร. ๐๘ ๖๒๓๑ ๓๔๗๔

ที่ อว ๐๖๐๓.๐๒ / ว ๓๖๒๖

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
ตำบลท่าโพธิ์ อำเภอเมืองพิษณุโลก
จังหวัดพิษณุโลก ๖๕๐๐๐

๒๑ ธันวาคม ๒๕๖๔

เรื่อง ขอความอนุเคราะห์ตรวจแก้ไขเครื่องมือที่ใช้ในการวิจัย

เรียน ผู้ช่วยศาสตราจารย์ ดร.ฐิติมา วงศ์อินตา

สิ่งที่ส่งมาด้วย ๑. โครงร่างวิทยานิพนธ์ จำนวน ๑ ฉบับ
๒. เครื่องมือที่ใช้ในการวิจัย จำนวน ๑ ฉบับ

ด้วย นางสาวอรณิชา บุตรพรหม รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก หลักสูตรปรัชญาดุษฎีบัณฑิต สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง "ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)" โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เฮงษฎีกุล เป็นประธานที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร พิจารณาแล้วเห็นว่าท่านเป็นผู้ที่มีความรู้ความเชี่ยวชาญในเนื้อหาสาระของวิทยานิพนธ์เรื่องนี้เป็นอย่างดียิ่ง จึงใคร่ขอความอนุเคราะห์ท่านเป็นผู้เชี่ยวชาญตรวจแก้ไขเครื่องมือที่ใช้ในการวิจัยดังเอกสารที่แนบมาพร้อมนี้ บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดี และขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
โทร. ๐ ๕๕๙๖ ๘๗๐๓
โทรสาร ๐ ๕๕๙๖ ๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร. ๐๘ ๖๒๓๑ ๓๔๗๔

# APPENDIX C LETTER FOR QUESTIONNAIRES RESPONDENTS

ที่ อว ๐๖๐๓.๐๒/ว ๑๕๓๙

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
อำเภอเมืองฯ จังหวัดพิษณุโลก ๖๕๐๐๐

๒๖ เมษายน ๒๕๖๖

เรื่อง ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

เรียน **ผู้ประกอบการผลิตอ้อยและน้ำตาลทราย**

สิ่งที่ส่งมาด้วย โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย **นางสาวอรณิชา บุตรพรหม** รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง **"ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย** (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)" เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาปรัชญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เสงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน บัณฑิตวิทยาลัย จึงใคร่ขอความอนุเคราะห์จากท่านโปรดอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย
โทร ๐-๕๕๙๖-๘๘๓๑
โทรสาร ๐-๕๕๙๖-๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ - ๒๓๑๓๕๗๔

ที่ อว ๐๖๐๓.๐๒/ว ๑๔๓๙

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
อำเภอเมืองฯ จังหวัดพิษณุโลก ๖๕๐๐๐

๒๖ เมษายน ๒๕๖๖

เรื่อง ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

เรียน **สมาชิกสมาคมแป้งมันสำปะหลังไทย**

สิ่งที่ส่งมาด้วย โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย **นางสาวอรณิชา บุตรพรหม** รหัสประจำตัว ๕๙๐๓๒๘๓๓ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง **"ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย** (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)" เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาปรัชญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เฮงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน บัณฑิตวิทยาลัย จึงใคร่ขอความอนุเคราะห์จากท่านโปรดอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย
โทร ๐-๕๕๙๖-๘๘๓๓
โทรสาร ๐-๕๕๙๖-๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ - ๒๓๑๓๔๗๔

ที่ อว ๐๖๐๓.๐๒/ว ๑๔๓๙

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
อำเภอเมืองฯ จังหวัดพิษณุโลก ๖๕๐๐๐

๒๖ เมษายน ๒๕๖๖

เรื่อง ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

เรียน **สมาชิกสมาคมยางพาราไทย**

สิ่งที่ส่งมาด้วย โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย **นางสาวอรณิชา บุตรพรหม** รหัสประจำตัว ๕๙๐๓๒๔๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง **"ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)"** เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาปรัชญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เฮงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน บัณฑิตวิทยาลัย จึงใคร่ขอความอนุเคราะห์จากท่านโปรดอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย
โทร ๐-๕๕๙๖-๘๘๓๓
โทรสาร ๐-๕๕๙๖-๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ - ๒๓๓๓๔๗๔

ที่ อว ๐๖๐๓.๐๒/ว ๑๔๓๙

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
อำเภอเมืองฯ จังหวัดพิษณุโลก ๖๕๐๐๐

๒๖ เมษายน ๒๕๖๖

เรื่อง ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

เรียน **สมาชิกสมาคมน้ำยางข้นไทย**

สิ่งที่ส่งมาด้วย โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย **นางสาวอรณิชา บุตรพรหม** รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง **"ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย** (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)" เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาปรัชญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เสงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน บัณฑิตวิทยาลัย จึงใคร่ขอความอนุเคราะห์จากท่านโปรดอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย
โทร ๐-๕๕๙๖-๘๘๓๓
โทรสาร ๐-๕๕๙๖-๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ - ๒๓๓๓๔๗๔

ที่ อว ๐๖๐๓.๐๒/ว ๑๔๓๙

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
อำเภอเมืองฯ จังหวัดพิษณุโลก ๖๕๐๐๐

๒๖ เมษายน ๒๕๖๖

เรื่อง ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

เรียน **สมาชิกกลุ่มอุตสาหกรรมน้ำมันปาล์ม**

สิ่งที่ส่งมาด้วย โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย **นางสาวอรณิชา บุตรพรหม** รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง **"ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)"** เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาปรัชญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เสงษฎ์กุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน บัณฑิตวิทยาลัยจึงใคร่ขอความอนุเคราะห์จากท่านโปรดอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย
โทร ๐-๕๕๙๖-๘๘๓๑
โทรสาร ๐-๕๕๙๖-๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ - ๒๓๑๓๕๗๔

ที่ อว ๐๖๐๓.๐๒/ว ๑๔๓๙

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
อำเภอเมืองฯ จังหวัดพิษณุโลก ๖๕๐๐๐

๒๖ เมษายน ๒๕๖๖

เรื่อง ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

เรียน **สมาชิกสมาคมผู้ส่งออกข้าวไทย**

สิ่งที่ส่งมาด้วย โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย **นางสาวอรณิชา บุตรพรหม** รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง **"ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย** (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)" เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาปรัชญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เสงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน บัณฑิตวิทยาลัยจึงใคร่ขอความอนุเคราะห์จากท่านโปรดอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย
โทร ๐-๕๕๙๖-๘๘๓๑
โทรสาร ๐-๕๕๙๖-๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ - ๒๓๓๓๔๗๔

ที่ อว ๐๖๐๓.๐๒/ว ๑๔๓๙

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
อำเภอเมืองฯ จังหวัดพิษณุโลก ๖๕๐๐๐

๒๖ เมษายน ๒๕๖๖

เรื่อง ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

เรียน **สมาคมการค้าปุ๋ยและธุรกิจการเกษตรไทย**

สิ่งที่ส่งมาด้วย โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย **นางสาวอรณิชา บุตรพรหม** รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง **"ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)"** เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาปรัชญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เฮงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน บัณฑิตวิทยาลัย จึงใคร่ขอความอนุเคราะห์จากท่านโปรดอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย
โทร ๐-๕๕๙๖-๘๘๓๑
โทรสาร ๐-๕๕๙๖-๘๘๒๖

๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ - ๒๓๑๓๔๗๔

ที่ อว ๐๖๐๓.๐๒/ว ๑๔๓๙

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
อำเภอเมืองฯ จังหวัดพิษณุโลก ๖๕๐๐๐

๒๖ เมษายน ๒๕๖๖

เรื่อง ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

เรียน **ผู้ประกอบการผลิตเกลือ**

สิ่งที่ส่งมาด้วย โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย **นางสาวอรณิชา บุตรพรหม** รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง **"ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย** (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)" เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาปรัชญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เฮงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน บัณฑิตวิทยาลัยจึงใคร่ขอความอนุเคราะห์จากท่านโปรดอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย
โทร ๐-๕๕๙๖-๘๘๓๑
โทรสาร ๐-๕๕๙๖-๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ - ๒๓๑๓๕๗๔

ที่ อว ๐๖๐๓.๐๒/ว ๑๔๓๙

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
อำเภอเมืองฯ จังหวัดพิษณุโลก ๖๕๐๐๐

๒๖ เมษายน ๒๕๖๖

เรื่อง ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

เรียน **สมาชิกสมาคมขนส่งสินค้าและโลจิสติกส์ไทย**

สิ่งที่ส่งมาด้วย โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย **นางสาวอรณิชา บุตรพรหม** รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง **"ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)"** เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาปรัชญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เฮงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน บัณฑิตวิทยาลัยจึงใคร่ขอความอนุเคราะห์จากท่านโปรดอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย
โทร ๐-๕๕๙๖-๘๘๓๑
โทรสาร ๐-๕๕๙๖-๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ - ๒๓๓๓๔๗๔

ที่ อว ๐๖๐๓.๐๒/ว ๑๔๓๙

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
อำเภอเมืองฯ จังหวัดพิษณุโลก ๖๕๐๐๐

๒๖ เมษายน ๒๕๖๖

เรื่อง ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

เรียน **ผู้ประกอบการที่ได้รับรองมาตรฐานคุณภาพบริการขนส่งด้วยรถบรรทุก (Q Mark)**

สิ่งที่ส่งมาด้วย โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย **นางสาวอรณิชา บุตรพรหม** รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง **"ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)"** เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาปรัชญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เฮงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน บัณฑิตวิทยาลัยจึงใคร่ขอความอนุเคราะห์จากท่านโปรดอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย
โทร ๐-๕๕๙๖-๘๘๓๑
โทรสาร ๐-๕๕๙๖-๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ - ๒๓๑๓๕๗๔

ที่ อว ๐๖๐๓.๐๒/ว ๑๔๓๙

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
อำเภอเมืองฯ จังหวัดพิษณุโลก ๖๕๐๐๐

๒๖ เมษายน ๒๕๖๖

เรื่อง ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

เรียน **ผู้ประกอบการขนส่งด้วยรถบรรทุก**

สิ่งที่ส่งมาด้วย โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย **นางสาวอรณิชา บุตรพรหม** รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง **"ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย** (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)" เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาปรัชญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เฮงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน บัณฑิตวิทยาลัย จึงใคร่ขอความอนุเคราะห์จากท่านโปรดอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย
โทร ๐-๕๕๙๖-๘๘๓๑
โทรสาร ๐-๕๕๙๖-๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ - ๒๓๓๓๔๗๔

ที่ อว ๐๖๐๓.๐๒/ว ๑๔๓๙

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
อำเภอเมืองฯ จังหวัดพิษณุโลก ๖๕๐๐๐

๒๖ เมษายน ๒๕๖๖

เรื่อง ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

เรียน **ผู้ประกอบการผู้ให้บริการโลจิสติกส์**

สิ่งที่ส่งมาด้วย โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย **นางสาวอรณิชา บุตรพรหม** รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง **"ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)"** เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาปรัชญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เฮงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน บัณฑิตวิทยาลัย จึงใคร่ขอความอนุเคราะห์จากท่านโปรดอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย
โทร ๐-๕๕๙๖-๘๘๓๑
โทรสาร ๐-๕๕๙๖-๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๒ - ๒๓๑๓๔๗๔

ที่ อว ๐๖๐๓.๐๒/ว ๑๔๓๙

บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร
อำเภอเมืองฯ จังหวัดพิษณุโลก ๖๕๐๐๐

๒๖ เมษายน ๒๕๖๖

เรื่อง ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

เรียน **สมาชิกสมาคมผู้รับจัดการขนส่งสินค้าระหว่างประเทศ**

สิ่งที่ส่งมาด้วย โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย **นางสาวอรณิชา บุตรพรหม** รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง **"ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (FOSTERING FACTORS TO RAIL FREIGHT IN THAILAND)"** เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาปรัชญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เฮงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน บัณฑิตวิทยาลัย จึงใคร่ขอความอนุเคราะห์จากท่านโปรดอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป บัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าคงจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร.อนามัย นาอุดม)
รองคณบดีฝ่ายวิชาการ ปฏิบัติราชการแทน
คณบดีบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร

๑. งานวิชาการ บัณฑิตวิทยาลัย
โทร ๐-๕๕๙๖-๘๘๓๑
โทรสาร ๐-๕๕๙๖-๘๘๒๖
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ - ๒๓๑๓๕๙๔

## APPENDIX D LETTER FOR FOCUS GROUP

ที่ อว ๐๖๐๓.๓๙/ว ๐๒๑

คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
มหาวิทยาลัยนเรศวร
อำเภอเมืองพิษณุโลก
จังหวัดพิษณุโลก ๖๕๐๐๐

๘ มกราคม ๒๕๖๗

**เรื่อง** ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

**เรียน** คุณพิสิทธิ์ เพียรประดิษฐ์กุล บริษัท เพียรประดิษฐ์รับเบอร์ จำกัด

**สิ่งที่ส่งมาด้วย** โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย นางสาวอรณิชา บุตรพรหม รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง "ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (Fostering Factors to Rail Freight in Thailand)" เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เฮงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน คณะโลจิสติกส์และดิจิทัลซัพพลายเชน จึงใคร่ขอความอนุเคราะห์จากท่านอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป คณะโลจิสติกส์และดิจิทัลซัพพลายเชน มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร. วัชรพล สุขโหตุ)
คณบดีคณะโลจิสติกส์และดิจิทัลซัพพลายเชน
มหาวิทยาลัยนเรศวร

๑. งานบริการการศึกษา คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
โทร. ๐ - ๕๕๙๖ - ๘๗๔๗
โทรสาร ๐ - ๕๕๙๖ - ๘๗๗๕
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ - ๒๓๑๓๔๗๔

ที่ อว ๐๖๐๓.๓๑/ว ๑๗๒๑

คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
มหาวิทยาลัยนเรศวร
อำเภอเมืองพิษณุโลก
จังหวัดพิษณุโลก ๖๕๐๐๐

๘ มกราคม ๒๕๖๗

**เรื่อง** ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

**เรียน** คุณอรุณ หัตถะรัชต์ บริษัท น้ำตาลมิตรผล จำกัด

**สิ่งที่ส่งมาด้วย** โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย นางสาวอรณิชา บุตรพรหม รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง "ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (Fostering Factors to Rail Freight in Thailand)" เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เฮงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน คณะโลจิสติกส์และดิจิทัลซัพพลายเชน จึงใคร่ขอความอนุเคราะห์จากท่านอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป คณะโลจิสติกส์และดิจิทัลซัพพลายเชน มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร. วัชรพล สุขโหตุ)
คณบดีคณะโลจิสติกส์และดิจิทัลซัพพลายเชน
มหาวิทยาลัยนเรศวร

๑. งานบริการการศึกษา คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
โทร. ๐ – ๕๕๙๖ - ๘๗๕๗
โทรสาร ๐ – ๕๕๙๖ - ๘๗๗๕
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ – ๒๓๑๑๓๘๗๙

ที่ อว ๐๖๐๓.๓๑/ว ๐๘๖๑

คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
มหาวิทยาลัยนเรศวร
อำเภอเมืองพิษณุโลก
จังหวัดพิษณุโลก ๖๕๐๐๐

๘ มกราคม ๒๕๖๗

**เรื่อง** ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

**เรียน** คุณสรายุทธ์ มณีอินทร์ บริษัท โซคอนันต์ไรซ์ (๒๐๐๓) จำกัด

**สิ่งที่ส่งมาด้วย** โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย นางสาวอรณิชา บุตรพรหม รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง "ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (Fostering Factors to Rail Freight in Thailand)" เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เสงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน คณะโลจิสติกส์และดิจิทัลซัพพลายเชน จึงใคร่ขอความอนุเคราะห์จากท่านอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป คณะโลจิสติกส์และดิจิทัลซัพพลายเชน มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร. วัชรพล สุขโหตุ)
คณบดีคณะโลจิสติกส์และดิจิทัลซัพพลายเชน
มหาวิทยาลัยนเรศวร

๑. งานบริการการศึกษา คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
โทร. ๐ – ๕๕๙๖ - ๘๓๘๘
โทรสาร ๐ – ๕๕๙๖ - ๘๓๓๕
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ - ๒๓๑๓๘๗๔

ที่ อว ๐๖๐๓.๓๑/ว ๐๐๖๑

คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
มหาวิทยาลัยนเรศวร
อำเภอเมืองพิษณุโลก
จังหวัดพิษณุโลก ๖๕๐๐๐

๘ มกราคม ๒๕๖๗

**เรื่อง** ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

**เรียน** คุณชัชชัย จิระธนะวัฒน์ บริษัท ชากังราว สตาร์ช จำกัด

**สิ่งที่ส่งมาด้วย** โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย นางสาวอรณิชา บุตรพรหม รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง "ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (Fostering Factors to Rail Freight in Thailand)" เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เฮงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน คณะโลจิสติกส์และดิจิทัลซัพพลายเชน จึงใคร่ขอความอนุเคราะห์จากท่านอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป คณะโลจิสติกส์และดิจิทัลซัพพลายเชน มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร. วัชรพล สุขโหตุ)
คณบดีคณะโลจิสติกส์และดิจิทัลซัพพลายเชน
มหาวิทยาลัยนเรศวร

๑. งานบริการการศึกษา คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
โทร. ๐ - ๕๕๙๖ - ๘๗๕๗
โทรสาร ๐ - ๕๕๙๖ - ๘๗๗๕
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ - ๒๑๑๓๕๗๔

ที่ อว ๐๖๐๓.๓๙/ว ๐๒๖๑

คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
มหาวิทยาลัยนเรศวร
อำเภอเมืองพิษณุโลก
จังหวัดพิษณุโลก ๖๕๐๐๐

๘ มกราคม ๒๕๖๗

**เรื่อง** ขอความร่วมมือเก็บข้อมูลเพื่อการวิจัย

**เรียน** คุณภานุวัชร ไหมแก้ว นายกสมาคมผู้ประกอบการส่งออกมังคุดทุเรียนแห่งประเทศไทย

**สิ่งที่ส่งมาด้วย** โครงการวิจัย จำนวน ๑ ฉบับ

ด้วย นางสาวอรณิชา บุตรพรหม รหัสประจำตัว ๕๙๐๓๒๘๑๑ นิสิตระดับปริญญาเอก สาขาวิชาโลจิสติกส์และโซ่อุปทาน สังกัดบัณฑิตวิทยาลัย มหาวิทยาลัยนเรศวร ได้รับอนุมัติให้ดำเนินการทำวิทยานิพนธ์ เรื่อง "ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (Fostering Factors to Rail Freight in Thailand)" เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาดุษฎีบัณฑิต โดยมี ว่าที่ร้อยตรี ดร.ธรรมนูญ เฮงษฎีกุล เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

ในการทำวิทยานิพนธ์เรื่องนี้ นิสิตมีความจำเป็นต้องขอเก็บข้อมูลจากท่าน คณะโลจิสติกส์และดิจิทัลซัพพลายเชน จึงใคร่ขอความอนุเคราะห์จากท่านอนุญาตให้นิสิตดำเนินการเก็บรวบรวมข้อมูลในการวิจัย ซึ่งจะเป็นประโยชน์ทางวิชาการต่อไป คณะโลจิสติกส์และดิจิทัลซัพพลายเชน มหาวิทยาลัยนเรศวร หวังเป็นอย่างยิ่งว่าจะได้รับความอนุเคราะห์จากท่านด้วยดีและขอขอบคุณอย่างสูงมา ณ โอกาสนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร. วัชรพล สุขโหตุ)
คณบดีคณะโลจิสติกส์และดิจิทัลซัพพลายเชน
มหาวิทยาลัยนเรศวร

๑. งานบริการการศึกษา คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
โทร. ๐ – ๕๕๙๖ - ๘๗๔๗
โทรสาร ๐ – ๕๕๙๖ - ๘๗๗๕
๒. นางสาวอรณิชา บุตรพรหม
โทร ๐๘๖ - ๒๓๑๑๓๗๕

# APPENDIX E LETTER REQUEST FOR TRUCK TRANSPORTATION TRAFFIC

ที่ อว ๐๖๐๓.๓๑/ ๐๖๕๗

คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
มหาวิทยาลัยนเรศวร
อำเภอเมืองพิษณุโลก
จังหวัดพิษณุโลก ๖๕๐๐๐

๑ ธันวาคม ๒๕๖๕

**เรื่อง** ขอความอนุเคราะห์ข้อมูลการขนส่งสินค้าของรถบรรทุก

**เรียน** อธิบดีกรมการขนส่งทางบก

ด้วย นางสาวอรณิชา บุตรพรหม นิสิตระดับปริญญาเอก สาขาโลจิสติกส์และดิจิทัลซัพพลายเชน คณะโลจิสติกส์และดิจิตัลซัพพลายเชน มหาวิทยาลัยนเรศวร ได้ดำเนินการทำวิทยานิพนธ์เรื่อง ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย (Fostering Factors to Rail Freight in Thailand) ซึ่งเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปรัชญาดุษฎีบัณฑิต สาขาโลจิสติกส์และดิจิทัลซัพพลายเชน

ในการนี้ การดำเนินการวิจัยต้องการข้อมูลขนส่งสินค้าของรถบรรทุกของผู้ขนส่งและผู้ประกอบการที่ดำเนินการขนส่งสินค้าในปี พ.ศ. ๒๕๖๐ ถึง พ.ศ. ๒๕๖๔ เพื่อประกอบการเลือกกลุ่มตัวอย่างในการดำเนินการเก็บข้อมูลเพื่อทำการวิจัย ดังนั้น เพื่อให้การดำเนินการวิจัยสำเร็จลุล่วงไปด้วยดี จึงใคร่ขอความอนุเคราะห์จากท่านผู้ให้ข้อมูลแก่ นางสาวอรณิชา บุตรพรหม โดยมีรายนามชื่อจังหวัดที่ต้องการข้อมูลตามเอกสารแนบ ทั้งนี้ นิสิตผู้วิจัยจะเป็นผู้ติดต่อประสานงานในรายละเอียดกับท่าน โดยตรงต่อไป

