



Office of Transport and Traffic Policy and Planning (OTP)
Ministry of Transport



By



TransConsult Co., Ltd.



Transportation Institute Chulalongkorn University



TEAM Logistics and Transport Co., Ltd.



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Executive Summary Report

The Study of Transport Cost Structure and Logistics System

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EXECUTIVE SUMMARY REPORT

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 - ✦ Study of Logistics and Transport Cost Structure of Strategic Cargoes and Related Factors
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 - ✦ Analysis and Assessment of Freight Transport Performance
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 - ✦ Conclusion and Recommendation
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1 INTRODUCTION

1.1 Rationales

Due to the continuation of high global oil prices, Thailand as the country relies on imported energy gaining economic impact significantly. Statistics figures showed that the impact of oil price to Thai economy increasingly. This appear from the figures that Thailand required energy in form of oil in the year 2006 about 58,783 tons compared to energy consumption of the country at 63,257 tons, which equivalent to crude oil at value of 873,565 million baht. That means Thailand imported energy at 92.98 % which is very high. When consider in detail, it was found that Thailand imported energy in the form of crude oil totally 41,387 tons, worth 752,976 million baht, representing 70.5 % of the imported commercial energy. Nonetheless, it also imported refined products of 1,383 tons, which equivalent to 23,514.million baht of crude oil price. In conclusion, Thailand imported oil of both forms compared with total energy at 72.80 and 88.89 % respectively. It confirmed that crude oil price increased impact directly to the Thai economy inevitably.

A number of energy consumption in the year 2006 also showed that transportation sector activities used the most energy and would mean to be most affected by changes of oil prices in world markets. In the year 2006 statistical figure indicated that Thai consumed

energy in term of commercial as high as 82.6 % as well as renewable natural at 17.47 %. The use of energy in term of commercial, there are refined oil of 31,650 tons equivalent to 60.6 % of all commercial energy used. Statistics also showed that transportation sector used refined oil at the highest proportion of 72.4 % of total consumption. Petroleum used in transportation sector in the year 2006 consisted of diesel (including palm diesel) 51.3 %, gasoline (including gasohol gas) 23.0 %, jet fuel 16.1 %, fuel oil 6.9 %, and LPG. 2.3 %. The transportation economic sector is considered as a sector most associated with fluctuation of world oil price, which affect the transportation cost structure. So, the study on factors and impact would be technical knowledge required to support decision-maker for planning on development of transportation infrastructure and service to respond to the economical energy consumption and cost-effective, which means of sustainable development.

The problem on the increase of oil prices in the world markets continuously and caused the higher loss of foreign currency from oil imported, Thai government has determined policy about renewable energy produced in Thailand to be used in transportation sector. Renewable energy under the existing technology and economic worth in present that is pushed to use in transportation sector constitutes of gasohol (gasoline substitute), biodiesel (diesel substitute), and LPG and NGV for the vehicles used oil, but engine has to be modified.

Office of Traffic and Transport Policy and Planning (OTP), as the central agency responsible for study, analyze, recommend policy and coordinate transportation and traffic plans, including analysis of work plans / projects and budget of the Ministry of Transport, considered that the study, analysis, and attention of main transportation cost structure will help to determine, design, and arrange infrastructure and develop service patterns of freight transportation that appropriate to the needs of users, as well as relevant sector partners. This will affect to the measures and approaches of governments in the strategic goals to reducing the transportation cost of the country as a whole and making the competition more effectively. The trend of energy fluctuation caused alternative dimension in the use of renewable energy, which currently is for partly relief impact on transportation sector, but still lack of problem consideration that lead to solving the problems in the long term and sustainable. Therefore, structural analysis of transportation and logistics costs is necessary and used as knowledge base for planning explicitly.

1.2 Objectives

- To analyze the transportation cost structure of land, water, air and rail systems of strategic cargo including supply chain and the continuous components to organize the strategic choice and the properly measure that response to the guideline of policy goals for reducing the transportation costs in the overview of Thailand.
- To analyze the factors and effects of transportation cost structure and logistics system to the transportation development in present and future including the continued effect with the decision of owner and transportation entrepreneur that affect to the energy using in the economical and efficiency transportation.
- To analyze and guideline the policy, measure and cost structure of transportation that economize and balance the energy using in transportation and reduce the effect from oil price fluctuation in world markets.
- To determine the strategic position in the development planning process by developing the transportation cost structure to support the logistics system development for keeping or improving the competitive ability of Thailand. The improvement of measure and plan to the actual process will affect the government and private sections for considering the related operation. In the past, The Ministry of Transport lacked of insight data for analyzing policy and strategic work plans / projects that focused on the variables related between the transportation cost structure of main strategic cargo and/or logistics management in various dimensions. Therefore, it is expected that if this project study result meet the objectives, it will be able to determine policy, strategy, work plans / projects for public and private sectors to response to the development of the basic transportation system in order to make the transportation cost of the country decrease or is able to compete effectively.

1.3 Scope of Study

- 1) **Study the policy, plan and the related study of energy using in transportation section.**
Study the cost structure in energy section that affect the transportation cost in various section. Analyze and build the transportation cost databases in agriculture and industrial cargo (5 or more types/groups) including model the cost structure that relate on the increase or decrease of energy cost. Moreover, the factors and effects of cost structure are analyzed for developing the format, type, service and organization of transportation.
- 2) **Analyze to reflect the circulation circuit, movement, and transportation of main strategic cargo** of each level or type and category of the products at the primary stage products (raw materials), intermediate stage products, and products that can add value by processing to create a new product from the origin to the production base. Present multimodal facilities and consumption base (origin - destination) associated with the capacity of the main network, secondary network, and present multimodal transportation can be used to evaluate potential and forecast the future demand of transportation. This will result in the development of infrastructure worthily. In addition, this can conduct the feasibility study for the development of additional network or extend the capabilities to meet future transportation needs effectively and can compete under the transportation cost structure systems of land, rail, water, and air transportation.
- 3) **Analyze the transportation cost structure under the main components of energy and other related important variables** to analyze capabilities and limitations of the policies to promote energy of each type/category in consistent with the mode of transportation. This will analyze the impact to the economy of the country fro the substitution of the current technology and economics, including analyzing supply chain of main strategic cargo transportation cost structure and continuous components that necessary and related to provide the appropriate strategy, choices, and measures.

- 4) **Analyze the strategic of the development of infrastructure and transportation service with the related strategy** such as energy consumption strategy, manufacturing and service sectors development strategy of the 10th National Economic and Social Development Plan, which consistent, relate, and link to the national strategy for integrating and optimizing utility.
- 5) **Study and analyze the behavioral factors responding to policies, which promote the energy consumption for each type/category** under the mode of transportation in present and future, including to recommend policies, guidelines, and measures to drive transportation developmental strategies, which have appropriate energy cost in the transportation sector for enhancing the competitiveness of the country as a whole. These also analyze comparative advantage for products that are lost opportunity because of choosing cost effective renewable energy as production factors for economic benefits.
- 6) **Analyze the investment in government and private section, guideline the development mechanisms and measure that support the using of renewable energy in transportation.** However, the guideline and measure have to economize the energy and build the net energy value in transportation section.
- 7) **Analyze and forecast the quantities and demand of the strategy cargo transportation that relate and respond the development of infrastructure and service of future transportation.** Support the economic development and strengthen the capacity building in both demand and supply. From this improvement, the transportation and logistics system cost will reduce or compete. The factors, which are environmental factors, time frame, investment and economic returns, will use to determine the policy and plan the actual process.

2 PROJECT FRAMEWORK

The analysis of transportation cost structure and logistics system are operated to understand the structure, transportation cost and logistics system of the strategy cargo transportation of Thailand including the creation of database system and cost analysis model. Therefore, these use to determine the position for processing the transportation development plan and set the measure and guideline to support the strategy goal for reducing the transportation cost in overview picture. Moreover, these processes will support the efficiency of the competition.

The analysis of the transportation cost structure and logistics system have framed the concept of study. The groups of works are divided into 3 parts as shown in *Figure 2-1*, which are:-

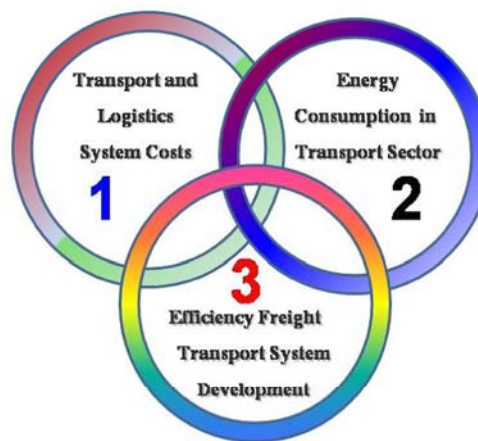


Figure 2-1: Project Framework

2.1 Analytical Study on the Cost of Transportation Structure and Logistics System

This study section aims to select, survey, and analyze the structure of transportation and logistics system costs of the selected main strategic cargo, transportation and logistics problems, provision of database and models for analysis of transportation and logistics costs. This is used as information and guideline to prepare guidelines for development of transportation systems to reduce the cost of transportation. This section includes

- 1) Study and analysis of logistics cost structure of main strategic cargo
 - Selection of main strategic cargo
 - Survey and collect data of main strategic cargo movement

- Survey to study on supply chain of main strategic cargo
 - Survey to study and analyze the transportation and logistics cost structures of main strategic cargo
- 2) The study and analysis on transportation cost structure of main strategic cargo
 - 3) Create the database system and model of the cost analysis of the strategic cargo. The cost model has to depend on the increase or decrease of the energy cost in various transportations.

2.2 Study Energy Consumption in the Transportation Sector

This study section aims to investigate and gather of both secondary and primary information in and outside the country involved energy policy and energy consumption in the transportation picture, as well as field survey to use as a guideline for conducting a strategic policy as a whole. This will lead to the use of energy in practice appropriately and efficiently and the consultants have already studied and collected relevant information. This section includes;

- 1) Study on energy consumption in transportation sector
 - Study on policy of energy consumption in transportation sector in Thailand
 - Revision on energy policy in transportation sector of foreign countries
 - Revision on energy situation as a whole in Thailand and in the world
- 2) Analysis of energy consumption in transportation sector
 - Analysis of energy consumption in transportation sector according to the transportation pattern in Thailand
 - Direction and policy of alternative energy in Thailand
 - Direction of development and policy of world electrical energy for automobiles
- 3) Analysis of cost-effective in promoting of the factors for the production of alternative energy
- 4) Survey and analysis of field data
 - Survey about attitude on fuel consumption
 - Survey about experience on fuel consumption
 - Survey about stated preference on fuel consumption
 - Interview car manufacturers

2.3 Study Ways to Drive a Pattern for Efficient Transportation Development

This study section will begin with a review of policies, strategies, and other related projects and leads to determine strategic policy to develop transportation network and system efficiently and to be as a guide to drive the Logistics System. This section includes

- 1) Analyze the situation of transportation
 - Review and collect the transportation situation data and current transportation system
 - Analyze the potential of infrastructure and transportation systems in both present and future
- 2) Guidelines for development of transportation system and logistics
 - Review the guidelines for development of transportation systems and logistics of the relevant agencies
 - Study roles of the Ministry of Transportation
 - Develop performance indicators for the transportation
- 3) Ways to reduce transportation
 - Survey to study and analyze the main factors that affect the transportation cost
 - Recommend guidelines to reduce transportation
 - Analyze and evaluate the cost of transportation as a whole and a result of cost reduction of the approaches

3 STUDY OF COMMODITY FLOW OF STRATEGIC CARGOES

3.1 Selection of Strategic Cargoes

The strategic cargoes, key variables for transport cost analysis, are chosen by adopting four criteria, i.e., economic development, freight transport volume, energy consumption, and production potential. As a result, they comprise 12 cargoes categorizing in 5 agricultural cargoes and 7 industrial cargoes as shown in *Figure 3.1-1*.

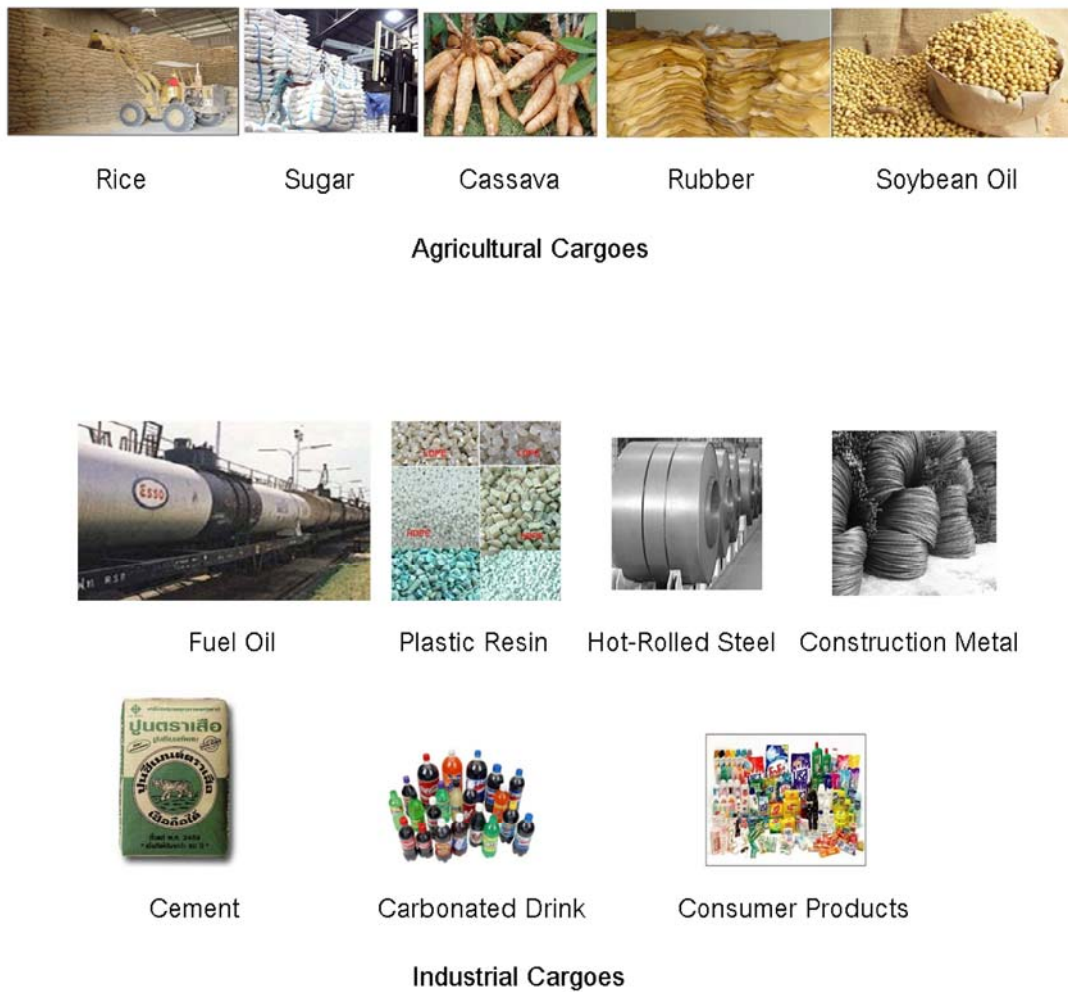


Figure 3.1-1: Strategic Cargoes

3.2 Supply Chain and Commodity Flow of Strategic Cargoes

This section will illustrate the mode of transport from origin (production base) to destination (consumption base) for each commodity. The details are expressed as follows:

Agricultural Cargoes consists of 5 products

1) Rice

The farmers are the upstream of rice's supply chain. The paddy rice will be moved from farmers to milling factory via middlemen, e.g. paddy rice merchant, rice agent, rice port, agricultural institute, government agency, etc, for transforming paddy rice to milled rice. Then, the milled rice will be moved to downstream, i.e. exporters, wholesalers and retailers. In this regard, the rice agent will be representative among milling factory, exporters, wholesalers, and retailers. The details of rice supply chain are shown in *Figure 3.2-1*.

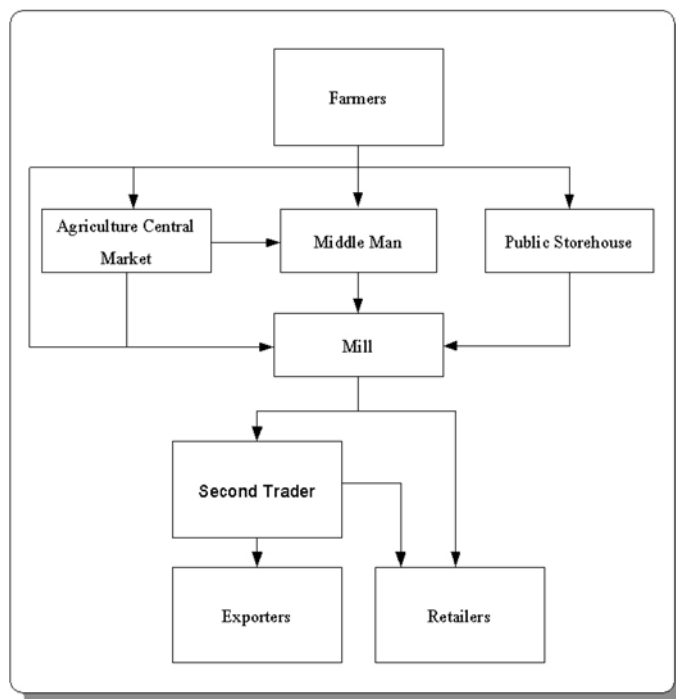
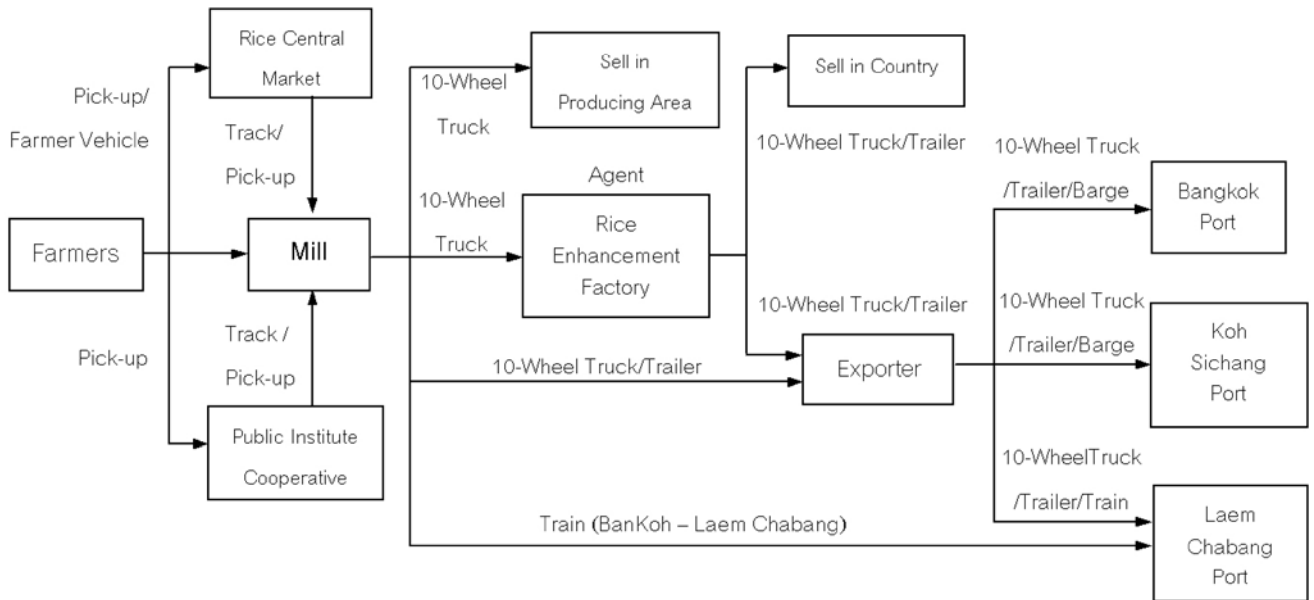


Figure 3.2-1: Supply Chain of Rice

Most of rice moving from farmers to milling factory is made by truck or pickup due to its convenience. While, the rice from milling factory to consumers and exporters are mostly made by road though some of them are transported via railway and waterway. The commodity flow of rice is shown in *Figure 3.2-2*.



Source: Study on Factors and Impact of Modal Shift from Road Transport to Rail and Water Transport (OTP 2009)

Figure 3.2-2: Commodity Flow of Rice

2) Cassava

The supply chain of cassava begins from fresh cassava roots. Most of farmers sell their fresh roots to local merchants and cassava yard. Then, they will be sent to large processing factory in nearby provinces. Some of fresh roots are processed to cassava pellets, chips and flour at factory located near production area. The processed cassava will be sent to downstream users, including consumers, exporters and relevant industries. Today, it is found that cassava plants are scattered in various sectors, mainly in the northeastern and central area. The supply chain of cassava is shown in *Figure 3.2-3*.

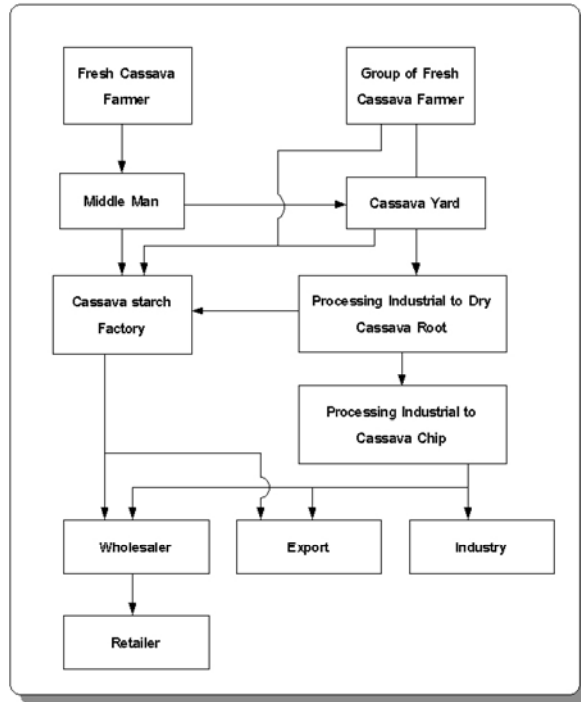


Figure 3.2-3: Supply Chain of Cassava

Most of fresh cassava roots moving from farmers to yard owners are made by truck. While, the processed cassava moving from factory to other industries, wholesalers, and retailers are also made by truck. Some exporters adopt railway transport as another option for shipping cassava to port. The commodity flow of cassava is shown in *Figure 3.2-4*.

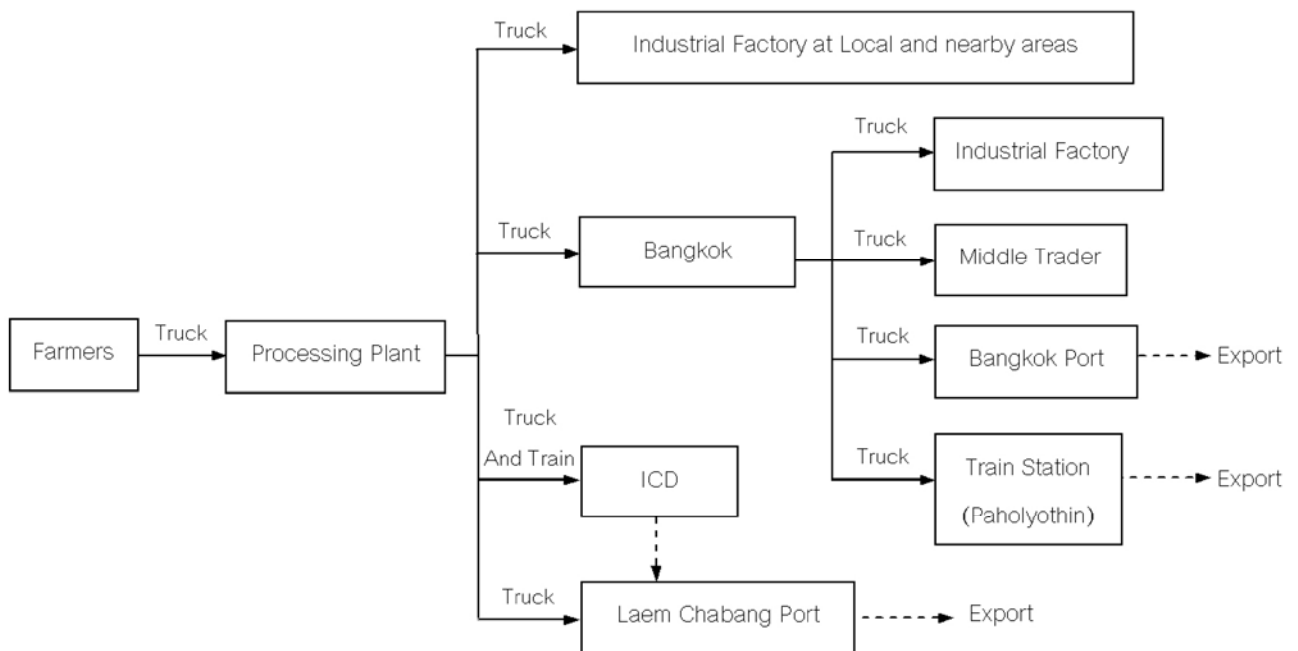


Figure 3.2-4: Commodity Flow of Cassava

3) Sugar

The supply chain of sugar begins from sugar cane and continues to processing factory as midstream industry. The sugar cane from local farmers is brought to each merchant with limited quota and then proceeds to sugar at processing factory. The sugar will be partly distributed to consumers within local area and some of them will be moved to midstream and downstream industry including Bangkok and Map Ta Phut Ports. The supply chain of sugar is shown in *Figure 3.2-5*.

