



A Survey on Opportunities in Thailand's e-Logistics and Supply Chain Market

Submitted to



New Energy and Industrial Technology Development
Organization

By

Thai-Nichi Institute of Technology

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By

Assoc. Prof. Dr. Bandhit	Rojarayanont
Assoc. Prof. Dr. Nuttapol	Limjeerajarus
Asst. Prof. Dr. Wipawadee	Wongsuwan
Asst. Prof. Dr. Jintawat	Chaichanawong
Dr. Siriaksorn	Jakborvornphan
Dr. Korakot	Hemsathapat

Thai-Nichi Institute of Technology (TNI)

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Executive Summary

Due to the on-going demand for consumer goods, the expanding number of internet user base has made Thailand an ideal growth environment for digital technologies and e-commerce businesses. The performance of Thailand's logistics significantly improved in 2018 because of the massive investment in transport infrastructure and relevant legal reforms. According to the World Bank's Logistics Performance Index 2018, Thailand rose to the 2nd place, overtaking Malaysia, and was seventh in Asia. The opportunities for the growth of logistics business are far greater because the government has extensively implemented a concrete strategy for national development in various basic infrastructure under the 12th National Economic and Social Development Plan with the aim of reducing the country's logistics costs down to 12% of the country's GDP by the year 2021.

To assure the achievement of logistics development targets, the office of the National Economic and Social Development Board (NESDB) launched the 3rd Thailand's Logistics Development Strategic Plan (2017-2021) which is consistent with the current National Economic and Social Development Plan and the 20-year national strategic plan. This plan is focused on development of value-added supply chain systems, infrastructure and facilities, and logistics support factors. Regarding the government supporting schemes, BOI provides privileges to foreign investors to support further logistics and transport infrastructure development, investment in the Special Economic Zones and EEC (Packages of tax incentives, general incentives, and assistance relating to smart visas and work permits). In addition, in order to drive the research and development and adoption of innovation in logistics industry, NSTDA, NIA and PMU C are funding agencies that provide financial support for research and development in e-logistics and supply chain. Thai government has committed to invest in logistics, transport infrastructure development, human resource development and e-logistics' research & development.

To improve efficiency, safety, reliability, and traceability of their operations, and to reduce their operating costs and wastes, and thus enhancement of their competitiveness in Thailand' logistics market, the LSPs currently focus on route optimization while the WIs focus on warehouse and inventory management system. For large companies, current government policies do not have neither significant positive nor negative impacts on their e-logistics and supply chain development plans. They are driven by customer's demand and competition in the market. On the contrary, local logistics SMEs are having difficulties in adapting themselves

toward the e-logistics era, mainly due to the lack of investment fund and expertise support. The government is asked to improve railway mode infrastructures as soon as possible. Otherwise, logistics cost is hardly to reduce below 10% as that in developed countries such as the US and Singapore. The government must also initiate a human resource development plan for supporting the e-logistics and supply chain technologies.

Logistics market in Thailand is rather large, approximately 2 Trillion Baht annually, however, there is no dominant players. To further extend, logistics cost in Thailand is still high, roughly 14% of the country's GDP, making a large gap for improvement and investment.

Political factor is the most influencing factors on the investment on logistic development, followed by technological, economic, environmental and social factors, respectively.

Current government policies and strategic plans have not yet been implemented. Some interviewees strongly requested that the Thai government must geared up on the improvement of railway mode infrastructure; otherwise, logistics cost is hard to be reduced to < 10%. Also, the development of human resource for e-logistics is a must now.

Besides investment on infrastructure, the government is being asked to evaluate and modify obsolete laws and regulations and create the connection between B2B and G2B to work closer with private investors.

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Chapter 1

Introduction

1.1 Background

As the world enters the digital age, today's technology development is rapidly changing due to intense competition in research and development in science, technology and innovation. The result is a revolution in the world of the logistics industry from the development of container transportation about 50 years ago to finding new business models that will make transportation of goods extremely convenient. In addition, the use of modern technology can respond to the needs of all types of customers and can manage resources worthwhile, including consideration of business operations that focus on sustainability and are environmentally friendly. Therefore, the change in technology in this globalized world makes international trade easier to access modern technology and innovation and inevitably affects every level of business.