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์ และขอขอบคุณมา ณ โอกาสนี้

ขอแสดงความนับถือ

(ผู้ช่วยศาสตราจารย์ ดร. วัชรพล สุขโหตุ)
คณบดีคณะโลจิสติกส์และดิจิทัลซัพพลายเชน
มหาวิทยาลัยนเรศวร

งานบริการการศึกษา สำนักงานเลขานุการ
คณะโลจิสติกส์และดิจิทัลซัพพลายเชน
โทร. ๐ ๕๕๙๖ ๘๗๔๗
โทรสาร ๐ ๕๕๙๖ ๘๗๗๕

# APPENDIX F QUESTIONNAIRES

**Questionnaire IOC (Main Parts)**

| | **5 Experts** | **1** | **2** | **3** | **4** | **5** | **Total** | **Mean** |
|---|---|---|---|---|---|---|---|---|
| | **Part 1 Basic Information** | | | | | | | |
| *What is your business type?* | | | | | | | | |
| | Manufactured | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| | Logistics Service Provider (LSP) | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| *Location of your company* | | | | | | | | |
| | Chachoengsao | 1 | 0 | 1 | 1 | 0 | 3 | 0.6 |
| | Nakhon Nayok | 1 | 0 | 1 | 1 | 0 | 3 | 0.6 |
| | Saraburi | 1 | 0 | 1 | 1 | 0 | 3 | 0.6 |
| | Nakhon Ratchasima | 1 | 0 | 1 | 1 | 0 | 3 | 0.6 |
| | Khon Kaen | 1 | 0 | 1 | 1 | 0 | 3 | 0.6 |
| | Lop Buri | 1 | 0 | 1 | 1 | 0 | 3 | 0.6 |
| | Nakhon Sawan | 1 | 0 | 1 | 1 | 0 | 3 | 0.6 |
| | Nakhon Pathom | 1 | 0 | 1 | 1 | 0 | 3 | 0.6 |
| | Ratchaburi | 1 | 0 | 1 | 1 | 0 | 3 | 0.6 |
| | Phetchaburi | 1 | 0 | 1 | 1 | 0 | 3 | 0.6 |
| | Prachuap Khiri Khan | 1 | 0 | 1 | 1 | 0 | 3 | 0.6 |
| | Chumphon | 1 | 0 | 1 | 1 | 0 | 3 | 0.6 |
| | Bangkok | 1 | 0 | 1 | 1 | 0 | 3 | 0.6 |
| | Other (please specific) ……………… | 1 | 0 | 1 | 1 | 0 | 3 | 0.6 |
| *Types of commodity cargo* | | | | | | | | |
| | General cargo | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| | Liquid bilk | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| | Dry Bulk | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| | Other (please specific) … | 0 | 1 | 1 | 1 | 1 | 4 | 0.8 |
| *Modes of Domestic Transportation* | | | | | | | | |
| | Road | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| | Railway | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| | Water and coastal | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| | Air | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| | **Part 2 Factors on Rail Freight Transport System** | | | | | | | |
| | ***Railway Infrastructures*** | | | | | | | |
| 1 | ปริมาณรางที่ใช้ได้มีผลต่อการขนส่งสินค้าทางราง The amount of available rails affects the transport of goods by rail. | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 2 | ประสิทธิภาพของรางและสถานี Track and station efficiency | 0 | 1 | 1 | 1 | 1 | 4 | 0.8 |
| 3 | สิ่งอำนวยความสะดวกด้านโลจิสติกส์เช่น ลานตู้สินค้า (CY) และสถานีบรรจุและแยกสินค้ากล่อง (ICD) เพียงพอ Logistics facilities such as container yards (CY) and case packing and sorting (ICD) stations are adequate. | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 4 | ปริมาณโครงข่ายรางรถไฟ Quantity of railway network | | 1 | 1 | 1 | 1 | 4 | 0.8 |
| 5 | การเชื่อมโยงกับการขนส่งรูปแบบอื่น และความสามารถเข้าถึงได้ Links with other forms of transport and accessibility | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 6 | สภาพหัวรถจักรเก่าและไม่เพียงพอ The condition of the locomotive is old and inadequate. | 0 | 1 | 1 | 0 | 1 | 3 | 0.6 |
| 7 | สภาพแคร่ที่เก่าและไม่เพียงพอ The condition of the carriage is old and inadequate. | 0 | 1 | 1 | 0 | 1 | 3 | 0.6 |
| 8 | ปริมาณแคร่ที่ใช้ได้และสรรหาได้ตรงเวลา Quantity of carriage available and available on time | 0 | 1 | 1 | 0 | 1 | 3 | 0.6 |
| 9 | จำนวนหัวรถจักรที่ใช้ได้น้อยกว่าความต้องการ The number of available locomotives is less than the demand. | 0 | 1 | 1 | 0 | 1 | 3 | 0.6 |

***Railway Performance***

| | 5 Experts | 1 | 2 | 3 | 4 | 5 | Total | Mean |
|---|---|---|---|---|---|---|---|---|
| 1 | คุณภาพการขนส่งสินค้า เช่น ตรงต่อเวลา ความถี่ ความเร็ว น่าเชื่อถือและมั่นใจได้ และความปลอดภัยของการเดินรถ Goods transportation quality such as punctuality, frequency, speed, reliability and confidence. and safety of driving | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 2 | ความพร้อมของสิ่งอำนวยความสะดวกด้านโลจิสติกส์ เช่น ลานตู้สินค้า (CY) และสถานีบรรจุและแยกสินค้ากล่อง (ICD) Availability of logistics facilities such as container yard (CY) and ICD (ICD) stations. | 1 | 0 | 1 | 1 | 1 | 4 | 0.8 |
| 3 | การบริการของพนักงานของการรถไฟแห่งประเทศไทย SRT's employee performance on service | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 4 | ความยาวของรางและความหนาแน่นของการใช้รางรถไฟ Length of tracks and density of track use | 1 | 1 | 1 | 0 | 0 | 3 | 0.6 |
| | ***Thailand's Railway Infrastructure Development Strategy*** | | | | | | | |
| 1 | การมุ่งเน้นพัฒนาคุณภาพโครงสร้างพื้นฐานของประเทศให้ระบบการขนส่งทางรางเป็นหลักของรัฐบาลปัจจุบันผ่านแผนพัฒนาเศรษฐกิจและสังคมแห่งชาติ Focusing on improving the quality of the country's infrastructure has made the rail transportation system a mainstay of the current government through the National Economic and Social Development Plan. | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 2 | ยุทธศาสตร์ชาติ รัฐบาล กระทรวงคมนาคมและนโยบายลงทุนของรัฐบาลในการพัฒนาโครงสร้างพื้นฐานโครงข่ายทางราง National strategy, government, Ministry of Transport and government investment policy in developing rail network infrastructure. | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 3 | ยุทธศาสตร์การพัฒนาโครงสร้างพื้นฐานด้านคมนาคมขนส่งของไทย พ.ศ. 2558-2565 ในการสร้างรถไฟทางคู่ส่งผลต่อระบบการขนส่งสินค้าทางราง Thailand's transport infrastructure development strategy 2015-2022 in the construction of double-track railways affects the rail freight transport system. | 1 | 1 | 0 | 1 | 1 | 4 | 0.8 |
| 4 | เป้าหมายการเพิ่มความได้เปรียบเชิงการแข่งขันของประเทศ The goal to increase the country's competitive advantage. | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 5 | เป้าหมายการลดต้นทุนโลจิสติกส์ต่อผลิตภัณฑ์มวลรวมในประเทศ Target of reducing logistics costs per gross domestic product | 1 | 0 | 1 | 1 | 1 | 4 | 0.8 |

| | **Part 3 Factors on Railway Freight Demand** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ***Local Economic*** | | | | | | | |
| 1 | ความต้องการสินค้าอุปโภคบริโภคของประชาชนในชุมชน Demand for consumer products of people in the community | 1 | 1 | 1 | 0 | 1 | 4 | 0.8 |
| 2 | กิจกรรมทางเศรษฐกิจต่าง ๆ เช่น การผลิต การบริโภค การกระจาย และการแลกเปลี่ยนสินค้า Various economic activities such as production, consumption, distribution, and exchange of goods | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 3 | รายได้เฉลี่ยของผู้บริโภคต่อการจับจ่ายซื้อสินค้า Average consumer income per purchase | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 4 | ความต้องการมีชีวิตที่ดีขึ้นของผู้บริโภค Consumers' desire for a better life | 1 | 1 | 1 | 0 | -1 | 2 | 0.4 |
| 5 | ความต้องการลดเชื้อเพลิงนำเข้าของประเทศและผู้บริโภค The need to reduce imported fuels of the country and consumers | 1 | 1 | 1 | 0 | -1 | 2 | 0.4 |
| | ***Demographic*** | | | | | | | |
| 1 | อาชีพของคนในชุมชน Occupations of people in the community | 1 | 1 | 0 | 0 | 1 | 3 | 0.6 |
| 2 | อายุของประชากร Ages of people in the community | 1 | 1 | 0 | 1 | 0 | 3 | 0.6 |
| 3 | อัตราการเกิดและการตายของประชากร Birth and death rates of the population | 1 | 1 | 0 | 0 | -1 | 1 | 0.2 |
| 4 | ความเจริญของเมือง การเพิ่มขึ้นของการตั้งถิ่นฐาน และการอพยพจากท้องถิ่นอื่นทำให้ขนาดของเมืองที่อาจจะใหญ่มากขึ้น city prosperity increase in settlement and immigration from other localities makes the size of the city potentially larger. | 1 | 1 | 1 | 1 | 1 | 5 | 1 |

| | 5 Experts | 1 | 2 | 3 | 4 | 5 | Total | Mean |
|---|---|---|---|---|---|---|---|---|
| 5 | ความหนาแน่นของประชากรข้างทางรถไฟ Population density next to the railway | 1 | 1 | 0 | 0 | 0 | 2 | 0.4 |
| | ***Commodities*** | | | | | | | |
| 1 | สินค้าเทกองและสินค้าน้ำหนักมาก ๆ เหมาะสมกับการขนส่งทางไกล Bulk goods and heavy goods are suitable for long-distance transport. | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 2 | ชนิดของสินค้าเช่น สินค้าเกษตร สินค้าก่อสร้างและสินค้าพลังงาน Types of goods such as agricultural products, construction products and energy products | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 3 | ความสามารถในการขนสินค้าได้คราวละมาก ๆ ของการขนส่งทางราง The ability to transport large quantities of goods at a time by rail transport | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 4 | มูลค่า ราคา และอายุการใช้งานของสินค้า Value, price and lifespan of products | 1 | 1 | 1 | 1 | 0 | 4 | 0.8 |
| 5 | ความคงทน ความสูญเสียและเสียหาย ความยากง่ายในการขนถ่ายสินค้าและขนส่งสินค้า Durability, loss and damage Difficulty in loading and unloading goods and transporting goods | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| | ***Mode Choice*** | | | | | | | |
| 1 | คุณภาพการให้บริการของรถไฟ เช่น การตรงต่อเวลา อุปกรณ์อำนวยความสะดวกในการขนถ่ายสินค้า Quality of train service, such as punctuality Equipment to facilitate loading and unloading goods | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 2 | ราคา การบริการและโครงสร้างของการขนส่งรูปแบบอื่น ๆ เช่นทางถนน และทางเรือ Prices, services and infrastructure of other modes of transport such as road and sea. | 1 | 1 | 1 | 0 | 1 | 4 | 0.8 |
| 3 | ความสามารถในการเชื่อมต่อการขนส่งรูปแบบอื่นของรถไฟ Ability to connect to other forms of rail transport. | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 4 | ระยะเวลาในการขนส่งสินค้า Shipping time | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| | ***Pricing*** | | | | | | | |
| 1 | นโยบายเรื่องราคาของการขนส่งทางรถไฟ Policy on the price of rail transport | 1 | 1 | 1 | 0 | 1 | 4 | 0.8 |
| 2 | อัตราค่าบริการการขนส่งสินค้าทางรถไฟ Railway freight service rates | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 3 | นโยบายการปรับค่าบริการในการขนถ่ายสินค้าทางรถไฟ Policy for adjusting service fees for transporting goods by rail | 1 | 1 | 1 | 0 | 1 | 4 | 0.8 |
| 4 | อัตราค่าบริการที่มีความเหมาะสม Service rates are appropriate. | 1 | 1 | 1 | 0 | 1 | 4 | 0.8 |
| | ***Fuel Price*** | | | | | | | |
| 1 | ระบบการขนส่งระบบรางที่ประหยัดเชื้อเพลิง Fuel-efficient rail transport system | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 2 | ราคาของเชื้อเพลิงหรือพลังงานที่ใช้ Price of fuel or energy used | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 3 | การขึ้นลงของราคาเชื้อเพลิง The fluctuation of fuel prices | 1 | 1 | 0 | 0 | 1 | 3 | 0.6 |
| 4 | การใช้เชื้อเพลิงหรือพลังงานทางเลือกให้เกิดประโยชน์สูงสุด Using fuel or alternative energy to get the most benefit | 1 | 1 | 1 | 0 | 1 | 4 | 0.8 |
| 5 | การตระหนักถึงมลพิษที่เกิดจากการใช้เชื้อเพลิงหรือพลังงาน Awareness of pollution caused by the use of fuel or energy. | 1 | 1 | 1 | 1 | 1 | 5 | 1 |

| | **Part 4 External factors on Fostering Factors of Railway Freight Transport in Thailand** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ***Political*** | | | | | | | |
| 1 | นโยบายการสนับสนุนการขนส่งสินค้าทางรางเป็นทางหลักเพื่อประหยัดเชื้อเพลิงในประเทศไทยและเพื่อนบ้าน Policy to support rail freight transport as the main way to save fuel in Thailand and neighboring countries | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 2 | นโยบายการปฏิรูปการรถไฟแห่งประเทศไทยของรัฐบาล State Railway of Thailand reform policy of the government | 1 | 1 | 1 | 1 | 1 | 5 | 1 |

| | 5 Experts | 1 | 2 | 3 | 4 | 5 | Total | Mean |
|---|---|---|---|---|---|---|---|---|
| 3 | นโยบายการค้าระหว่างประเทศของประเทศมหาอำนาจโลก International trade policies of world superpowers | 1 | 1 | 1 | 0 | 1 | 4 | 0.8 |
| 4 | นโยบายหนึ่งแถบหนึ่งเส้นทางของประเทศจีนเพื่อพัฒนาโครงสร้างพื้นฐานเชื่อมโยงตลาด China's One Belt and Road Policy to develop market-linked infrastructure | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 5 | นโยบายการลงทุนระบบโครงสร้างพื้นฐานทางรางของเพื่อนบ้าน Neighborhood rail infrastructure investment policy | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| | ***Economic*** | | | | | | | |
| 1 | การขนส่งสินค้าทางรางทำให้ธุรกิจมีโอกาสในการขยายตลาดได้ Transporting goods by rail gives businesses the opportunity to expand their markets. | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 2 | เศรษฐกิจภายในประเทศ ภูมิภาค และโลก Domestic, regional and world economies | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 3 | รูปแบบการขนส่งสินค้าที่ประหยัด เช่น ระบบรางจะช่วยให้เกิดการทำกำไรได้มากขึ้น Economical modes of transport such as rail will help increase profits. | 1 | 1 | 1 | 0 | 1 | 4 | 0.8 |
| 4 | ราคาน้ำมันที่ผันผวนและสูงขึ้น Fluctuating and rising oil prices | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 5 | การเพิ่มขึ้นของอัตราดอกเบี้ยธนาคารต่อนักลงทุนและผู้อุปโภคบริโภค An increase in bank interest rates affects investors and consumers. | 0 | 1 | 1 | 0 | 1 | 3 | 0.6 |
| 6 | อัตราเงินเฟ้อในประเทศ Inflation rate in the country | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| | ***Sociocultural*** | | | | | | | |
| 1 | ทัศนคติ และรสนิยมของผู้บริโภคเปลี่ยนแปลงส่งผลต่อการกระจายและการขนส่งสินค้าทางราง Changing consumer attitudes and tastes affect the distribution and transport of goods by rail. | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 2 | ระดับการศึกษาที่สูงขึ้น higher education level | 1 | 1 | 1 | 0 | 0 | 3 | 0.6 |
| 3 | การส่งผ่านหรือการถ่ายทอดวัฒนธรรมจากการกระจายสินค้า The transmission or transfer of culture from the distribution of goods. | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 4 | สังคมที่เน้นและตระหนักเรื่องความปลอดภัยของการนำคมนาคมสู่ชุมชน A society that emphasizes and is aware of the safety of bringing transportation to the community. | 1 | 1 | 1 | -1 | 1 | 3 | 0.6 |
| 5 | สังคมที่เน้นคุณค่าวัฒนธรรมการพัฒนาทางเศรษฐกิจ A society that emphasizes cultural values and economic development | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| | ***Technology*** | | | | | | | |
| 1 | เทคโนโลยีและนวัตกรรมทางราง Railway technology and innovation | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 2 | การวิจัยและพัฒนาเทคโนโลยีทางราง Research and development of railway technology | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 3 | ความเชื่อมั่นเทคโนโลยีในการขนส่งสินค้าทางราง Confidence in technology in rail transport | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 4 | ประสิทธิภาพเทคโนโลยีนำมาซึ่งการขนส่งที่หยืดหยุ่น เข้าถึงและสามารถใช้บริการได้ Technology efficiency brings flexible transportation Access and be able to use the service | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| | ***Environmental*** | | | | | | | |
| 1 | พลังงานและยานพาหนะสะอาด Clean energy and vehicles | 1 | 0 | 1 | 1 | 1 | 4 | 0.8 |
| 2 | ความรับผิดชอบของธุรกิจในด้านสิ่งแวดล้อม Environmental responsibilities of business | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 3 | แนวโน้มการเพิ่มขึ้นของพลังงานทางเลือกในการขนส่งสินค้า The increasing trend of alternative energy for transporting goods | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 4 | กฎระเบียบและนโยบายด้านสิ่งแวดล้อม Environmental regulations and policies | 1 | 1 | 1 | -1 | 1 | 3 | 0.6 |
| 5 | การขนส่งที่สะอาดลดมลพิษ ฝุ่นควัน และเสียง Clean transportation reduces pollution, dust, smoke, and noise. | 1 | 0 | 1 | 1 | 1 | 4 | 0.8 |

| | 5 Experts | 1 | 2 | 3 | 4 | 5 | Total | Mean |
|---|---|---|---|---|---|---|---|---|
| | ***Legal*** | | | | | | | |
| 1 | ข้อตกลงการค้าระหว่างประเทศในการอำนวยความสะดวกการขนส่งสินค้าข้ามแดน และผ่านแดนของไทย international trade agreements that simplify the movement of commodities across international borders and across the Thai border | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 2 | กฎระเบียบและการควบคุมจากรัฐบาล Government regulations and controls | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 3 | ข้อกฎหมายที่สนับสนุนให้เกิดการลงทุนจากเอกชนในการดำเนินงานการขนส่งสินค้าทางราง Legislation that encourages private investment in rail freight operations | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 4 | กฎหมายที่เอื้ออำนวยต่อการปฏิบัติงานที่รวดเร็วและกระชับขึ้น Legislation that facilitates faster and more concise operations | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| 5 | การผ่อนคลายกฎ ระเบียบ และข้อบังคับด้านค่าระวางสินค้า Relaxation of rules, regulations, and freight regulations. | 1 | 1 | 1 | 1 | 1 | 5 | 1 |

**Part 5 Suggestions/Comments**

# แบบสอบถาม
## ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย

แบบสอบถามชุดนี้จัดทำขึ้นเพื่อนำข้อมูลที่ได้ไปใช้ในการศึกษาดุษฎีนิพนธ์เรื่อง "ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย" โดยมีวัตถุประสงค์ เพื่อศึกษาปัจจัยที่ส่งผลต่อความต้องการการขนส่งสินค้าทางราง และเพื่อสำรวจปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย ผู้วิจัยจะเก็บข้อมูลที่ได้รับเป็นความลับและข้อมูลจะถูกนำไปแปรผลในรูปของการวิเคราะห์ในภาพรวมเพื่อวัตถุประสงค์ทางการศึกษาเท่านั้น การตอบคำถามของท่านจะมีผลต่อความสำเร็จในการทำวิจัยครั้งนี้ ผู้วิจัยใคร่ขอความร่วมมือจากท่านในการกรอกแบบสอบถามให้ครบถ้วน

การสละเวลาตอบแบบสอบถามของท่าน จะเป็นประโยชน์ต่อการศึกษาปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย ซึ่งเป็นประโยชน์อย่างสูงในด้านวิชาการ และอาจยังประโยชน์ต่อภาคธุรกิจของไทยในอนาคต หากท่านมีข้อสงสัยประการใดเกี่ยวกับแบบสอบถามชุดนี้ โปรดติดต่อผู้วิจัย นางสาวอรณิชา บุตรพรหม หมายเลขโทรศัพท์ 086-231-3474 E-mail: oranicha@buu.ac.th

**แบบสอบถามประกอบด้วย 5 ส่วน ดังต่อไปนี้**

ส่วนที่ 1 ข้อมูลทั่วไปของผู้ตอบแบบสอบถาม
ส่วนที่ 2 ปัจจัยที่ส่งผลต่อความต้องการการขนส่งสินค้าทางราง
ส่วนที่ 3 ระบบการขนส่งสินค้าทางราง
ส่วนที่ 4 ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางราง
ส่วนที่ 5 ข้อเสนอแนะ

**<u>ส่วนที่ 1</u>** ข้อมูลทั่วไปของผู้ตอบแบบสอบถาม

**<u>คำชี้แจง</u>** กรุณาใส่เครื่องหมายถูก (✓) ลงในช่อง ☐ (สี่เหลี่ยม) หน้าตัวเลือกที่ต้องการและกรุณากรอกรายละเอียดลงในช่องว่างที่กำหนดถ้าเลือกตัวข้อนั้น ๆ

1. ประเภทธุรกิจ/อุตสาหกรรมของท่าน

☐ ผู้ผลิตสินค้า ☐ ผู้ให้บริการโลจิสติกส์
☐ อื่น ๆ (โปรดระบุ).......................................