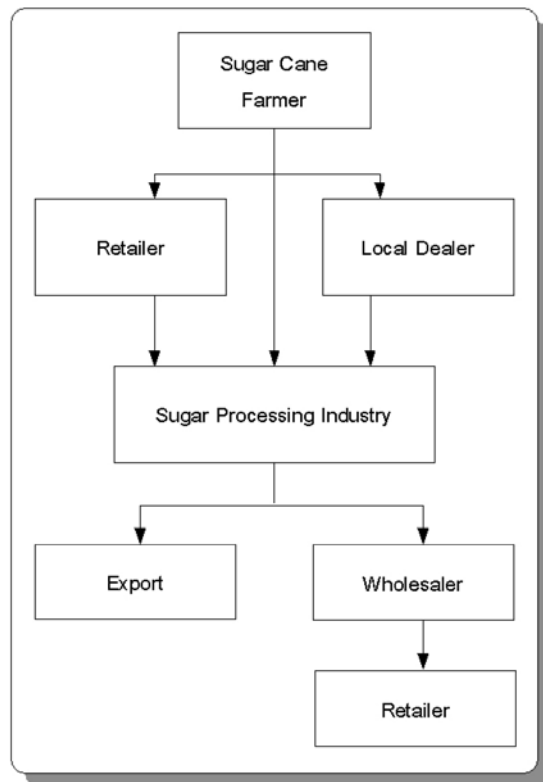
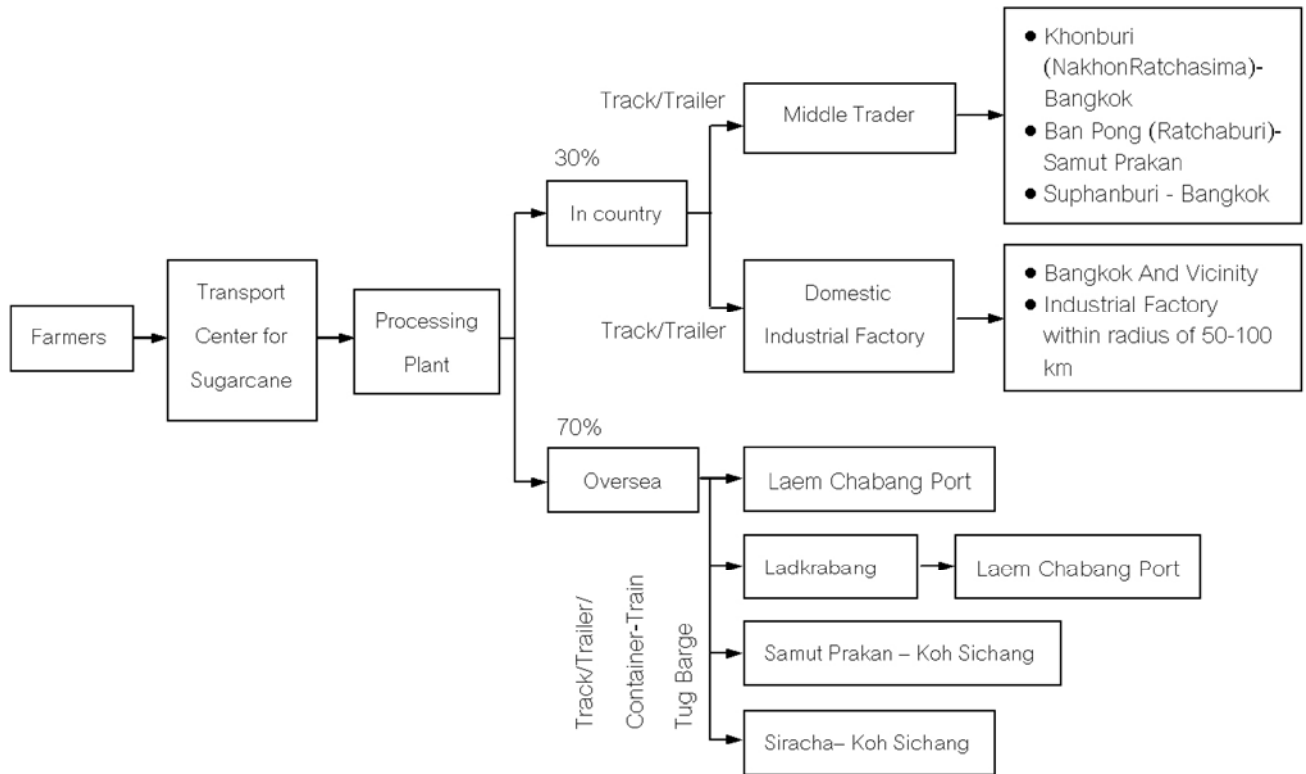


Figure 3.2-5: Supply Chain of Sugar

Most of sugar cane moving from farmers to sugar plant is made by truck. While, all processed sugar moving from factory to other industries and domestic consumers are made by truck. Some exporters adopt inland waterway transport as another option for shipping sugar to port. The commodity flow of sugar is shown in *Figure 3.2-6*.



Source: TDRI (2009)

Figure 3.2-6: Commodity Flow of Sugar

4) Rubber

The supply chain of rubber begins from raw rubber, i.e. latex, sheet and cube, and proceeds local merchants, cooperatives, central market. These raw rubbers will be processed to downstream outputs, i.e. concentrated latex, skimmed rubber, smoked sheet, crepe rubber, and block rubber. About 70% of processed rubber will be exported in terms of smoked and block rubber whereas another 30% portion will be inputs for midstream and downstream industry. The supply chain of rubber is shown in *Figure 3.2-7*.

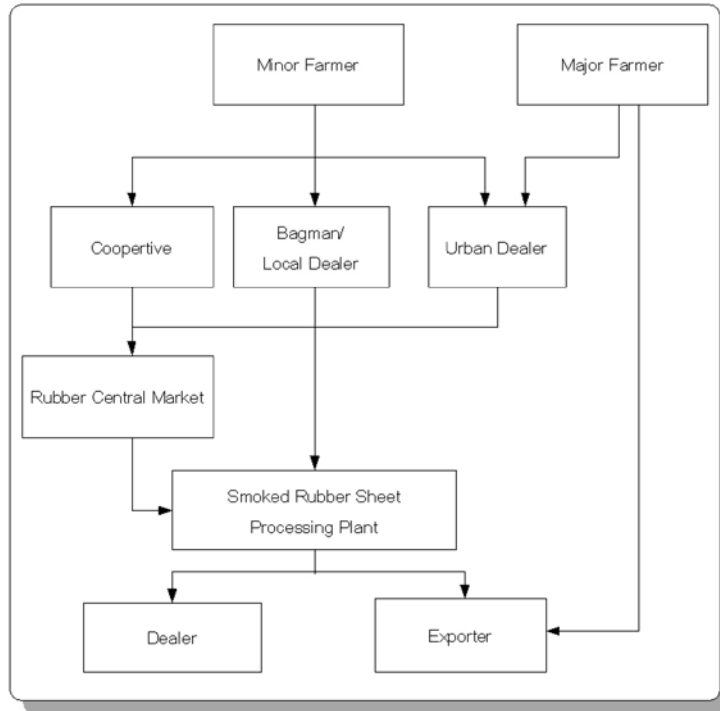


Figure 3.2-7: Supply Chain of Rubber

The latex, sheet, and cube rubbers moving from farm to local processing factory as well as the processed rubber from factory to other industries and domestic consumers are made by truck. Some exporters adopt railway and inland waterway transport as another option for shipping processed rubber to port. The commodity flow of rubber is shown in *Figure 3.2-8*.

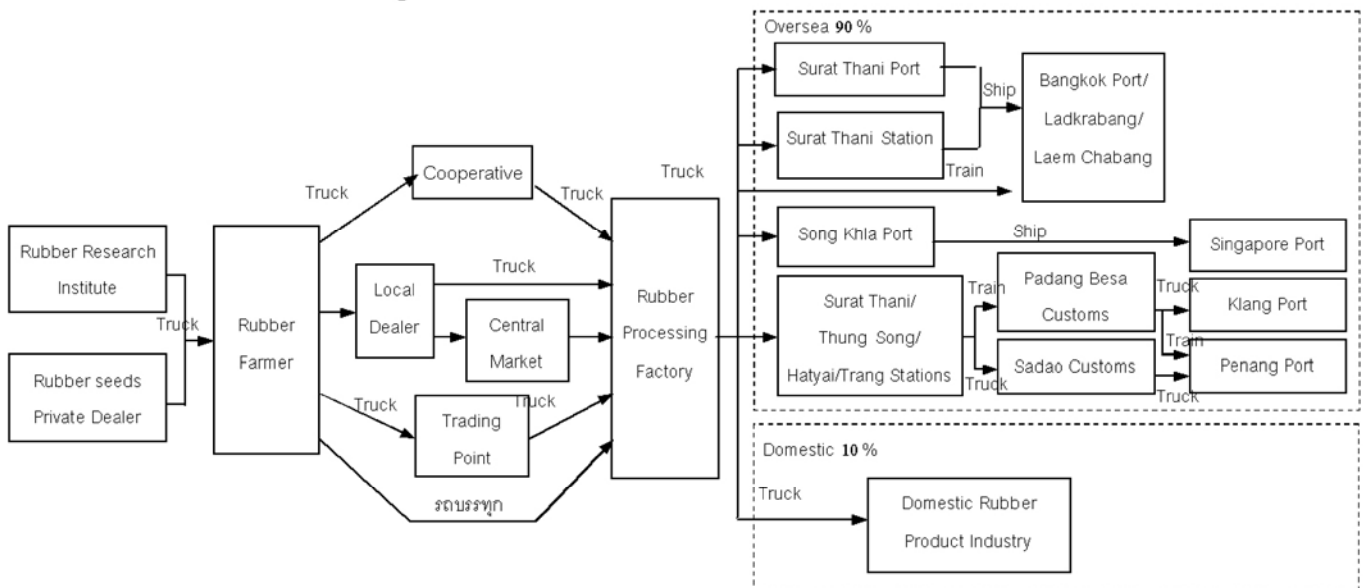


Figure 3.2-8: Commodity flow of Rubber

5) Soybean Oil

The raw soybean and soybean meal is widely used as based materials for several products. The local collectors will gather raw soybean from farmers by pickup and send them to other merchants in Bangkok by truck which is moved to processing factory for soybean oil production, distributors, and exporters. However, most of raw soybean used in Thai industry is imported from foreign countries via Laem Chabang Port. Then, they are sent to soybean oil plants via barge and truck. The supply chain of soybean oil is shown in *Figure 3.2-9*.

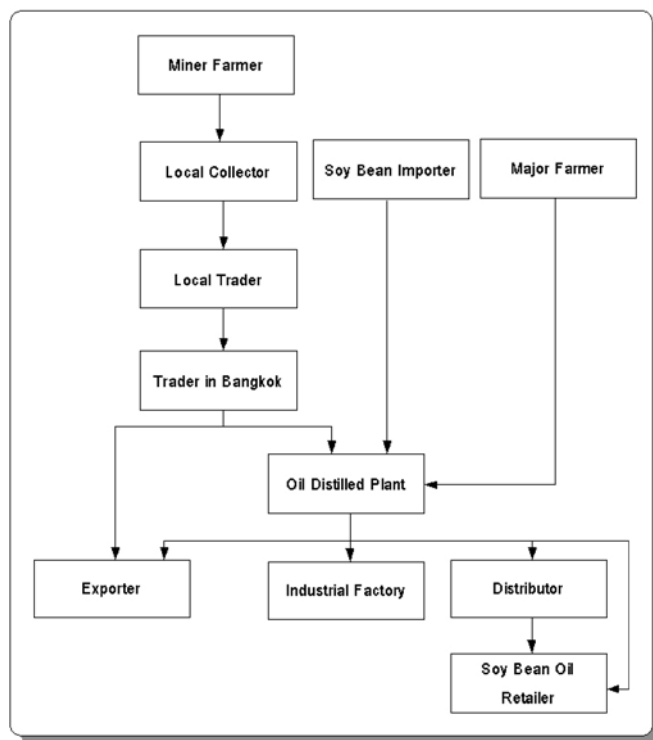


Figure 3.2-9: Supply Chain of Soybean Oil

The soybean oil moving from processing factory to other industries, distributors, wholesalers, retailers, and exporters are made by truck. The commodity flow of soybean oil is shown in *Figure 3.2-10*.

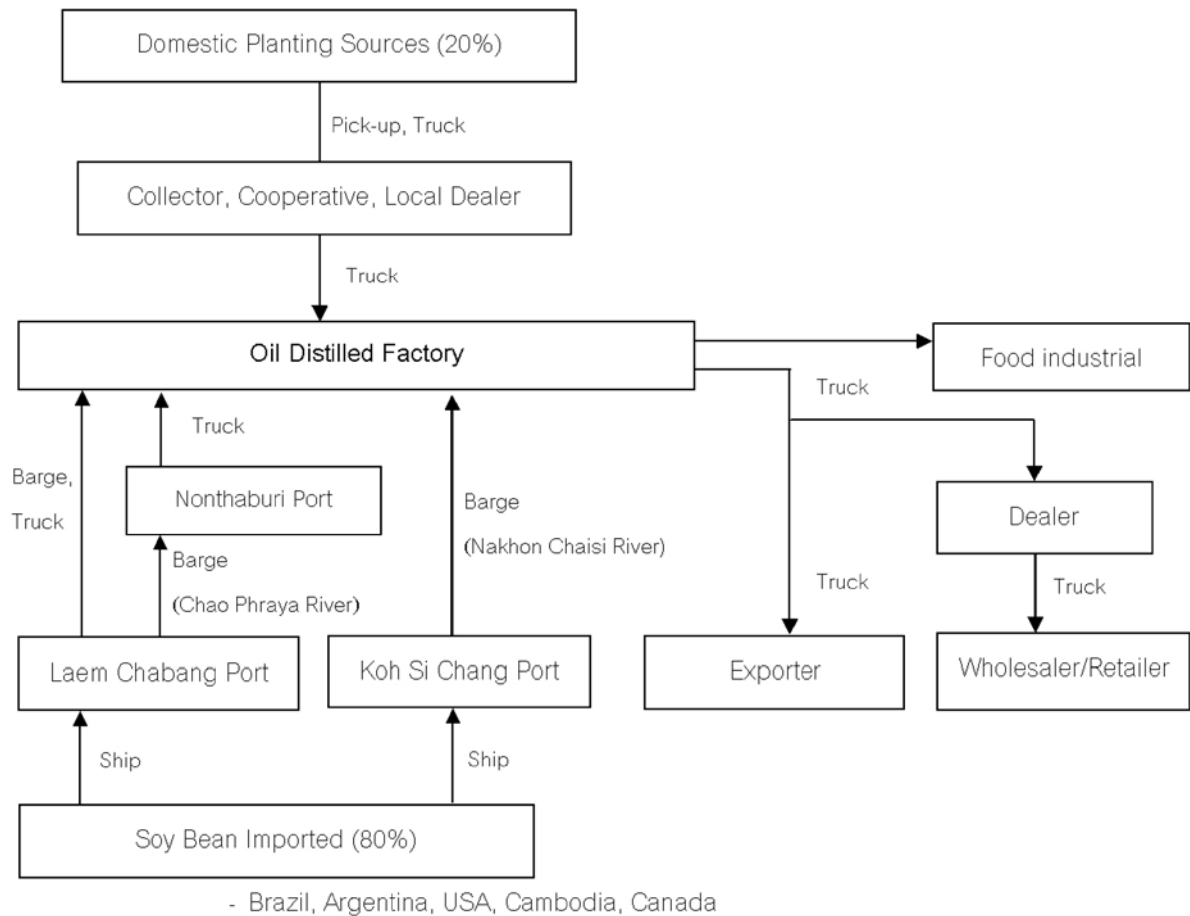


Figure 3.2-10: Commodity Flow of Soybean Oil

Industrial Cargoes consists of 7 products

1) Fuel Oil

The supply chain of fuel oil starts from the crude oil imported by sea or from the middle Gulf of Thailand and proceeds to refineries, depots, and fuel stations by pipeline. The process of transportation of oil and gas from refineries to consumers is complicated than other types of products since oil and gas are composed of various products. Each product has different properties, so containers and vehicles, as well as methods used in conveyor transport must be designed and added as a special measure to improve transport safety in handling. The supply chain of fuel oil is shown in *Figure 3.2-11*.

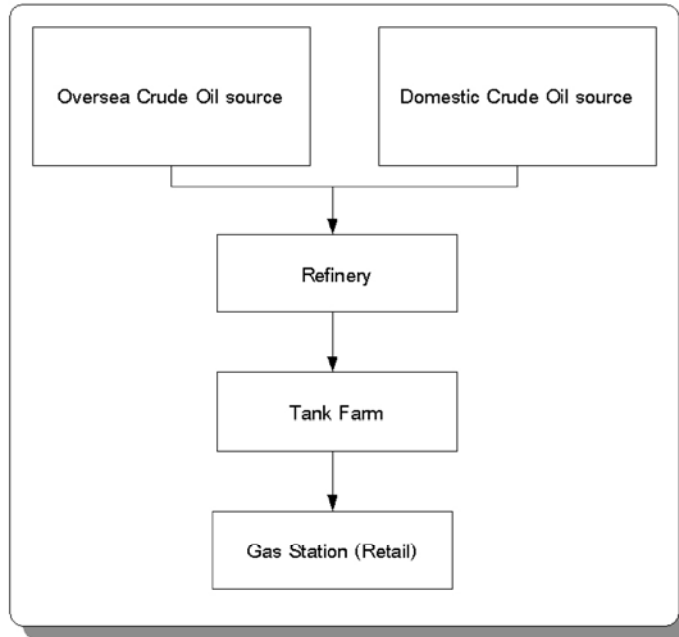


Figure 3.2-11: Supply Chain of Fuel Oil

The fuel oil moving from refinery to central oil depot are made by pipeline and barge and continues to regional depots and fuel stations by truck and train. The vehicles used in oil transport consist of four types which are pipeline, barge, tank car, and tank truck. The commodity flow of fuel oil is shown in *Figure 3.2-12*.

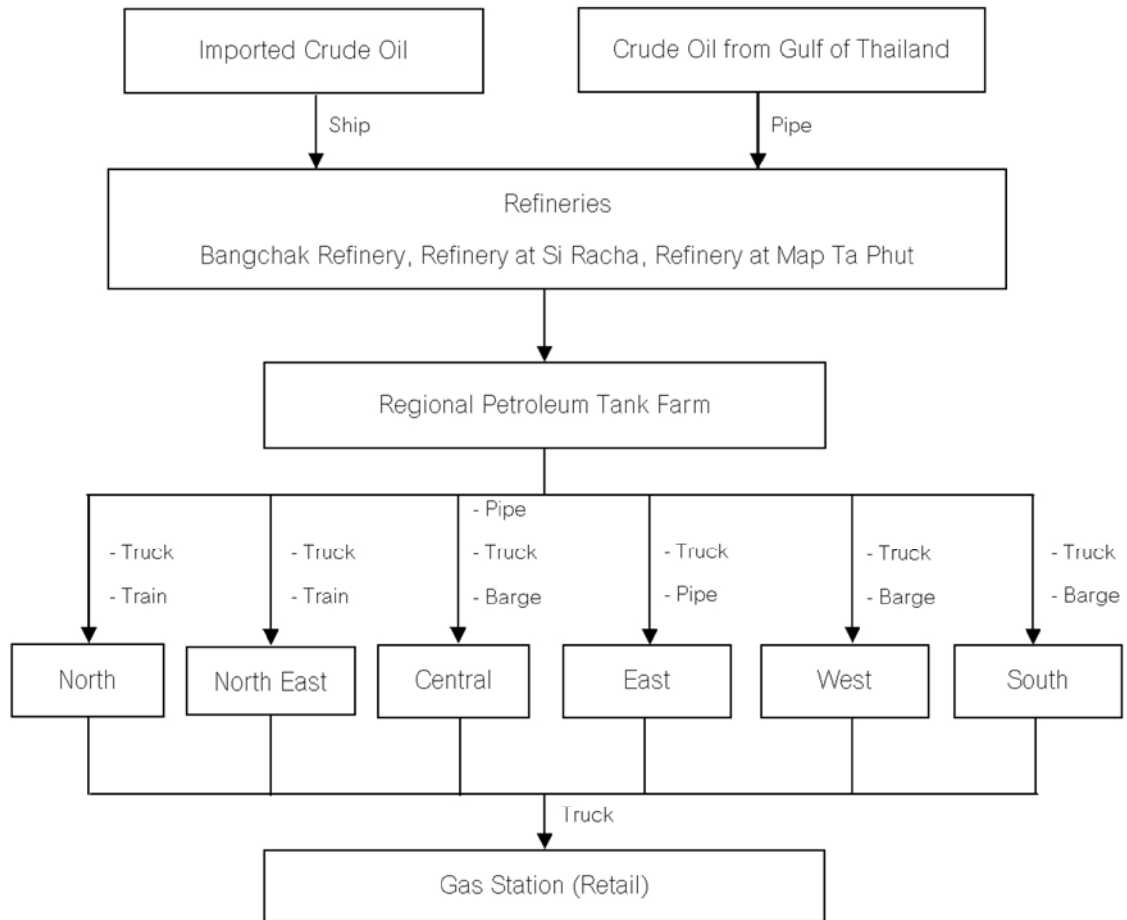


Figure 3.2-12: Commodity Flow of Fuel Oil

2) Plastic Resin

The supply chain of plastic resin starts from the upstream petrochemical industry and proceeds to intermediate petrochemical and downstream petrochemical industry in order to produce plastic products. Currently, the number of manufacturer of plastic resins is about 37 companies with the main production base located in Rayong accounted for up to 95% of total production of the country. About 40 % of total production will be used as feedstock within the country and 60 % exported to foreign countries. The supply chain of plastic resin is shown in *Figure 3.2-13*.

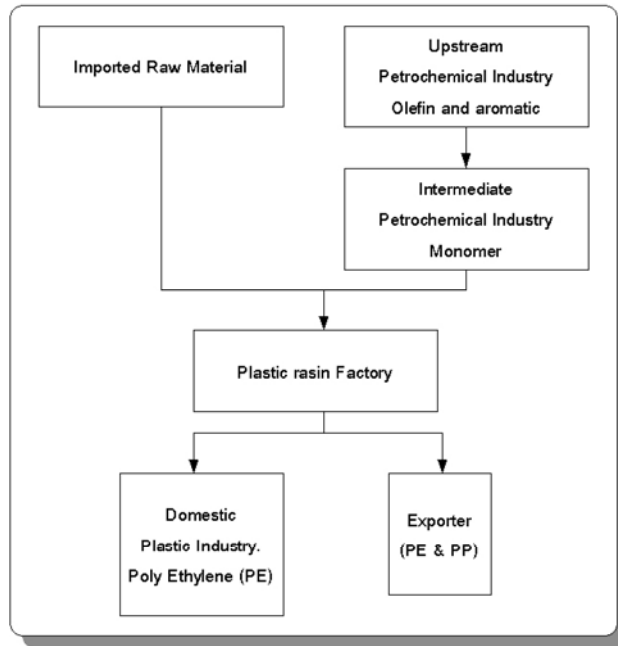


Figure 3.2-13: Supply Chain of Plastic Resin

The plastic resin moving from upstream and midstream petrochemical base to processing factory is mainly made by pipeline. The processed plastic resin will be sent to other relevant industries and exporters via truck. The commodity flow of plastic resin is shown in *Figure 3.2-14*.