2. ที่ตั้งของสถานประกอบการ

| | | | |
|---|---|---|---|
| ☐ ฉะเชิงเทรา | ☐ นครนายก | ☐ สระบุรี | ☐ นครราชสีมา |
| ☐ ขอนแก่น | ☐ ลพบุรี | ☐ นครสวรรค์ | ☐ นครปฐม |
| ☐ ราชบุรี | ☐ เพชรบุรี | ☐ ประจวบคีรีขันธ์ | ☐ ชุมพร |
| ☐ กรุงเทพฯ | ☐ อื่น ๆ (โปรดระบุ)............................................ | | |

3. บริษัทของท่านมีการรับหรือส่งสินค้าจากภาคใดบ้าง (สามารถตอบได้มากกว่า 1)

☐ ภาคใต้ ☐ ภาคกลาง ☐ ภาคตะวันออก
☐ ภาคเหนือ ☐ ภาคตะวันตก ☐ ภาคตะวันออกเฉียงเหนือ

4. บริษัทของท่านมีการนำเข้าหรือส่งออกสินค้าไปประเทศใดบ้าง (สามารถตอบได้มากกว่า 1)

☐ มาเลเซีย ☐ สปป. ลาว ☐ กัมพูชา
☐ เมียนมาร์ ☐ เวียดนาม ☐ จีน
☐ อื่น ๆ (โปรดระบุ)...................................

5. ลักษณะสินค้าบริษัทของท่านเป็นอย่างไร

☐ สินค้าทั่วไป เช่น สินค้าอุปโภคบริโภค ☐ สินค้าเทกองแบบเปียก เช่น น้ำมัน ก๊าซ
☐ สินค้าเทกองแบบแห้ง เช่น ปูนซีเมนต์ ข้าว ☐ อื่น ๆ (โปรดระบุ)...................................

6. บริษัทของท่านรับส่งสินค้าโดยการขนส่งรูปแบบใดบ้าง (สามารถตอบได้มากกว่า 1)

☐ ทางถนน ☐ ทางราง ☐ ทางเรือ ☐ ทางอากาศ ☐ ทางท่อ

7. ปัจจุบันปริมาณสินค้าที่ขนส่งต่อเดือนประมาณเท่าไหร่ (สามารถตอบได้มากกว่า 1)

ทางถนน.....................ตัน ทางราง.....................ตัน ทางเรือ..............ตัน
ทางอากาศ................ตัน ทางท่อ......................ตัน

8. การคาดการณ์ปริมาณสินค้าที่ขนส่งในอนาคต**ต่อเดือน**ประมาณเท่าไหร่ (สามารถตอบได้มากกว่า 1)

ทางถนน.....................ตัน ทางราง.....................ตัน ทางเรือ..............ตัน
ทางอากาศ................ตัน ทางท่อ.........................ตัน

9. การคาดการณ์ปริมาณความต้องการการขนส่งสินค้าทางรางในอนาคตของบริษัทท่าน

ช่วงปี พ.ศ. 2566-2570 ปริมาณ.................................ตัน/ ปี
ช่วงปี พ.ศ. 2571-2575 ปริมาณ.................................ตัน/ ปี
ช่วงปี พ.ศ. 2576-2580 ปริมาณ.................................ตัน/ ปี

**<u>ส่วนที่ 2</u>** ข้อมูลเกี่ยวกับปัจจัยที่ส่งผลต่อความต้องการการขนส่งสินค้าทางราง ลักษณะแบบสอบถามเป็นแบบมาตราส่วนประเมินค่า (Ratio Scale)

**<u>คำชี้แจง</u>** กรุณาทำเครื่องหมาย √ ลงในช่องว่างที่ตรงกับความคิดเห็นของท่านมากที่สุด จากระดับความคิดเห็น 5 ระดับ

| ปัจจัยที่ส่งผลกระทบต่อความต้องการการขนส่งสินค้าทางราง | | ระดับการส่งผลกระทบ | | | | |
|---|---|---|---|---|---|---|
| | | มากที่สุด | มาก | ปานกลาง | น้อย | น้อยที่สุด |
| **ปัจจัยด้านเศรษฐกิจท้องถิ่น** | | | | | | |
| 1 | ความต้องการสินค้าอุปโภคบริโภคของประชาชนในชุมชน | | | | | |
| 2 | กิจกรรมทางเศรษฐกิจต่าง ๆ เช่น การผลิต การบริโภค การกระจาย และการแลกเปลี่ยนสินค้า | | | | | |
| 3 | รายได้เฉลี่ยของผู้บริโภคต่อการจับจ่ายซื้อสินค้า | | | | | |
| **ปัจจัยด้านประชากร** | | | | | | |
| 1 | อาชีพของคนในชุมชน | | | | | |
| 2 | อายุของประชากร | | | | | |
| 3 | ความเจริญของเมือง การเพิ่มขึ้นของการตั้งถิ่นฐาน และการอพยพจากท้องถิ่นอื่นทำให้ขนาดของเมืองที่อาจจะใหญ่มากขึ้น | | | | | |
| **ปัจจัยชนิดของสินค้า** | | | | | | |
| 1 | สินค้าเทกองและสินค้าน้ำหนักมาก ๆ เหมาะสมกับการขนส่งทางไกล | | | | | |
| 2 | ชนิดของสินค้าเช่น สินค้าเกษตร สินค้าก่อสร้างและสินค้าพลังงาน | | | | | |
| 3 | ความสามารถในการขนสินค้าได้คราวละมาก ๆ ของการขนส่งทางราง | | | | | |
| 4 | มูลค่า ราคา และอายุการใช้งานของสินค้า | | | | | |
| 5 | ความคงทน ความสูญเสียและเสียหาย ความยากง่ายในการขนถ่ายสินค้าและขนส่งสินค้า | | | | | |
| **ปัจจัยทางเลือกรูปแบบการขนส่งสินค้า** | | | | | | |
| 1 | คุณภาพการให้บริการของรถไฟ เช่น การตรงต่อเวลา อุปกรณ์อำนวยความสะดวกในการขนถ่ายสินค้า | | | | | |
| 2 | ราคา การบริการและโครงสร้างของการขนส่งรูปแบบอื่น ๆ เช่นทางถนน และทางเรือ | | | | | |
| 3 | ความสามารถในการเชื่อมต่อการขนส่งรูปแบบอื่นของรถไฟ | | | | | |
| 4 | ระยะเวลาในการขนส่งสินค้า | | | | | |
| **ปัจจัยด้านราคา** | | | | | | |
| 1 | นโยบายเรื่องราคาของการขนส่งทางรถไฟ | | | | | |
| 2 | อัตราค่าบริการการขนส่งสินค้าทางรถไฟ | | | | | |
| 3 | นโยบายการปรับค่าบริการในการขนถ่ายสินค้าทางรถไฟ | | | | | |
| 4 | อัตราค่าบริการที่มีความเหมาะสม | | | | | |
| **ปัจจัยด้านราคาเชื้อเพลิง** | | | | | | |
| 1 | ระบบการขนส่งระบบรางที่ประหยัดเชื้อเพลิง | | | | | |
| 2 | ราคาของเชื้อเพลิงหรือพลังงานที่ใช้ | | | | | |
| 3 | การขึ้นลงของราคาเชื้อเพลิง | | | | | |
| 4 | การใช้เชื้อเพลิงหรือพลังงานทางเลือกให้เกิดประโยชน์สูงสุด | | | | | |
| 5 | การตระหนักถึงมลพิษที่เกิดจากการใช้เชื้อเพลิงหรือพลังงาน | | | | | |

<u>ส่วนที่ 3</u> ข้อมูลเกี่ยวกับปัจจัยที่ส่งผลต่อระบบการขนส่งสินค้าทางราง ลักษณะแบบสอบถามเป็นแบบมาตราส่วนประเมินค่า (Ratio Scale)

<u>คำชี้แจง</u> กรุณาทำเครื่องหมาย √ ลงในช่องว่างที่ตรงกับความคิดเห็นของท่านมากที่สุด จากระดับความคิดเห็น 5 ระดับ

| ปัจจัยที่ส่งผลต่อระบบการขนส่งสินค้าทางราง | | ระดับการส่งผลกระทบ | | | | |
|---|---|---|---|---|---|---|
| | | มากที่สุด | มาก | ปานกลาง | น้อย | น้อยที่สุด |
| **ปัจจัยด้านโครงสร้างพื้นฐานทางราง** | | | | | | |
| 1 | ปริมาณรางที่ใช้ได้มีผลต่อการขนส่งสินค้าทางราง | | | | | |
| 2 | ประสิทธิภาพของรางและสถานี | | | | | |
| 3 | สิ่งอำนวยความสะดวกด้านโลจิสติกส์เช่น ลานตู้สินค้า (CY) และสถานีบรรจุและแยกสินค้ากล่อง (ICD) เพียงพอ | | | | | |
| 4 | ปริมาณโครงข่ายรางรถไฟ | | | | | |
| 5 | การเชื่อมโยงกับการขนส่งรูปแบบอื่น และความสามารถเข้าถึงได้ | | | | | |
| 6 | สภาพหัวรถจักรเก่าและไม่เพียงพอ | | | | | |
| 7 | สภาพแคร่ที่เก่าและไม่เพียงพอ | | | | | |
| 8 | ปริมาณแคร่ที่ใช้ได้และสรรหาได้ตรงเวลา | | | | | |
| 9 | จำนวนหัวรถจักรที่ใช้ได้น้อยกว่าความต้องการ | | | | | |
| **ปัจจัยด้านประสิทธิภาพของการขนส่งสินค้าทางราง** | | | | | | |
| 1 | คุณภาพการขนส่งสินค้า เช่น ตรงต่อเวลา ความถี่ ความเร็ว น่าเชื่อถือและมั่นใจได้ และความปลอดภัยของการเดินรถ | | | | | |
| 2 | ความพร้อมของสิ่งอำนวยความสะดวกด้านโลจิสติกส์ เช่น ลานตู้สินค้า (CY) และสถานีบรรจุและแยกสินค้ากล่อง (ICD) | | | | | |
| 3 | การบริการของพนักงานของการรถไฟแห่งประเทศไทย | | | | | |
| 4 | ความยาวของรางและความหนาแน่นของการใช้รางรถไฟ | | | | | |
| **ปัจจัยด้านยุทธศาสตร์การพัฒนาโครงสร้างพื้นฐานทางราง** | | | | | | |
| 1 | การมุ่งเน้นพัฒนาคุณภาพโครงสร้างพื้นฐานของประเทศให้ระบบการขนส่งทางรางเป็นหลักของรัฐบาลปัจจุบันผ่านแผนพัฒนาเศรษฐกิจและสังคมแห่งชาติ | | | | | |
| 2 | ยุทธศาสตร์ชาติ รัฐบาล กระทรวงคมนาคมและนโยบายลงทุนของรัฐบาลในการพัฒนาโครงสร้างพื้นฐานโครงข่ายทางราง | | | | | |
| 3 | ยุทธศาสตร์การพัฒนาโครงสร้างพื้นฐานด้านคมนาคมขนส่งของไทย พ.ศ. 2558-2565 ในการสร้างรถไฟทางคู่ส่งผลต่อระบบการขนส่งสินค้าทางราง | | | | | |
| 4 | เป้าหมายการเพิ่มความได้เปรียบเชิงการแข่งขันของประเทศ | | | | | |
| 5 | เป้าหมายการลดต้นทุนโลจิสติกส์ต่อผลิตภัณฑ์มวลรวมในประเทศ | | | | | |

<u>ส่วนที่ 4</u> ปัจจัยที่ส่งเสริมการขนส่งสินค้าทางรางในประเทศไทย ลักษณะแบบสอบถามเป็นแบบมาตราส่วนประเมินค่า (Ratio Scale)

<u>คำชี้แจง</u> กรุณาทำเครื่องหมาย √ ลงในช่องว่างที่ตรงกับความคิดเห็นของท่านมากที่สุด จากระดับความคิดเห็น 5 ระดับ

| ปัจจัยภายนอกที่ส่งผลกระทบในการขนส่งสินค้าทางรางในประเทศไทย | | ระดับการส่งผลกระทบ | | | | |
|---|---|---|---|---|---|---|
| | | มากที่สุด | มาก | ปานกลาง | น้อย | น้อยที่สุด |
| **ปัจจัยด้านการเมือง** | | | | | | |
| 1 | นโยบายการสนับสนุนการขนส่งสินค้าทางรางเป็นทางหลักเพื่อประหยัดเชื้อเพลิงในประเทศไทยและเพื่อนบ้าน | | | | | |
| 2 | นโยบายการปฏิรูปการรถไฟแห่งประเทศไทยของรัฐบาล | | | | | |
| 3 | นโยบายการค้าระหว่างประเทศของประเทศมหาอำนาจโลก | | | | | |
| 4 | นโยบายหนึ่งแถบหนึ่งเส้นทางของประเทศจีนเพื่อพัฒนาโครงสร้างพื้นฐานเชื่อมโยงตลาด | | | | | |
| 5 | นโยบายการลงทุนระบบโครงสร้างพื้นฐานทางรางของเพื่อนบ้าน | | | | | |
| **ปัจจัยด้านเศรษฐกิจ** | | | | | | |
| 1 | การขนส่งสินค้าทางรางทำให้ธุรกิจมีโอกาสในการขยายตลาดได้ | | | | | |
| 2 | เศรษฐกิจภายในประเทศ ภูมิภาค และโลก | | | | | |
| 3 | รูปแบบการขนส่งสินค้าที่ประหยัด เช่น ระบบรางจะช่วยให้เกิดการทำกำไรได้มากขึ้น | | | | | |
| 4 | ราคาน้ำมันที่ผันผวนและสูงขึ้น | | | | | |
| 5 | การเพิ่มขึ้นของอัตราดอกเบี้ยธนาคารต่อนักลงทุนและผู้อุปโภคบริโภค | | | | | |
| 6 | อัตราเงินเฟ้อในประเทศ | | | | | |
| **ปัจจัยด้านสังคมและวัฒนธรรม** | | | | | | |
| 1 | ทัศนคติ และรสนิยมของผู้บริโภคเปลี่ยนแปลงส่งผลต่อการกระจายและการขนส่งสินค้าทางราง | | | | | |
| 2 | ระดับการศึกษาที่สูงขึ้น | | | | | |
| 3 | การส่งผ่านหรือการถ่ายทอดวัฒนธรรมจากการกระจายสินค้า | | | | | |
| 4 | สังคมที่เน้นและตระหนักเรื่องความปลอดภัยของการนำคมนาคมสู่ชุมชน | | | | | |
| 5 | สังคมที่เน้นคุณค่าวัฒนธรรมการพัฒนาทางเศรษฐกิจ | | | | | |
| **ปัจจัยด้านเทคโนโลยี** | | | | | | |
| 1 | เทคโนโลยีและนวัตกรรมทางราง | | | | | |
| 2 | การวิจัยและพัฒนาเทคโนโลยีทางราง | | | | | |
| 3 | ความเชื่อมั่นเทคโนโลยีในการขนส่งสินค้าทางราง | | | | | |
| 4 | ประสิทธิภาพเทคโนโลยีนำมาซึ่งการขนส่งที่ยืดหยุ่น เข้าถึงและสามารถใช้บริการได้ | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **ปัจจัยด้านสิ่งแวดล้อม** | | | | | | |
| 1 | พลังงานและยานพาหนะสะอาด | | | | | |
| 2 | ความรับผิดชอบของธุรกิจในด้านสิ่งแวดล้อม | | | | | |
| 3 | แนวโน้มการเพิ่มขึ้นของพลังงานทางเลือกในการขนส่งสินค้า | | | | | |
| 4 | กฎระเบียบและนโยบายด้านสิ่งแวดล้อม | | | | | |
| 5 | การขนส่งที่สะอาดลดมลพิษ ฝุ่นควัน และเสียง | | | | | |
| **ปัจจัยด้านกฎระเบียบ ข้อบังคับ และกฎหมาย** | | | | | | |
| 1 | ข้อตกลงการค้าระหว่างประเทศในการอำนวยความสะดวกการขนส่งสินค้าข้ามแดน และผ่านแดนของไทย | | | | | |
| 2 | กฎระเบียบและการควบคุมจากรัฐบาล | | | | | |
| 3 | ข้อกฎหมายที่สนับสนุนให้เกิดการลงทุนจากเอกชนในการดำเนินงานการขนส่งสินค้าทางราง | | | | | |
| 4 | กฎหมายที่เอื้ออำนวยต่อการปฏิบัติงานที่รวดเร็วและกระชับขึ้น | | | | | |
| 5 | การผ่อนคลายกฎ ระเบียบ และข้อบังคับด้านค่าระวางสินค้า | | | | | |

**ส่วนที่ 5 ข้อเสนอแนะ**

..................................................................................................................................................................

..................................................................................................................................................................

..................................................................................................................................................................

..................................................................................................................................................................

..................................................................................................................................................................

..................................................................................................................................................................

..................................................................................................................................................................

..................................................................................................................................................................

..................................................................................................................................................................

..................................................................................................................................................................

..................................................................................................................................................................

..................................................................................................................................................................

..................................................................................................................................................................

..................................................................................................................................................................

..................................................................................................................................................................

**ขอขอบพระคุณเป็นอย่างสูงที่ท่านกรุณาสละเวลาในการตอบคำถามครั้งนี้**

## APPENDIX G CONFIRMATORY FACTORS ANALYSIS

**Estimates (Group number 1 - Default model)**

Scalar Estimates (Group number 1 - Default model)

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

| | | | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|---|---|
| X1 | <--- | RfrtTpt | 1.000 | | | | |
| X2 | <--- | RfrtTpt | 1.158 | .071 | 16.224 | *** | par_1 |
| X3 | <--- | RfrtTpt | 1.076 | .073 | 14.839 | *** | par_2 |

**Standardized Regression Weights: (Group number 1 - Default model)**

| | | | Estimate |
|---|---|---|---|
| X1 | <--- | RfrtTpt | .841 |
| X2 | <--- | RfrtTpt | .871 |
| X3 | <--- | RfrtTpt | .817 |

**Variances: (Group number 1 - Default model)**

| | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|
| RfrtTpt | .470 | | | | |
| e1 | .195 | .029 | 6.613 | *** | par_3 |
| e2 | .201 | .037 | 5.418 | *** | par_4 |
| e3 | .272 | .039 | 7.061 | *** | par_5 |

**Squared Multiple Correlations: (Group number 1 - Default model)**

| | Estimate |
|---|---|
| X3 | .667 |
| X2 | .758 |
| X1 | .707 |

**Matrices (Group number 1 - Default model)**

**Factor Score Weights (Group number 1 - Default model)**

| | X3 | X2 | X1 |
|---|---|---|---|
| RfrtTpt | .218 | .317 | .282 |

**Total Effects (Group number 1 - Default model)**

| | RfrtTpt |
|---|---|
| X3 | 1.076 |
| X2 | 1.158 |
| X1 | 1.000 |

**Standardized Total Effects (Group number 1 - Default model)**

| | RfrtTpt |
|---|---|
| X3 | .817 |
| X2 | .871 |

| | RfrtTpt |
|---|---|
| X1 | .841 |

**Direct Effects (Group number 1 - Default model)**

| | RfrtTpt |
|---|---|
| X3 | 1.076 |
| X2 | 1.158 |
| X1 | 1.000 |

**Standardized Direct Effects (Group number 1 - Default model)**

| | RfrtTpt |
|---|---|
| X3 | .817 |
| X2 | .871 |
| X1 | .841 |

**Indirect Effects (Group number 1 - Default model)**

| | RfrtTpt |
|---|---|
| X3 | .000 |
| X2 | .000 |
| X1 | .000 |

**Standardized Indirect Effects (Group number 1 - Default model)**

| | RfrtTpt |
|---|---|
| X3 | .000 |
| X2 | .000 |
| X1 | .000 |

**Model Fit Summary**
**CMIN**

| Model | NPAR | CMIN | DF | P | CMIN/DF |
|---|---|---|---|---|---|
| Default model | 5 | .094 | 1 | .759 | .094 |
| Saturated model | 6 | .000 | 0 | | |
| Independence model | 3 | 325.734 | 3 | .000 | 108.578 |

RMR, **GFI**

| Model | RMR | GFI | AGFI | PGFI |
|---|---|---|---|---|
| Default model | .015 | 1.000 | .998 | .167 |
| Saturated model | .000 | 1.000 | | |
| Independence model | .397 | .494 | -.013 | .247 |

**Baseline Comparisons**

| Model | NFI Delta1 | RFI rho1 | IFI Delta2 | TLI rho2 | CFI |
|---|---|---|---|---|---|
| Default model | 1.000 | .999 | 1.003 | 1.008 | 1.000 |
| Saturated model | 1.000 | | 1.000 | | 1.000 |
| Independence model | .000 | .000 | .000 | .000 | .000 |

Parsimony-**Adjusted Measures**

| Model | PRATIO | PNFI | PCFI |
|---|---|---|---|
| Default model | .333 | .333 | .333 |
| Saturated model | .000 | .000 | .000 |
| Independence model | 1.000 | .000 | .000 |

**NCP**

| Model | NCP | LO 90 | HI 90 |
|---|---|---|---|
| Default model | .000 | .000 | 3.245 |
| Saturated model | .000 | .000 | .000 |
| Independence model | 322.734 | 267.152 | 385.723 |

**FMIN**

| Model | FMIN | F0 | LO 90 | HI 90 |
|---|---|---|---|---|
| Default model | .000 | .000 | .000 | .016 |
| Saturated model | .000 | .000 | .000 | .000 |
| Independence model | 1.637 | 1.622 | 1.342 | 1.938 |

**RMSEA**

| Model | RMSEA | LO 90 | HI 90 | PCLOSE |
|---|---|---|---|---|
| Default model | .000 | .000 | .128 | .811 |
| Independence model | .735 | .669 | .804 | .000 |

**AIC**

| Model | AIC | BCC | BIC | CAIC |
|---|---|---|---|---|
| Default model | 10.094 | 10.299 | 26.586 | 31.586 |
| Saturated model | 12.000 | 12.246 | 31.790 | 37.790 |
| Independence model | 331.734 | 331.857 | 341.629 | 344.629 |

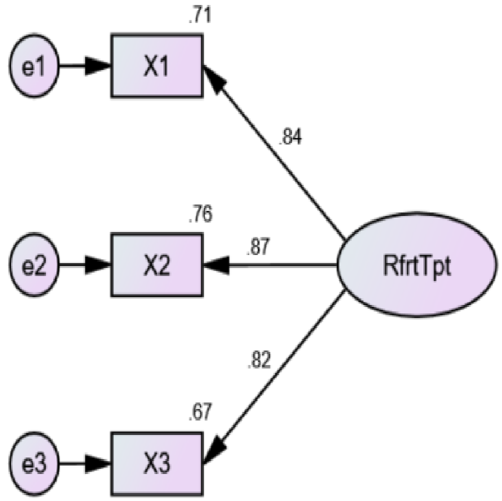
ECVI

| Model | ECVI | LO 90 | HI 90 | MECVI |
|---|---|---|---|---|
| Default model | .051 | .055 | .072 | .052 |

| Model | ECVI | LO 90 | HI 90 | MECVI |
|---|---|---|---|---|
| Saturated model | .060 | .060 | .060 | .062 |
| Independence model | 1.667 | 1.388 | 1.984 | 1.668 |

HOELTER

| Model | HOELTER .05 | HOELTER .01 |
|---|---|---|
| Default model | 8120 | 14025 |
| Independence model | 5 | 7 |




Chi-square = .094, df = 1, P-value = .759, Chi-square/df = .094,
CFI = 1.000, GFI = 1.000, AGFI = .998, IFI = 1.003, NFI=1.000, TLI=1.008,
RMR=.015 , RMSEA = .000

Estimates **(Group number 1 - Default model)**

Scalar **Estimates (Group number 1 - Default model)**

Maximum **Likelihood Estimates**

Regression **Weights: (Group number 1 - Default model)**

| | | | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|---|---|
| X4 | <--- | RfrtDmnd | 1.000 | | | | |
| X5 | <--- | RfrtDmnd | .833 | .140 | 5.933 | *** | par_1 |
| X6 | <--- | RfrtDmnd | 1.137 | .135 | 8.401 | *** | par_2 |
| X7 | <--- | RfrtDmnd | 1.885 | .151 | 12.461 | *** | par_3 |
| X8 | <--- | RfrtDmnd | 1.492 | .135 | 11.079 | *** | par_4 |
| X9 | <--- | RfrtDmnd | 1.555 | .140 | 11.072 | *** | par_5 |

**Standardized** Regression **Weights: (Group number 1 - Default model)**

| | | | Estimate |
|---|---|---|---|
| X4 | <--- | RfrtDmnd | .522 |
| X5 | <--- | RfrtDmnd | .461 |
| X6 | <--- | RfrtDmnd | .595 |
| X7 | <--- | RfrtDmnd | .865 |
| X8 | <--- | RfrtDmnd | .782 |
| X9 | <--- | RfrtDmnd | .805 |

Covariances: **(Group number 1 - Default model)**

| | | | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|---|---|
| e1 | <--> | e2 | .421 | .051 | 8.255 | *** | par_6 |
| e1 | <--> | e4 | -.136 | .049 | -2.782 | .005 | par_7 |
| e2 | <--> | e4 | -.047 | .035 | -1.328 | .184 | par_8 |
| e2 | <--> | e3 | -.066 | .035 | -1.905 | .057 | par_9 |
| e2 | <--> | e5 | .080 | .038 | 2.106 | .035 | par_10 |
| e3 | <--> | e6 | .064 | .032 | 1.963 | .050 | par_11 |
| e1 | <--> | e3 | -.116 | .044 | -2.657 | .008 | par_12 |
| e4 | <--> | e6 | .037 | .053 | .709 | .478 | par_13 |
| e1 | <--> | e6 | -.077 | .044 | -1.767 | .077 | par_14 |

Correlations: **(Group number 1 - Default model**

| | | | Estimate |
|---|---|---|---|
| e1 | <--> | e2 | .844 |
| e1 | <--> | e4 | -.401 |
| e2 | <--> | e4 | -.140 |
| e2 | <--> | e3 | -.141 |
| e2 | <--> | e5 | .222 |
| e3 | <--> | e6 | .190 |
| e1 | <--> | e3 | -.242 |
| e4 | <--> | e6 | .157 |
| e1 | <--> | e6 | -.217 |

Variances: **(Group number 1 - Default model)**

| | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|
| RfrtDmnd | .190 | | | | |
| e1 | .508 | .060 | 8.479 | *** | par_15 |
| e2 | .488 | .056 | 8.676 | *** | par_16 |
| e3 | .449 | .051 | 8.760 | *** | par_17 |
| e4 | .227 | .069 | 3.281 | .001 | par_18 |
| e5 | .269 | .046 | 5.820 | *** | par_19 |
| e6 | .250 | .057 | 4.378 | *** | par_20 |

**Squared Multiple Correlations: (Group number 1 - Default model)**

| | Estimate |
|---|---|
| X9 | .648 |
| X8 | .611 |
| X7 | .748 |
| X6 | .354 |
| X5 | .213 |
| X4 | .272 |

Matrices **(Group number 1 - Default model)**

Factor **Score Weights (Group number 1 - Default model)**

| | X9 | X8 | X7 | X6 | X5 | X4 |
|---|---|---|---|---|---|---|
| RfrtDmnd | .119 | .133 | .207 | .055 | -.239 | .306 |

**Total Effects (Group number 1 - Default model)**

| | RfrtDmnd |
|---|---|
| X9 | 1.555 |
| X8 | 1.492 |
| X7 | 1.885 |
| X6 | 1.137 |
| X5 | .833 |
| X4 | 1.000 |

Standardized **Total Effects (Group number 1 - Default model)**

| | RfrtDmnd |
|---|---|
| X9 | .805 |
| X8 | .782 |
| X7 | .865 |
| X6 | .595 |
| X5 | .461 |
| X4 | .522 |

**Direct Effects (Group number 1 - Default model)**

| | RfrtDmnd |
|---|---|
| X9 | 1.555 |
| X8 | 1.492 |
| X7 | 1.885 |
| X6 | 1.137 |
| X5 | .833 |
| X4 | 1.000 |

**Standardized Direct Effects (Group number 1 - Default model)**

| | RfrtDmnd |
|---|---|
| X9 | .805 |
| X8 | .782 |
| X7 | .865 |
| X6 | .595 |
| X5 | .461 |
| X4 | .522 |

**Indirect Effects (Group number 1 - Default model)**

| | RfrtDmnd |
|---|---|
| X9 | .000 |
| X8 | .000 |
| X7 | .000 |
| X6 | .000 |
| X5 | .000 |
| X4 | .000 |

**Standardized Indirect Effects (Group number 1 - Default model)**

| | RfrtDmnd |
|---|---|
| X9 | .000 |
| X8 | .000 |
| X7 | .000 |
| X6 | .000 |
| X5 | .000 |
| X4 | .000 |

**Model Fit** Summary

CMIN

| Model | NPAR | CMIN | DF | P | CMIN/DF |
|---|---|---|---|---|---|
| Default model | 20 | .106 | 1 | .745 | .106 |
| Saturated model | 21 | .000 | 0 | | |
| Independence model | 6 | 742.067 | 15 | .000 | 49.471 |

**RMR, GFI**

| Model | RMR | GFI | AGFI | PGFI |
|---|---|---|---|---|
| Default model | .008 | 1.000 | .996 | .048 |
| Saturated model | .000 | 1.000 | | |
| Independence model | .315 | .434 | .207 | .310 |

**Baseline** Comparisons

| Model | NFI Delta1 | RFI rho1 | IFI Delta2 | TLI rho2 | CFI |
|---|---|---|---|---|---|
| Default model | 1.000 | .998 | 1.001 | 1.018 | 1.000 |
| Saturated model | 1.000 | | 1.000 | | 1.000 |
| Independence model | .000 | .000 | .000 | .000 | .000 |

**Parsimony**-Adjusted **Measures**

| Model | PRATIO | PNFI | PCFI |
|---|---|---|---|
| Default model | .067 | .067 | .067 |
| Saturated model | .000 | .000 | .000 |
| Independence model | 1.000 | .000 | .000 |

NCP

| Model | NCP | LO 90 | HI 90 |
|---|---|---|---|
| Default model | .000 | .000 | 3.377 |
| Saturated model | .000 | .000 | .000 |
| Independence model | 727.067 | 641.567 | 819.968 |

FMIN

| Model | FMIN | F0 | LO 90 | HI 90 |
|---|---|---|---|---|
| Default model | .001 | .000 | .000 | .017 |
| Saturated model | .000 | .000 | .000 | .000 |
| Independence model | 3.729 | 3.654 | 3.224 | 4.120 |

RMSEA

| Model | RMSEA | LO 90 | HI 90 | PCLOSE |
|---|---|---|---|---|
| Default model | .000 | .000 | .130 | .799 |
| Independence model | .494 | .464 | .524 | .000 |

AIC

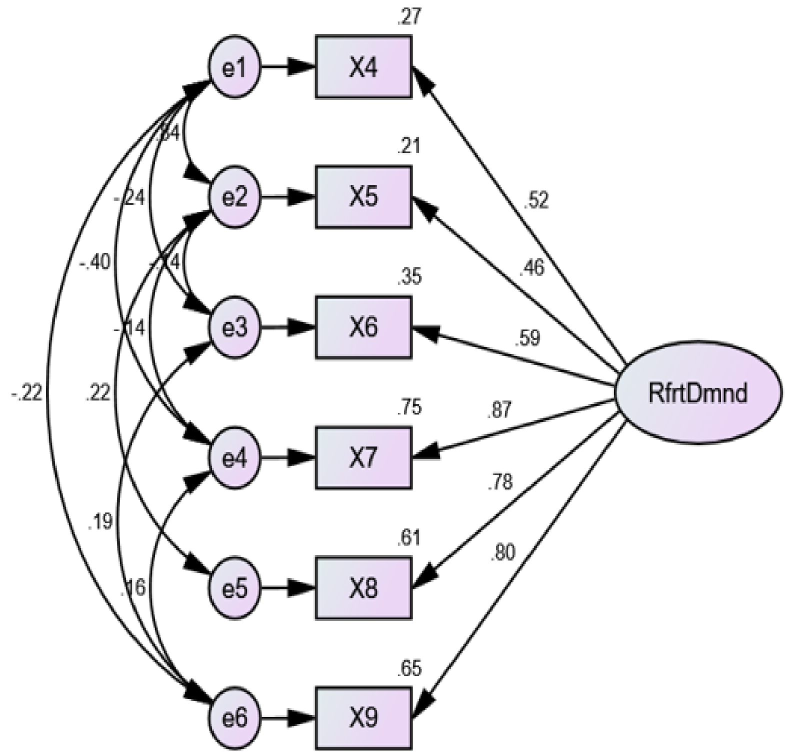
| Model | AIC | BCC | BIC | CAIC |
|---|---|---|---|---|
| Default model | 40.106 | 41.564 | 106.072 | 126.072 |
| Saturated model | 42.000 | 43.531 | 111.265 | 132.265 |
| Independence model | 754.067 | 754.505 | 773.857 | 779.857 |

**ECVI**

| Model | ECVI | LO 90 | HI 90 | MECVI |
|---|---|---|---|---|
| Default model | .202 | .206 | .223 | .209 |
| Saturated model | .211 | .211 | .211 | .219 |
| Independence model | 3.789 | 3.360 | 4.256 | 3.791 |

HOELTER

| Model | HOELTER .05 | HOELTER .01 |
|---|---|---|
| Default model | 7212 | 12457 |
| Independence model | 7 | 9 |




Chi-square = .106, df = 1, P-value = .745, Chi-square/df = .106,
CFI = 1.000, GFI = 1.000, AGFI = .996, IFI = 1.001, NFI=1.000, TLI=1.018,
RMR=.008 , RMSEA = .000

**Estimates (Group number 1 - Default model)**

Scalar **Estimates (Group number 1 - Default model)**

Maximum **Likelihood Estimates**

Regression **Weights: (Group number 1 - Default model)**

| | | | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|---|---|
| Y1 | <--- | Fstrfctrs | 1.000 | | | | |
| Y2 | <--- | Fstrfctrs | .428 | .091 | 4.676 | *** | par_1 |
| Y3 | <--- | Fstrfctrs | .637 | .102 | 6.226 | *** | par_2 |
| Y4 | <--- | Fstrfctrs | 1.429 | .136 | 10.494 | *** | par_3 |
| Y5 | <--- | Fstrfctrs | 1.153 | .116 | 9.932 | *** | par_4 |
| Y6 | <--- | Fstrfctrs | .964 | .106 | 9.070 | *** | par_5 |

Standardized **Regression Weights: (Group number 1 - Default model)**

| | | | Estimate |
|---|---|---|---|
| Y1 | <--- | Fstrfctrs | .643 |
| Y2 | <--- | Fstrfctrs | .336 |
| Y3 | <--- | Fstrfctrs | .536 |
| Y4 | <--- | Fstrfctrs | .951 |
| Y5 | <--- | Fstrfctrs | .835 |
| Y6 | <--- | Fstrfctrs | .742 |

Covariances: **(Group number 1 - Default model)**

| | | | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|---|---|
| e1 | <--> | e2 | .256 | .049 | 5.234 | *** | par_6 |
| e3 | <--> | e5 | .133 | .029 | 4.531 | *** | par_7 |
| e2 | <--> | e4 | -.052 | .033 | -1.576 | .115 | par_8 |
| e1 | <--> | e3 | -.109 | .029 | -3.708 | *** | par_9 |
| e2 | <--> | e6 | .097 | .034 | 2.818 | .005 | par_10 |

Correlations: **(Group number 1 - Default model)**

| | | | Estimate |
|---|---|---|---|
| e1 | <--> | e2 | .434 |
| e3 | <--> | e5 | .422 |
| e2 | <--> | e4 | -.227 |
| e1 | <--> | e3 | -.222 |
| e2 | <--> | e6 | .225 |

**Variances:** (Group **number 1 - Default model)**

| | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|
| Fstrfctrs | .412 | .084 | 4.926 | *** | par_11 |
| e1 | .585 | .062 | 9.503 | *** | par_12 |
| e2 | .595 | .061 | 9.695 | *** | par_13 |
| e3 | .414 | .043 | 9.546 | *** | par_14 |
| e4 | .088 | .033 | 2.640 | .008 | par_15 |

| | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|
| e5 | .239 | .032 | 7.381 | *** | par_16 |
| e6 | .312 | .035 | 8.830 | *** | par_17 |

**Squared Multiple Correlations: (Group number 1 - Default model)**

| | Estimate |
|---|---|
| Y6 | .551 |
| Y5 | .697 |
| Y4 | .905 |
| Y3 | .288 |
| Y2 | .113 |
| Y1 | .413 |

**Matrices (Group number 1 - Default model)**

**Factor Score Weights (Group number 1 - Default model)**

| | Y6 | Y5 | Y4 | Y3 | Y2 | Y1 |
|---|---|---|---|---|---|---|
| Fstrfctrs | .074 | .126 | .463 | .011 | .033 | .034 |

**Total Effects (Group number 1 - Default model)**

| | Fstrfctrs |
|---|---|
| Y6 | .964 |
| Y5 | 1.153 |
| Y4 | 1.429 |
| Y3 | .637 |
| Y2 | .428 |
| Y1 | 1.000 |

**Standardized Total Effects (Group number 1 - Default model)**

| | Fstrfctrs |
|---|---|
| Y6 | .742 |
| Y5 | .835 |
| Y4 | .951 |
| Y3 | .536 |
| Y2 | .336 |
| Y1 | .643 |

**Direct Effects (Group number 1 - Default model)**

| | Fstrfctrs |
|---|---|
| Y6 | .964 |
| Y5 | 1.153 |
| Y4 | 1.429 |
| Y3 | .637 |
| Y2 | .428 |

| | Fstrfctrs |
|---|---|
| Y1 | 1.000 |

**Standardized Direct** Effects **(Group number 1 - Default model)**

| | Fstrfctrs |
|---|---|
| Y6 | .742 |
| Y5 | .835 |
| Y4 | .951 |
| Y3 | .536 |
| Y2 | .336 |
| Y1 | .643 |

Indirect Effects (Group number 1 - Default model)

| | Fstrfctrs |
|---|---|
| Y6 | .000 |
| Y5 | .000 |
| Y4 | .000 |
| Y3 | .000 |
| Y2 | .000 |
| Y1 | .000 |

Standardized **Indirect Effects (Group number 1 - Default model)**

| | Fstrfctrs |
|---|---|
| Y6 | .000 |
| Y5 | .000 |
| Y4 | .000 |
| Y3 | .000 |
| Y2 | .000 |
| Y1 | .000 |

Model Fit Summary

CMIN

| Model | NPAR | CMIN | DF | P | CMIN/DF |
|---|---|---|---|---|---|
| Default model | 17 | 1.676 | 4 | .795 | .419 |
| Saturated model | 21 | .000 | 0 | | |
| Independence model | 6 | 650.907 | 15 | .000 | 43.394 |

RMR, GFI

| Model | RMR | GFI | AGFI | PGFI |
|---|---|---|---|---|
| Default model | .010 | .997 | .985 | .190 |
| Saturated model | .000 | 1.000 | | |
| Independence model | .346 | .436 | .210 | .311 |

Baseline Comparisons

| Model | NFI Delta1 | RFI rho1 | IFI Delta2 | TLI rho2 | CFI |
|---|---|---|---|---|---|
| Default model | .997 | .990 | 1.004 | 1.014 | 1.000 |
| Saturated model | 1.000 | | 1.000 | | 1.000 |
| Independence model | .000 | .000 | .000 | .000 | .000 |

Parsimony-**Adjusted Measures**

| Model | PRATIO | PNFI | PCFI |
|---|---|---|---|
| Default model | .267 | .266 | .267 |
| Saturated model | .000 | .000 | .000 |
| Independence model | 1.000 | .000 | .000 |

NCP

| Model | NCP | LO 90 | HI 90 |
|---|---|---|---|
| Default model | .000 | .000 | 3.743 |
| Saturated model | .000 | .000 | .000 |
| Independence model | 635.907 | 556.127 | 723.095 |

FMIN

| Model | FMIN | F0 | LO 90 | HI 90 |
|---|---|---|---|---|
| Default model | .008 | .000 | .000 | .019 |
| Saturated model | .000 | .000 | .000 | .000 |
| Independence model | 3.271 | 3.196 | 2.795 | 3.634 |

RMSEA

| Model | RMSEA | LO 90 | HI 90 | PCLOSE |
|---|---|---|---|---|
| Default model | .000 | .000 | .069 | .903 |
| Independence model | .462 | .432 | .492 | .000 |

AIC

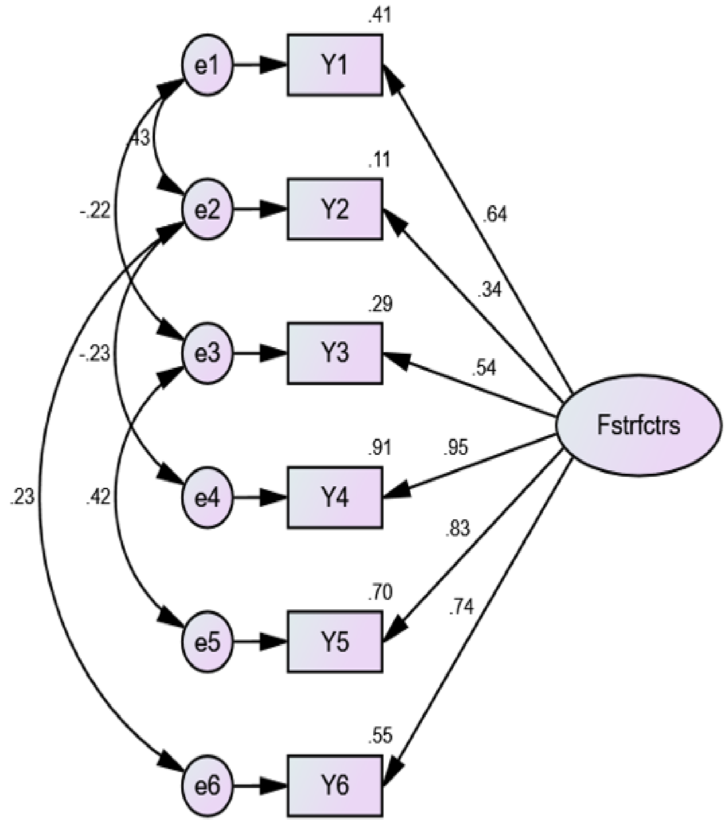
| Model | AIC | BCC | BIC | CAIC |
|---|---|---|---|---|
| Default model | 35.676 | 36.916 | 91.748 | 108.748 |
| Saturated model | 42.000 | 43.531 | 111.265 | 132.265 |
| Independence model | 662.907 | 663.345 | 682.697 | 688.697 |

ECVI

| Model | ECVI | LO 90 | HI 90 | MECVI |
|---|---|---|---|---|
| Default model | .179 | .191 | .210 | .186 |
| Saturated model | .211 | .211 | .211 | .219 |
| Independence model | 3.331 | 2.930 | 3.769 | 3.333 |

HOELTER

| Model | HOELTER .05 | HOELTER .01 |
|---|---|---|
| Default model | 1127 | 1577 |
| Independence model | 8 | 10 |




Chi-square = 1.676, df = 4, P-value = .795, Chi-square/df = .419,
CFI = 1.000, GFI = .997, AGFI = .985, IFI = 1.004, NFI=.997, TLI=1.014,
RMR=.010 , RMSEA = .000

Estimates (Group number 1 - Default model)
Scalar Estimates (Group number 1 - Default model)
Maximum Likelihood Estimates
Regression Weights: (Group number **1 - Default model)**

| | | | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|---|---|
| X1 | <--- | RfrtTpt | 1.000 | | | | |
| X2 | <--- | RfrtTpt | 1.123 | .070 | 16.044 | *** | par_1 |
| X3 | <--- | RfrtTpt | 1.043 | .073 | 14.366 | *** | par_2 |
| X4 | <--- | RfrtDmnd | 1.000 | | | | |
| X5 | <--- | RfrtDmnd | 1.061 | .080 | 13.331 | *** | par_3 |
| X6 | <--- | RfrtDmnd | 1.134 | .216 | 5.262 | *** | par_4 |
| X7 | <--- | RfrtDmnd | 2.156 | .331 | 6.523 | *** | par_5 |
| X8 | <--- | RfrtDmnd | 1.907 | .295 | 6.461 | *** | par_6 |
| X9 | <--- | RfrtDmnd | 1.815 | .286 | 6.346 | *** | par_7 |
| Y1 | <--- | Fstrfctrs | 1.000 | | | | |
| Y2 | <--- | Fstrfctrs | .613 | .094 | 6.487 | *** | par_8 |
| Y3 | <--- | Fstrfctrs | .651 | .119 | 5.459 | *** | par_9 |
| Y4 | <--- | Fstrfctrs | 1.490 | .171 | 8.693 | *** | par_10 |
| Y5 | <--- | Fstrfctrs | 1.373 | .171 | 8.037 | *** | par_11 |
| Y6 | <--- | Fstrfctrs | 1.175 | .153 | 7.668 | *** | par_12 |