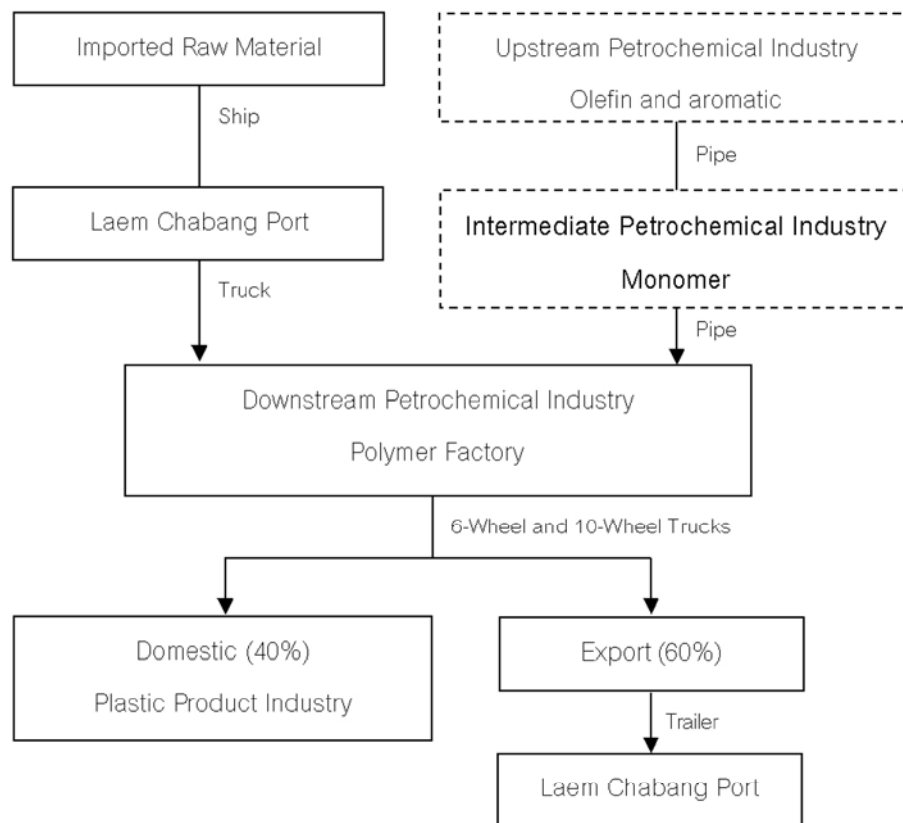


Figure 3.2-14: Commodity Flow of Plastic Resin

3) Hot-Rolled Steel

The hot rolled steel is the downstream steel industry which is derived from a flat steel bar (slab) through a hot rolled process with temperature of 1100-1250 ° C and then cooled through cooling water. Hot-rolled steel is composed of both hot-rolled steel sheet and coil that can be used as raw material in various downstream industries such as construction, industry, shipbuilding, steel processing industry, etc. The supply chain of hot-rolled steel is shown in *Figure 3.2-15*.

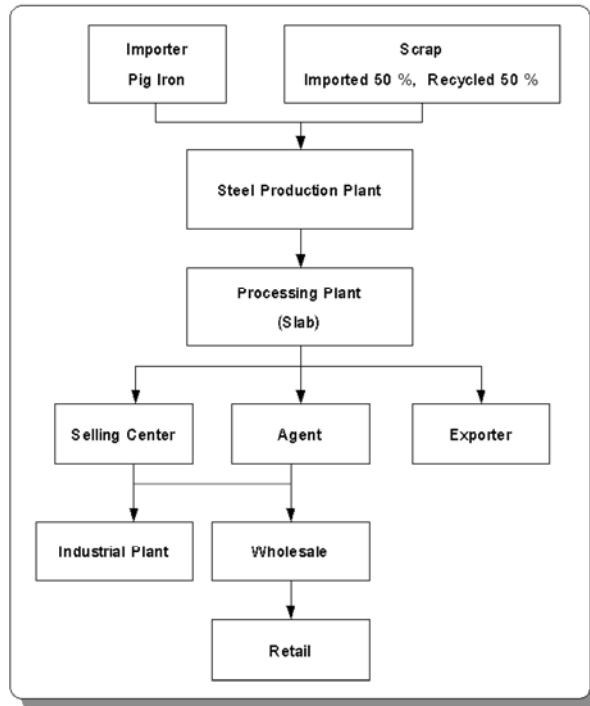


Figure 3.2-15: Supply Chain of Hot-Rolled Steel

The hot rolled steel moving from upstream base to other relevant industries, dealers, exporters, wholesalers and retailers is mainly made by road due to weighing constraint. The commodity flow of hot rolled steel is shown in *Figure 3.2-16*.

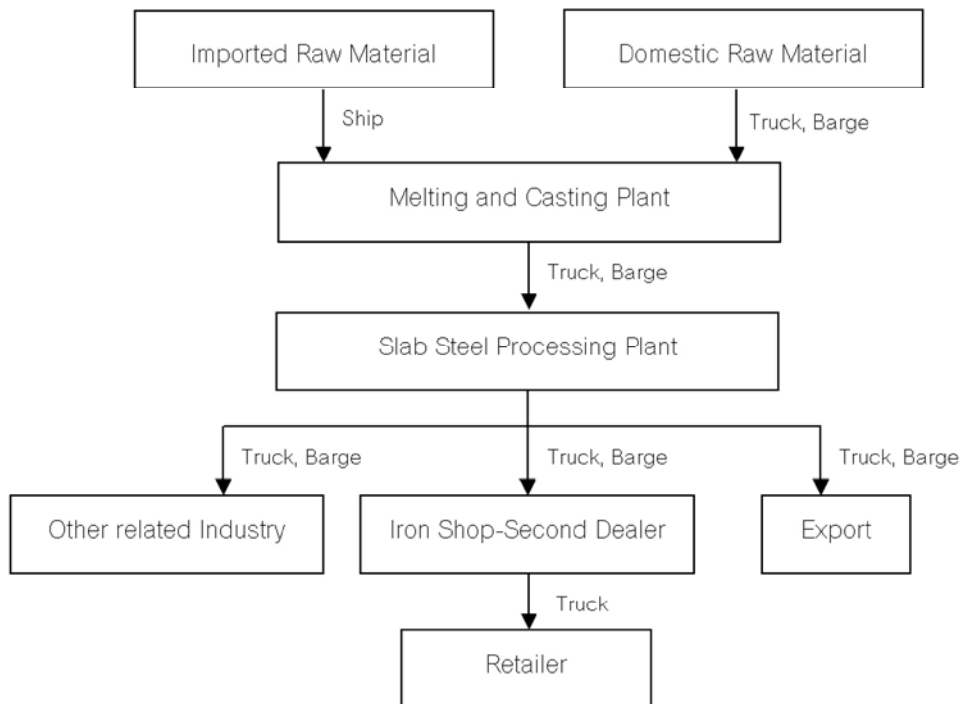


Figure 3.2-16: Commodity Flow of Hot-Rolled Steel

4) Construction Metal

Construction Metal (long steel) can be divided into two major categories, including manufacturing facilities and produces a furnace without melting. The location is near the coast or major rivers since the import of raw materials needed in manufacturing mainly come from abroad whereas the steel industry in Thailand is mainly in the intermediate and downstream. The raw materials will be transported by ship from abroad, processed at the plant and then sent to dealers, which are located mainly in Bangkok and its vicinity, via truck with some portion via barge. The supply chain and commodity flow of construction metal are shown in *Figure 3.2-17* and *Figure 3.2-18*, respectively.

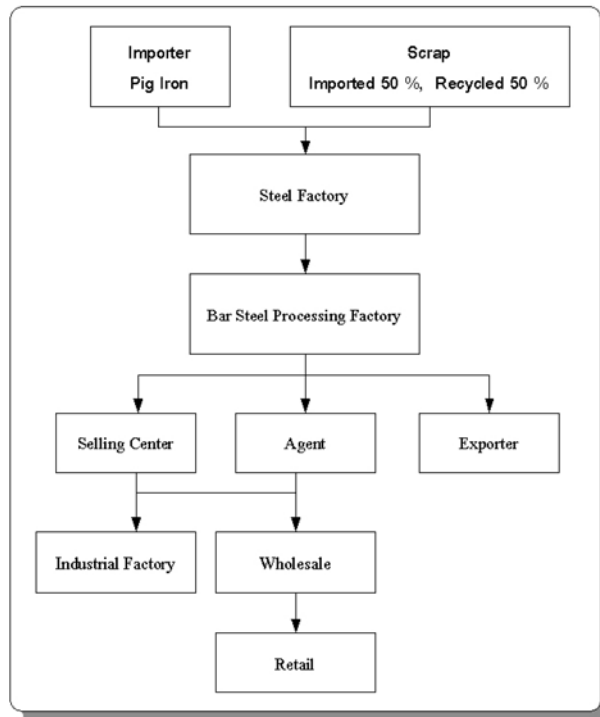


Figure 3.2-17: Supply Chain of Construction Metal

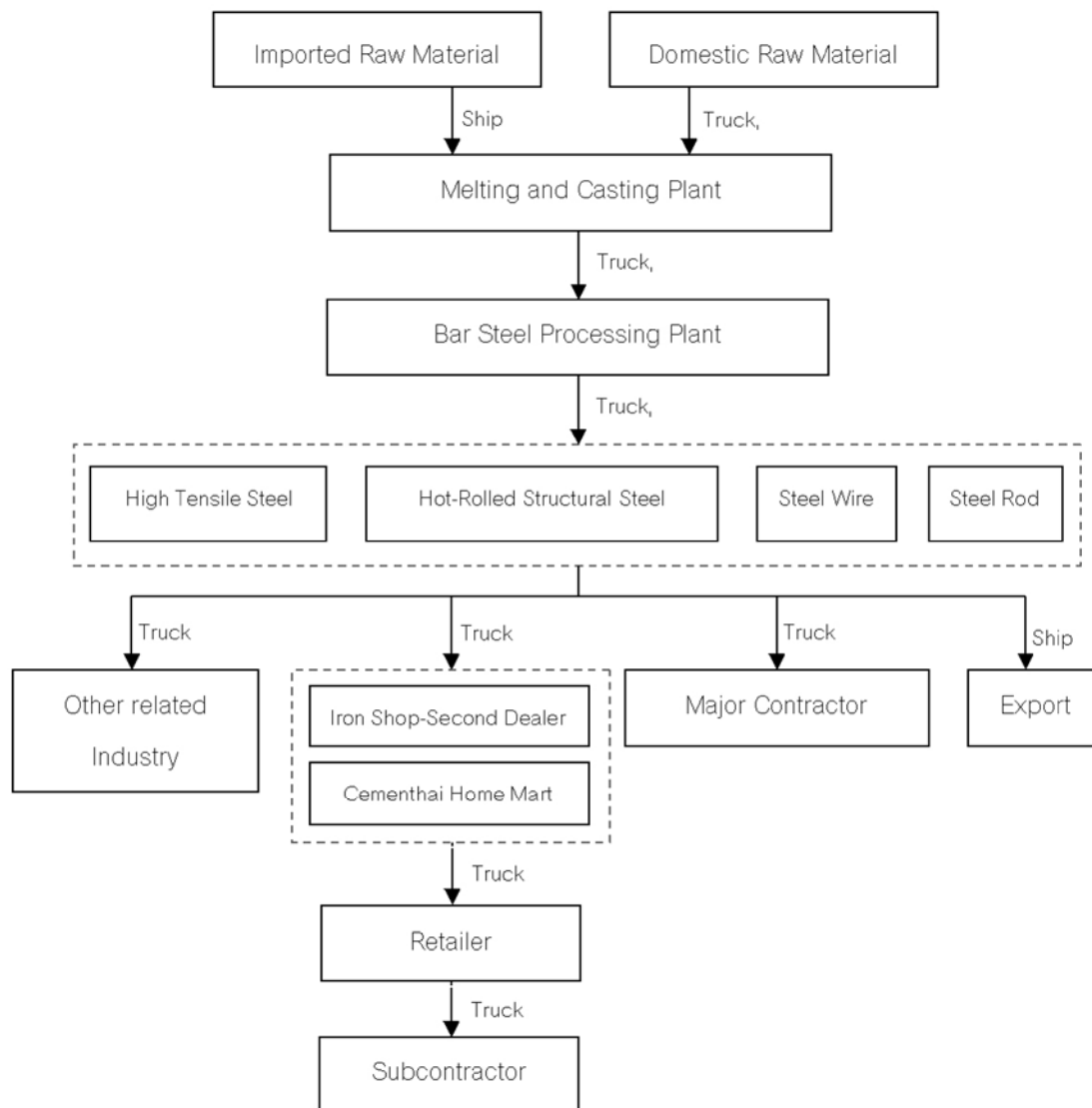


Figure 3.2-18: Commodity Flow of Construction Metal

5) Cement

The supply chain of cement starts from raw materials such as limestone and shale mines abundantly located in Saraburi province. In addition, limestone and coal are also sent to the cement factory as well. Cement Plant currently has approximately 13 companies, which are distributed in Saraburi Province. The finished product will have two types of cement, i.e., grain and cement powder.

The cement, which is in terms of bagged and powder cement, distributing to domestic consumers are mainly made by 22-wheel, 18-wheel, and 10-wheel trailer. Then, they will be distributed to the cement collection or hub in the north, south, east, west,

northeast, and central region. The cement moving from distribution center to retailers will be distributed by truck whereas some portions are moved by barge to Sriracha and Kantang Port. The supply chain and commodity flow of cement are shown in **Figure 3.2-19** and **Figure 3.2-20**, respectively.

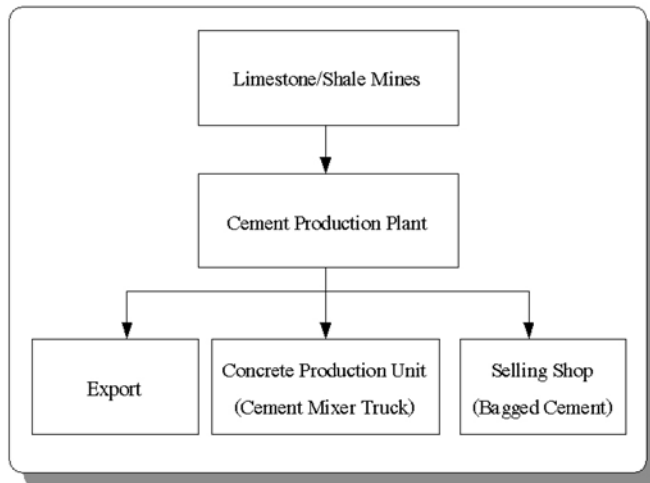


Figure 3.2-19: Supply Chain of Cement

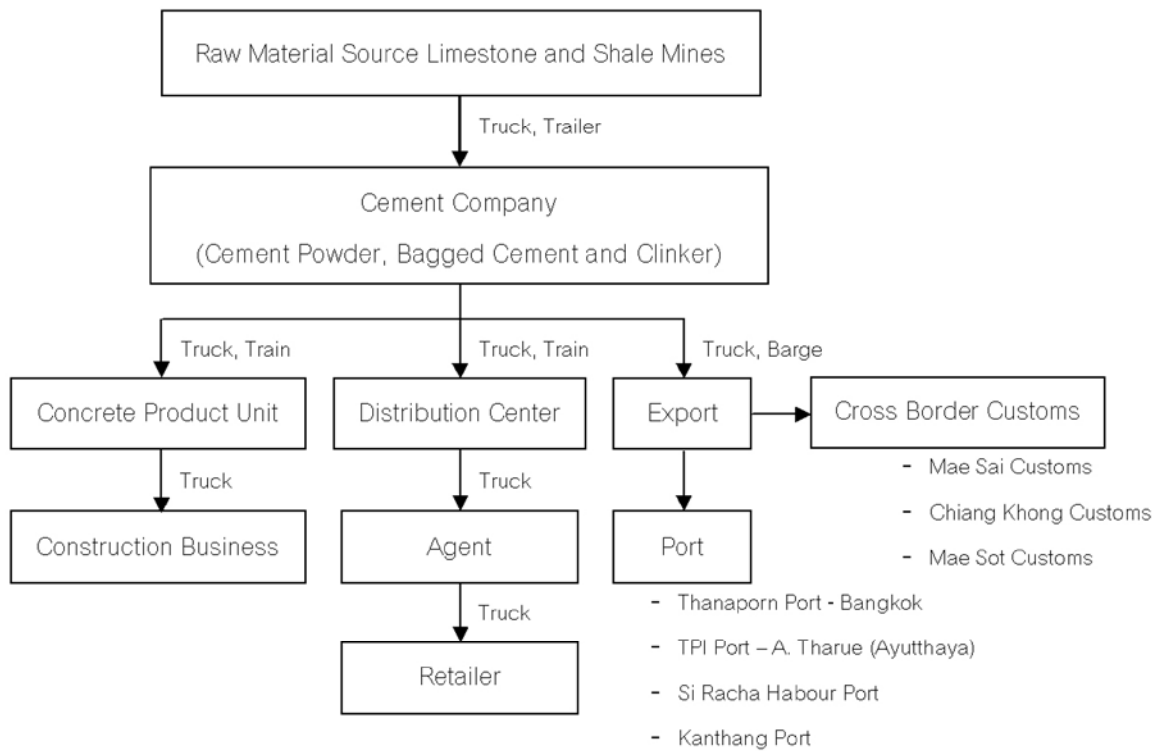


Figure 3.2-20: Commodity Flow of Cement

6) Carbonated Drink

The supply chain of carbonated drink starts from buying raw materials from suppliers. The raw material comes from a variety of sources and begins production by some companies. When fuel price is increased, the transport cost becomes higher. Therefore, manufacturer has developed a manual distribution center in order to disperse directly to consumers resulting in cost reduction and sale volume increase. The supply chain of carbonated drink is shown in *Figure 3.2-21*.

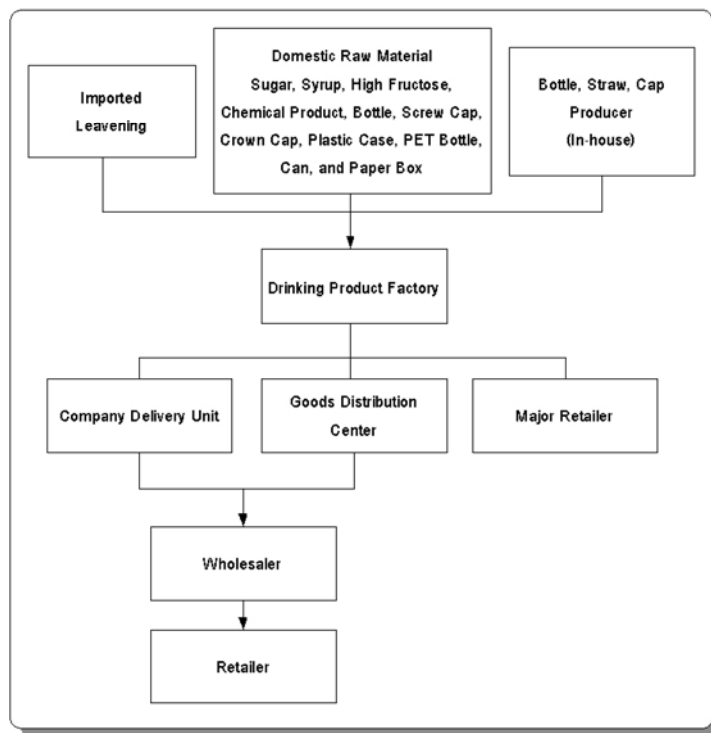


Figure 3.2-21: Supply Chain of Carbonated Drink

The finished carbonated drink will be sent to distribution centers and large retail stores by trailers and sent to small wholesalers and retailers by open-sided trucks.

Road is the main mode of transport due to its convenience and limitation in terms of packaging. The commodity flow of carbonated drink is shown in *Figure 3.2-22*.

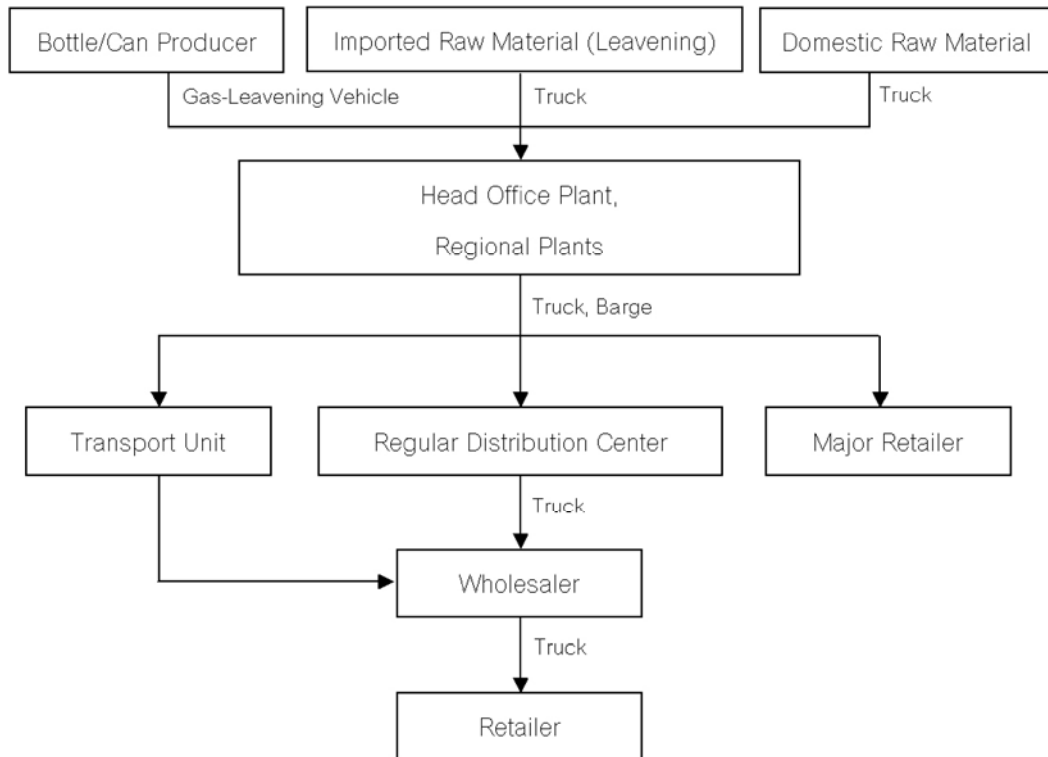
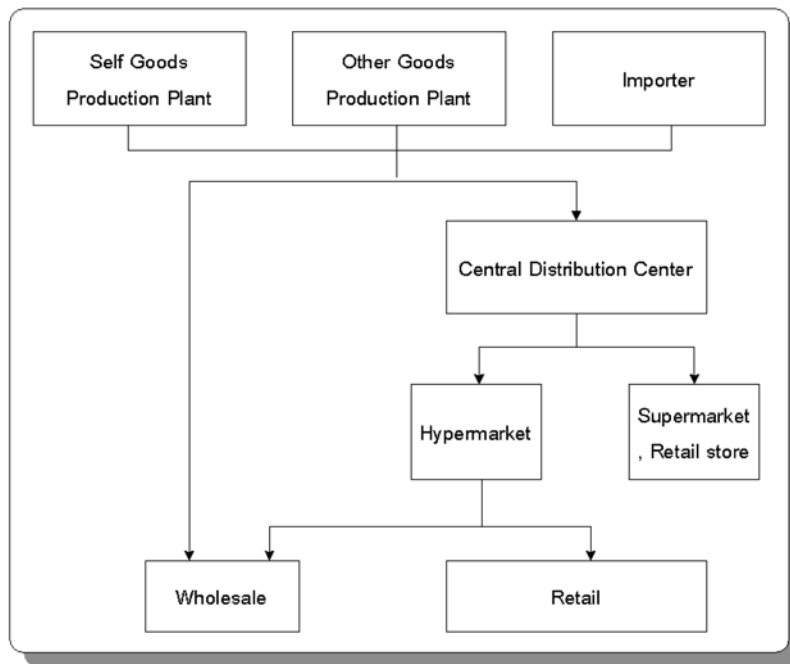


Figure 3.2-22: Commodity Flow of Carbonated Drink

7) Consumer Products

The supply chain of consumer products starts from the collection of finished cargo to distribution centers. The product will be received from three sources, i.e., manufacturers, house-brand factories, and importing. All products are delivered to distribution centers in order to separate cargo according to demand of each branch and wholesalers' order. The products will be transported by truck. The supply chain of consumer product is shown in *Figure 3.2-23*.



Source: The Study of Supply Chain Development for Retail Business, Department of Business Development, Ministry of Commerce (2004)

Figure 3.2-23: Supply Chain of Consumer Products

The transportation process starts from raw materials to manufacturers or importing from other countries. When it is processed, it will be distributed to the markets. The manufacturers usually have distribution center to manage their own transportation. The commodity flow of consumer products is shown in *Figure 3.2-24*.

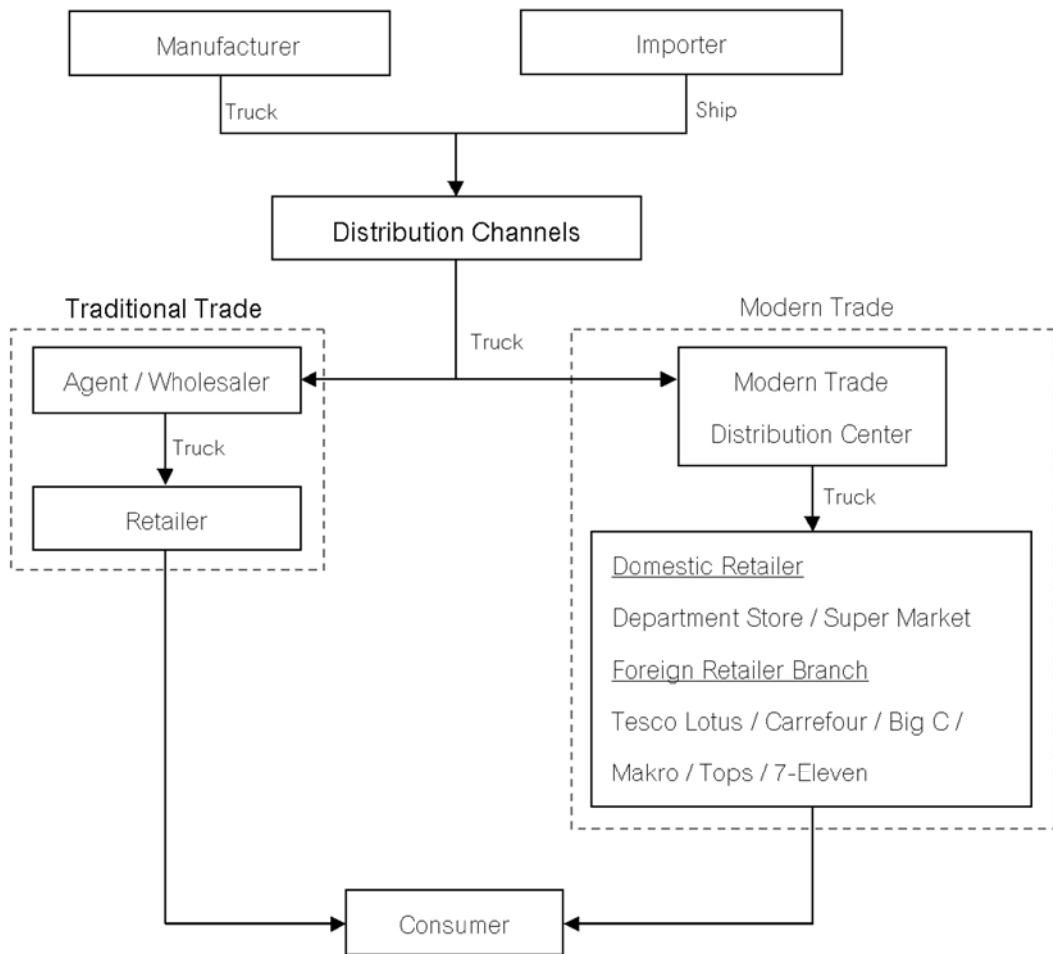


Figure 3.2-24: Commodity Flow of Consumer Products

3.3 Demand Forecast of Strategic Cargoes

This section will summarize the demand forecast of strategic cargoes which the details are shown in *Table 3.3-1*.

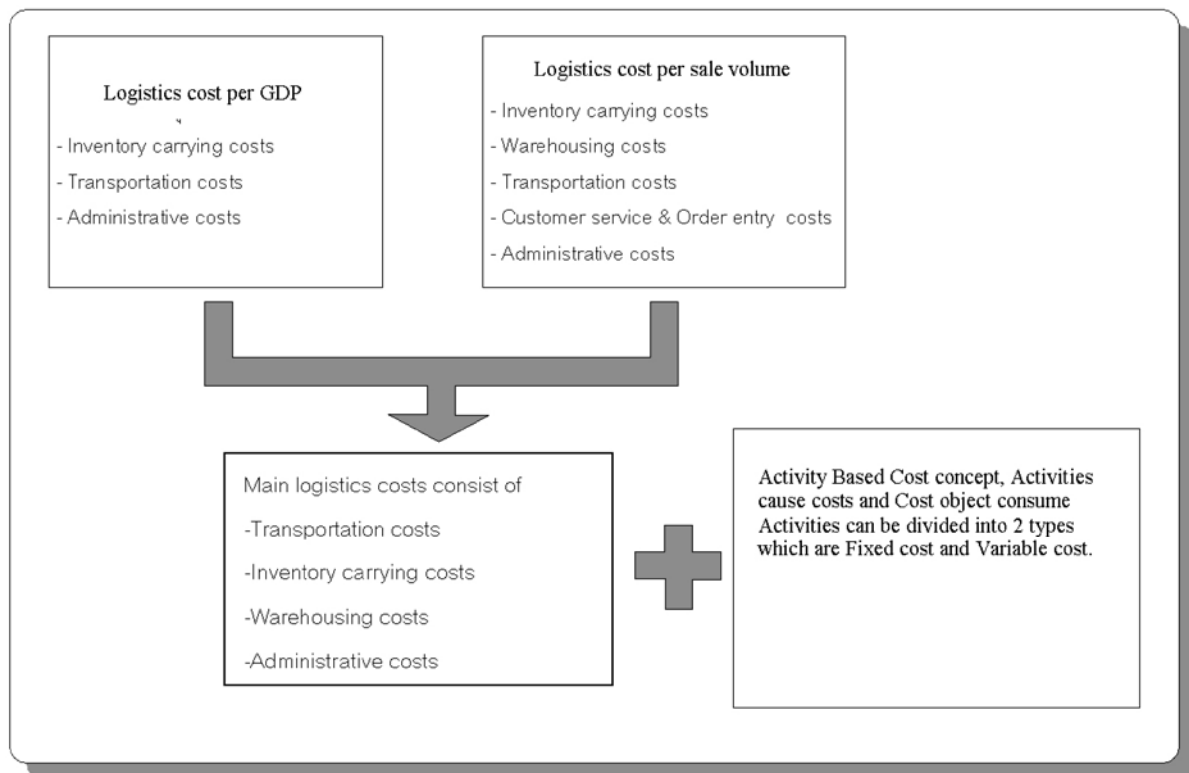
Table 3.3-1: Demand Forecast of Strategic Cargoes

Commodity	Unit	Year		
		2009	2014	2019
Rice	1,000 tons	8,620	8,604	8,604
Cassava	1,000 tons	7,287	9,300.26	11,869.76
Sugar	1,000 tons	5,052	5,052	5,052
Rubber	1,000 tons	2,745	2,885	3,032
Soybean Oil	1,000 tons	1,740	1,849	1,964
Fuel Oil	Million liters	47,194	49,601	52,131
Plastic Resin	1,000 tons	5,190	6,623	8,453
Hot-Rolled Steel	1,000 metric tons	3,203	3,366	3,538
Construction Metal	1,000 tons	9,992	10,502	11,037
Cement	1,000 tons	42.25	44.41	46.67
Carbonated Drink	Million liters	2,289	2,654	3,076
Consumer Products	Billion baht	1.37	1.75	2.23

4 STUDY OF LOGISTICS AND TRANSPORT COST STRUCTURE OF STRATEGIC CARGOES AND RELATED FACTORS

4.1 Analysis Method of Logistics Cost for Strategic Cargoes

This study take the main cost used to calculate logistics cost per GDP and logistics cost per sale volume to be conceptual framework for calculate and application of computing based activities (Activity Based Cost) is a cost classify to fixed costs and variable costs to be logistics cost calculation method as shown in *Figure 4.1-1*.



Source: Consultant

Figure 4.1-1: Methodology of This Study Applied from Literature Review

Logistics cost structure on this study comprise with:

- Warehouse management cost is the cost from service activities in cargos, storage, select factory location and warehouse.
- Inventory carrying costs is an ownership cost or opportunity costs that lose and sink in cargo.

- Transportation cost is a cost that owner paid to transport entrepreneur or expense that business owner administer to dispatch from production source to destination or end user.
- Logistics Administration cost comprise of service cost, purchase cost, and purchase quantity cost which this study use American calculate method that use 10% proportion of total logistics cost for delivery activities, cargo management and cargo ownership.

Data collection of this study is from field surveys and interviews with the product owner from source of production to wholesaler and retailer at the end. Finally, the data are analyzed. The details of calculation are as follows:

(1) Warehousing cost

The cost model is as follows:

$$\text{Warehousing cost} = (\text{depreciation handling equipment} + \text{cargo management system depreciation} + \text{full time staff salary} + \text{warehouse insurance}) + (\text{warehouse space} \times (\text{public utility of warehouse department} + \text{part time staff salary} + \text{over time wage of full time and part time staff} + \text{fuel}) \div \text{total warehouse space})$$

(2) Inventory Carrying cost

The cost model is as follows:

$$\text{Inventory carrying cost} = (\text{raw material insurance} + \text{cargo in process insurance} + \text{finish cargo insurance}) + (\text{turnover of inventory} \times ((\text{raw material quantity} \times \text{raw material unit price} \times \text{interest}) + (\text{quantity cargo in process} \times \text{good in process unit price} \times \text{interest}) + (\text{finish cargo quantity} \times \text{finish cargo unit price} \times \text{interest})))$$

(3) Transportation cost

The cost model is as follows:

$$\text{Transportation cost} = (\text{depreciation truck} + \text{full time salary} + \text{truck insurance} + \text{loading cost}) + (\text{part time salary} + \text{full time and part time staff OT} + \text{maintenance cost}) + (\text{fuel price} \times \text{distant} \times \text{consumption})$$

(4) Administrative cost

The cost model is as follows

$$\text{Administrative cost} = 10\% \times (\text{warehousing cost} + \text{inventory carrying cost} + \text{transportation cost})$$

From above, logistics costs calculate form can summarize as following:

$$\text{Total Logistics Cost} = \text{Warehousing cost} + \text{Inventory carrying cost} + \text{Transportation cost} + \text{Administrative cost}$$

4.2 Analysis Results of Logistics Costs of Strategic Cargoes

Logistics cost throughout the supply chain of 12 strategic commodities illustrated the overview of the costs covering from the stage in which raw materials went through manufacturing process and transformed into final products waiting to be sent to consumers. Agricultural cargoes were classified into 5 types including rice, rubber, cassava, soybean oil and sugar. Industrial cargoes were classified into 7 types including cement, fuel oil, hot-rolled steel, construction metals, plastic resin, carbonated drink and consumer products. The logistics cost analysis can be summarized as follows:

Logistics cost per sales for each type of cargoes would have different cost share of activities. For example, agricultural cargoes such as cassava, soybean oil and sugar had the highest transport cost, while rice and rubber had high warehousing cost instead.

Logistics cost for industrial products such as cement and oil would have the highest transport cost, while hot-rolled steel, construction metal, carbonated drink and consumer products would have the highest inventory carrying cost and plastic resin would have the highest warehouse management cost as shown in *Figure 4.2-1* and *Table 4.2-1*.

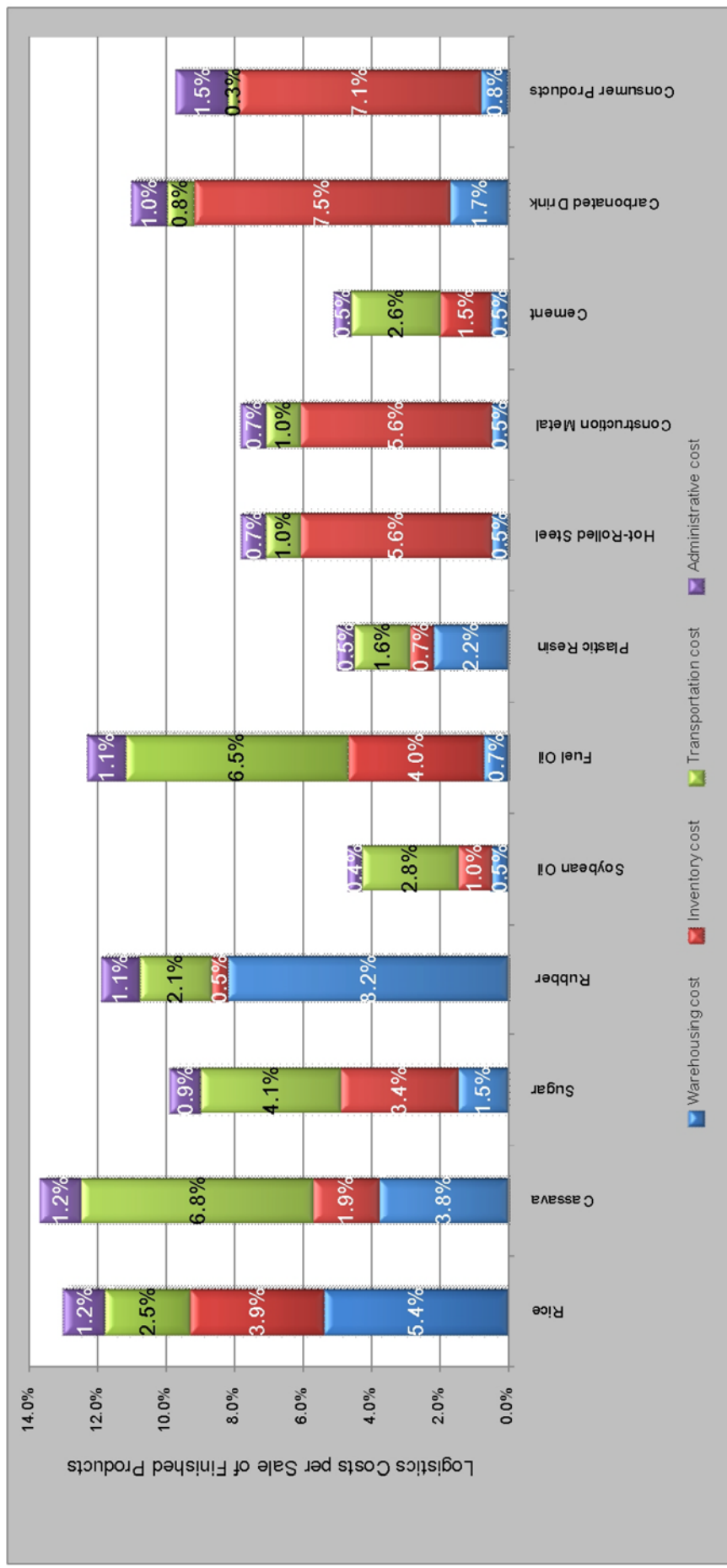


Figure 4.2-1: Comparison of Logistics Cost per Sales of 12 Cargoes

Table 4.2-1: Comparison of Logistics Cost to Sales of 12 Cargoes

	Logistics Costs					Total Logistics Costs
	Warehousing cost	Inventory cost	Transportation cost	Administrative cost		
Rice	5.41%	3.89%	2.52%	1.18%		13.00%
Cassava	3.76%	1.92%	6.81%	1.21%		13.70%
Sugar	1.47%	3.44%	4.07%	0.90%		9.87%
Rubber	8.22%	0.48%	2.13%	1.08%		11.91%
Soybean Oil	0.53%	0.98%	2.80%	0.43%		4.74%
Fuel Oil	0.66%	4.01%	6.47%	1.11%		12.25%
Plastic Resin	2.23%	0.66%	1.64%	0.45%		4.98%
Hot-rolled Steel	0.53%	5.60%	1.02%	0.71%		7.86%
Construction Metal	0.53%	5.60%	1.03%	0.72%		7.88%
Cement	0.54%	1.54%	2.57%	0.46%		5.11%
Carbonated Drink	1.70%	7.50%	0.82%	1.00%		11.02%
Consumer Products	0.77%	7.12%	0.30%	1.49%		9.67%

The logistics costs of each cargo are described in details as follows:

1. Logistics costs of rice

The study shows that Logistics cost of rice's supply chain is accounted for 13.00 % of its total sales. It is comprised of the cost of warehousing 5.41 % of total sales, the cost of inventory carrying 3.89 % of total sales, the cost of transportation 2.52 % of total sales and the cost of Logistics management 1.18 % of total sales. The highest portions are at warehousing and stock holding because government's rice pledging policy causes the increasing of rice in the warehouse and affect to high product carrying cost. Moreover, to preserve the quality of Hom Mali rice, the investment has to be put on the construction of air-conditioned silo.

The transportation of rice within the country mostly uses road transportation by truck. The limitations of this mode of transportation are the traffic condition, small transportation quantity for each truck and high transportation cost due to one-way transportation. While other modes of transportation are not effective and the market or the destination is not proper for the transportation by train and ship, the effort for modal shift to rail or water mode may decrease the transportation cost.

2. Logistics costs of cassava

Logistics cost of cassava's supply chain is accounted for 13.70 % of its total sales. It is comprised of the cost of warehousing 3.76 % of total sales, the cost of inventory carrying 1.92 % of total sales, the cost of transportation 6.81 % of total sales and the cost of Logistics management 1.21 % of total sales. It can be noticed that the cost of transportation is the main problem for cassava. The entrepreneurs are likely to use the outsourced transporters in order to avoid the expense on trucks and drivers. Moreover, some entrepreneurs solve this problem by using the railway transportation. However, difficulty to access train stations makes the road transportation is still needed.

3. Logistics costs of sugar

Logistics cost of sugar's supply chain is accounted for 9.87 % of its total sales. It is comprised of the cost of warehousing 1.47 % of total sales, the cost of inventory carrying 3.44 % of total sales, the cost of transportation 4.07 % of total sales and the cost of Logistics management 0.90 % of total sales. The cost of transportation is higher than other Logistics costs because most of entrepreneurs use road as the main transportation.

4. Logistics costs of rubber

Logistics cost of rubber's supply chain is accounted for 11.91 % of its total sales. It is comprised of the cost of warehousing 8.22 % of total sales, the cost of inventory carrying 0.48 % of total sales, the cost of transportation 2.13 % of total sales and the cost of Logistics management 1.08 % of total sales. The rubber is another product which has quite high cost for warehousing which is due to the harvest season so that the entrepreneurs have to keep the rubber in the proper place.

The cost of transportation is the second large portion, the entrepreneurs currently use railway and trailer container because the distance is not far from client and the cost is cheaper. Meanwhile, the nearest port is Songkhla port, the shallow-sea port where the large ship could not access as a result higher cost from many process of transportation occurs.

5. Logistics costs of soybean oil

Logistics cost of soybean oil's supply chain is accounted for 4.74 % of its total sales. It is comprised of the cost of warehousing 0.53 % of total sales, the cost of inventory carrying 0.98 % of total sales, the cost of transportation 2.80 % of total sales and the cost of Logistics management 0.43 % of total sales.

The transportation cost is the main problem for soybean oil. Currently, soybean oil has been transported only by road transportation. There is slight opportunity to replace road with railway transportation due to the indifference in cost. Therefore, the most efficient Logistics management will be the solution to reduce the cost of transportation.

6. Logistics costs of fuel oil

And Logistics cost of Oil's supply chain is accounted for 12.25 % of its total sales. It is comprised of the cost for warehousing 0.66 % of total sales, the cost of inventory carrying 4.01 % of total sales, the cost of transportation 6.47 % of total sales and the cost of Logistics management 1.11 % of total sales.

The highest cost is transportation cost. The principal direction to improve the efficiency of oil's transportation is to encourage the transportation projects via pipeline, railway and on-shore to replace the road transportation.

7. Logistics costs of plastic resin

Logistics cost of plastic resin's supply chain is accounted for 4.98 % of its total sales. It is comprised of the cost of warehousing 2.23 % of total sales, the cost of inventory carrying 0.66 % of total sales, the cost of transportation 1.64 % of total sales and the cost of Logistics management 0.45 % of total sales. The cost of warehousing is quite high due to the product is needed to be preserved in the well-control area.

The second large portion cost is the transportation cost. As most entrepreneurs use the road transportation as the main mode, the cost also has serious impact from rising in energy price. Therefore, if it is possible to change from road transportation to other modes which can use the rail, it will save more cost for the entrepreneurs.

8. Logistics costs of hot rolled steel

Logistics cost of hot-rolled steel's supply chain is accounted for 7.86 % of its total sales. It is comprised of the cost of warehousing 0.53 % of total sales, the cost of inventory carrying 5.60 % of total sales, the cost of transportation 1.02 % of total sales and the cost of Logistics management 0.71 % of total sales. The main cost of finished cargo for hot-rolled steel is the cost of inventory carrying due to the expanding direction of both domestic and international economy, government's investment projects and the increasing trend in the cost of steel production. For the entrepreneurs, particularly downstream entrepreneurs who will be directly affected by the higher cost, should have plans for purchasing, selling and stocking products. As a result, the cost of inventory carrying is in the high level while the existing transportation mode via ship is still the best choice.

9. Logistics costs of construction metal

Logistics cost of construction metal's supply chain is accounted for 7.88 % of its total sales. It is comprised of the cost for warehousing 0.53 % of total sales, the cost of inventory carrying 5.60 % of total sales, the cost of transportation 1.03 % of total sales and the cost of Logistics management 0.72 % of total sales.

Like hot-rolled steel, the main cost of construction metal is the cost of inventory carrying since they are in the same industry. Because the price of steel for construction is volatile, carrying the product in hand will make the cost more stable

especially for the industrial construction projects which sometimes take many years to finish. The second large portion of cost is the cost of transportation, which is also similar to hot-rolled steel. It is also found that transporting metal for construction via road transportation has the minimum weight limitation as well.

10. Logistics cost of cement

Logistics cost of cement's supply chain is accounted for 5.11 % of its total sales. It is comprised of the cost of warehousing 0.54 % of total sales, the cost of inventory carrying 1.54 % of total sales, the cost of transportation 2.57 % of total sales and the cost of Logistics management 0.46 % of total sales.

As cement is a product with low value per unit, therefore; the cost of transportation seems to be the highest portion. This is because it is very heavy and too much tonnage. As a result, the existing entrepreneurs face high expense problem comparing with the low value of product especially the transportation is over 100 kilometers. In conclusion, it can be said that Cement is not worth for distributing via road transportation with trucks due to the high expense.

11. Logistics costs of carbonated Drink

Logistics cost of carbonated drink's supply chain is accounted for 11.02 % of its total sales. It is comprised of the cost of warehousing 1.70 % of total sales, the cost of inventory carrying 7.50 % of total sales, the cost of transportation 0.82 % of total sales and the cost of Logistics management 1.00 % of total sales.

The cost of transportation is not the main problem of this product. The entrepreneurs are likely to use road transportation as a main pattern to distribute the products. Only Sermsuk Co., Ltd also uses the water transportation. Therefore, the efficient transportation management will be the solution for reduce the cost of transportation for this product.

12. Logistics cost of consumer products

Logistics cost of consumer product's supply chain is accounted for 9.67% of its total sales. It is comprised of the cost for warehousing 0.77 % of total sales, the cost of inventory carrying 7.12 % of total sales, the cost of transportation 0.30 % of total sales and the cost of Logistics management 1.49 % of total sales.

Most entrepreneurs use road as main mode of transport to distribute their products to modern trades and convenient stores. The main cost will be the cost of inventory carrying because the consumer products are necessary for every household, trading all the time and involving with thousands of producers; therefore, building the warehouse will make more efficient in cost of Logistics management. However, some consumer products need rapid distribution, particularly Fast Moving Consumer Cargo: FMCG, then the transportation via road is the most appropriate.

4.3 Analysis of Transport Cost Structure of Strategic Cargoes

Transportation is an activity in a logistics process. The analysis of transport costs structure of key strategic commodity is an important part that helps understand and establish transport plans to reduce transport cost. The analysis applied traditional cost method which separated costs into two parts which were:

1. **Fixed Costs.** These costs do not vary by transport volume, even if there is no transport volume at all.
2. **Variable Costs or Operation Costs.** These costs occur when transport activities take place and they vary by transport volume.

The transport cost of strategic cargoes is classified by transport modes, which consisted of road transport, rail transport, and water and coastal transport. According to the study, it is found that the modes of transport of each cargo are shown in *Table 4.3-1*.

Table 4.3-1: Transportation Modes for Strategic Commodities

Commodity	Transport Modes		
	Road	Rail	Water
Rice	✓	✓	✓
Cassava	✓	✓	✓
Sugar	✓	✓	✓
Rubber	✓	✓	✓
Soybean Oil	✓	✗	✗
Fuel Oil	✓	✓	✓
Plastic Resin	✓	✗	✗
Hot-rolled Steel	✓	✗	✓
Construction Metal	✓	✗	✓
Cement	✓	✓	✓
Carbonated Drink	✓	✗	✓
Consumer Products	✓	✗	✗

Source: From Consultant's Survey

The transport cost for each type of vehicle is calculated first in terms of baht per kilometer. Later, the transport characteristics of each commodity, e.g. vehicle type, average tonnage, proportion of empty backhaul, etc., will be taken into account in the cost structure. Finally, the proportion of vehicle type for each commodity will be used as weighted factor for retrieving the weighted average transport cost for each cargo.

As a result, the weighted average of transport cost, in terms of baht per ton-kilometer, for each commodity categorized by mode of transport is expressed in *Table 4.3-2*.

Table 4.3-2 Transport Costs Classified by Strategic Cargo and Transport Mode

(Unit: Baht per ton-kilometer)

Commodity	Road	Rail	Water
Rice	1.61	0.97	0.62
Cassava	1.51	1.04	0.51
Sugar	1.54	0.99	0.68
Rubber	1.52	0.83	0.46
Soybean Oil	2.59	-	-
Fuel Oil	2.42	1.02	0.65
Plastic Resin	2.48	-	-
Hot-rolled Steel	1.24	-	0.71
Construction Metal	1.64	-	0.71
Cement	1.18	0.85	0.69
Carbonated Drink	1.97	-	0.70
Consumer Products	1.80	-	-
Average	1.72	0.93	0.64

It is found that road transport would have the highest transport cost, followed by rail and water transport. The averages are 1.72, 0.93 and 0.64 baht per ton-km for the three modes respectively. Soybean oil is a product with the highest road transport cost at 2.59 baht per ton-kilometer. Cement is a product with the lowest road transport cost at 1.18 baht per ton-kilometer.