**Standardized** Regression **Weights: (Group number 1 - Default model)**

| | | | Estimate |
|---|---|---|---|
| X1 | <--- | RfrtTpt | .858 |
| X2 | <--- | RfrtTpt | .871 |
| X3 | <--- | RfrtTpt | .823 |
| X4 | <--- | RfrtDmnd | .431 |
| X5 | <--- | RfrtDmnd | .484 |
| X6 | <--- | RfrtDmnd | .493 |
| X7 | <--- | RfrtDmnd | .820 |
| X8 | <--- | RfrtDmnd | .826 |
| X9 | <--- | RfrtDmnd | .785 |
| Y1 | <--- | Fstrfctrs | .568 |
| Y2 | <--- | Fstrfctrs | .432 |
| Y3 | <--- | Fstrfctrs | .497 |
| Y4 | <--- | Fstrfctrs | .880 |
| Y5 | <--- | Fstrfctrs | .881 |
| Y6 | <--- | Fstrfctrs | .799 |

Covariances: **(Group number 1 - Default model)**

| | | | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|---|---|
| RfrtTpt | <--> | RfrtDmnd | .257 | .045 | 5.701 | *** | par_13 |
| RfrtTpt | <--> | Fstrfctrs | .393 | .068 | 5.747 | *** | par_14 |
| RfrtDmnd | <--> | Fstrfctrs | .208 | .050 | 4.192 | *** | par_15 |
| e1 | <--> | e4 | -.071 | .026 | -2.745 | .006 | par_16 |
| e1 | <--> | e5 | -.073 | .024 | -3.045 | .002 | par_17 |
| e1 | <--> | e11 | -.068 | .026 | -2.592 | .010 | par_18 |
| e13 | <--> | e14 | .014 | .034 | .401 | .689 | par_19 |
| e12 | <--> | e14 | .135 | .032 | 4.254 | *** | par_20 |
| e11 | <--> | e13 | -.052 | .020 | -2.615 | .009 | par_21 |
| e10 | <--> | e11 | .241 | .038 | 6.279 | *** | par_22 |
| e9 | <--> | e12 | .120 | .027 | 4.452 | *** | par_23 |
| e9 | <--> | e14 | .124 | .031 | 3.993 | *** | par_24 |
| e9 | <--> | e15 | .019 | .024 | .792 | .429 | par_25 |
| e8 | <--> | e15 | .162 | .029 | 5.657 | *** | par_26 |
| e8 | <--> | e14 | -.100 | .023 | -4.331 | *** | par_27 |
| e8 | <--> | e13 | -.082 | .022 | -3.665 | *** | par_28 |
| e7 | <--> | e13 | .184 | .036 | 5.158 | *** | par_29 |
| e6 | <--> | e15 | .039 | .025 | 1.568 | .117 | par_30 |
| e5 | <--> | e11 | .403 | .046 | 8.733 | *** | par_31 |
| e6 | <--> | e9 | .117 | .023 | 5.021 | *** | par_32 |
| e4 | <--> | e13 | -.013 | .021 | -.632 | .528 | par_33 |
| e4 | <--> | e5 | .450 | .049 | 9.186 | *** | par_34 |
| e3 | <--> | e10 | .212 | .040 | 5.282 | *** | par_35 |
| e3 | <--> | e11 | .044 | .017 | 2.527 | .012 | par_36 |
| e3 | <--> | e12 | -.083 | .026 | -3.144 | .002 | par_37 |
| e3 | <--> | e13 | -.034 | .015 | -2.273 | .023 | par_38 |
| e1 | <--> | e10 | .046 | .037 | 1.236 | .216 | par_39 |
| e1 | <--> | e12 | -.041 | .019 | -2.140 | .032 | par_40 |
| e2 | <--> | e10 | -.041 | .039 | -1.049 | .294 | par_41 |
| e3 | <--> | e9 | .001 | .023 | .049 | .961 | par_42 |
| e3 | <--> | e14 | -.051 | .025 | -2.076 | .038 | par_43 |
| e3 | <--> | e15 | .031 | .021 | 1.466 | .143 | par_44 |
| e4 | <--> | e11 | .471 | .052 | 9.112 | *** | par_45 |
| e5 | <--> | e10 | .242 | .036 | 6.769 | *** | par_46 |
| e6 | <--> | e12 | .248 | .034 | 7.386 | *** | par_47 |
| e7 | <--> | e10 | .162 | .035 | 4.630 | *** | par_48 |
| e9 | <--> | e10 | .056 | .029 | 1.924 | .054 | par_49 |
| e6 | <--> | e7 | .096 | .027 | 3.503 | *** | par_50 |
| e6 | <--> | e13 | .016 | .026 | .618 | .537 | par_51 |
| e10 | <--> | e14 | .074 | .035 | 2.109 | .035 | par_52 |
| e1 | <--> | e15 | .011 | .013 | .870 | .384 | par_53 |

| | | | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|---|---|
| e3 | <--> | e8 | .039 | .023 | 1.696 | .090 | par_54 |
| e7 | <--> | e12 | .070 | .026 | 2.673 | .008 | par_55 |
| e9 | <--> | e11 | .022 | .015 | 1.477 | .140 | par_56 |
| e11 | <--> | e14 | -.026 | .020 | -1.344 | .179 | par_57 |
| e4 | <--> | e10 | .245 | .038 | 6.429 | *** | par_58 |
| e6 | <--> | e11 | .013 | .018 | .703 | .482 | par_59 |
| e4 | <--> | e7 | -.013 | .013 | -.962 | .336 | par_60 |
| e14 | <--> | e15 | -.081 | .022 | -3.649 | *** | par_61 |
| e10 | <--> | e15 | .008 | .021 | .375 | .708 | par_62 |
| e10 | <--> | e13 | .141 | .045 | 3.123 | .002 | par_63 |
| e7 | <--> | e9 | .078 | .021 | 3.642 | *** | par_64 |
| e7 | <--> | e15 | .051 | .025 | 2.006 | .045 | par_65 |
| e5 | <--> | e13 | -.023 | .017 | -1.305 | .192 | par_66 |
| e3 | <--> | e6 | -.023 | .025 | -.913 | .361 | par_67 |
| e11 | <--> | e12 | -.013 | .017 | -.748 | .454 | par_68 |
| e12 | <--> | e13 | .070 | .031 | 2.261 | .024 | par_69 |
| e6 | <--> | e8 | .055 | .025 | 2.198 | .028 | par_70 |
| e15 | <--> | RfrtTpt | .072 | .033 | 2.202 | .028 | par_71 |
| e12 | <--> | RfrtTpt | .014 | .027 | .510 | .610 | par_72 |
| e13 | <--> | RfrtTpt | -.029 | .041 | -.697 | .486 | par_73 |
| e14 | <--> | RfrtTpt | -.108 | .041 | -2.634 | .008 | par_74 |
| e9 | <--> | RfrtTpt | -.039 | .020 | -1.970 | .049 | par_75 |

Correlations: **(Group number 1 - Default model)**

| | | | Estimate |
|---|---|---|---|
| RfrtTpt | <--> | RfrtDmnd | .993 |
| RfrtTpt | <--> | Fstrfctrs | .965 |
| RfrtDmnd | <--> | Fstrfctrs | 1.005 |
| e1 | <--> | e4 | -.220 |
| e1 | <--> | e5 | -.245 |
| e1 | <--> | e11 | -.217 |
| e13 | <--> | e14 | .070 |
| e12 | <--> | e14 | .497 |
| e11 | <--> | e13 | -.157 |
| e10 | <--> | e11 | .400 |
| e9 | <--> | e12 | .356 |
| e9 | <--> | e14 | .570 |
| e9 | <--> | e15 | .072 |
| e8 | <--> | e15 | .683 |
| e8 | <--> | e14 | -.506 |
| e8 | <--> | e13 | -.379 |
| e7 | <--> | e13 | .734 |

| | | | Estimate |
|---|---|---|---|
| e6 | <--> | e15 | .106 |
| e5 | <--> | e11 | .794 |
| e6 | <--> | e9 | .311 |
| e4 | <--> | e13 | -.038 |
| e4 | <--> | e5 | .852 |
| e3 | <--> | e10 | .499 |
| e3 | <--> | e11 | .116 |
| e3 | <--> | e12 | -.248 |
| e3 | <--> | e13 | -.146 |
| e1 | <--> | e10 | .130 |
| e1 | <--> | e12 | -.148 |
| e2 | <--> | e10 | -.110 |
| e3 | <--> | e9 | .004 |
| e3 | <--> | e14 | -.237 |
| e3 | <--> | e15 | .121 |
| e4 | <--> | e11 | .850 |
| e5 | <--> | e10 | .422 |
| e6 | <--> | e12 | .528 |
| e7 | <--> | e10 | .359 |
| e9 | <--> | e10 | .131 |
| e6 | <--> | e7 | .242 |
| e6 | <--> | e13 | .048 |
| e10 | <--> | e14 | .215 |
| e1 | <--> | e15 | .053 |
| e3 | <--> | e8 | .159 |
| e7 | <--> | e12 | .199 |
| e9 | <--> | e11 | .059 |
| e11 | <--> | e14 | -.086 |
| e4 | <--> | e10 | .390 |
| e6 | <--> | e11 | .024 |
| e4 | <--> | e7 | -.031 |
| e14 | <--> | e15 | -.382 |
| e10 | <--> | e15 | .019 |
| e10 | <--> | e13 | .372 |
| e7 | <--> | e9 | .275 |
| e7 | <--> | e15 | .184 |
| e5 | <--> | e13 | -.071 |
| e3 | <--> | e6 | -.061 |
| e11 | <--> | e12 | -.028 |
| e12 | <--> | e13 | .235 |
| e6 | <--> | e8 | .162 |
| e15 | <--> | RfrtTpt | .202 |

| | | | Estimate |
|---|---|---|---|
| e12 | <--> | RfrtTpt | .030 |
| e13 | <--> | RfrtTpt | -.088 |
| e14 | <--> | RfrtTpt | -.361 |
| e9 | <--> | RfrtTpt | -.105 |

**Variances: (Group number 1 - Default model)**

| | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|
| RfrtTpt | .509 | .069 | 7.417 | *** | par_76 |
| RfrtDmnd | .131 | .041 | 3.234 | .001 | par_77 |
| Fstrfctrs | .325 | .083 | 3.929 | *** | par_78 |
| e1 | .182 | .024 | 7.534 | *** | par_79 |
| e2 | .204 | .028 | 7.368 | *** | par_80 |
| e3 | .264 | .033 | 8.099 | *** | par_81 |
| e4 | .577 | .058 | 10.029 | *** | par_82 |
| e5 | .484 | .048 | 10.015 | *** | par_83 |
| e6 | .526 | .053 | 9.974 | *** | par_84 |
| e7 | .298 | .035 | 8.479 | *** | par_85 |
| e8 | .222 | .029 | 7.680 | *** | par_86 |
| e9 | .270 | .035 | 7.651 | *** | par_87 |
| e10 | .682 | .071 | 9.602 | *** | par_88 |
| e11 | .532 | .054 | 9.945 | *** | par_89 |
| e12 | .420 | .043 | 9.713 | *** | par_90 |
| e13 | .210 | .058 | 3.599 | *** | par_91 |
| e14 | .176 | .051 | 3.483 | *** | par_92 |
| e15 | .254 | .039 | 6.542 | *** | par_93 |

**Squared Multiple** Correlations**: (Group number 1 - Default model)**

| | Estimate |
|---|---|
| Y6 | .638 |
| Y5 | .777 |
| Y4 | .775 |
| Y3 | .247 |
| Y2 | .187 |
| Y1 | .323 |
| X9 | .616 |
| X8 | .683 |
| X7 | .672 |
| X6 | .243 |
| X5 | .234 |
| X4 | .186 |
| X3 | .677 |
| X2 | .759 |

| | Estimate |
|---|---|
| X1 | .736 |

**Matrices (Group number 1 - Default model)**

Factor **Score Weights (Group number 1 - Default model)**

| | Y6 | Y5 | Y4 | Y3 | Y2 | Y1 | X9 | X8 | X7 | X6 | X5 | X4 | X3 | X2 | X1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fstrfctrs | -.462 | .568 | .334 | -.196 | .174 | -.356 | -.239 | .307 | -.122 | .095 | .082 | -.087 | .423 | .005 | .215 |
| RfrtDmnd | -.311 | .386 | .219 | -.126 | .126 | -.241 | -.176 | .178 | -.098 | .065 | .049 | -.065 | .300 | .016 | .157 |
| RfrtTpt | .103 | -.025 | .163 | .098 | -.003 | -.166 | .021 | .041 | .042 | -.039 | .133 | .024 | .248 | .091 | .243 |

**Total Effects (**Group **number 1 - Default model)**

| | Fstrfctrs | RfrtDmnd | RfrtTpt |
|---|---|---|---|
| Y6 | 1.175 | .000 | .000 |
| Y5 | 1.373 | .000 | .000 |
| Y4 | 1.490 | .000 | .000 |
| Y3 | .651 | .000 | .000 |
| Y2 | .613 | .000 | .000 |
| Y1 | 1.000 | .000 | .000 |
| X9 | .000 | 1.815 | .000 |
| X8 | .000 | 1.907 | .000 |
| X7 | .000 | 2.156 | .000 |
| X6 | .000 | 1.134 | .000 |
| X5 | .000 | 1.061 | .000 |
| X4 | .000 | 1.000 | .000 |
| X3 | .000 | .000 | 1.043 |
| X2 | .000 | .000 | 1.123 |
| X1 | .000 | .000 | 1.000 |

Standardized **Total Effects (Group number 1 - Default model)**

| | Fstrfctrs | RfrtDmnd | RfrtTpt |
|---|---|---|---|
| Y6 | .799 | .000 | .000 |
| Y5 | .881 | .000 | .000 |
| Y4 | .880 | .000 | .000 |
| Y3 | .497 | .000 | .000 |
| Y2 | .432 | .000 | .000 |
| Y1 | .568 | .000 | .000 |
| X9 | .000 | .785 | .000 |
| X8 | .000 | .826 | .000 |
| X7 | .000 | .820 | .000 |
| X6 | .000 | .493 | .000 |
| X5 | .000 | .484 | .000 |
| X4 | .000 | .431 | .000 |
| X3 | .000 | .000 | .823 |

| | Fstrfctrs | RfrtDmnd | RfrtTpt |
|---|---|---|---|
| X2 | .000 | .000 | .871 |
| X1 | .000 | .000 | .858 |

**Direct Effects (Group number 1 - Default model)**

| | Fstrfctrs | RfrtDmnd | RfrtTpt |
|---|---|---|---|
| Y6 | 1.175 | .000 | .000 |
| Y5 | 1.373 | .000 | .000 |
| Y4 | 1.490 | .000 | .000 |
| Y3 | .651 | .000 | .000 |
| Y2 | .613 | .000 | .000 |
| Y1 | 1.000 | .000 | .000 |
| X9 | .000 | 1.815 | .000 |
| X8 | .000 | 1.907 | .000 |
| X7 | .000 | 2.156 | .000 |
| X6 | .000 | 1.134 | .000 |
| X5 | .000 | 1.061 | .000 |
| X4 | .000 | 1.000 | .000 |
| X3 | .000 | .000 | 1.043 |
| X2 | .000 | .000 | 1.123 |
| X1 | .000 | .000 | 1.000 |

**Standardized Direct Effects (Group number 1 - Default model)**

| | Fstrfctrs | RfrtDmnd | RfrtTpt |
|---|---|---|---|
| Y6 | .799 | .000 | .000 |
| Y5 | .881 | .000 | .000 |
| Y4 | .880 | .000 | .000 |
| Y3 | .497 | .000 | .000 |
| Y2 | .432 | .000 | .000 |
| Y1 | .568 | .000 | .000 |
| X9 | .000 | .785 | .000 |
| X8 | .000 | .826 | .000 |
| X7 | .000 | .820 | .000 |
| X6 | .000 | .493 | .000 |
| X5 | .000 | .484 | .000 |
| X4 | .000 | .431 | .000 |
| X3 | .000 | .000 | .823 |
| X2 | .000 | .000 | .871 |
| X1 | .000 | .000 | .858 |

**Indirect Effects (Group number 1 - Default model)**

| | Fstrfctrs | RfrtDmnd | RfrtTpt |
|---|---|---|---|
| Y6 | .000 | .000 | .000 |
| Y5 | .000 | .000 | .000 |
| Y4 | .000 | .000 | .000 |
| Y3 | .000 | .000 | .000 |
| Y2 | .000 | .000 | .000 |
| Y1 | .000 | .000 | .000 |
| X9 | .000 | .000 | .000 |
| X8 | .000 | .000 | .000 |
| X7 | .000 | .000 | .000 |
| X6 | .000 | .000 | .000 |
| X5 | .000 | .000 | .000 |
| X4 | .000 | .000 | .000 |
| X3 | .000 | .000 | .000 |
| X2 | .000 | .000 | .000 |
| X1 | .000 | .000 | .000 |

Standardized **Indirect Effects (Group number 1 - Default model)**

| | Fstrfctrs | RfrtDmnd | RfrtTpt |
|---|---|---|---|
| Y6 | .000 | .000 | .000 |
| Y5 | .000 | .000 | .000 |
| Y4 | .000 | .000 | .000 |
| Y3 | .000 | .000 | .000 |
| Y2 | .000 | .000 | .000 |
| Y1 | .000 | .000 | .000 |
| X9 | .000 | .000 | .000 |
| X8 | .000 | .000 | .000 |
| X7 | .000 | .000 | .000 |
| X6 | .000 | .000 | .000 |
| X5 | .000 | .000 | .000 |
| X4 | .000 | .000 | .000 |
| X3 | .000 | .000 | .000 |
| X2 | .000 | .000 | .000 |
| X1 | .000 | .000 | .000 |

Model Fit Summary

CMIN

| Model | NPAR | CMIN | DF | P | CMIN/DF |
|---|---|---|---|---|---|
| Default model | 93 | 37.168 | 27 | .092 | 1.377 |
| Saturated model | 120 | .000 | 0 | | |
| Independence model | 15 | 3430.108 | 105 | .000 | 32.668 |

RMR, GFI

| Model | RMR | GFI | AGFI | PGFI |
|---|---|---|---|---|
| Default model | .029 | .976 | .895 | .220 |
| Saturated model | .000 | 1.000 | | |
| Independence model | .399 | .190 | .074 | .166 |

Baseline Comparisons

| Model | NFI Delta1 | RFI rho1 | IFI Delta2 | TLI rho2 | CFI |
|---|---|---|---|---|---|
| Default model | .989 | .958 | .997 | .988 | .997 |
| Saturated model | 1.000 | | 1.000 | | 1.000 |
| Independence model | .000 | .000 | .000 | .000 | .000 |

Parsimony-Adjusted Measures

| Model | PRATIO | PNFI | PCFI |
|---|---|---|---|
| Default model | .257 | .254 | .256 |
| Saturated model | .000 | .000 | .000 |
| Independence model | 1.000 | .000 | .000 |

NCP

| Model | NCP | LO 90 | HI 90 |
|---|---|---|---|
| Default model | 10.168 | .000 | 30.305 |
| Saturated model | .000 | .000 | .000 |
| Independence model | 3325.108 | 3137.502 | 3520.017 |

FMIN

| Model | FMIN | F0 | LO 90 | HI 90 |
|---|---|---|---|---|
| Default model | .187 | .051 | .000 | .152 |
| Saturated model | .000 | .000 | .000 | .000 |
| Independence model | 17.237 | 16.709 | 15.766 | 17.689 |

RMSEA

| Model | RMSEA | LO 90 | HI 90 | PCLOSE |
|---|---|---|---|---|
| Default model | .044 | .000 | .075 | .595 |
| Independence model | .399 | .387 | .410 | .000 |

AIC

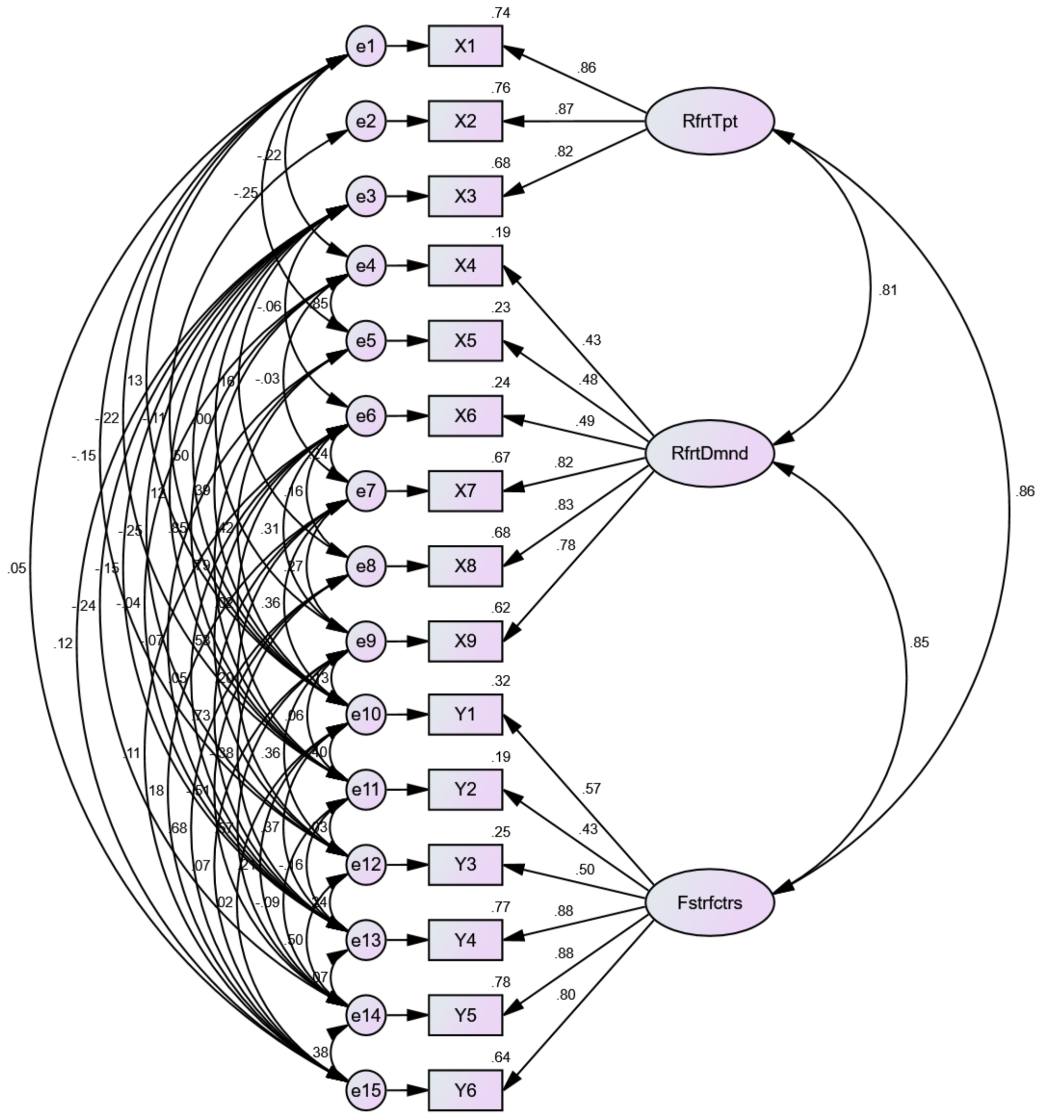
| Model | AIC | BCC | BIC | CAIC |
|---|---|---|---|---|
| Default model | 223.168 | 239.431 | 529.912 | 622.912 |
| Saturated model | 240.000 | 260.984 | 635.798 | 755.798 |
| Independence model | 3460.108 | 3462.731 | 3509.583 | 3524.583 |