5 THE STUDY ON ENERGY CONSUMPTION

In the past, the development of transportation policy and plan in Thailand mostly focused on solving existing problem and increasing the efficiency of transportation and traffic operations. There had been very few transportation plans involving energy issues until 2002. During that year, the Ministry of Energy, Thailand, has issued an energy policy involving transportation sector. This policy covers the energy security, energy conservation, and alternative energy development. It mainly focuses on industrial and service sectors, as well as, the residential areas. However, the policy on transportation section was mainly about the support of alternative fuels, such as ethanol, biodiesel, and compressed natural gas (CNG). This plan was recently concentrated in the late 2008 to 2009 during the period of skyrocket crude oil price. It was coupled by the use of liquid petroleum gas (LPG) in road transportation as an alternative of gasoline or diesel. The LPG was partly subsidized by Thai government to support the low cost of fuel use in the household. A large use of LPG as a transport fuel would interrupt the LPG supply and bring a large subsidization cost to Thai government.

5.1 World Energy Situation

Nevertheless, since the demand and supply of energy use are worldwide connected, the development of Thai energy policy would be based on the worldwide trends of energy use. The careful considerations would be made regarding the forms of reserved fuels, energy price structure, and the support of alternative fuels so that the policy would be realistic and practical.

In the U.S., high oil prices brought higher cost of production to manufactures and transportation. This led to higher cost of products and travel costs to U.S. consumers. Since there are still lots of undrilled crude oil fields in the U.S., the mitigation methods of U.S. government regarding this issue are to explore more oil fields when the oil price is high, and reserve imported oil during the low-price period.

In contrast, the European countries have less oil field. Most of them have to import oil. During the oil price crisis, the EU focused on the development of renewable fuels within its continent to find the cheaper quality fuel, reduce the dependence of fossil oil, and reduce the energy usage.

For Japan, two energy policies have been dominated even before the energy crisis: 1) the government supports the increase in fuel efficiency, and 2) the use of alternative fuels. Since Japan has no domestic energy source, Japan has developed its own technology since the oil crisis in 1970s and continued its program until today. Japan invested in the nuclear power plant to solve the energy problem as well. Currently, Japan focuses on the energy security through the collaboration with Southeast Asian countries and OPEC. It also stressed on the environmental issue since the Kyoto Protocol in 1997.

The trend of energy use in the world has been increased continuously through the economic development and growth of world population. These factors are driving force for increasing in the transportation activities especially for the emerging countries such as China and India. The increase of energy use significantly affects the world's energy supply and prices. Nevertheless, the increase of energy use in the developed countries (OECD) with saturated economy might not be in the high rate

5.2 Thailand's Energy Situation

In Thailand, the energy consumption as well as the use of oil fuel has been steadily grown. From the data of energy use separated by the sector, energy is mainly used in the transportation and industrial sectors. In 2007, industrial sector was accounted for 35.7% of total energy use. It was followed closely by the transportation sector (36.5% of energy use). By comparing each sector's energy efficiencies in terms of energy intensity per production value (Energy Intensity: EI), it was found that the transportation sector has the highest EI. It implied that transportation sector uses more energy per production value than any other sector. This value was used to compare among countries as well. It was found that Thai transportation sector has less energy efficiencies than many countries in the same region. Therefore, we conclude that energy efficiency is one of the major issues for Thai transportation sector. Also, this problem could affect the whole economy and Thailand's competitiveness especially during the high-oil price period.

Road transportation is the transportation mode that consumes highest energy in Thailand. We found that the trend of energy use is continuously increasing for several decades (except a few years during oil crisis or Asian economic crisis). Higher transportation demand causes higher oil demand. Although Thai government has supported the alternative fuels, e.g., natural gas, or biofuel, etc, most Thai consumers still depend on

fossil oils. Several factors including lack of sufficient alternative fuels' technology and service centers, and lower price, cause little changes in Thai energy consumption. This results in oil dependence of Thailand's operators and consumers in the near future. However, it is possible that under the new policy of alternative fuels and better alternative fuel's technologies from the U.S., EU, or Japan, alternative fuels could play an important role in Thailand in the long run. There are seen a significant increase in the adapting of alternative fuels in transportation sector during the last few years. The study shows that government subsidization, new price structure, and high oil price would result in higher uses of gasohol, biodiesel, and natural gas for vehicles.

5.3 Recommendation of Energy Policy for Transport Sector

In this study, the energy policies for transport sector in macro view are developed to serve as guidelines for determining the suitable and efficient consumption of energy and help setting up the transport policy framework for Thailand. *Figure 5.3-1* shows the overview picture of how the guidelines were developed:

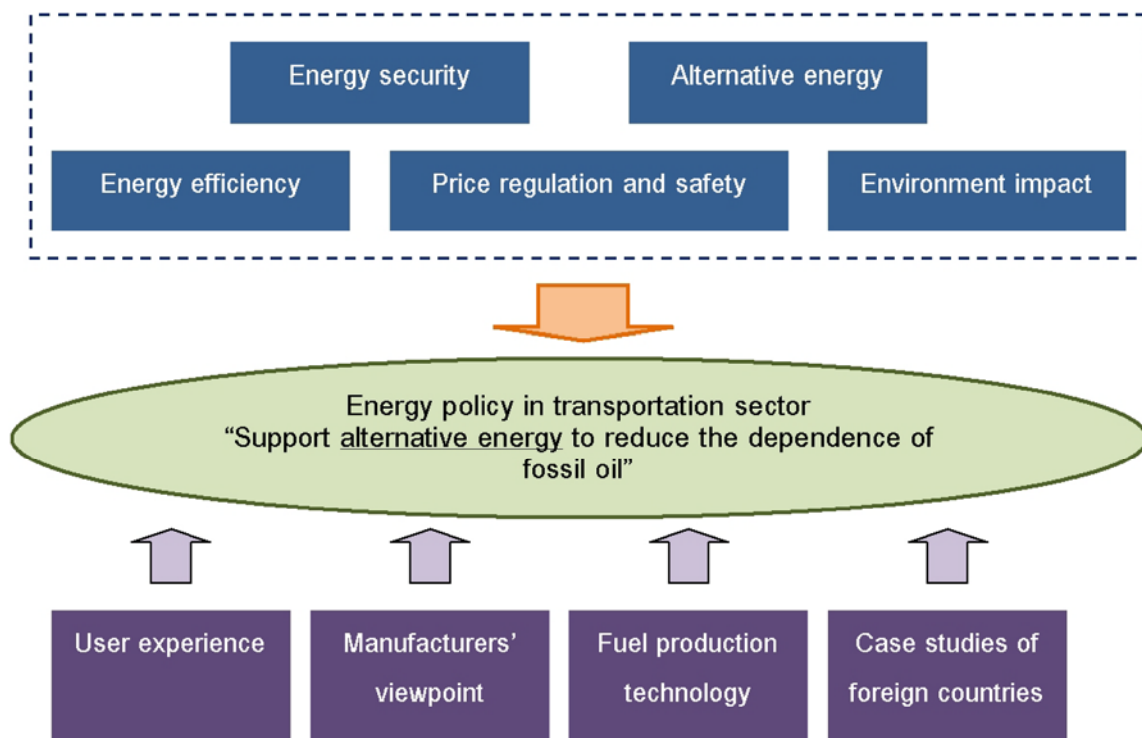


Figure 5.3-1: Overview Picture of Guideline Development

Development of Energy Policy in Transportation Sector for Thailand

The development of energy policy in transportation sector for Thailand is based on the balance of development in five main areas:

1. energy security
2. alternative energy
3. price regulation and safety
4. energy conservation and efficiency
5. environmental impact

The guidelines based on these five areas of consideration would cover all aspects and respond to the overall development of country's energy and economy. The strategy of supporting alternative energy must be developed on the market base and sustainable competition, i.e., the support of biofuel and natural gas for vehicles must depend on their costs that are competitive in the long run. However, there could be some initial subsidization to develop new market for alternative energy, e.g., installation cost, hidden cost in price structures, etc, such that the transportation cost will not be significantly affected.

In addition to the recommended guidelines for energy policy, the study team surveyed the attitudes and preferences of vehicle users, interviewed manufacturers, as well as, collected case studies and policy directions from foreign countries. This study pointed out the factors affecting the improvement of energy efficiency and users' readiness in switching to alternative fuels. There are summarized the study as well as recommend policy energy for transport sector with the focus on the energy efficiency and the support of alternative fuels. This summary is in *Table 5.3-1* below.

Table 5.3-1: Summary of Recommendations on Energy Policy in Transportation Sector

Key area	Study summary	Policy recommendations/ energy measures in transportation sector	Results
Energy Efficiency	<p>The study shows the potentials in improving fuel consumption rate of current vehicle engines.</p> <p>The study shows the effect of vehicle usage and maintenance toward fuel consumption rate especially for big trucks.</p> <p>The data from this study could be used as a base for selecting vehicle types that would be fitted with different loads, usages, and maintenance routines.</p>	<p>Order all vehicle manufacturers and sellers to post vehicles' fuel consumption rate under the standard test. Also, the government might specify the minimum fuel consumption rate that is allowable for vehicle registration for each vehicle type.</p> <p>Government would support and create measures for developing technology to increase fuel efficiency. For example, issue a guideline for selecting vehicle types that would be fitted with different loads, usages, or a handbook of energy maintenance.</p>	<p>The vehicles' users and operators have a choice, can plan ahead and estimate the cost more accurately. On the other hand, the vehicle manufacturers would be pushed toward the development of more energy-efficient vehicles.</p> <p>Transport operators could manage their costs to be the lowest under their vehicles' engine capability for better energy efficiency.</p>

Table 5.3-1: Summary of Recommendations on Energy Policy in Transportation Sector (Continued)

Key area	Study summary	Policy recommendations/ energy measures in transportation sector	Results
Fuel Switching	<p>Both vehicle users and manufacturers see the need of alternative fuel in the long run</p> <p>The study shows that the factors affecting the fuel switch for vehicle users are comparative fuel prices, location of fuel stations, and followed by environmental concerns.</p> <p>The study of fuel consumption and vehicle usage can be used as a base for assessing the value of vehicle usages as well as evaluating impact if the fuel prices will be adjusted in the future.</p>	<p>Accelerate the implementation of the 15-year alternative energy plan which focuses on biofuel and natural gas development through several measures.</p> <p>The support of natural gas use on vehicles would be focused on only specific user types for economic and engineering reasons (after considering the real price of natural gas). This would lead to the ease in planning the gas station. For example, public buses and fixed route trucks could be arranged for locating natural gas stations in some specific areas along the pipeline (instead of locating stations all over the country and use trucks).</p> <p>Also, there must be some long-term measures to mitigate the higher cost of natural gas for some users if the price increase according to the real price</p>	<p>The operators have alternatives to protect their costs from world's fuel price fluctuation.</p> <p>The natural gas, one of alternative fuels, would have more users and would be sustainable in the long run.</p>

Table 5.3-1: Summary of Recommendations on Energy Policy in Transportation Sector (Continued)

Key area	Study summary	Policy recommendations/ energy measures in transportation sector	Results
	<p>The study shows that the use of electric vehicles around the world grows steadily. Also, large vehicle manufactures now have plans to expand production of electric vehicles for commercial uses in the near future. Therefore, Thailand would focus on this trend.</p> <p>The study also shows that regular vehicle users do not have electric vehicles' basic knowledge, e.g., mechanics of engine, usage, maintenance, etc.</p>	<p>The government would include the support and advertise the use of electric vehicles through the Alternative Energy Support Plan and focus on the main target of electric vehicles, i.e., small private car users in large cities.</p>	<p>The electric vehicle would be one of operators' alternatives and lead to more flexibility in transportation cost control and management.</p>

6 ANALYSIS AND ASSESSMENT OF FREIGHT TRANSPORT PERFORMANCE

6.1 Potential Analysis of Transportation Network Development

Potential analysis of transportation network including international ports, and also domestic and international network, will be adopted in planning and decision making process of infrastructure development policy on worthwhile investment basis. Moreover, the transport network capacity needs to be considered in order to expand its capability of the network to cope with the increasing freight demand both in the current and future time efficiently under the competitive transport cost for all modes of transport, i.e., road, rail, water, air transport as well as multimodal transport.

6.1.1 Main Gateways



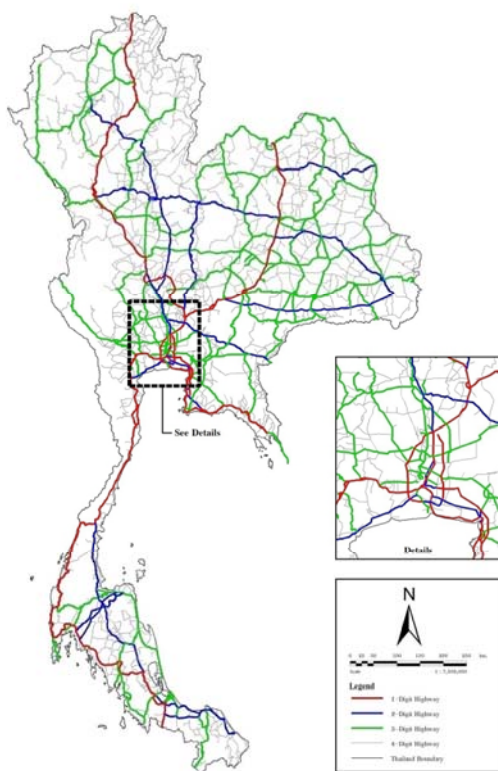
International ports are the important gateway for international trade and economy of country since they are the importing and exporting channels as well as intermodal terminals where a lot of cargoes passing through annually generating wide range of economic activities. Major international ports are, e.g., Laem Chabang port, Map Ta Phut port, Songkla port, and Phuket port. While, the major private ports are such as Sriracha Harbor port, Siam Seaport. In addition, the international river ports are, for instance, Chiang Saen port and Chiang Khong port as shown in *Figure 6.1-1*.

Figure 6.1-1: Major International Ports of Thailand

6.1.2 Transportation system network

Transportation system network will cover both domestic and international network in all modes of transport comprising land transport, railway transport, inland waterway, coastal transport, and air transport. Each mode of transport has its own characteristics in different ways and deals with the connection nodes for consolidation and distribution among different modes. Thus, the study of transportation network status will be the key factor for freight transport planning and specifying the development direction.

1) Road Transportation



Thailand has road network about 390,000 kilometers which connect to all regions of the country as shown in *Figure 6.1-2*. Thailand has intensely and continually developed highway network. Presently, the highway reaches all area of the country and also links to neighboring countries e.g. Myanmar, Lao, Cambodia and Malaysia. In addition, all trunk highways are high standard with asphaltic concrete or reinforced



concrete surface. Thus, the domestic highway network are completely available.

Figure 6.1-2: Highway Network in Thailand

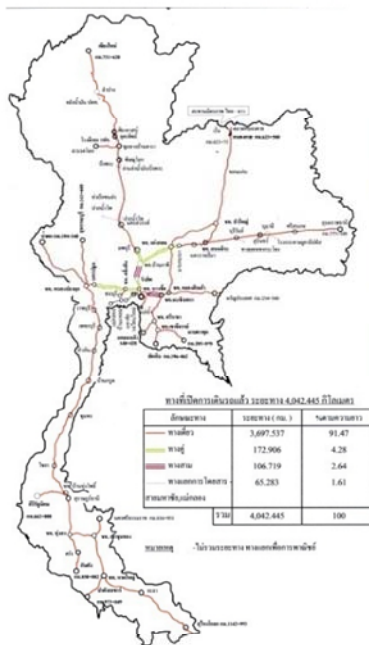
Road transport becomes remarkably popular since it is fast and convenient with easily access to the production base and consumption source directly, or so-called door-to-door service, without mode shift along the way. It is the most effective mode for short-haul route and there are minor roads connecting to other regions.

Department of Land Transport (DLT) has established three truck terminals at the outskirts of Bangkok area, i.e., Klong Luang, Romklao, and Buddha Monthon truck

terminals. In the future, there will be more truck terminals in other regions. This will help organizing the truck fleet and being the consolidation and distribution center as well as encouraging the economical mode of transport.

2) Railway Transportation

The cargo transport by rail network and route are the same route as passenger transport that connect Bangkok to other 46 province in nationwide consisting of 4 routes e.g. northern route, northeastern route, eastern route, and southern route with



total distant about 4,180 kilometer. With this total, 3,901 kilometers are single-track, 220 kilometers are double-track and 59 kilometers are triple-track accounting for 93.3%, 5.3% and 1.4% respectively. The track width is 1.00 meter (or meter gauge) as shown in *Figure 6.1-3*.

Figure 6.1-3: Railway Network in Thailand

At present, the railway transport consist of passenger transport and cargo transport, passenger transport will be crowded since outskirts around Bangkok and suburbs to inner area of Bangkok. The second dense route is the long distance travel to other regions such as Northern line, Northeastern line and Southern line whereas the Eastern line becomes less popular because most passenger choose to travel by bus that is faster and more convenient. For cargo transport, it is crowded at ICD Ladkrabang and Laem Chabang port.

The major cargoes using the railway transport are normally low value and high weight such as coal, petroleum products, cement, rice and sugar. The type of carriage is varied by types of cargo such as box car for general commodities,

tanker for liquid and gas. Besides, railway transportation can carry the containers. Inefficient service quality of railway transport is the result from the following problems:

- Declined infrastructure, locomotives, and carriages
- Inadequacy of locomotives, carriages, and handling equipments.
- Incomplete network with mostly single track railway system affecting the service quality, delay in operation, bottleneck problem in some routes from train switching.

3) Waterway Transportation

Currently, the waterway route in Thailand is about 4,000 kilometers in total length comprising 2,500 kilometers for river and canal route, 950 kilometers for international river route (Mekong River) and 625 kilometers for lake. The major rivers for logistics are Chao Phraya River, Pasak River, Bangpakong River, Maeklong River and Tha Chin River (*Figure 6.1-4*). Nowadays, the international liners can navigate in Chao Phraya River only 45 kilometers from the estuary whereas only barges can navigate beyond that distance due to limitation of horizontal and vertical clearance. Pasak River is navigable only by barges whereas Bangpakong River and Maeklong River can support coastal ships. Only Initial section of Tha Chin River can support coastal ships.



Figure 6.1-4: Waterway Network in Thailand

Most river ports are private and located in Bangkok and its vicinities as well as in Ayutthaya province. The most intense area for river ports are at middle of Chao Phraya River which is in Amphur Bang Pa-In and Amphur Bangsai in Ayutthaya province. While, the most crowded cargo traffic are in Amphur Pa Mok, Angthong province

because the route is narrow and shallow and it is the longest navigable route of river that the cargo can be delivered.

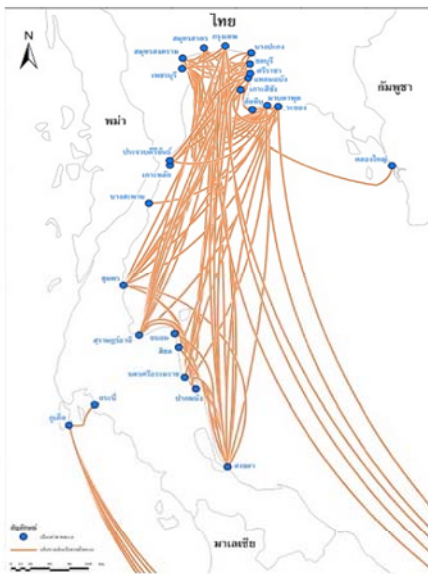
Inefficient service quality of waterway transport is the result from the following problems:

- Infrastructure problems: such as lacking of public river ports with efficient connecting system at hinterland
- Physical problems: shallow and crook channel.
- Regulation problems: such as the terminal handling charge of private sector is not well defined, some regulations for waterway transport business are obsolete.

4) Coastal Transportation

Thailand coast is about 2,600 kilometer in length which 954 kilometers are in the east coast or Gulf of Thailand side whereas 1,600 kilometers are in the west coast or Andaman sea side

covering 24 province of Thailand. Gulf of Thailand is the main coast for logistics with large amount of cargoes. The shipping line of coastal cargo in Thailand usually originates from or destined to



the central region, eastern region, and Gulf of Thailand coast. The major coast ports are

Lam Chabang port, Bangkok port, BMT port, Sahathai port, Prachuab port and Suratthani port as shown in **Figure 6.1-5**.

Figure 6.1-5: Coastal Network in Thailand

Inefficient service quality of coastal transport is the result from the following problems:

- Infrastructure problems: such as lacking of public coast ports with efficient connecting system at hinterland, lacking of proper handling equipments
- Shallow channel problem and unreliable tug service especially during windy season
- Regulation problems: such as the terminal handling charge of private sector is not well defined, the regulations for coastal transport business have many constraints.

5) Air Transport

Presently, there are 36 commercial airports in Thailand consisting of 7 international airports and 29 domestic airports. Most of domestic freight are originated from or destined to the international airports which make them the aviation hub for both domestic and international freight. The existing airports capable of handling cargo comprise Suvarnabhumi Airport (opened for serviced in 2006), Don Muang Airport, Chiang Mai Airport, Chiang Rai Airport, Phuket Airport and Hat Yai Airport as shown in **Figure 6.1-6**.

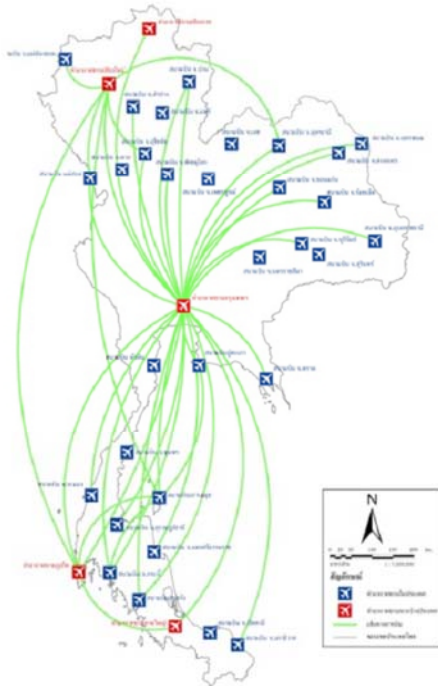


Figure 6.1-6: Airway Network in Thailand

Suvarnabhumi Airport is positioned as major airport of the country where the one stop service has been established to reduce the service time and all international cargo is in the duty free area. In addition the cargo service and customs free zone has been operated at Suvarnabhumi for 24 hours a day with capacity of about 3 million tons per year.

6) Pipeline Transport

Currently, there are two pipeline companies with high potential service in Thailand. The first company is Thai Petroleum Pipeline Co., Ltd (THAPPLINE) which operates on five sections, i.e., (Maptaphut-Sriracha, Sriracha-Lumlukka, Lumlukka-Don Muang,



Lumlukka-Suvarnabhumi, and Lumlukka-Saraburi). However, the average utilization rate is only 32% of capacity. Lumlukka-Don Muang is the most utilized section with 56%, whereas the second most is Lumlukka-Saraburi with 30%.

The second company is Fuel Pipeline Transportation Limited (FPT), opened since 1994, offer pipeline service in four sections, presently, the utilization is below its capacity, that is, the capacity of pipeline is 9,600 million liters per year but the actual utilization is only 3,400 million liters per year accounting for 36% which is nearly the rate of Thappline. So, it is noticed that pipeline transport of

both THAPPLINE and FPT are below its capacity since the transport cost of this mode is very high.

7) Multimodal transport

Multimodal transport is a method in delivering goods, from one place (sender) to another place (receiver), by using various (more than 2) modes of transportation.

Multimodal transport focuses on effectiveness in cost when compares to purely use truck transport. In general multimodal transport aims to use a cheaper transportation mode such as railway transport or water transport to minimize the total shipping cost. An example is to limit the distant of using truck transport by yielding only a short trip from the starting point (a factory) to a connecting point (a rail station) and from another connecting point (another rail station) to the end point (destination). Therefore, a key characteristic of multimodal transport is to have one or more connecting points between an origin (factory) and a destination (consumer or gateway).

In addition to connecting between two modes of transportation, a connecting point may also act as a collecting and distributing center or a place where any logistics activity can be performed. The followings describe potentials and limitations of various kinds of connecting points.

7.1) Truck Transportation Connecting Points



Figure 6.1-7: Truck Transportation Connecting Points

For truck transportation, the Department of Land Transport have currently set up three truck terminals for operations in Bangkok suburb; i.e., Klongluang, Romklao, and Putthamonthon terminals. Truck terminals will play a vital role of logistics by collecting and distributing goods from manufacturers to consumers in such a cost-efficient manner. *Figure 6.1-7* illustrates the locations of the three truck terminals in the Bangkok road network.

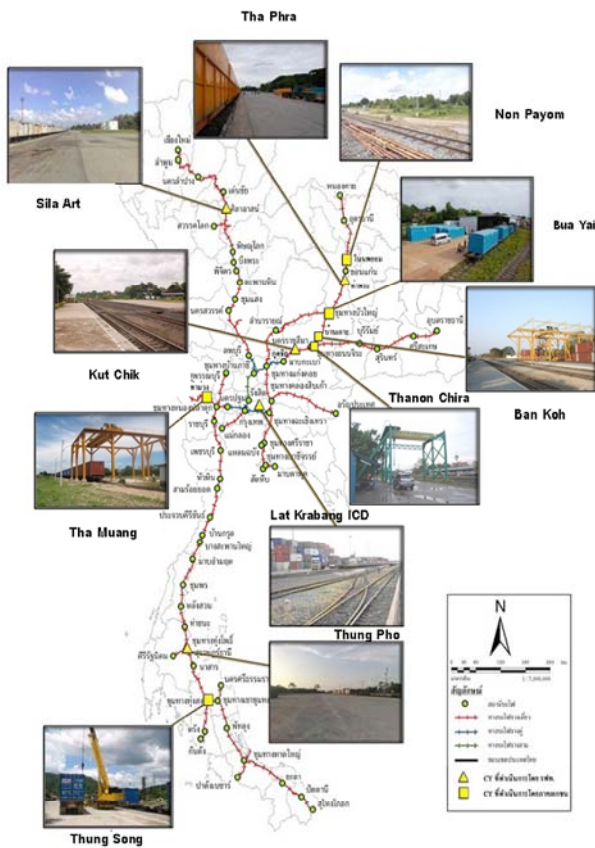


Figure 6.1-8: Thailand's Container Yards

7.2) Railway Connecting Points

The State Railway of Thailand (SRT) has built Ladkrabang Inland Container Depot at (LICD); alternatively, it may also be called as ICD Ladkrabang, to support country import and export and the growth of port cargo container at Lam Chabang. In addition to that, SRT has also built many container yards all over the country to support railway connecting points. *Figure 6.1-8* illustrates locations of the SRT container yards, which include Kudchick station in Nakhon Ratchasima province, Thapra station in Khonkaen province, Silaard station in Uttaradit province, and Ban Thung Pho Junction Train Station in Suratthani province. Moreover, there are many private container yards to support the rail transport. The locations of these private container yards are also shown in the Figure.

7.3) River and Coastal Transport Connecting Points

Most river ports are privately held and located in the Bangkok and Phranakhon Sri Ayudhaya areas. There are 61 ports that are large enough to support a ship of 500 gross tons or more. These ports are located along the Chao Phraya River and mostly are the ports that transfer goods in the middle of the river nearby the Bangkok port, the Si Chang anchorage ground area, or some small coastal vessels for major coastal ports such as Laem Chabang and Prachuap, as shown in *Figure 6.1-9*.



Figure 6.1-9: Important River and Coastal Ports in Thailand

8) Network transport links to international regions

The national highway and railway networks do not only support domestic transport, but also be a part of the Trans-Asian Highway and Railway networks and the ASEAN Highway/Rail networks.



Asian Highway



Trans-Asian Railway



ASEAN Highway



ASEAN Railway

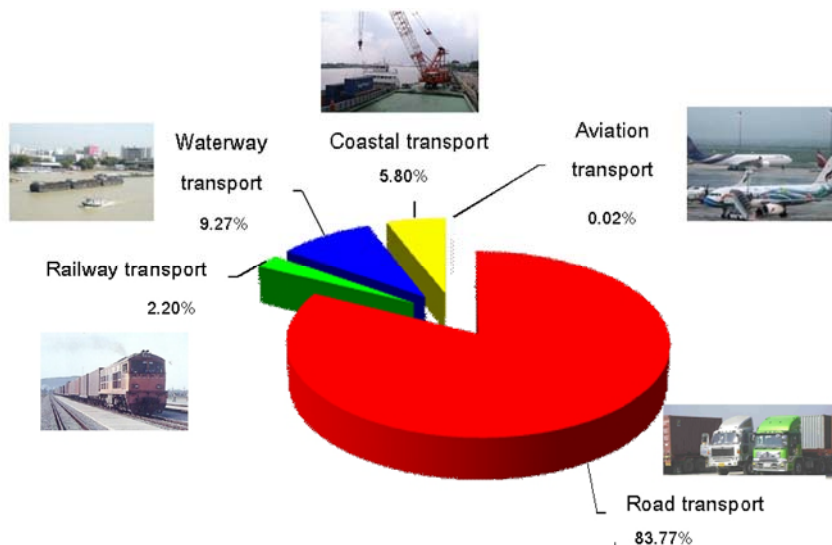
At present, Thailand agrees on the bilateral trade agreement and also is a member of the ASEAN Great Mekong Subregion: GMS, the World Trade Organization: WTO, and the United Nations Conference on Trade and Development: UNCTAD, which induce more demands to transport goods within and across the country. In addition, Thailand has been inducing trades with the neighbor countries via international agreements such as GMS, Ayeyawady-Chao Phraya-Mekong Economic Cooperation Strategy (ACMECS), Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMESTEC), and ASEAN. Therefore, improving transport infrastructure and management policy will be a key factor to strengthen the bilateral, sub-regional, and regional level trade in addition to promoting the tourism activities in conjunction with the developments of the Asian national highway policy, railway within the Asia continent, and the Asian collaboration projects mentioned above.

6.2 Transportation Market Shares by Mode

The Information and Communication of Technology, Ministry of Transport, is an organization that is responsible for annually collecting and presenting the information of transportation market shares by mode. Each year the information is collected and classified by mode of transportation and by type of goods. The important data include volumes of transported goods in the units of “thousand tons” and “million tons-kilometers” (a product of weight multiplied by traveling distant).

6.2.1 Proportions of Transported Goods by Mode of Transport

Road transport is the major domestic freight transportation. In 2009, road transport has the highest volume of 423.6 million tons or 83.77% of the total domestic transport. The second is waterway transport which serves 41.6 million ton or 8.22%. The third is coastal transport which serves 29.3 million ton or 5.80%. Railway transport serves 11.1 million ton or 2.20% whereas aviation transport has the smallest proportion of 0.02% as illustrated in *Figure 6.2-1*.



Source: Ministry of Transport

Figure 6.2-1: Proportion of Transported Goods by Mode of Transport in 2009

In consideration of freight volumes in the past 5 years (2005-2009), as tabulated in *Table 6.2-1* and plotted in *Figures 6.2-2* and *6.2-3*, it can be seen that road transport has the largest market share and it consistently dominates the other modes of transportation. The road transport serves in average of 427 million tons per annual or 83% of the total transported volume.

Table 6.2-1: Transportation Volume by Mode

Transportation Mode	Transportation Volume (Thousand Tons)					
	2005	2006	2007	2008	2009	Average
Road	430,275	427,581	428,123	424,456	423,677	426,822
Railway	11,760	11,579	11,055	12,807	11,133	11,667
Waterway	42,306	40,340	47,229	47,687	41,561	43,825
Coastal	34,254	31,574	31,216	29,615	29,311	31,194
Aviation	120	122	110	106	103	112
Total	518,715	511,196	517,733	514,671	505,785	513,620

Source: Ministry of Transport (<http://vigportal.mot.go.th/portal/site/PortalMOT/stat/indexURL/October2010>)

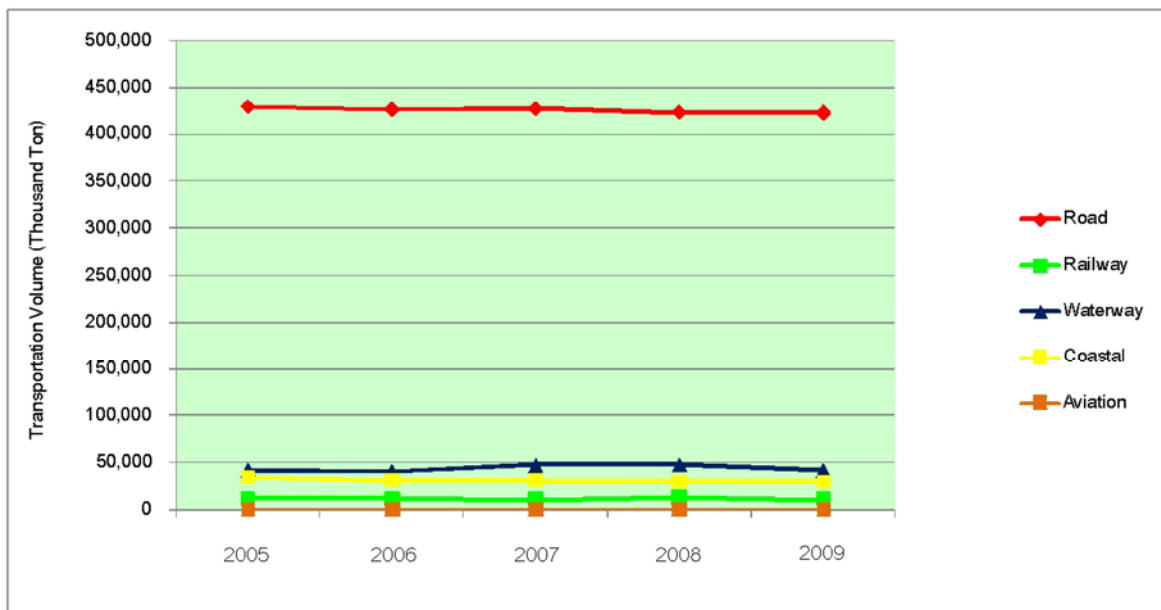


Figure 6.2-2: Transportation Volume Trend



Figure 6.2-3: Proportions of Transportation Volumes

6.2.2 Tons-kilometers of Transported Goods by Mode of Transport

Transportation volumes multiplied by distant (in the unit of tons-kilometers) is another key index in determining market shares. It mirrors the usage of infrastructure by mode. Since the major transportation mode in Thailand is road transport, we found that in 2009 road transport serves the volume of 179,009 million tons-kilometers or 95.63% among all domestic transportation modes. The second is coastal transport which serves 3,587 million tons-kilometers or 1.92%. The third is railway transport which serves 2,533 million tons-kilometers or 1.35%. The domestic water transport serves 2,024 million tons-kilometers or 1.08%. At last, aviation transport serves a very tiny proportion comparing to the total transport volume as shown in *Figure 6.2-4*.

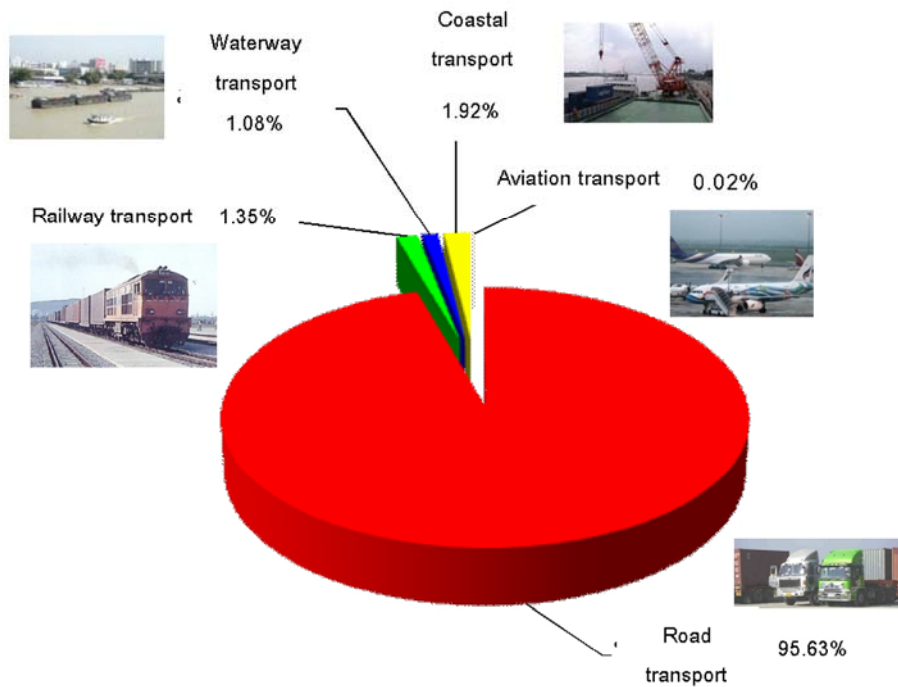


Figure 6.2-4: Transport Volume Proportions multiplied by Distant (million tons-kilometers) in 2009

In consideration of freight volumes in the unit of tons-kilometers in the past 5 years (2005-2009), as tabulated in *Table 6.2-2* and plotted in *Figures 6.2-5* and *6.2-6*, it can be seen that road transport has the largest market share and it consistently dominates the other modes of transportation. The road transport serves in average of 181 billion tons-kilometers annually or 96%.

Table 6.2-2: Transportation Volume Classified by Domestic Transport

Transportation Mode	Transportation Volume (Million Tons-Kilometers)					
	2005	2006	2007	2008	2009	Average
Road	176,751	184,006	186,174	181,452	179,009	181,478
Railway	3,002	2,904	2,688	2,857	2,533	2,797
Waterway	1,906	2,051	2,134	2,058	2,024	2,034
Coastal	3,649	3,834	3,631	3,616	3,587	3,663
Aviation	34	31	31	31	33	32
Total	185,342	192,826	194,658	190,014	187,185	190,005

Source: Ministry of Transport (<http://vigportal.mot.go.th/portal/site/PortalMOT/stat/indexURL/October 2010>)



Figure 6.2-5: Transport Volume multiplied by Distant (million tons-kilometers) during 2005-2009

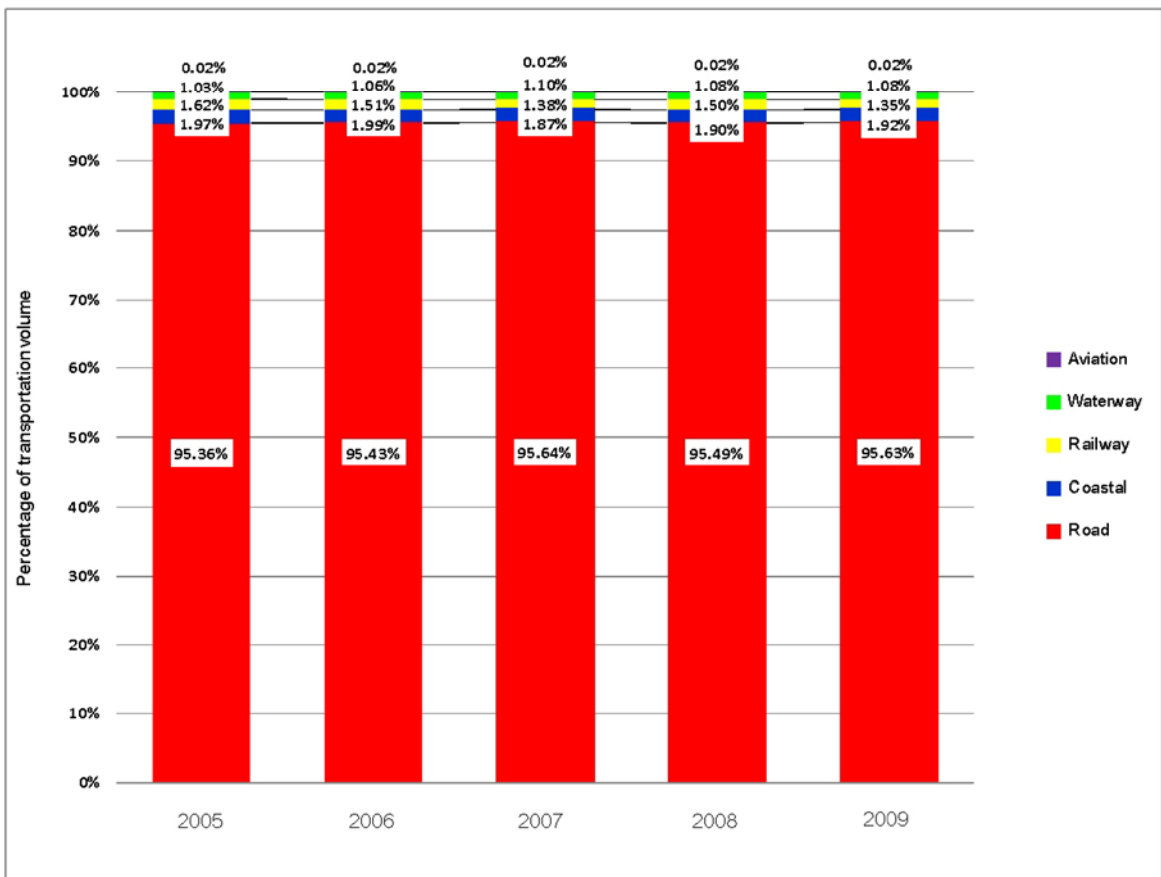


Figure 6.2-6: Transport Volume Proportion multiplied by Distant (million tons-kilometers) during 2005-2009

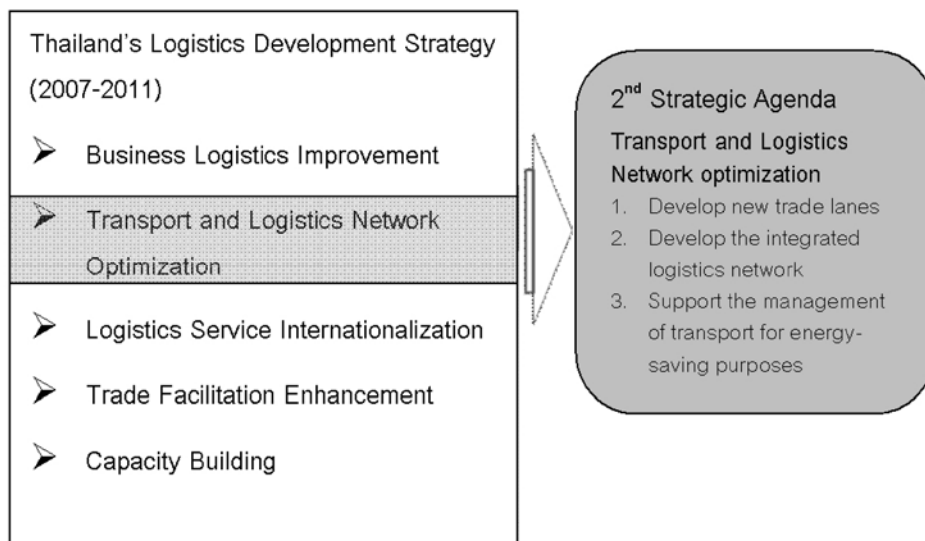
7 RECOMMENDATIONS ON TRANSPORT SYSTEM AND LOGISTICS DEVELOPMENT

7.1 Recommendations on Transport System and Logistics Development

Since logistics compose of many activities, the logistics system development should deal with multiple agencies, both business and government sectors. That means every ministry that relates to business management has an impact to logistics activities. That is because they are responsible for supporting and being a part of supply chain activities.

The office of the National Economic and Social Development Board (NESDB) is the major government agency that is responsible for preparing the logistics system development and strategy plan for Thailand. The agency also has a key role in coordinating with other agencies and pushing the plan. The current plan of 2007-2011 is to promote transportation efficiency, both physical and management, and also to strengthen potential of contest. The plan has 5 key strategies. Each of them has a specific government agency that is responsible for.

The Ministry of Transport is the agency that is responsible for the "2nd key strategy, which is to improve the transportation system and logistics efficiency (Transport and Logistics Network Optimization)". That is to improve relevant infrastructure and to facilitate freight transportation by all means.



Within the 2nd key strategy (Transport and Logistics Network Optimization), there are three major strategies which are as follows.

1st major strategies: **Develop new trade lanes to the Middle East, Africa and Europe via Thailand's Andaman Sea and to accommodate the expanding trade activities of its neighboring countries**

Purpose: To support the new industrial area development and the expansion of international trade volume in world level and region level

Method: 1.1 Develop Pak Bara port and transport connecting system.
 1.2 Develop Ranong port and transport connecting system.
 1.3 Develop Landbridge to connect Gulf of Thailand and Andaman sea port.
 1.4 Develop Transport system to support trade with south of China.

2nd major strategies: **Develop an integrated logistics network, both locally and internationally, in such a way that the country is linked with overseas markets**

Purpose: To connect and use the multimodal transport network efficiency

Method: 2.1 Increase the efficiency of current major Trade door (Lam Chabang port and Suvarnabhumi Airport).
 2.2 Develop transport route on trade route with neighbor countries.
 2.3 Develop collecting system and distribution cargo.
 2.4 Increase service ability of Thai businessman and joint venture with neighbor businessman.

3rd major strategies: **Support the management of transport for energy-saving purposes. This will eventually lower transport costs at both business and national levels**

Purpose: To support the modal shift from road transport to water, railway, and pipeline transport in order to reduce the transport and logistics costs and consume energy efficiently

Method: 3.1 Develop water transport infrastructure.
 3.2 Develop railway infrastructure.
 3.3 Re-engineering transport management system.
 3.4 Application of Intelligent Transport Systems (ITS) in freight transport

The development of infrastructure and facility that is sufficient and harmonizes with the demand will create an efficient transportation system that is able to decrease the transportation cost which is the major cost of logistics. Besides, it is the part of supporting country's transport system and logistics development strategies to compete with other countries.

7.2 Methods of Decreasing Transport Cost

7.2.1 Reduce Empty Trips

The dispatch and return cargo strategy is to increase transport efficiency by reducing empty trips or backhauling management which targets to taking advantages of moving vehicles (Load utilization). That is because freight delivering in general making two trips: dispatching with loads and returning without loads. The returning trip is a non-value added cost that companies have to bear. The current practice of backhauling management is, however, not quite efficient. That is because the quantity and destination of demands for transport have not been known well enough. Also, it is quite usual to have an imbalanced demand--the freight demand of inbound is not equal to the outbound.

From surveying and collecting road transport data of empty backhauling, proportion of empty trips and cost (in Baht per ton-kilometer) in delivering twelve strategic cargoes are presented in *Table 7.2-1*.

Table 7.2-1: Proportion of Empty Backhauling and Transport Cost by Strategic Cargoes

Strategic Cargoes	Proportion of empty backhauling	Transport Costs (Baht per ton-kilometer)
Rice	40%	1.61
Cassava	40%	1.51
Sugar	35%	1.54
Rubber	33%	1.52
Soybean oil	36%	2.59
Fuel Oil	100%	2.42
Plastic Resin	100%	2.48
Construction Metal	50%	1.61
Hot-rolled Steel	50%	1.24
Cement	58%	1.18
Carbonated Drink	72%	1.97
Consumer Products	40%	1.80
Average	48%	1.72

Source: Consultant

From the analysis of transport cost, it is found that the proportion of empty trips in returning to the warehouse is the key factor of unnecessary cost, which should be minimized. **Table 7.2-2** illustrates the changes of road transport cost as a result of the changes of empty trip proportions.

Table 7.2-2: Comparison of Empty Backhauling Proportion and Road Transport Cost

Empty Trip Proportions in Returning	48%	45%	40%	35%	30%	25%	20%	15%	10%
Road transport cost (Baht per ton-kilometer)	1.72	1.67	1.59	1.53	1.47	1.42	1.37	1.33	1.29

As a result of the analysis, it is also found that: if the proportion of the empty trips reduces by 1%, the road transportation cost will decrease by 0.65% or about 2,000 million baht per year with current demand as illustrated in *Figure 7.2-1*.

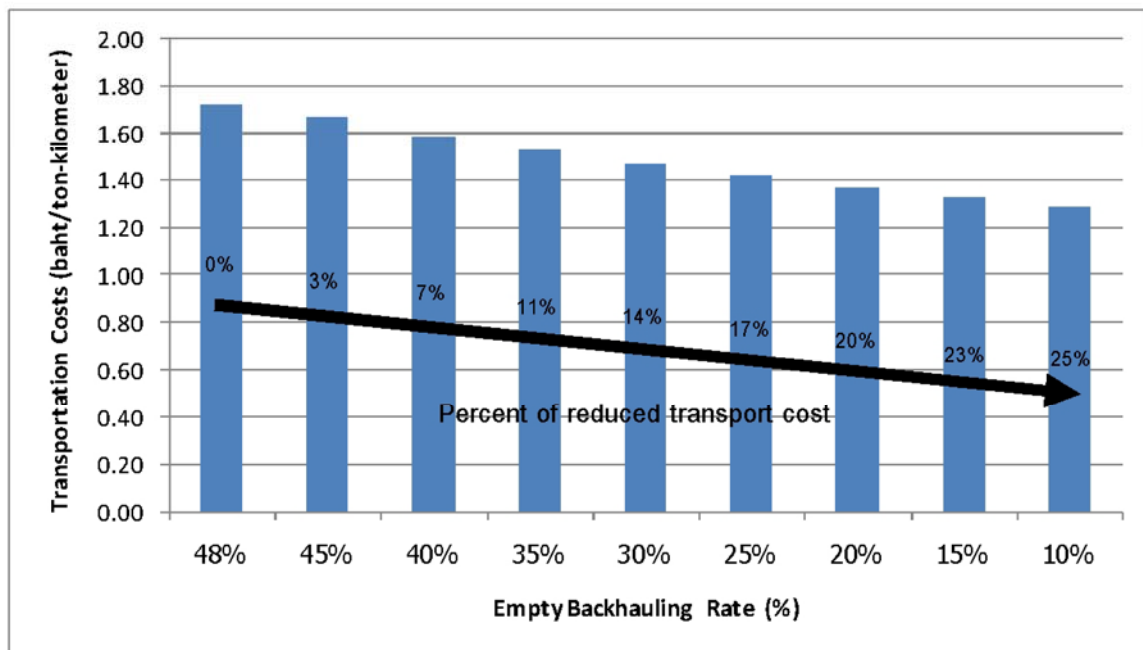


Figure 7.2-1: The Success of Reduced Road Transport Cost

Therefore, the backhauling management is very necessary and it should be implemented. Important items that should be improved to make the backhauling management succeeded is information flow management. Entrepreneurs shall cooperate, plan, and forecast demands in fulfilling the stock in advance. Recently, Department of Land Transport (DLT) has established the web database of truck operators as central information between service providers and customers. The key success in reducing cost due to empty trips is then depending on usages of information technology, collaboration network, and logistics providers.