ECVI

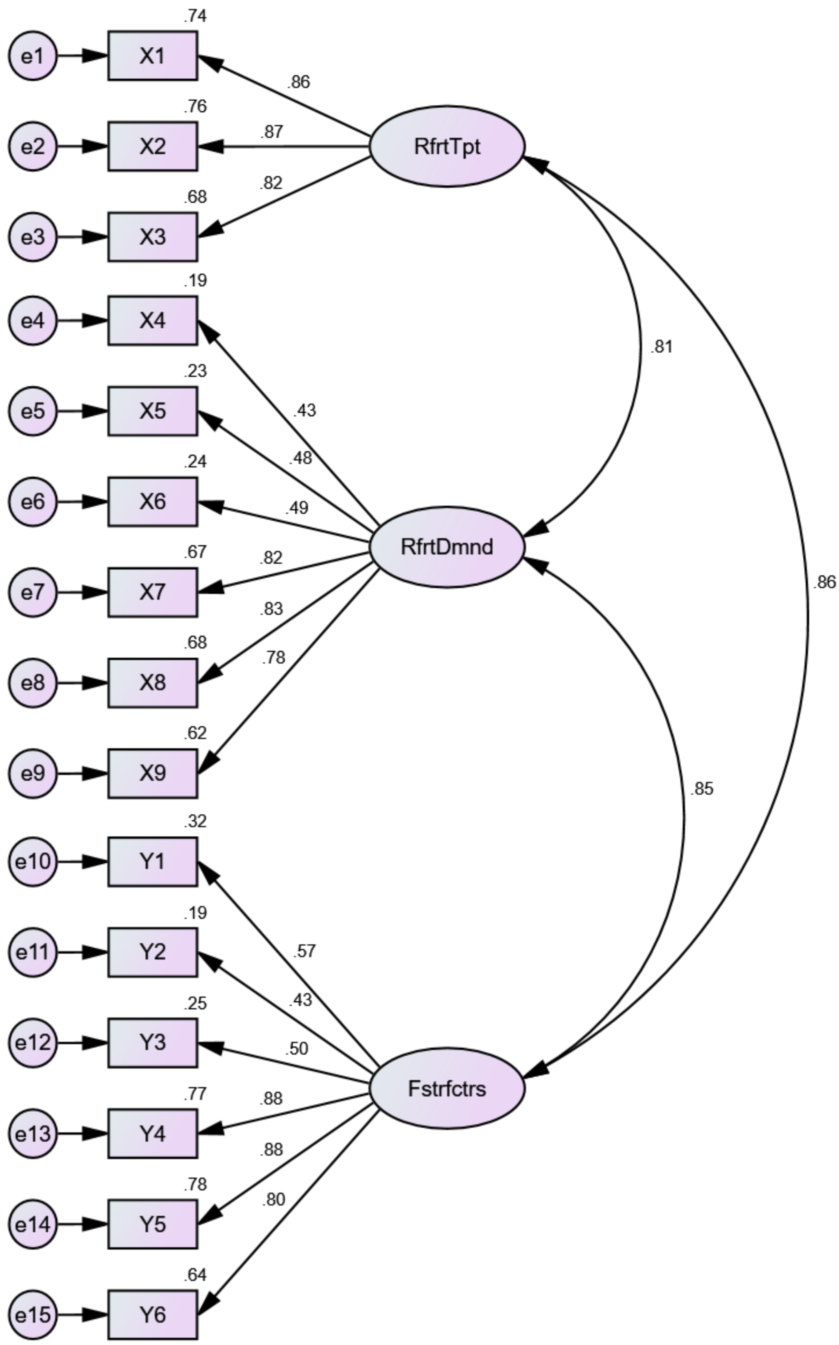
| Model | ECVI | LO 90 | HI 90 | MECVI |
|---|---|---|---|---|
| Default model | 1.121 | 1.070 | 1.223 | 1.203 |
| Saturated model | 1.206 | 1.206 | 1.206 | 1.311 |
| Independence model | 17.387 | 16.445 | 18.367 | 17.401 |

HOELTER

| Model | HOELTER .05 | HOELTER .01 |
|---|---|---|
| Default model | 215 | 252 |
| Independence model | 8 | 9 |




Chi-square = 37.168, df = 27, P-value = .092, Chi-square/df = 1.377,
CFI = .997, GFI = .976, AGFI = .895, IFI = .997, NFI=.989, TLI=.988,
RMR=.029 , RMSEA = .044




Chi-square = 37.168, df = 27, P-value = .092, Chi-square/df = 1.377,
CFI = .997, GFI = .976, AGFI = .895, IFI = .997, NFI=.989, TLI=.988,
RMR=.029 , RMSEA = .044

**APPENDIX H STRUCTURAL EQUATION MODELING**

Estimates (Group number 1 - Default model)
Scalar Estimates (Group number 1 - Default model)
Maximum Likelihood Estimates
Regression Weights: (Group number 1 - Default model)

| | | | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|---|---|
| RfrtDmnd | <--- | RfrtTpt | .540 | .076 | 7.141 | *** | par_13 |
| Fstrfctrs | <--- | RfrtDmnd | 2.154 | .490 | 4.392 | *** | par_14 |
| Fstrfctrs | <--- | RfrtTpt | -.277 | .210 | -1.316 | .188 | par_15 |
| X1 | <--- | RfrtTpt | 1.000 | | | | |
| X2 | <--- | RfrtTpt | 1.122 | .072 | 15.689 | *** | par_1 |
| X3 | <--- | RfrtTpt | 1.058 | .073 | 14.444 | *** | par_2 |
| X4 | <--- | RfrtDmnd | 1.000 | | | | |
| X5 | <--- | RfrtDmnd | 1.014 | .175 | 5.779 | *** | par_3 |
| X6 | <--- | RfrtDmnd | 1.019 | .181 | 5.625 | *** | par_4 |
| X7 | <--- | RfrtDmnd | 2.058 | .275 | 7.473 | *** | par_5 |
| X8 | <--- | RfrtDmnd | 1.692 | .232 | 7.292 | *** | par_6 |
| X9 | <--- | RfrtDmnd | 1.651 | .230 | 7.191 | *** | par_7 |
| Y1 | <--- | Fstrfctrs | 1.000 | | | | |
| Y2 | <--- | Fstrfctrs | .639 | .093 | 6.861 | *** | par_8 |
| Y3 | <--- | Fstrfctrs | .616 | .086 | 7.123 | *** | par_9 |
| Y4 | <--- | Fstrfctrs | 1.245 | .118 | 10.586 | *** | par_10 |
| Y5 | <--- | Fstrfctrs | 1.059 | .106 | 9.952 | *** | par_11 |
| Y6 | <--- | Fstrfctrs | 1.121 | .103 | 10.920 | *** | par_12 |

Standardized Regression Weights: (Group number 1 - Default model)

| | | | Estimate |
|---|---|---|---|
| RfrtDmnd | <--- | RfrtTpt | .942 |
| Fstrfctrs | <--- | RfrtDmnd | 1.351 |
| Fstrfctrs | <--- | RfrtTpt | -.303 |
| X1 | <--- | RfrtTpt | .855 |
| X2 | <--- | RfrtTpt | .863 |
| X3 | <--- | RfrtTpt | .822 |
| X4 | <--- | RfrtDmnd | .481 |
| X5 | <--- | RfrtDmnd | .518 |
| X6 | <--- | RfrtDmnd | .496 |
| X7 | <--- | RfrtDmnd | .878 |
| X8 | <--- | RfrtDmnd | .822 |
| X9 | <--- | RfrtDmnd | .793 |
| Y1 | <--- | Fstrfctrs | .646 |
| Y2 | <--- | Fstrfctrs | .501 |
| Y3 | <--- | Fstrfctrs | .523 |

| | | | Estimate |
|---|---|---|---|
| Y4 | <--- | Fstrfctrs | .834 |
| Y5 | <--- | Fstrfctrs | .772 |
| Y6 | <--- | Fstrfctrs | .869 |

Variances: (Group number 1 - Default model)

| | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|
| RfrtTpt | .499 | .068 | 7.379 | *** | par_16 |
| res1 | .019 | .008 | 2.425 | .015 | par_17 |
| res2 | -.061 | .015 | -4.174 | *** | par_18 |
| e1 | .184 | .024 | 7.757 | *** | par_19 |
| e2 | .216 | .028 | 7.574 | *** | par_20 |
| e3 | .269 | .032 | 8.305 | *** | par_21 |
| e4 | .546 | .055 | 10.010 | *** | par_22 |
| e5 | .462 | .046 | 10.014 | *** | par_23 |
| e6 | .523 | .052 | 10.012 | *** | par_24 |
| e7 | .207 | .022 | 9.242 | *** | par_25 |
| e8 | .226 | .023 | 9.752 | *** | par_26 |
| e9 | .263 | .027 | 9.864 | *** | par_27 |
| e10 | .585 | .058 | 10.134 | *** | par_28 |
| e11 | .508 | .050 | 10.072 | *** | par_29 |
| e12 | .422 | .042 | 10.080 | *** | par_30 |
| e13 | .283 | .028 | 9.975 | *** | par_31 |
| e14 | .318 | .031 | 10.129 | *** | par_32 |
| e15 | .171 | .018 | 9.737 | *** | par_33 |

Squared Multiple Correlations: (Group number 1 - Default model)

| | Estimate |
|---|---|
| RfrtDmnd | .887 |
| Fstrfctrs | 1.146 |
| Y6 | .754 |
| Y5 | .596 |
| Y4 | .696 |
| Y3 | .273 |
| Y2 | .251 |
| Y1 | .417 |
| X9 | .630 |
| X8 | .675 |
| X7 | .770 |
| X6 | .246 |
| X5 | .268 |
| X4 | .231 |
| X3 | .675 |

| | Estimate |
|---|---|
| X2 | .745 |
| X1 | .730 |

Matrices (Group number 1 - Default model)

Factor Score Weights (Group number 1 - Default model)

| | Y6 | Y5 | Y4 | Y3 | Y2 | Y1 | X9 | X8 | X7 | X6 | X5 | X4 | X3 | X2 | X1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RfrtTpt | .112 | .057 | .075 | .025 | .022 | .029 | .019 | .022 | .029 | .006 | .006 | .005 | .140 | .186 | .193 |
| RfrtDmnd | .209 | .106 | .140 | .047 | .040 | .055 | -.017 | -.020 | -.026 | -.005 | -.006 | -.005 | .012 | .015 | .016 |
| Fstrfctrs | -.099 | -.050 | -.066 | -.022 | -.019 | -.026 | .200 | .239 | .317 | .062 | .070 | .058 | .067 | .089 | .093 |

Total Effects (Group number 1 - Default model)

| | RfrtTpt | RfrtDmnd | Fstrfctrs |
|---|---|---|---|
| RfrtDmnd | .540 | .000 | .000 |
| Fstrfctrs | .887 | 2.154 | .000 |
| Y6 | .994 | 2.414 | 1.121 |
| Y5 | .939 | 2.281 | 1.059 |
| Y4 | 1.104 | 2.682 | 1.245 |
| Y3 | .546 | 1.326 | .616 |
| Y2 | .567 | 1.377 | .639 |
| Y1 | .887 | 2.154 | 1.000 |
| X9 | .892 | 1.651 | .000 |
| X8 | .914 | 1.692 | .000 |
| X7 | 1.112 | 2.058 | .000 |
| X6 | .550 | 1.019 | .000 |
| X5 | .548 | 1.014 | .000 |
| X4 | .540 | 1.000 | .000 |
| X3 | 1.058 | .000 | .000 |
| X2 | 1.122 | .000 | .000 |
| X1 | 1.000 | .000 | .000 |

Standardized Total Effects (Group number 1 - Default model)

| | RfrtTpt | RfrtDmnd | Fstrfctrs |
|---|---|---|---|
| RfrtDmnd | .942 | .000 | .000 |
| Fstrfctrs | .969 | 1.351 | .000 |
| Y6 | .842 | 1.173 | .869 |
| Y5 | .748 | 1.042 | .772 |
| Y4 | .808 | 1.127 | .834 |
| Y3 | .506 | .706 | .523 |
| Y2 | .486 | .677 | .501 |
| Y1 | .626 | .872 | .646 |
| X9 | .747 | .793 | .000 |
| X8 | .774 | .822 | .000 |
| X7 | .826 | .878 | .000 |

| | RfrtTpt | RfrtDmnd | Fstrfctrs |
|---|---|---|---|
| X6 | .467 | .496 | .000 |
| X5 | .487 | .518 | .000 |
| X4 | .453 | .481 | .000 |
| X3 | .822 | .000 | .000 |
| X2 | .863 | .000 | .000 |
| X1 | .855 | .000 | .000 |

Direct Effects (Group number 1 - Default model)

| | RfrtTpt | RfrtDmnd | Fstrfctrs |
|---|---|---|---|
| RfrtDmnd | .540 | .000 | .000 |
| Fstrfctrs | -.277 | 2.154 | .000 |
| Y6 | .000 | .000 | 1.121 |
| Y5 | .000 | .000 | 1.059 |
| Y4 | .000 | .000 | 1.245 |
| Y3 | .000 | .000 | .616 |
| Y2 | .000 | .000 | .639 |
| Y1 | .000 | .000 | 1.000 |
| X9 | .000 | 1.651 | .000 |
| X8 | .000 | 1.692 | .000 |
| X7 | .000 | 2.058 | .000 |
| X6 | .000 | 1.019 | .000 |
| X5 | .000 | 1.014 | .000 |
| X4 | .000 | 1.000 | .000 |
| X3 | 1.058 | .000 | .000 |
| X2 | 1.122 | .000 | .000 |
| X1 | 1.000 | .000 | .000 |

Standardized Direct Effects (Group number 1 - Default model)

| | RfrtTpt | RfrtDmnd | Fstrfctrs |
|---|---|---|---|
| RfrtDmnd | .942 | .000 | .000 |
| Fstrfctrs | -.303 | 1.351 | .000 |
| Y6 | .000 | .000 | .869 |
| Y5 | .000 | .000 | .772 |
| Y4 | .000 | .000 | .834 |
| Y3 | .000 | .000 | .523 |
| Y2 | .000 | .000 | .501 |
| Y1 | .000 | .000 | .646 |
| X9 | .000 | .793 | .000 |
| X8 | .000 | .822 | .000 |
| X7 | .000 | .878 | .000 |
| X6 | .000 | .496 | .000 |
| X5 | .000 | .518 | .000 |

| | RfrtTpt | RfrtDmnd | Fstrfctrs |
|---|---|---|---|
| X4 | .000 | .481 | .000 |
| X3 | .822 | .000 | .000 |
| X2 | .863 | .000 | .000 |
| X1 | .855 | .000 | .000 |

Indirect Effects (Group number 1 - Default model)

| | RfrtTpt | RfrtDmnd | Fstrfctrs |
|---|---|---|---|
| RfrtDmnd | .000 | .000 | .000 |
| Fstrfctrs | 1.163 | .000 | .000 |
| Y6 | .994 | 2.414 | .000 |
| Y5 | .939 | 2.281 | .000 |
| Y4 | 1.104 | 2.682 | .000 |
| Y3 | .546 | 1.326 | .000 |
| Y2 | .567 | 1.377 | .000 |
| Y1 | .887 | 2.154 | .000 |
| X9 | .892 | .000 | .000 |
| X8 | .914 | .000 | .000 |
| X7 | 1.112 | .000 | .000 |
| X6 | .550 | .000 | .000 |
| X5 | .548 | .000 | .000 |
| X4 | .540 | .000 | .000 |
| X3 | .000 | .000 | .000 |
| X2 | .000 | .000 | .000 |
| X1 | .000 | .000 | .000 |

Standardized Indirect Effects (Group number 1 - Default model)

| | RfrtTpt | RfrtDmnd | Fstrfctrs |
|---|---|---|---|
| RfrtDmnd | .000 | .000 | .000 |
| Fstrfctrs | 1.272 | .000 | .000 |
| Y6 | .842 | 1.173 | .000 |
| Y5 | .748 | 1.042 | .000 |
| Y4 | .808 | 1.127 | .000 |
| Y3 | .506 | .706 | .000 |
| Y2 | .486 | .677 | .000 |
| Y1 | .626 | .872 | .000 |
| X9 | .747 | .000 | .000 |
| X8 | .774 | .000 | .000 |
| X7 | .826 | .000 | .000 |
| X6 | .467 | .000 | .000 |
| X5 | .487 | .000 | .000 |
| X4 | .453 | .000 | .000 |
| X3 | .000 | .000 | .000 |

| | RfrtTpt | RfrtDmnd | Fstrfctrs |
|---|---|---|---|
| X2 | .000 | .000 | .000 |
| X1 | .000 | .000 | .000 |

Modification Indices (Group number 1 - Default model)
Covariances: (Group number 1 - Default model)

| | | | M.I. | Par Change |
|---|---|---|---|---|
| e15 | <--> | res1 | 18.763 | -.017 |
| e15 | <--> | res2 | 4.707 | -.010 |
| e14 | <--> | res1 | 15.955 | .023 |
| e14 | <--> | e15 | 7.418 | -.042 |
| e13 | <--> | e14 | 32.675 | .114 |
| e12 | <--> | res1 | 8.233 | .020 |
| e12 | <--> | e15 | 6.687 | -.046 |
| e12 | <--> | e14 | 36.304 | .151 |
| e12 | <--> | e13 | 5.453 | .055 |
| e11 | <--> | res1 | 4.139 | -.016 |
| e11 | <--> | res2 | 9.459 | -.030 |
| e11 | <--> | e14 | 7.642 | -.076 |
| e11 | <--> | e13 | 22.912 | -.123 |
| e11 | <--> | e12 | 4.992 | -.072 |
| e10 | <--> | e13 | 4.181 | .056 |
| e10 | <--> | e12 | 9.050 | -.104 |
| e10 | <--> | e11 | 21.311 | .175 |
| e9 | <--> | e15 | 10.529 | -.044 |
| e9 | <--> | e14 | 43.486 | .128 |
| e9 | <--> | e12 | 12.865 | .083 |
| e9 | <--> | e10 | 4.353 | -.056 |
| e8 | <--> | res1 | 5.922 | -.013 |
| e8 | <--> | e15 | 45.441 | .084 |
| e8 | <--> | e14 | 13.296 | -.065 |
| e8 | <--> | e13 | 26.404 | -.084 |
| e8 | <--> | e12 | 4.045 | -.043 |
| e8 | <--> | e10 | 4.351 | -.052 |
| e7 | <--> | e15 | 6.751 | -.030 |
| e7 | <--> | e13 | 43.292 | .101 |
| e7 | <--> | e11 | 7.529 | -.061 |
| e7 | <--> | e9 | 4.863 | .035 |
| e7 | <--> | e8 | 5.194 | -.033 |
| e6 | <--> | res2 | 6.372 | -.025 |
| e6 | <--> | e15 | 7.552 | -.055 |
| e6 | <--> | e12 | 44.175 | .219 |
| e6 | <--> | e10 | 15.466 | -.152 |
| e6 | <--> | e9 | 21.463 | .120 |
| e6 | <--> | e7 | 7.115 | .061 |
| e5 | <--> | e14 | 7.550 | -.072 |
| e5 | <--> | e13 | 22.968 | -.117 |

| | | | M.I. | Par Change |
|---|---|---|---|---|
| e5 | <--> | e12 | 5.489 | -.073 |
| e5 | <--> | e11 | 130.360 | .388 |
| e5 | <--> | e10 | 18.501 | .156 |
| e5 | <--> | e8 | 4.060 | .045 |
| e5 | <--> | e7 | 13.334 | -.078 |
| e4 | <--> | e13 | 11.252 | -.089 |
| e4 | <--> | e11 | 153.486 | .458 |
| e4 | <--> | e10 | 20.299 | .177 |
| e4 | <--> | e7 | 18.456 | -.100 |
| e4 | <--> | e5 | 140.179 | .419 |
| e3 | <--> | e15 | 9.539 | .048 |
| e3 | <--> | e14 | 20.664 | -.099 |
| e3 | <--> | e13 | 11.879 | -.070 |
| e3 | <--> | e12 | 20.865 | -.117 |
| e3 | <--> | e11 | 16.868 | .116 |
| e3 | <--> | e10 | 44.553 | .201 |
| e3 | <--> | e8 | 8.931 | .056 |
| e3 | <--> | e7 | 4.876 | -.039 |
| e3 | <--> | e6 | 4.757 | -.063 |
| e3 | <--> | e5 | 11.809 | .093 |
| e3 | <--> | e4 | 8.007 | .083 |
| e2 | <--> | res2 | 4.622 | -.015 |
| e2 | <--> | e14 | 5.357 | -.047 |
| e2 | <--> | e10 | 27.109 | -.145 |
| e1 | <--> | res2 | 5.013 | .015 |
| e1 | <--> | e15 | 8.911 | .039 |
| e1 | <--> | e13 | 4.387 | .036 |
| e1 | <--> | e11 | 9.272 | -.073 |
| e1 | <--> | e5 | 10.310 | -.074 |
| e1 | <--> | e4 | 9.559 | -.077 |