7.2.2 Alternative Energy Consumption

Alternative energy consumption is another option that can reduce the cost of transport and logistics. As a result of the study of cost structure of road transport, it is found that fuel cost is the major element that occupies 72% of the variable cost as illustrated in *Figure 7.2-2*.

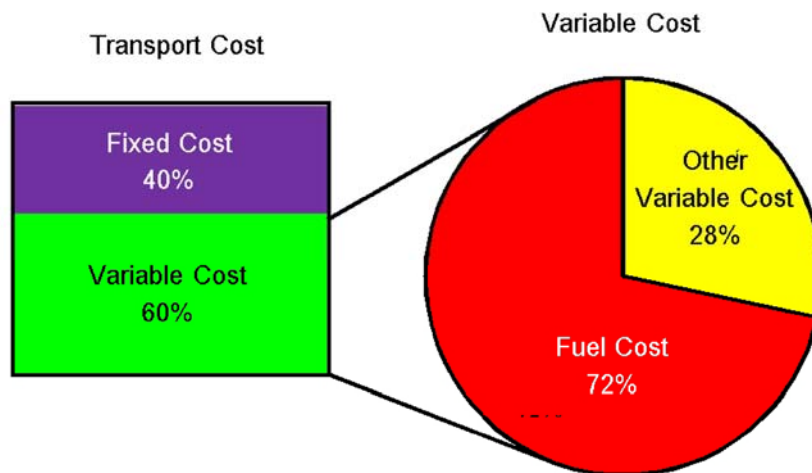


Figure 7.2-2: Percentage of Fuel Cost as a Component in Road Transport Cost

Therefore, alternative energy usability is another option that can remedy the impact of price fluctuation of crude oil to the transport cost. From the analysis of the impact of fuel price to the road transport cost, it is found that 1% increase in domestic fuel price results in 0.48% increase in road transport cost as illustrated in *Table 7.2-3*.

Table 7.2-3: Impact of Fuel Price to the Road Transport Cost

Increase in domestic fuel price (%)	0%	10%	20%	30%	40%	50%	Average of each 1%
Increase in road transport cost (%)	0.0%	4.7%	9.3%	14.0%	19.2%	23.8%	0.48%

Source: Consultant

For the analysis of cost reduction from alternative energy, the consultant studied the fuel consumption from 10 wheels truck fuel cost when using diesel fuel in comparison to using NGV gas. It is found that using NGV gas saves about 50% of cost in relative to using Diesel fuel as summarized in *Table 7.2-4*.

Table 7.2-4: Fuel Cost Reduction from Using Alternative Energy

Diesel consumption rate (km/ltr)	3.60	NGV consumption rate (km/kgs)	2.23
Diesel retail price (bht/Ltr)	27.19	NGV retail price (bht/kgs)	8.5
Fuel rate (bht/kgs)	7.55	Fuel rate (bht/kgs)	3.81
Reduce cost (bht/kgs)	3.74		

However, entrepreneurs may have additional costs from modifying vehicle engines for using the NGV gas and the maintenance cost of using the NGV engine is typically higher than using the diesel engine. The details of additional transport costs are shown in *Table 7.2-5* and *Table 7.2-6*.

Table 7.2-5: Additional Cost to Modify to NGV Engine

Modify to NGV engine (baht)	650,000
Engine Lifetime (years)	7
Average usage per year (km)	75,000
Additional cost to modify to NGV engine (baht/km)	1.24

Table 7.2-6: Additional Maintenance Costs

Diesel engine maintenance cost (baht/km)	1.07
NGV engine maintenance cost (baht/km)	1.39
Additional maintenance cost when using NGV (baht/km)	0.32

Therefore, with the consideration of modifying vehicle engine in the case of 10 wheels truck, the study indicates that the alternative energy option will decrease transport cost by 2.18 baht per kilometer, or 13%. As a result, it can be translated to the reduction in cost of 165,000 baht per truck per year. *Figure 7.2-3* illustrates the comparison between percentage reductions in energy and transport costs when using the alternative energy.

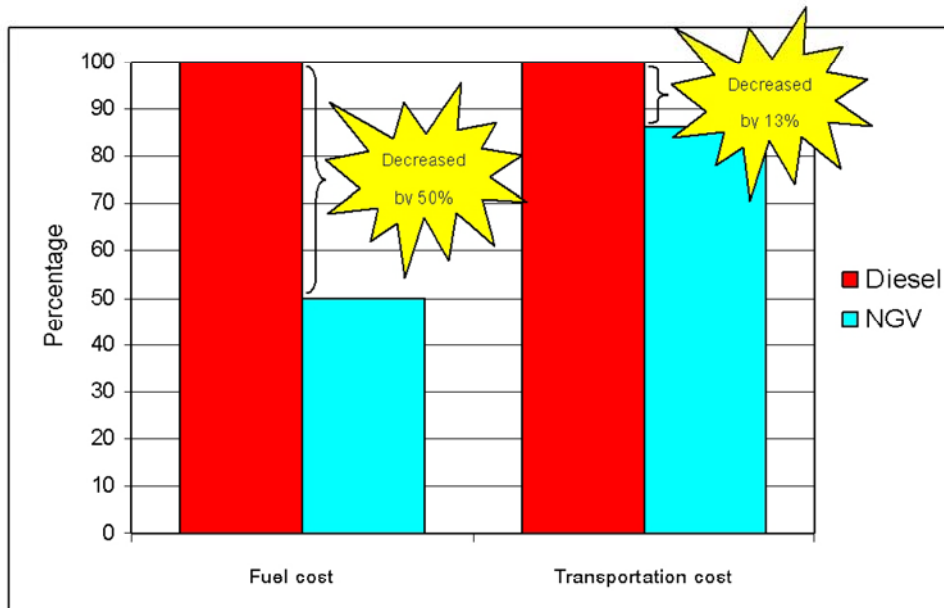
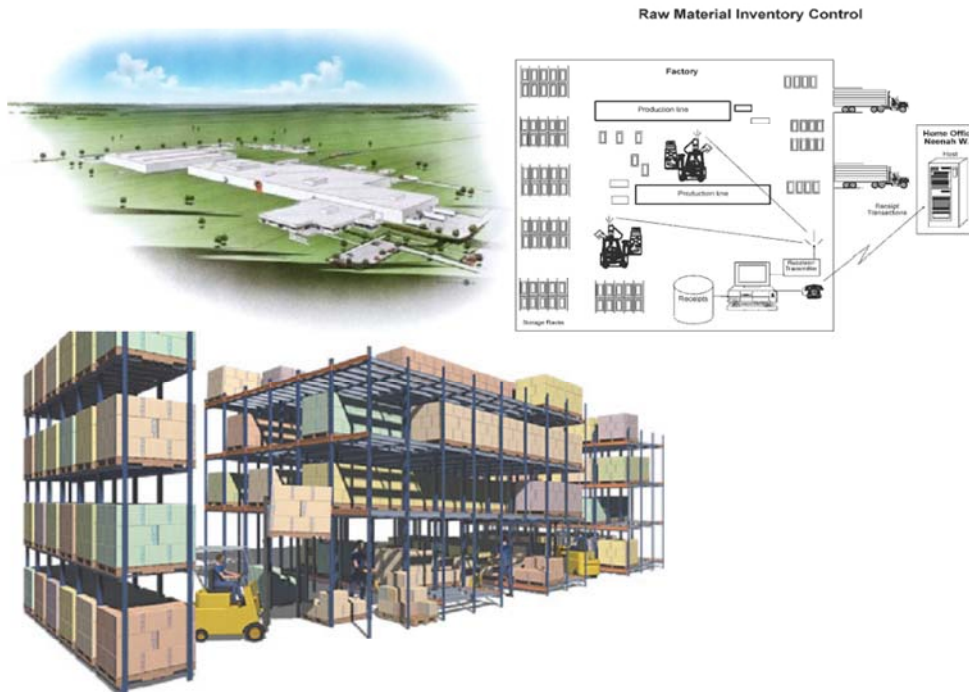


Figure 7.2-3: Compare the Cost when use NGV and Diesel

Nevertheless, apart from the feasibility in monetary term, the transport entrepreneurs must also consider adequacy and locations of NGV stations within the relevant routes.

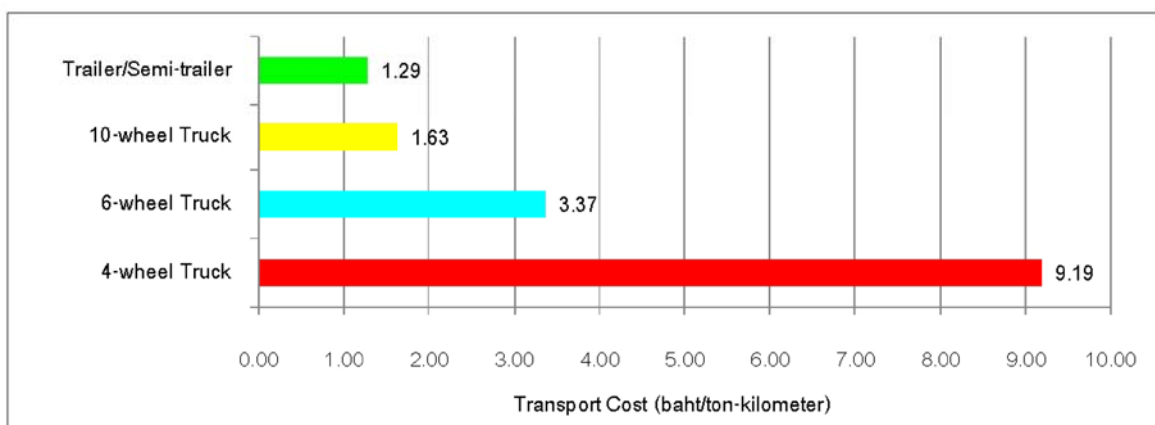
7.2.3 Location and Warehouse Management



Strategically picking the locations of warehouses for collecting and distributing goods is very important to transport goods to nearby provinces or countries. It will reduce transport cost. Delivering goods to a province that does not have a warehouse mostly requires empty trucks during the returning trip. Strategically picking the locations can remedy the problem. An efficient network of warehouses should be created to fully load trucks, assign an appropriate number of trucks to the quantity of goods and delivery locations, and have a supportive system in collecting various cargos or changing transportation mode for more energy saving.

7.2.4 Development of Truck Routes

Development of truck routes is to promote road transport by allowing big trucks that can carry a lot of goods to use truck routes instead of normal routes. This approach can remedy congestion, accident, and environmental problems created by trucks. As a result of the study of road transport cost structure, it is found that using big trucks has a lower transport cost than using many small trucks. For example, using trailer/semi-trailer trucks has transport cost of 1.29 Bahts per ton per kilometer whereas using 4-wheel trucks has 9.19 Bahts per ton per kilometer. *Figure 7.2-4* illustrates cost of using various types of trucks.



Source: Consultant

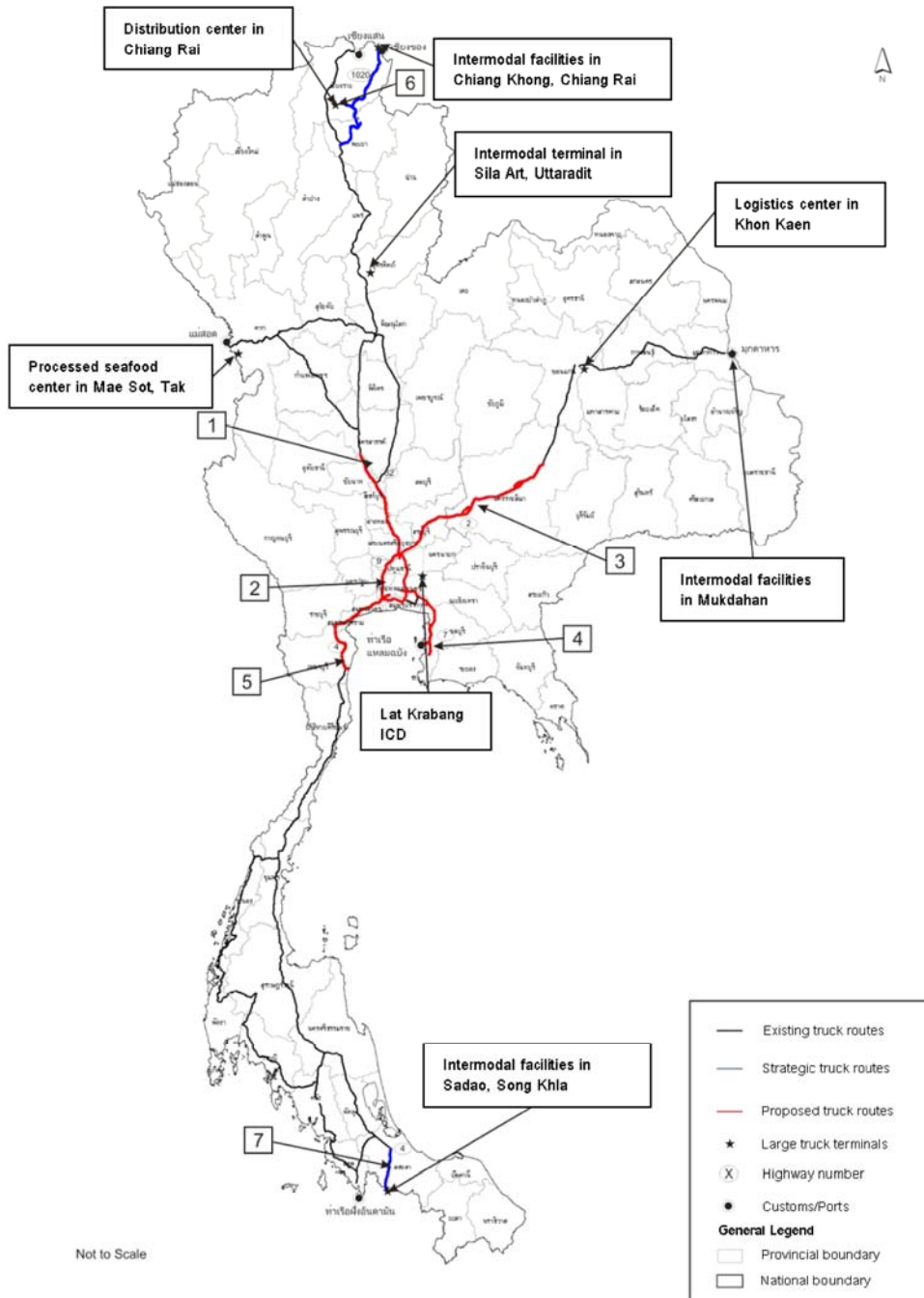
Figure 7.2-4: Cost of using Various Types of Trucks (baht per ton per kilometer)

The development of truck routes must consider two important issues; i.e., creation and operations of truck routes. Creation of truck routes includes both construction a new roadway and improvement existing roadways. Operations (or management) of truck routes include dealing with legislative issues and using technology to improve operational efficiency.

From the studies for truck route development and multimodal freight management, done by OTP, a tentative truck route network was proposed as shown in *Figure 7.2-5* whereas the details of each route are as follows

- Northern route: Highway no. 32 from Amphoe Bang Pa-in in Ayutthaya province to Nakhon Sawan province section with total distance of 167 km
- Central route: Inter-city motorway no. 9 with total distance of 165 km
- Northeastern route: Highway no. 1 and 2 from Amphoe Bang Pa-in in Ayutthaya province to Nakhon Ratchasima province with total distance of 199 km
- Eastern route: Inter-city motorway no. 7 from Outer Ring Road junction to Laem Chabang port with total distance of 98 km
- Southern route: Highway no. 35 and 4 from Outer Ring Road junction to Amphoe Pak Tho in Ratchaburi province and Amphoe Cha-Am in Petchaburi province with total distance of 141 km

In conclusion, the development of truck routes will help transport cost reduction by changing from using many small trucks to fewer big trucks. In addition, it improves efficiency of logistics which covers traveling route and transferring points of transporting goods from sources to consumers. Also, it serves entrepreneurs' need and remedy traffic congestion, accident, and environmental problems. Nevertheless, the feasibility of investment should be carefully considered by taking into account of both demand and supply sides.



Source: The Study for Truck Route Development and Multimodal Freight Management (OTP)

Figure 7.2-5: A Tentative Truck Route Network as proposed by OTP

7.2.5 Applications of ITS Technology in Transport Activities

Commercial Vehicle Operation (CVO) is a part of Intelligent Transportation System (ITS) that takes the state-of-the-art technology to increase the efficiency of transport. This leads to operational cost savings, accuracy, and reliability in terms delivery time and product safety. *Figure 7.2-6* illustrates some applications of ITS technology in transport activities.

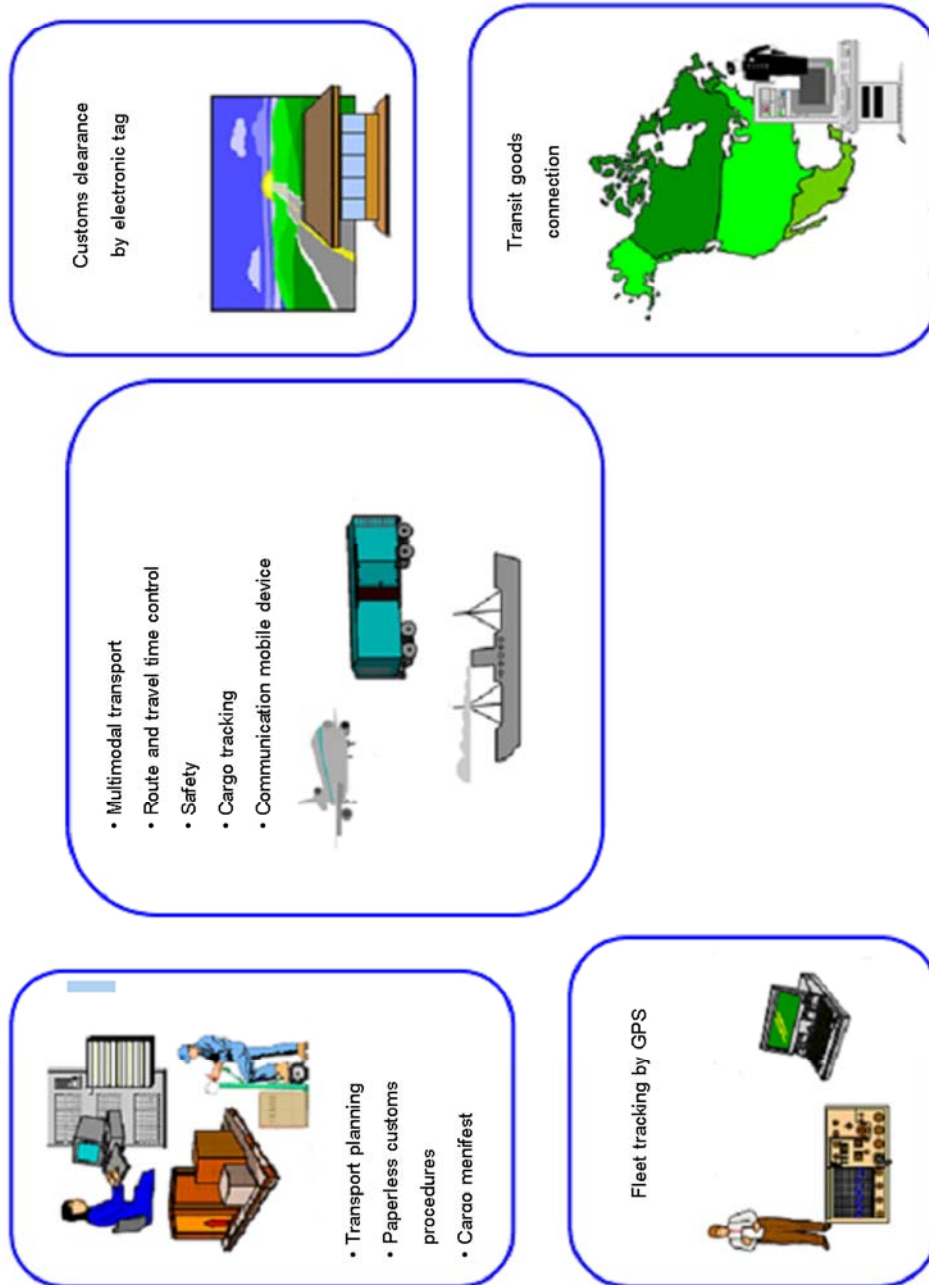


Figure 7.2-6: ITS Technology for Better Efficient and Safe Transport

From the study of ITS Benefits, Costs and Lessons Learned, done by the U.S. Department of Transportation, it evaluates the use of ITS technology in transport activities as follows.

- A study done by the American Trucking Association Foundation found that electronic data interchange will reduce paper cost by 9-18%.
- An electronic registering and licensing system helps reduction in many unnecessary procedures and saves relevant cost by 60-75%.
- An information exchange system for motor vehicle inspection among states helps to arrest more cars that did not pass inspection by 2%; that reduces accidents related to truck by 84 times per annual.
- Georgia, Kentucky, North Carolina and Tennessee states participated in the evaluation system of vehicle inspection by infrared--when a truck drives thru a weight checkpoint. It was found that the system can indicate more trucks (that do not pass brake-condition requirements) 2.5 times.
- An evaluation of an electronic border inspection system at the Ambassador Bridge checkpoint indicates that the checkpoint time decreases by 50%.
- A monitoring and managing fleet vehicle system increases efficiency of transport by increasing the number of less-than-truck-load trips by 3.5%. It also increases the number of full-truck-load trips by 11%. That is translated to the cost saving for long distant trips by \$1,500-\$10,968 per truck per year.

7.2.6 Improvement of Relevant Rules and Regulations

Rules and regulations could be barriers or facilitators to logistics activities such as delivery products and services within the country, import and export products to and from other countries, etc. Rules and regulations that facilitate the flow of cargos and services will enhance logistics process to run smoothly and efficiently both in terms of cost-effectiveness and timely needs by clients both inside and outside of the country.

Rules and regulations that can support logistics activities and relevant services provided by the government should be improved to the international standard.

- Improve rules and regulations for supporting logistics activities to the international standard.
- Push law enforcement to support electronic transactions.
- Revise rules and regulations related to international logistics activities so that the interregional logistics collaboration can be done efficiently.
- Improve database systems by having a central standard to share or exchange information.

7.3 Modal Shift Strategies

7.3.1 Guidelines for Implementation of Modal Shift

Modal shift from road transport to other transport modes is well accepted as it could lessen a unit cost of energy consumption and impact to environment. Especially, modal shift to rail and water transports are the important strategy and well accepted by many countries, both in developed and developing countries. Modal shift can reduce costs, create competitive advantages in service, and be a part of logistics management to maximize efficiency for supporting the development of competitiveness of the country.

The strategic developments of multimodal transport have basic guidelines to create multimodal transport corridors that aim for:

- Providing a major route that utilizes railway or coastal barge instead of roadway to transport between various transportation hubs as show in *Figure 7.3-1*.
- Creating regional clusters in corresponding to service areas of various logistics centers.
- Developing a feeder system for each transportation hub for transferring goods to trains or ships.

The development of modal shift should solve the Missing Links problem, lacking (insufficient or inefficient) transferring points. Using a Hub-and-Spoke system or well managing transferring connections will create an efficient system that is convenient to use, fast, and cheap. This results in competitive advantages. Therefore, the development of modal shift should focus on networking all the links, inside and outside of the country. Besides, technology to support modal shift should be considered as one of the most important factors to develop an efficient modal shift system.