Variances: (Group number 1 - Default model)

| | M.I. | Par Change |
|---|---|---|

Regression Weights: (Group number 1 - Default model)

| | | | M.I. | Par Change |
|---|---|---|---|---|
| Y6 | <--- | Y3 | 4.933 | -.081 |
| Y6 | <--- | X9 | 7.157 | -.088 |
| Y6 | <--- | X8 | 11.791 | .114 |
| Y6 | <--- | X7 | 4.122 | -.059 |
| Y6 | <--- | X6 | 7.772 | -.093 |
| Y6 | <--- | X3 | 4.835 | .067 |

| | | | M.I. | Par Change |
|---|---|---|---|---|
| Y5 | <--- | Y4 | 10.795 | .133 |
| Y5 | <--- | Y3 | 26.764 | .265 |
| Y5 | <--- | Y2 | 5.793 | -.114 |
| Y5 | <--- | X9 | 21.459 | .214 |
| Y5 | <--- | X5 | 4.178 | -.100 |
| Y5 | <--- | X3 | 8.611 | -.126 |
| Y4 | <--- | Y5 | 13.964 | .153 |
| Y4 | <--- | Y3 | 4.021 | .095 |
| Y4 | <--- | Y2 | 17.374 | -.183 |
| Y4 | <--- | X8 | 6.369 | -.110 |
| Y4 | <--- | X7 | 15.813 | .152 |
| Y4 | <--- | X5 | 14.386 | -.173 |
| Y4 | <--- | X4 | 6.984 | -.114 |
| Y3 | <--- | Y5 | 15.466 | .203 |
| Y3 | <--- | Y1 | 5.416 | -.106 |
| Y3 | <--- | X9 | 5.271 | .124 |
| Y3 | <--- | X6 | 34.086 | .320 |
| Y3 | <--- | X3 | 9.423 | -.154 |
| Y2 | <--- | Y4 | 7.547 | -.143 |
| Y2 | <--- | Y1 | 12.752 | .179 |
| Y2 | <--- | X7 | 6.149 | -.131 |
| Y2 | <--- | X6 | 4.841 | -.133 |
| Y2 | <--- | X5 | 83.657 | .578 |
| Y2 | <--- | X4 | 105.724 | .613 |
| Y2 | <--- | X1 | 4.122 | -.123 |
| Y1 | <--- | Y3 | 6.670 | -.181 |
| Y1 | <--- | Y2 | 16.150 | .261 |
| Y1 | <--- | X6 | 10.690 | -.210 |
| Y1 | <--- | X5 | 14.944 | .260 |
| Y1 | <--- | X4 | 16.987 | .262 |
| Y1 | <--- | X3 | 15.193 | .229 |
| X9 | <--- | Y5 | 20.198 | .182 |
| X9 | <--- | Y3 | 10.066 | .150 |
| X9 | <--- | X6 | 16.276 | .174 |
| X8 | <--- | Y6 | 14.294 | .150 |
| X8 | <--- | Y5 | 5.406 | -.087 |
| X8 | <--- | Y4 | 8.573 | -.101 |
| X8 | <--- | X3 | 4.838 | .080 |
| X7 | <--- | Y4 | 12.130 | .114 |
| X7 | <--- | Y2 | 7.252 | -.103 |
| X7 | <--- | X6 | 5.396 | .088 |
| X7 | <--- | X5 | 9.822 | -.124 |

| | | | M.I. | Par Change |
|---|---|---|---|---|
| X7 | <--- | X4 | 14.258 | -.141 |
| X6 | <--- | Y3 | 40.376 | .427 |
| X6 | <--- | Y1 | 5.066 | -.115 |
| X6 | <--- | X9 | 8.169 | .173 |
| X5 | <--- | Y4 | 6.564 | -.128 |
| X5 | <--- | Y2 | 101.379 | .587 |
| X5 | <--- | Y1 | 12.181 | .167 |
| X5 | <--- | X4 | 108.268 | .593 |
| X5 | <--- | X3 | 4.205 | .108 |
| X4 | <--- | Y4 | 4.861 | -.119 |
| X4 | <--- | Y2 | 112.957 | .674 |
| X4 | <--- | Y1 | 10.758 | .171 |
| X4 | <--- | X7 | 4.467 | -.116 |
| X4 | <--- | X5 | 103.230 | .668 |
| X3 | <--- | Y5 | 8.660 | -.132 |
| X3 | <--- | Y3 | 15.231 | -.204 |
| X3 | <--- | Y2 | 12.934 | .174 |
| X3 | <--- | Y1 | 26.976 | .207 |
| X3 | <--- | X5 | 8.754 | .148 |
| X3 | <--- | X4 | 6.229 | .118 |
| X2 | <--- | Y1 | 13.314 | -.135 |
| X1 | <--- | Y2 | 8.867 | -.122 |
| X1 | <--- | X5 | 6.699 | -.110 |
| X1 | <--- | X4 | 6.562 | -.103 |

Model Fit Summary

CMIN

| Model | NPAR | CMIN | DF | P | CMIN/DF |
|---|---|---|---|---|---|
| Default model | 33 | 1443.801 | 87 | .000 | 16.595 |
| Saturated model | 120 | .000 | 0 | | |
| Independence model | 15 | 3430.108 | 105 | .000 | 32.668 |

RMR, GFI

| Model | RMR | GFI | AGFI | PGFI |
|---|---|---|---|---|
| Default model | .097 | .524 | .343 | .380 |
| Saturated model | .000 | 1.000 | | |
| Independence model | .399 | .190 | .074 | .166 |

Baseline Comparisons

| Model | NFI Delta1 | RFI rho1 | IFI Delta2 | TLI rho2 | CFI |
|---|---|---|---|---|---|
| Default model | .579 | .492 | .594 | .508 | .592 |
| Saturated model | 1.000 | | 1.000 | | 1.000 |
| Independence model | .000 | .000 | .000 | .000 | .000 |

Parsimony-Adjusted Measures

| Model | PRATIO | PNFI | PCFI |
|---|---|---|---|
| Default model | .829 | .480 | .490 |
| Saturated model | .000 | .000 | .000 |
| Independence model | 1.000 | .000 | .000 |

NCP

| Model | NCP | LO 90 | HI 90 |
|---|---|---|---|
| Default model | 1356.801 | 1237.355 | 1483.645 |
| Saturated model | .000 | .000 | .000 |
| Independence model | 3325.108 | 3137.502 | 3520.017 |

FMIN

| Model | FMIN | F0 | LO 90 | HI 90 |
|---|---|---|---|---|
| Default model | 7.255 | 6.818 | 6.218 | 7.456 |
| Saturated model | .000 | .000 | .000 | .000 |
| Independence model | 17.237 | 16.709 | 15.766 | 17.689 |

RMSEA

| Model | RMSEA | LO 90 | HI 90 | PCLOSE |
|---|---|---|---|---|
| Default model | .280 | .267 | .293 | .000 |
| Independence model | .399 | .387 | .410 | .000 |

AIC

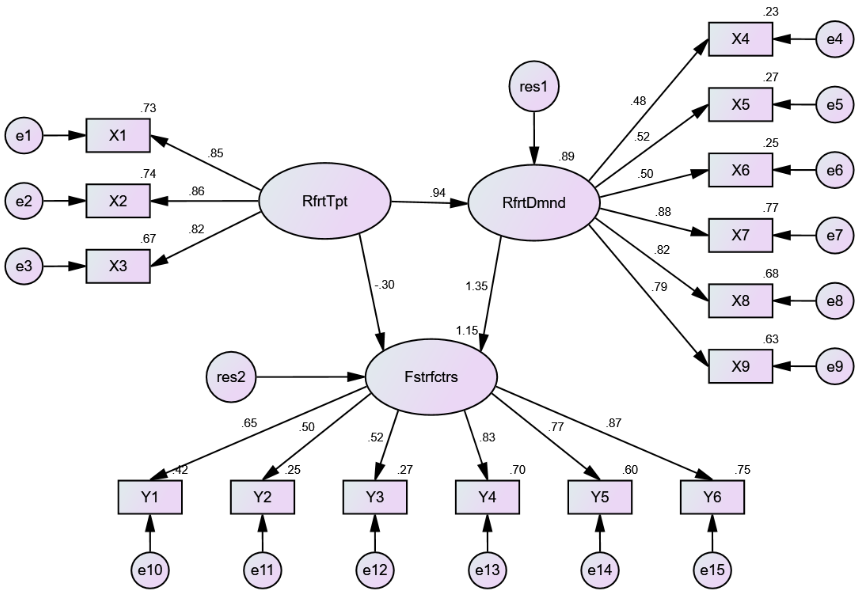
| Model | AIC | BCC | BIC | CAIC |
|---|---|---|---|---|
| Default model | 1509.801 | 1515.571 | 1618.645 | 1651.645 |
| Saturated model | 240.000 | 260.984 | 635.798 | 755.798 |
| Independence model | 3460.108 | 3462.731 | 3509.583 | 3524.583 |

ECVI

| Model | ECVI | LO 90 | HI 90 | MECVI |
|---|---|---|---|---|
| Default model | 7.587 | 6.987 | 8.224 | 7.616 |
| Saturated model | 1.206 | 1.206 | 1.206 | 1.311 |
| Independence model | 17.387 | 16.445 | 18.367 | 17.401 |

HOELTER

| Model | HOELTER .05 | HOELTER .01 |
|---|---|---|
| Default model | 16 | 17 |
| Independence model | 8 | 9 |




Chi-square = 1443.801, df = 87, P-value = .000, Chi-square/df = 16.595,
CFI = .592, GFI = .524, AGFI = .343, IFI = .594, NFI=.579, TLI=.508,
RMR=.097 , RMSEA = .280

Estimates (Group number 1 - Default model)
Scalar Estimates (Group number 1 - Default model)
Maximum Likelihood Estimates
Regression Weights: (Group number 1 - Default model)

| | | | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|---|---|
| RfrtDmnd | <--- | RfrtTpt | .433 | .075 | 5.757 | *** | par_13 |
| Fstrfctrs | <--- | RfrtDmnd | 1.416 | .352 | 4.017 | *** | par_14 |
| Fstrfctrs | <--- | RfrtTpt | .370 | .162 | 2.279 | .023 | par_15 |
| X1 | <--- | RfrtTpt | 1.000 | | | | |
| X2 | <--- | RfrtTpt | 1.119 | .070 | 16.065 | *** | par_1 |
| X3 | <--- | RfrtTpt | .950 | .076 | 12.422 | *** | par_2 |
| X4 | <--- | RfrtDmnd | 1.000 | | | | |
| X5 | <--- | RfrtDmnd | 1.084 | .093 | 11.667 | *** | par_3 |
| X6 | <--- | RfrtDmnd | 1.227 | .247 | 4.975 | *** | par_4 |
| X7 | <--- | RfrtDmnd | 2.293 | .383 | 5.988 | *** | par_5 |
| X8 | <--- | RfrtDmnd | 2.013 | .339 | 5.934 | *** | par_6 |
| X9 | <--- | RfrtDmnd | 1.813 | .313 | 5.791 | *** | par_7 |
| Y1 | <--- | Fstrfctrs | 1.000 | | | | |
| Y2 | <--- | Fstrfctrs | .416 | .067 | 6.224 | *** | par_8 |
| Y3 | <--- | Fstrfctrs | .493 | .083 | 5.941 | *** | par_9 |
| Y4 | <--- | Fstrfctrs | 1.017 | .104 | 9.738 | *** | par_10 |
| Y5 | <--- | Fstrfctrs | .820 | .093 | 8.858 | *** | par_11 |
| Y6 | <--- | Fstrfctrs | .978 | .102 | 9.598 | *** | par_12 |

Standardized Regression Weights: (Group number 1 - Default model)

| | | | Estimate |
|---|---|---|---|
| RfrtDmnd | <--- | RfrtTpt | .936 |
| Fstrfctrs | <--- | RfrtDmnd | .643 |
| Fstrfctrs | <--- | RfrtTpt | .363 |
| X1 | <--- | RfrtTpt | .900 |
| X2 | <--- | RfrtTpt | .908 |
| X3 | <--- | RfrtTpt | .784 |
| X4 | <--- | RfrtDmnd | .410 |
| X5 | <--- | RfrtDmnd | .477 |
| X6 | <--- | RfrtDmnd | .510 |
| X7 | <--- | RfrtDmnd | .830 |
| X8 | <--- | RfrtDmnd | .833 |
| X9 | <--- | RfrtDmnd | .743 |
| Y1 | <--- | Fstrfctrs | .749 |
| Y2 | <--- | Fstrfctrs | .384 |
| Y3 | <--- | Fstrfctrs | .497 |
| Y4 | <--- | Fstrfctrs | .802 |
| Y5 | <--- | Fstrfctrs | .704 |

| | | | Estimate |
|---|---|---|---|
| Y6 | <--- | Fstrfctrs | .890 |

Covariances: (Group number 1 - Default model)

| | | | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|---|---|
| e4 | <--> | e11 | .502 | .055 | 9.173 | *** | par_16 |
| e5 | <--> | e6 | -.008 | .015 | -.555 | .579 | par_17 |
| e1 | <--> | e5 | -.014 | .012 | -1.123 | .261 | par_18 |
| e2 | <--> | e10 | -.226 | .041 | -5.533 | *** | par_19 |
| e6 | <--> | e12 | .195 | .035 | 5.573 | *** | par_20 |
| e7 | <--> | e13 | .249 | .033 | 7.577 | *** | par_21 |
| e3 | <--> | e12 | -.071 | .024 | -2.979 | .003 | par_22 |
| e4 | <--> | e5 | .450 | .050 | 8.968 | *** | par_23 |
| e3 | <--> | e8 | .078 | .027 | 2.905 | .004 | par_24 |
| e5 | <--> | e11 | .423 | .048 | 8.781 | *** | par_25 |
| e4 | <--> | e13 | .023 | .017 | 1.360 | .174 | par_26 |
| e3 | <--> | e10 | .128 | .048 | 2.633 | .008 | par_27 |
| e5 | <--> | e13 | -.003 | .019 | -.177 | .860 | par_28 |
| e9 | <--> | e14 | .216 | .036 | 5.970 | *** | par_29 |
| e12 | <--> | e14 | .143 | .029 | 4.992 | *** | par_30 |
| e12 | <--> | e13 | .050 | .019 | 2.593 | .010 | par_31 |
| e10 | <--> | e15 | -.165 | .036 | -4.565 | *** | par_32 |
| e10 | <--> | e14 | -.023 | .034 | -.686 | .492 | par_33 |
| e9 | <--> | e11 | .044 | .011 | 4.006 | *** | par_34 |
| e9 | <--> | e10 | -.051 | .030 | -1.701 | .089 | par_35 |
| e3 | <--> | e15 | .071 | .026 | 2.758 | .006 | par_36 |
| e3 | <--> | e14 | -.031 | .022 | -1.428 | .153 | par_37 |
| e3 | <--> | e9 | .023 | .022 | 1.081 | .280 | par_38 |
| e13 | <--> | e14 | .160 | .035 | 4.536 | *** | par_39 |
| e9 | <--> | e13 | .092 | .027 | 3.410 | *** | par_40 |
| e7 | <--> | e9 | .102 | .028 | 3.652 | *** | par_41 |
| e7 | <--> | e14 | .078 | .038 | 2.071 | .038 | par_42 |
| e8 | <--> | e15 | .114 | .022 | 5.316 | *** | par_43 |
| e8 | <--> | e14 | -.027 | .028 | -.943 | .346 | par_44 |
| e7 | <--> | e11 | .027 | .014 | 1.877 | .061 | par_45 |
| e4 | <--> | e10 | .233 | .049 | 4.746 | *** | par_46 |
| e10 | <--> | e11 | .240 | .048 | 4.989 | *** | par_47 |
| e5 | <--> | e10 | .202 | .047 | 4.337 | *** | par_48 |
| e12 | <--> | e15 | -.077 | .023 | -3.315 | *** | par_49 |
| e6 | <--> | e15 | -.068 | .026 | -2.642 | .008 | par_50 |
| e9 | <--> | e12 | .088 | .026 | 3.411 | *** | par_51 |
| e3 | <--> | e11 | .128 | .031 | 4.157 | *** | par_52 |
| e6 | <--> | e9 | .126 | .029 | 4.388 | *** | par_53 |

| | | | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|---|---|
| e3 | <--> | e5 | .092 | .029 | 3.212 | .001 | par_54 |
| e3 | <--> | e4 | .099 | .031 | 3.238 | .001 | par_55 |
| e15 | <--> | res2 | .002 | .007 | .307 | .759 | par_56 |
| e11 | <--> | e13 | -.009 | .019 | -.492 | .623 | par_57 |
| e5 | <--> | e8 | .013 | .009 | 1.384 | .166 | par_58 |
| e12 | <--> | res1 | .024 | .012 | 1.990 | .047 | par_59 |
| e2 | <--> | e14 | -.014 | .015 | -.942 | .346 | par_60 |
| e3 | <--> | e7 | .031 | .014 | 2.212 | .027 | par_61 |
| e5 | <--> | e7 | -.008 | .014 | -.619 | .536 | par_62 |
| e6 | <--> | e7 | .077 | .028 | 2.789 | .005 | par_63 |
| e6 | <--> | e10 | -.135 | .033 | -4.046 | *** | par_64 |
| e6 | <--> | res2 | .051 | .023 | 2.213 | .027 | par_65 |
| e8 | <--> | e10 | -.105 | .036 | -2.962 | .003 | par_66 |
| e8 | <--> | e12 | -.068 | .026 | -2.620 | .009 | par_67 |
| e10 | <--> | e12 | -.129 | .035 | -3.695 | *** | par_68 |
| e10 | <--> | e13 | .009 | .021 | .412 | .680 | par_69 |
| e14 | <--> | e15 | -.048 | .022 | -2.131 | .033 | par_70 |
| e14 | <--> | res1 | .026 | .014 | 1.828 | .067 | par_71 |
| e1 | <--> | e2 | -.059 | .031 | -1.902 | .057 | par_72 |
| e1 | <--> | e10 | -.074 | .036 | -2.038 | .042 | par_73 |
| e1 | <--> | e12 | -.042 | .022 | -1.957 | .050 | par_74 |

Correlations: (Group number 1 - Default model)

| | | | Estimate |
|---|---|---|---|
| e4 | <--> | e11 | .863 |
| e5 | <--> | e6 | -.016 |
| e1 | <--> | e5 | -.055 |
| e2 | <--> | e10 | -.872 |
| e6 | <--> | e12 | .435 |
| e7 | <--> | e13 | .819 |
| e3 | <--> | e12 | -.202 |
| e4 | <--> | e5 | .852 |
| e3 | <--> | e8 | .302 |
| e5 | <--> | e11 | .808 |
| e4 | <--> | e13 | .052 |
| e3 | <--> | e10 | .340 |
| e5 | <--> | e13 | -.009 |
| e9 | <--> | e14 | .663 |
| e12 | <--> | e14 | .396 |
| e12 | <--> | e13 | .139 |
| e10 | <--> | e15 | -.657 |
| e10 | <--> | e14 | -.060 |

| | | | Estimate |
|---|---|---|---|
| e9 | <--> | e11 | .102 |
| e9 | <--> | e10 | -.136 |
| e3 | <--> | e15 | .339 |
| e3 | <--> | e14 | -.095 |
| e3 | <--> | e9 | .074 |
| e13 | <--> | e14 | .481 |
| e9 | <--> | e13 | .284 |
| e7 | <--> | e9 | .341 |
| e7 | <--> | e14 | .255 |
| e8 | <--> | e15 | .662 |
| e8 | <--> | e14 | -.101 |
| e7 | <--> | e11 | .068 |
| e4 | <--> | e10 | .454 |
| e10 | <--> | e11 | .472 |
| e5 | <--> | e10 | .437 |
| e12 | <--> | e15 | -.329 |
| e6 | <--> | e15 | -.253 |
| e9 | <--> | e12 | .248 |
| e3 | <--> | e11 | .302 |
| e6 | <--> | e9 | .314 |
| e3 | <--> | e5 | .239 |
| e3 | <--> | e4 | .231 |
| e15 | <--> | res2 | .057 |
| e11 | <--> | e13 | -.021 |
| e5 | <--> | e8 | .041 |
| e12 | <--> | res1 | .318 |
| e2 | <--> | e14 | -.063 |
| e3 | <--> | e7 | .103 |
| e5 | <--> | e7 | -.023 |
| e6 | <--> | e7 | .203 |
| e6 | <--> | e10 | -.282 |
| e6 | <--> | res2 | .722 |
| e8 | <--> | e10 | -.340 |
| e8 | <--> | e12 | -.234 |
| e10 | <--> | e12 | -.307 |
| e10 | <--> | e13 | .022 |
| e14 | <--> | e15 | -.220 |
| e14 | <--> | res1 | .374 |
| e1 | <--> | e2 | -.421 |
| e1 | <--> | e10 | -.307 |
| e1 | <--> | e12 | -.186 |

Variances: (Group number 1 - Default model)

| | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|
| RfrtTpt | .555 | .074 | 7.530 | *** | par_75 |
| res1 | .015 | .007 | 2.099 | .036 | par_76 |
| res2 | .010 | | | | |
| e1 | .130 | .033 | 3.989 | *** | par_77 |
| e2 | .149 | .040 | 3.764 | *** | par_78 |
| e3 | .313 | .038 | 8.169 | *** | par_79 |
| e4 | .588 | .060 | 9.837 | *** | par_80 |
| e5 | .475 | .049 | 9.738 | *** | par_81 |
| e6 | .508 | .053 | 9.665 | *** | par_82 |
| e7 | .282 | .036 | 7.744 | *** | par_83 |
| e8 | .213 | .028 | 7.617 | *** | par_84 |
| e9 | .318 | .035 | 9.017 | *** | par_85 |
| e10 | .450 | .074 | 6.114 | *** | par_86 |
| e11 | .576 | .058 | 10.014 | *** | par_87 |
| e12 | .394 | .042 | 9.382 | *** | par_88 |
| e13 | .330 | .038 | 8.682 | *** | par_89 |
| e14 | .333 | .047 | 7.042 | *** | par_90 |
| e15 | .140 | .025 | 5.562 | *** | par_91 |

Squared Multiple Correlations: (Group number 1 - Default model)

| | Estimate |
|---|---|
| RfrtDmnd | .875 |
| Fstrfctrs | .983 |
| Y6 | .799 |
| Y5 | .573 |
| Y4 | .644 |
| Y3 | .307 |
| Y2 | .148 |
| Y1 | .562 |
| X9 | .552 |
| X8 | .693 |
| X7 | .690 |
| X6 | .260 |
| X5 | .227 |
| X4 | .168 |
| X3 | .615 |
| X2 | .824 |
| X1 | .810 |

Matrices (Group number 1 - Default model)

Factor Score Weights (Group number 1 - Default model)

| | Y6 | Y5 | Y4 | Y3 | Y2 | Y1 | X9 | X8 | X7 | X6 | X5 | X4 | X3 | X2 | X1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RfrtTpt | .431 | -.225 | -.129 | .166 | -.091 | .578 | .132 | -.077 | -.074 | -.026 | -.103 | -.058 | -.371 | .558 | .229 |
| RfrtDmnd | .279 | .065 | -.286 | .117 | -.091 | .275 | -.050 | -.019 | .176 | -.016 | -.060 | .037 | -.203 | .200 | .037 |
| Fstrfctrs | .725 | .126 | -.408 | .122 | -.105 | .650 | -.137 | -.152 | .117 | .148 | -.134 | -.027 | -.475 | .498 | .079 |

Total Effects (Group number 1 - Default model)

| | RfrtTpt | RfrtDmnd | Fstrfctrs |
|---|---|---|---|
| RfrtDmnd | .433 | .000 | .000 |
| Fstrfctrs | .983 | 1.416 | .000 |
| Y6 | .962 | 1.385 | .978 |
| Y5 | .806 | 1.160 | .820 |
| Y4 | 1.000 | 1.440 | 1.017 |
| Y3 | .485 | .698 | .493 |
| Y2 | .409 | .589 | .416 |
| Y1 | .983 | 1.416 | 1.000 |
| X9 | .785 | 1.813 | .000 |
| X8 | .872 | 2.013 | .000 |
| X7 | .993 | 2.293 | .000 |
| X6 | .531 | 1.227 | .000 |
| X5 | .469 | 1.084 | .000 |
| X4 | .433 | 1.000 | .000 |
| X3 | .950 | .000 | .000 |
| X2 | 1.119 | .000 | .000 |
| X1 | 1.000 | .000 | .000 |

Standardized Total Effects (Group number 1 - Default model)

| | RfrtTpt | RfrtDmnd | Fstrfctrs |
|---|---|---|---|
| RfrtDmnd | .936 | .000 | .000 |
| Fstrfctrs | .965 | .643 | .000 |
| Y6 | .859 | .573 | .890 |
| Y5 | .679 | .453 | .704 |
| Y4 | .774 | .516 | .802 |
| Y3 | .479 | .320 | .497 |
| Y2 | .371 | .247 | .384 |
| Y1 | .723 | .482 | .749 |
| X9 | .695 | .743 | .000 |
| X8 | .779 | .833 | .000 |
| X7 | .777 | .830 | .000 |
| X6 | .477 | .510 | .000 |
| X5 | .446 | .477 | .000 |
| X4 | .384 | .410 | .000 |
| X3 | .784 | .000 | .000 |
| X2 | .908 | .000 | .000 |
| X1 | .900 | .000 | .000 |

Direct Effects (Group number 1 - Default model)

| | RfrtTpt | RfrtDmnd | Fstrfctrs |
|---|---|---|---|
| RfrtDmnd | .433 | .000 | .000 |
| Fstrfctrs | .370 | 1.416 | .000 |
| Y6 | .000 | .000 | .978 |
| Y5 | .000 | .000 | .820 |
| Y4 | .000 | .000 | 1.017 |
| Y3 | .000 | .000 | .493 |
| Y2 | .000 | .000 | .416 |
| Y1 | .000 | .000 | 1.000 |
| X9 | .000 | 1.813 | .000 |
| X8 | .000 | 2.013 | .000 |
| X7 | .000 | 2.293 | .000 |
| X6 | .000 | 1.227 | .000 |
| X5 | .000 | 1.084 | .000 |
| X4 | .000 | 1.000 | .000 |
| X3 | .950 | .000 | .000 |
| X2 | 1.119 | .000 | .000 |
| X1 | 1.000 | .000 | .000 |

Standardized Direct Effects (Group number 1 - Default model)

| | RfrtTpt | RfrtDmnd | Fstrfctrs |
|---|---|---|---|
| RfrtDmnd | .936 | .000 | .000 |
| Fstrfctrs | .363 | .643 | .000 |
| Y6 | .000 | .000 | .890 |
| Y5 | .000 | .000 | .704 |
| Y4 | .000 | .000 | .802 |
| Y3 | .000 | .000 | .497 |
| Y2 | .000 | .000 | .384 |
| Y1 | .000 | .000 | .749 |
| X9 | .000 | .743 | .000 |
| X8 | .000 | .833 | .000 |
| X7 | .000 | .830 | .000 |
| X6 | .000 | .510 | .000 |
| X5 | .000 | .477 | .000 |
| X4 | .000 | .410 | .000 |
| X3 | .784 | .000 | .000 |
| X2 | .908 | .000 | .000 |
| X1 | .900 | .000 | .000 |

Indirect Effects (Group number 1 - Default model)

| | RfrtTpt | RfrtDmnd | Fstrfctrs |
|---|---|---|---|
| RfrtDmnd | .000 | .000 | .000 |

| | RfrtTpt | RfrtDmnd | Fstrfctrs |
|---|---|---|---|
| Fstrfctrs | .613 | .000 | .000 |
| Y6 | .962 | 1.385 | .000 |
| Y5 | .806 | 1.160 | .000 |
| Y4 | 1.000 | 1.440 | .000 |
| Y3 | .485 | .698 | .000 |
| Y2 | .409 | .589 | .000 |
| Y1 | .983 | 1.416 | .000 |
| X9 | .785 | .000 | .000 |
| X8 | .872 | .000 | .000 |
| X7 | .993 | .000 | .000 |
| X6 | .531 | .000 | .000 |
| X5 | .469 | .000 | .000 |
| X4 | .433 | .000 | .000 |
| X3 | .000 | .000 | .000 |
| X2 | .000 | .000 | .000 |
| X1 | .000 | .000 | .000 |

Standardized Indirect Effects (Group number 1 - Default model)

| | RfrtTpt | RfrtDmnd | Fstrfctrs |
|---|---|---|---|
| RfrtDmnd | .000 | .000 | .000 |
| Fstrfctrs | .602 | .000 | .000 |
| Y6 | .859 | .573 | .000 |
| Y5 | .679 | .453 | .000 |
| Y4 | .774 | .516 | .000 |
| Y3 | .479 | .320 | .000 |
| Y2 | .371 | .247 | .000 |
| Y1 | .723 | .482 | .000 |
| X9 | .695 | .000 | .000 |
| X8 | .779 | .000 | .000 |
| X7 | .777 | .000 | .000 |
| X6 | .477 | .000 | .000 |
| X5 | .446 | .000 | .000 |
| X4 | .384 | .000 | .000 |
| X3 | .000 | .000 | .000 |
| X2 | .000 | .000 | .000 |
| X1 | .000 | .000 | .000 |

Model Fit Summary
CMIN

| Model | NPAR | CMIN | DF | P | CMIN/DF |
|---|---|---|---|---|---|
| Default model | 91 | 36.525 | 29 | .159 | 1.259 |
| Saturated model | 120 | .000 | 0 | | |
| Independence model | 15 | 3430.108 | 105 | .000 | 32.668 |

RMR, GFI

| Model | RMR | GFI | AGFI | PGFI |
|---|---|---|---|---|
| Default model | .024 | .976 | .902 | .236 |
| Saturated model | .000 | 1.000 | | |
| Independence model | .399 | .190 | .074 | .166 |

Baseline Comparisons

| Model | NFI Delta1 | RFI rho1 | IFI Delta2 | TLI rho2 | CFI |
|---|---|---|---|---|---|
| Default model | .989 | .961 | .998 | .992 | .998 |
| Saturated model | 1.000 | | 1.000 | | 1.000 |
| Independence model | .000 | .000 | .000 | .000 | .000 |

Parsimony-Adjusted Measures

| Model | PRATIO | PNFI | PCFI |
|---|---|---|---|
| Default model | .276 | .273 | .276 |
| Saturated model | .000 | .000 | .000 |
| Independence model | 1.000 | .000 | .000 |

NCP

| Model | NCP | LO 90 | HI 90 |
|---|---|---|---|
| Default model | 7.525 | .000 | 27.139 |
| Saturated model | .000 | .000 | .000 |
| Independence model | 3325.108 | 3137.502 | 3520.017 |

FMIN

| Model | FMIN | F0 | LO 90 | HI 90 |
|---|---|---|---|---|
| Default model | .184 | .038 | .000 | .136 |
| Saturated model | .000 | .000 | .000 | .000 |
| Independence model | 17.237 | 16.709 | 15.766 | 17.689 |

RMSEA

| Model | RMSEA | LO 90 | HI 90 | PCLOSE |
|---|---|---|---|---|
| Default model | .036 | .000 | .069 | .725 |
| Independence model | .399 | .387 | .410 | .000 |

AIC

| Model | AIC | BCC | BIC | CAIC |
|---|---|---|---|---|

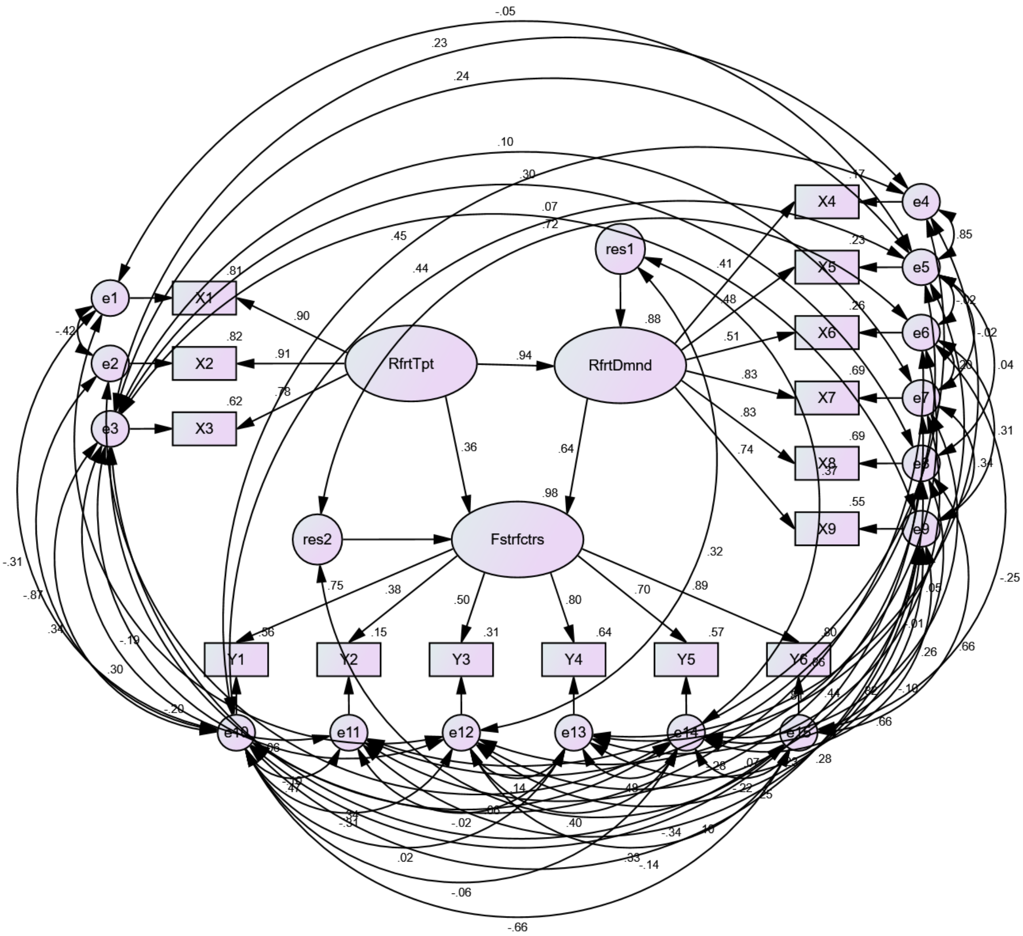
| Model | AIC | BCC | BIC | CAIC |
|---|---|---|---|---|
| Default model | 218.525 | 234.437 | 518.672 | 609.672 |
| Saturated model | 240.000 | 260.984 | 635.798 | 755.798 |
| Independence model | 3460.108 | 3462.731 | 3509.583 | 3524.583 |

ECVI

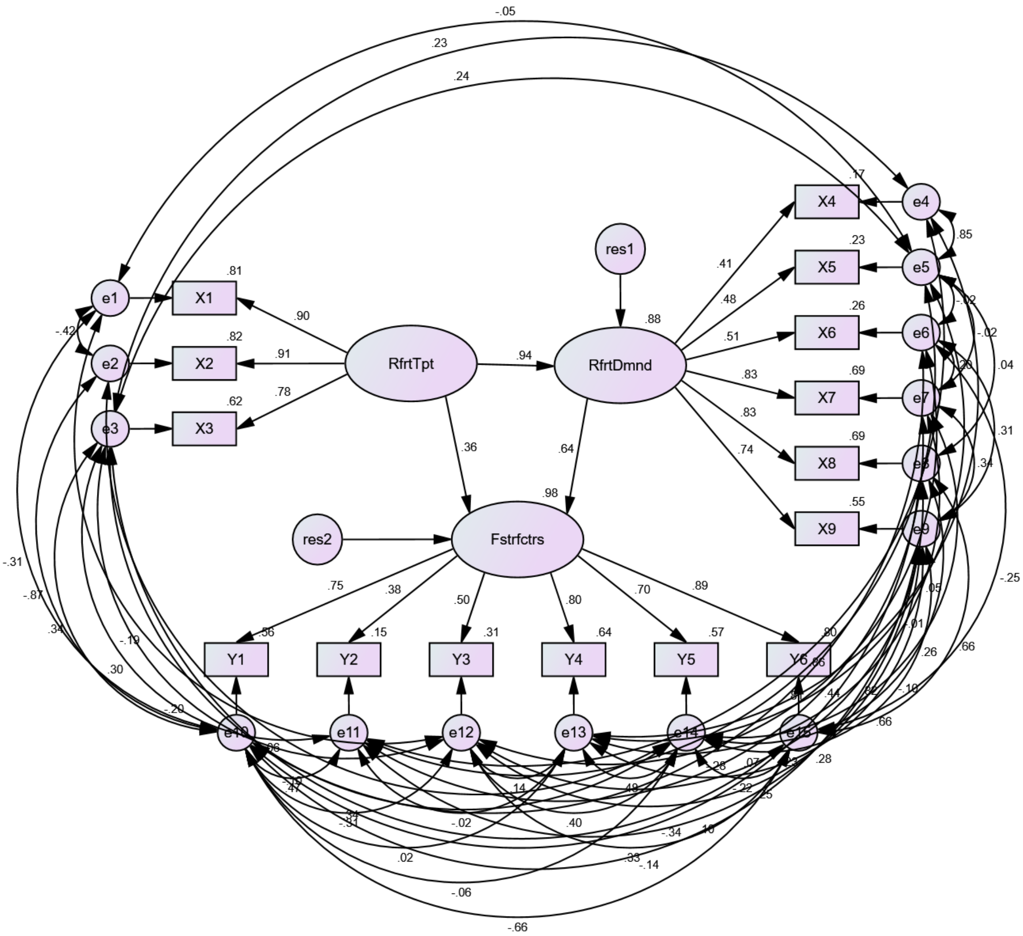
| Model | ECVI | LO 90 | HI 90 | MECVI |
|---|---|---|---|---|
| Default model | 1.098 | 1.060 | 1.197 | 1.178 |
| Saturated model | 1.206 | 1.206 | 1.206 | 1.311 |
| Independence model | 17.387 | 16.445 | 18.367 | 17.401 |

HOELTER

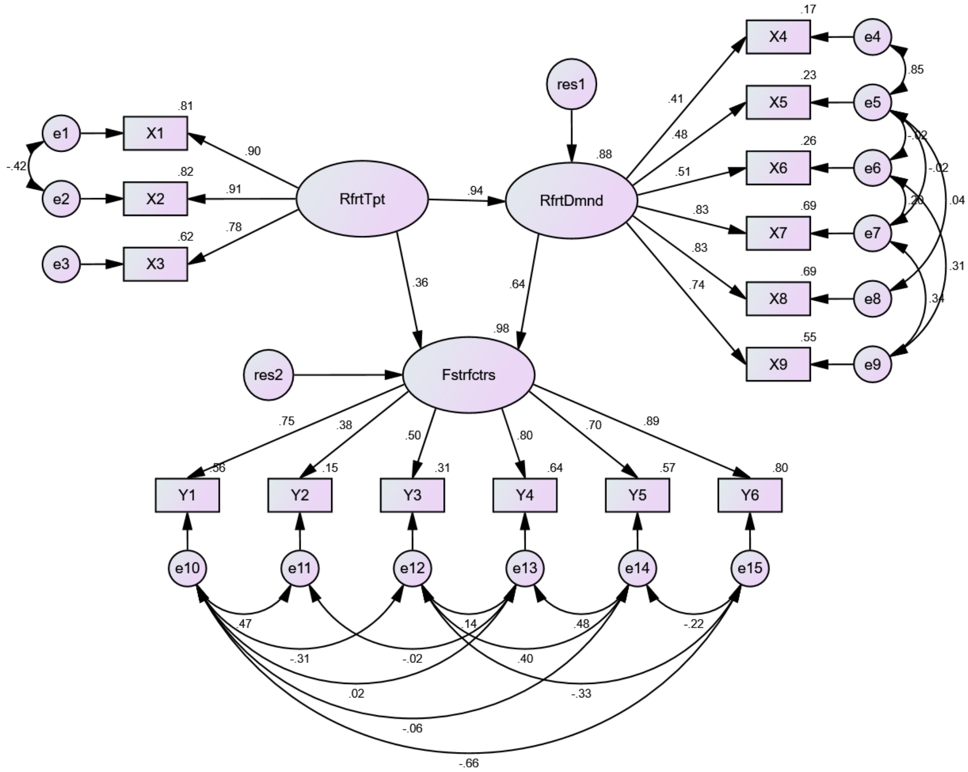
| Model | HOELTER .05 | HOELTER .01 |
|---|---|---|
| Default model | 232 | 271 |
| Independence model | 8 | 9 |



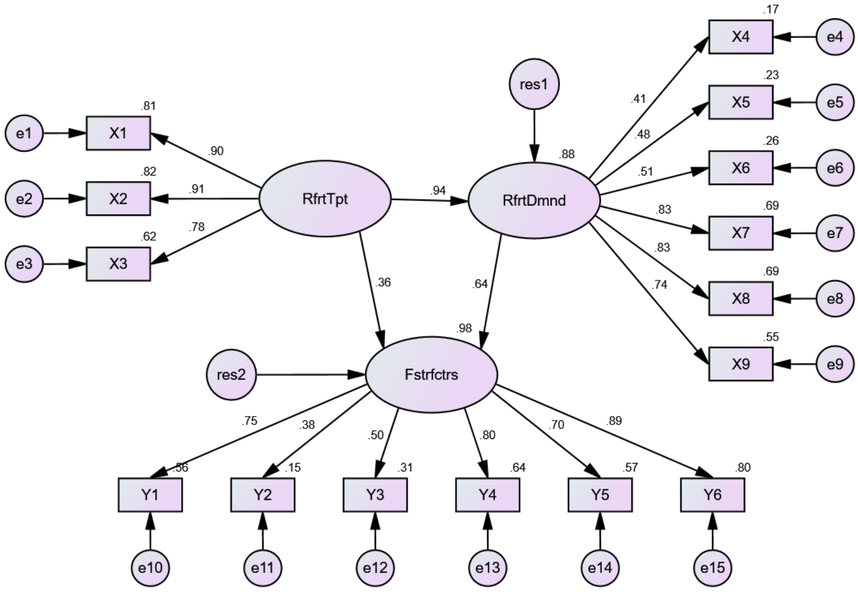

Chi-square = 36.525, df = 29, P-value = .159, Chi-square/df = 1.259,
CFI = .998, GFI = .976, AGFI = .902, IFI = .998, NFI=.989, TLI=.992,
RMR=.024 , RMSEA = .036




Chi-square = 36.525, df = 29, P-value = .159, Chi-square/df = 1.259,
CFI = .998, GFI = .976, AGFI = .902, IFI = .998, NFI=.989, TLI=.992,
RMR=.024 , RMSEA = .036




Chi-square = 36.525, df = 29, P-value = .159, Chi-square/df = 1.259,
CFI = .998, GFI = .976, AGFI = .902, IFI = .998, NFI=.989, TLI=.992,
RMR=.024 , RMSEA = .036




Chi-square = 36.525, df = 29, P-value = .159, Chi-square/df = 1.259,
CFI = .998, GFI = .976, AGFI = .902, IFI = .998, NFI=.989, TLI=.992,
RMR=.024 , RMSEA = .036

# BIOGRAPHY

# BIOGRAPHY

| | |
|---|---|
| **Name-Surname** | Oranicha Buthphorm |
| **Date of Birth** | 22 April 1971 |
| **Address** | 60/13 Moo. 7, T. Plutaluang, A. Sattahip, Chonburi 20180 |
| **Current Workplace** | Burapha Universiry, Sakaew Campus<br>254 M00 4, T. Wattana Nakhon,<br>Sakaew 27160 |
| **Current Position** | Lecturer |
| **Work Experience** | 2013 - Present  Lecturer, Burapha University, Sakaeo Campus |
| **Education Background** | 2011  MSC. (Transportation and Logistics Management), Burapha University<br>2005  MM. (Human Resource Management), Burapha University<br>1994  BA. (English), Burapha University |
| **Publication** | Buthphorm, O. (2021). Quality Improvement through DMAIC: A Case Study of Wire Harness Tape Manufacturing. Journal of Multidisciplinary in Social Sciences, 17(2), 40-47.<br><br>Buthphorm, O. (2024). Evaluating English Proficiency Requirement for logistics core competency: CEFR framework for entry-level logisticians in Thailand’s EEC context. Asia Social Issues, 17(2), e262134-e262134. |