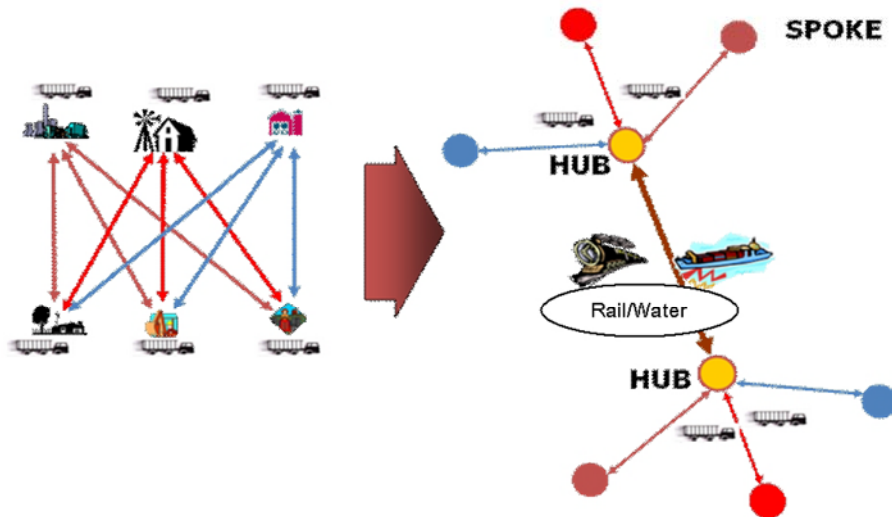


Figure 7.3-1: Modal Shift from Road Transport to Rail or Water Modes

From the study results entitled “*The Study of Factors and Impacts of Modal Shift from Road to Rail and Water Transport*” in 2008, it was found that the market shares of railway and water transportation modes are very low. The development of modal shift from road transport to rail and water transports to an appropriate amount will require some significant time and effort to make it happen, especially to build basic infrastructures to support the logistics network and services. Therefore, there is a need to act immediately for promoting and increasing the market shares of railway and waterway transports. At the same time, the long term plan should be set as to support a sustainable transport by having a system with enough coverage and efficient. The followings are the list of the short term plans for promoting and increasing the market shares of railway and waterway transports for decreasing cost and environmental impacts.

- Improve the railway and waterway transport services

Railway: Reform the operations of the State Railway of Thailand in acquiring locomotives and supply equipment, building and improving railway lines, and controlling signals at intersections. The important projects by SRT are, e.g.,

- (1) Track rehabilitation phase 5 and 6: total distance of 586 km and total investment cost of 15,287 baht
- (2) Double-track railway line for Chachoengsao-Klong Sib Klao-Kaeng Khoi section: total distance of 106 km and total investment cost of 11,348 baht

- (3) Procurement of electrified locomotives consisting of 7 locomotives with investment cost of 1,155 million baht and 50 locomotives with investment cost of 6,563 million baht
- (4) Procurement of 308 merchandise bogeys with investment cost of 770 million baht
- (5) Double-track railway lines such as Lopburi - Pak Nam Pho section (7,860 million baht), Map Kabao – Nakhon Ratchasima section (11,640 million baht), Nakhon Ratchasima-Khon Kaen section (13,010 million baht), etc.
- (6) Procurement of traffic control lighting with investment of 11,358 million baht

Waterway: Improve inspection and maintenance of channels to avoid the shallow problem as well as develop a water traffic system.

- (1) Railway freight train center at Laem Chabang port with investment cost of 2,025.30 million baht
 - (2) Construction of river ports for energy saving with investment cost of 379.60 million baht
 - (3) Development of the second Songkhla deep sea port with investment cost of 5,757 million baht
 - (4) Construction of the second Chiang Saen port in Chiang Rai port with investment cost of 1,530 million baht
 - (5) Construction of Pakbara deep sea port in Satul province with investment cost of 12,479 million baht
- Apply technology to help managing both transportation and information systems to improve efficiency and reduce cost.
 - Encourage rail and water transport operators by improving the regulatory obstacles and reducing operational redundancy.

The long term plan is to ensure an appropriate mode shift to rail and water transport.

Action plans include:

- Construct and improve railway network to serve increasing demand and link with neighboring countries. Also, expand the coverage of railway and waterway network to serve more transferring points of collecting and distributing cargos in corresponding to the growth of cities and economy by talking into account production sources and consumers of major industries that should be appropriately allocated.

- Construct and improve major national highway network to access railway and waterway networks as well as border gateways to neighbor countries.
- Encourage private participants, especially Thai private companies, to participate in investment and management so that the government does not have to bear all the cost and that will also increase efficiency of administration.

7.3.2 Guidelines for Assessment of Modal Shift

1) Transport Model

A transport model shall be used to assess and forecast modal shift. The current model (Transport Database, Transport Model and Logistics System (TDML) was developed by OTP in B.E. 2552 based on the prior projects: “Development of Multimodal Transport and Logistics Supply Chain Management for Implementation of Action Plan” and “National Model: NAM”. The TDML model is necessary for modeling freight transport. Within the model, multimodal transportation is taken into account which includes both passenger and freight trips in various modes of transportation; i.e., roadway, railway, waterway, and aviation transports. The followings are the study years in the TDML model.

- | | |
|---------------------------|------|
| ● Base year | 2009 |
| ● 5 years from base year | 2014 |
| ● 10 years from base year | 2019 |

2) Applications of Transport Model

Impacts from a project to cost of transport can be analyzed by the transport model. The model shall be used to forecast and compare changes in cost between two cases:

- Case 1 : Without Project (Do-Nothing)
- Case 2 : With Project (Committed Project)

The committed project that was used in this analysis composes of planned improvement and construction projects for roadway, railway, and various important ports. Examples are the inter-cities national highway project, the track doubling project, the construction of Pak Bara Port project, the Song Khla second port project, etc. *Table 7.3-1* tabulates the set of committed projects which costs 514,639 million bahts.

Table 7.3-1: Details of Committed Projects in This Study

No.	Project Title	Analysis Time Horizon		Investment (million baht)
		Phase 1: 2009-2014	Phase 2: 2014-2019	
1	Four-Lane Highway Widening Project (Second Phase)	✓	✓	51,395
2	Inter-city Motorway Project			
	2.1 Bang Pa-In – Saraburi – Nakhon Ratchasima		✓	52,720
	2.2 Bang Yai – Ban Pong – Kanchanaburi		✓	23,770
	2.3 Chonburi – Pattaya – Map Ta Phut		✓	10,650
	2.4 Nakhon Pathom – Samut Songkhram – Cha-Am		✓	37,300
	2.5 Bang Pa-In – Nakhon Sawan		✓	32,400
3	Double Track Railway Lines			
	3.1 Chachoengsao – Sriracha – Laem Chabang	✓	✓	5,250
	3.2 Chachoengsao – Klong Sib Khiao – Kaeng Koi	✓	✓	11,348
	3.3 Lopburi – Nakhon Sawan – Pak Nam Pho		✓	7,860
	3.4 Map Kabao – Thanon Jira		✓	11,640
	3.5 Thanon Jira – Khon Kaen		✓	13,010
	3.6 Nakhon Pathom – Nong Pladook – Hua Hin		✓	16,600
	3.7 Prachuap Khiri Khan – Chumporn		✓	17,000
	3.8 Kaeng Koi – Bua Yai		✓	28,800
	3.9 Pak Nam Pho – Taphan Hin		✓	7,500
	3.10 Hua Hin – Prachuap Khiri Khan		✓	9,100
	3.11 Chumporn – Surat Thani		✓	17,000
4	Railway Track Rehabilitation Phase 5 and 6	✓	✓	15,287
5	New Railway Lines			
	5.1 Denchai – Chiang Saen – Chiang Khong		✓	45,000
	5.2 Bua Yai – Mukdahan – Nakhon Panom		✓	38,000
6	New ICD at Lad Krabang	✓	✓	6,066
7	Railway Traffic Control and Communication Improvement	✓	✓	23,750
8	Railway Locomotives and Carriages Improvement	✓	✓	13,427
9	Pakbara Port Construction		✓	12,479
10	Second Songkhla Port Construction	✓	✓	5,757
11	Second Chiang Saen Port Construction	✓	✓	1,530
Grand Total		514,639 Million Baht		

The forecasted freight demand are shown in *Figure 7.3-2*.

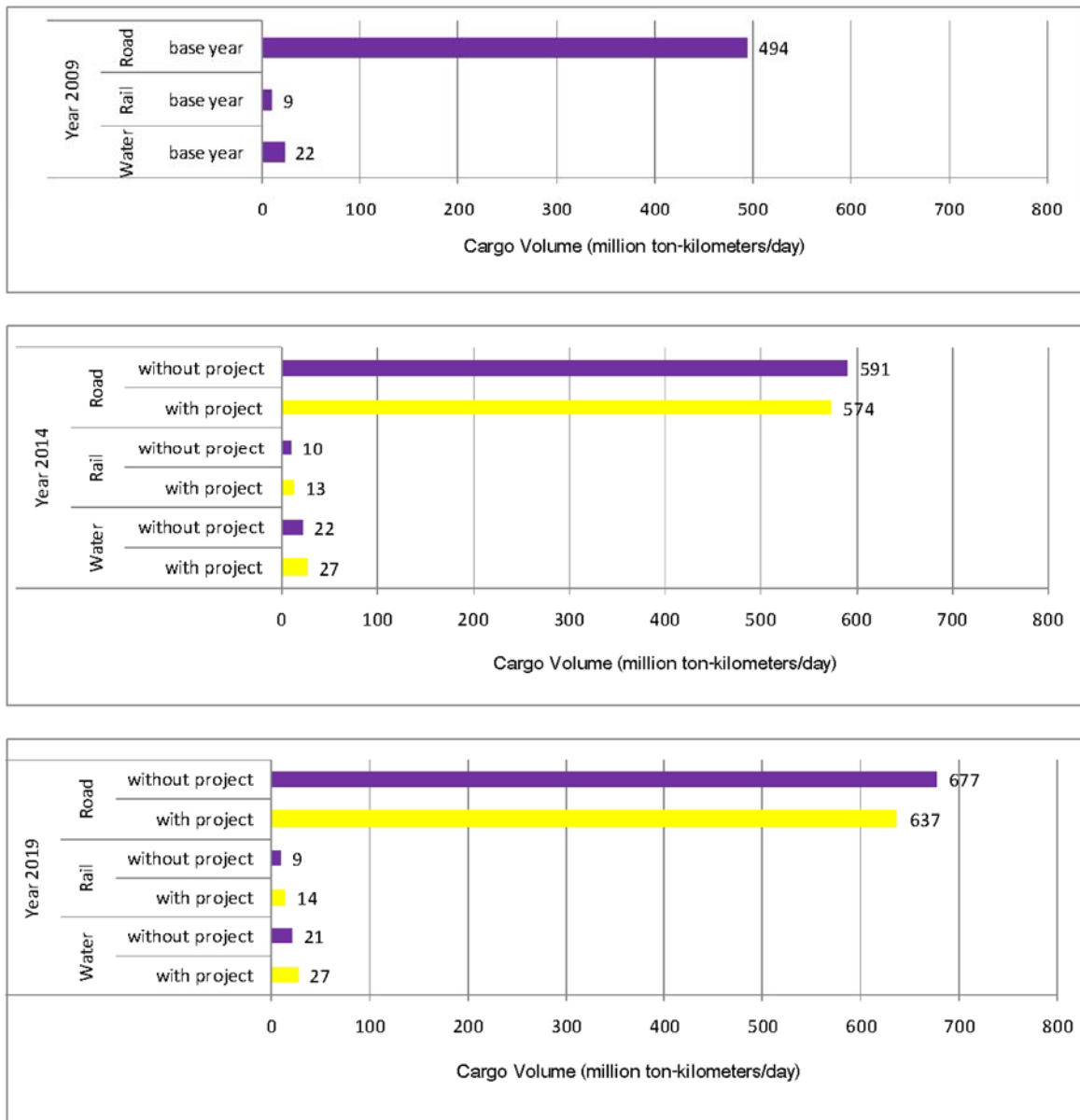


Figure 7.3-2: Results of Forecasted Transport Demand Analysis (with and without project cases)

7.3.3 Impact of Modal Shift to Transport Cost

From the study, the unit costs of road, rail, and water transports are 1.72, 0.93, and 0.64 baht per tons-kilometers, respectively. Given that the transport volumes of each mode are known (in the unit of tons-kilometers), the average transport cost of all modes can be calculated as follows.

$$\text{Average transport cost} = \sum (\text{Volume}_i \times \text{Unit cost}) / \text{Total volume}$$

Where i is a transport mode (i.e., road, rail, and water)

The average transport costs in the cases of with and without project in various study years are summarized in **Table 7.3-2** for comparison.

Table 7.3-2: Summary of Transport Costs in Study Years

Description	Average transport cost (baht/tons-kilometers)		
	2009	2014	2019
Without project	1.6609	1.7452	1.9949
With project	-	1.6740	1.8669

Note: These costs are taken into account of the impact from traffic in the road network

From **Table 7.3-2**, it can be noticed that, in the year 2014 without project, the transport cost increases from the base-year of 1.6609 to 1.7452 baht per tons-kilometers. However, with project, the transport cost decreases to 1.6740. Similarly, for the year 2019 without project, the transport cost increase from the base-year to 1.9949. However, with project, the transport cost decreases to 1.8669,

7.4 Development of Indicators to Evaluate Transport Efficiency

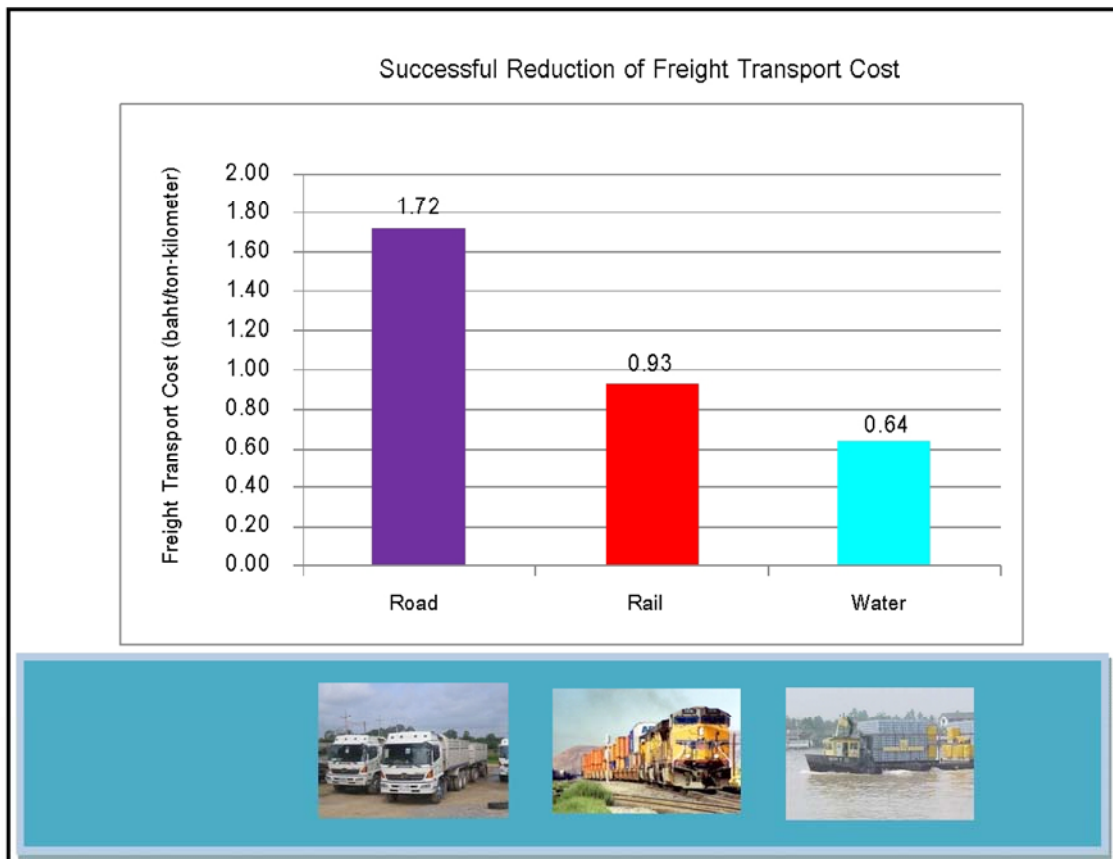
This section defines Key Performances Indicators (KPIs) to evaluate transport efficiency. The indicators should reflect the performance of transportation services to be used as a tool to monitor, assess, and drive the development of infrastructure and facilities to create an efficient freight transportation that minimizes the cost of logistics which is a part of supporting the strategic development of transport and logistics of the country.

This study focuses on transport cost dimension instead of simply using the traditional indicator of transport cost per gross domestic product (GDP), which is published by the Office of the National Economic and Social Development Board (NESDB). That is because the use of transport cost per GDP may not be appropriate for the Ministry of Transport. The study team comprehensively studies by digging down to the detailed calculation of transport cost per GDP which is only a part of logistics cost per GDP. It is found that the cost per GDP biases from many external factors and it deals with many other agencies outside of the Ministry of Transport. Therefore, this study proposes to use an indicator of

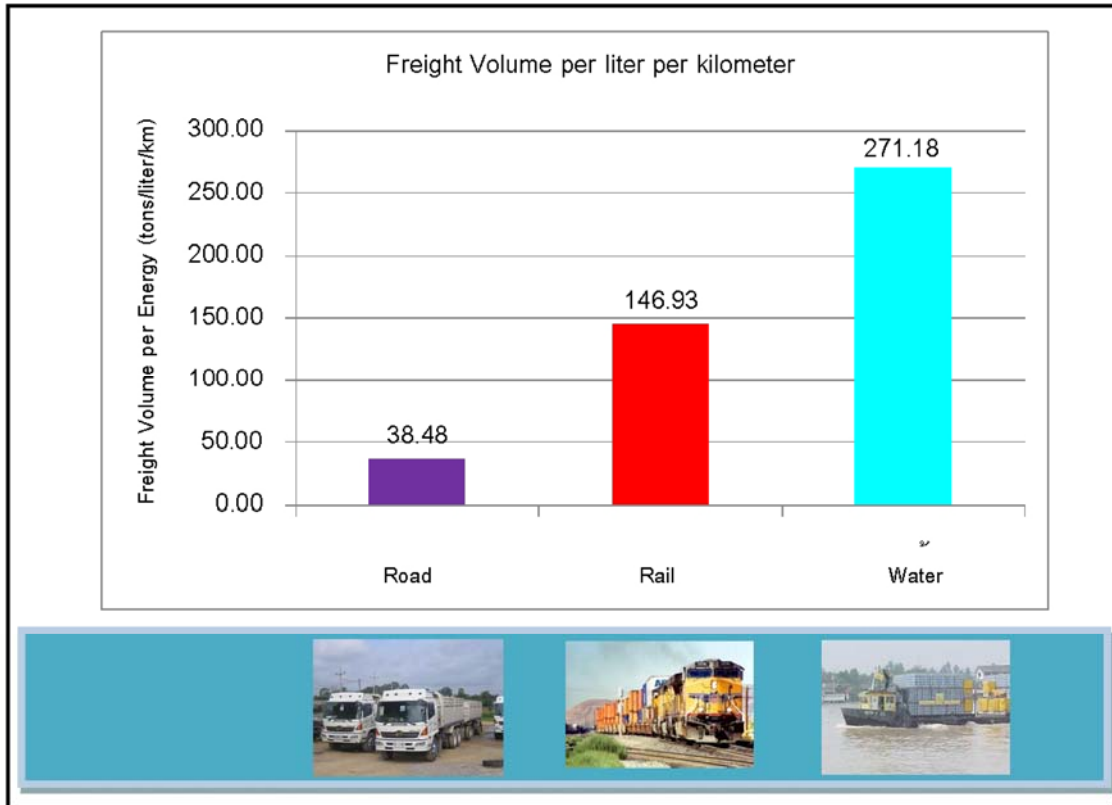
Reduced Freight Transport Cost, instead of the transport cost per GDP, since they can be quantified under the responsibility of the Ministry of Transport.

However, the study found that the transport system should not only focus on reducing freight transport cost to enable low-cost carrier, but also need to consider the suitability and quality of service. Low cost but poor quality cannot enhance the potential of competitiveness. Many times users focus on the quality of service rather than cost. Therefore, the study team proposes to use additional indicators to cover multi aspects as follows.

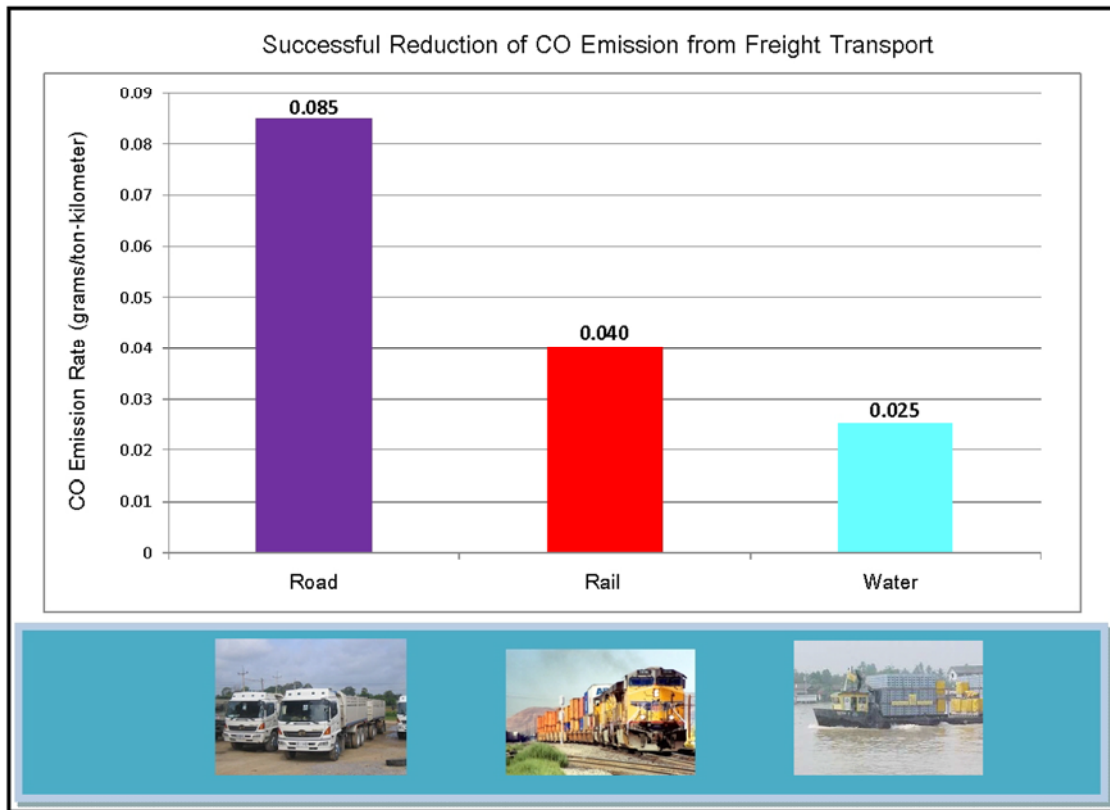
- Index 1: Reduce unit costs of freight transportation (baht/ton-km) is a measure on cost of freight transportation (Cost of Freight Transportation Indicator)



- Index 2: Reduce energy consumption ratio in transportation (units: liters/ton-km) is a measure on energy consumption (Energy Consumption Indicator)



- Index 3: Reduce the emission of carbon monoxide (CO) resulting from the shipment (unit: grams/ton-km/year) as an environment indicator (Environmental Indicator)



- Index 4: Quality and satisfaction of transport service (Quality Indicator) is a measure of transport system usability quality by questionnaire the user's satisfied of each service.

To measure and evaluate the quality of service can be done by field survey or questionnaire on the following items.

- Transport Cost
- Travel Time
- Transport Reliability
- Freight Transport Safety
- Transport Convenience
- Tracking Ability

8 CONCLUSION AND RECOMMENDATION

Logistics management is an activity associated with the movement of cargo. The supply chain management is the strategic management concept trying to create cooperation and coordination among network partners in all levels of the supply chain to be able to function well together as one without a seam and to be a channel or networks that are optimized for information flows, materials and capital flows. Thus, under business competition today, the logistics management and supply chain management are harmonized and dependent on each other. This is the logistics management in terms of supply chain that focuses on collaboration.

- Logistics cost reduction
- Create more economic value from logistics industry and related industries
- Increase business performance in response with customer's demand

Transport and logistics cost reduction is a way to enhance competitiveness. However, it is only one; there are many other ways to enhance competitive capability with integrated and sustainable manner, i.e.,

- Integration of supply chain
- Value added of product
- Development of cluster

However, in accelerating of Thailand logistics system development, apart from the development of an efficient transportation infrastructure system, there is a need to accelerate the development of trade mechanism, "Trade Logistics", in conjunction with the following 3 key issues, namely:

- Efficient trading network, both domestic and international levels
- Logistics service business that supports more efficient movement, storage, collection and distribution of goods inside and outside of the country
- Facilitation of procedures and documentation process to become more efficient in terms of cost and time



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