Thailand is the ideal location for investors to spread their network throughout ASEAN and enjoy an enormous THB 90 trillion (USD 3 trillion) market. The reason for this is that Thailand is being recognized as the key regional logistics hub for multinational industries, ranging from the automotive sectors, electrical and electronics, medical and food sectors. Moreover, the logistics service providers are benefiting from the country's prosperous automotive industry. This is because Thailand aims to become one of the topmost nations in the world automotive market by producing more than 3,500,00 units of vehicles by 2020 [1].

% Logistics Cost to GDP, Y2016	
World (avg.)	10.9%
Europe	9.5%
 United State	7.5%
Asia Pacific	12.7%
 Singapore	7.4%
 Malaysia	13.6%
 Thailand	13.9%
 Vietnam	21.0%
 Indonesia	25.2%

Figure 1.1 Logistics cost (%) to GDP in 2016 [1]

According to the Office of the National Economic and Social Development Board (NESDB), the costs of logistics as a percentage of GDP in Thailand has dropped significantly, from 18% in 2007 to about 14% currently [1]. **Figure 1.1** represents the percentage of logistics costs to GDP in a year 2016. It seems that logistics market in Thailand is huge, but the cost of logistics is relatively high as compared to the country's GDP. However, there is a room for additional investment in logistics business to implement the technology related to logistics business, particularly for investors who want to take advantage of growth opportunities in Third-Party Logistics.

According to the type of technology being implemented by various logistics companies, and the shares in logistics cost (i.e. 54% for transportation cost, 34% for warehouse and inventory), we classify roles of logistics businesses by three main functions (see **Figure 1.2**); namely, Logistics Service Providers (LSPs) or also known as Third-Party Logistics (or 3PL), Warehouse and Inventory and Public Authorities. List of the interviewees can be found in **Appendix A**.

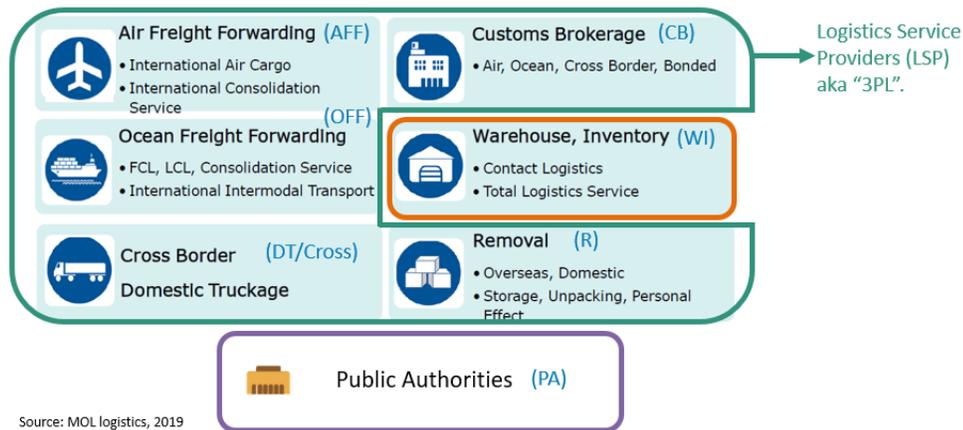


Figure 1.2 Three roles in logistics business by the functions (Adapted from [2])

In this report, we interviewed 8 logistics service companies, which account for 25% of all interviewees. In addition, we interviewed all 5 warehouse and inventory operators, accounting for 16%. Furthermore, another 9 companies operate both logistics services and warehouse management, which account for 28 percent of the total interviewees. Aside from this, we had the opportunity to interview eight public authorities, accounting for 31% of the total interviewees.

1.1.1 Logistics in the 4.0 era

The concept of Logistics in the 4.0 era means the use of digital technology in various activities of business logistics management. Logistics development in an era 4.0 will help shorten the gap between logistics and supply chain activities. Manufacturers can meet the needs of consumers with the form of their business through the digital process, enabling them to create value to consumers and compete with competitors in the world market. To transform the industry into a smart transport, and smart logistics, it must have a clear goal and keep up with the world trend. For example, the United States has a concept of transport drones to be fast. Customers, time, costs and technology costs must be developed to be sustainable. At present, 80% of the investment budget in Thailand has spent on an improvement of infrastructures, particularly railway and road transport. Our challenge is to create sustainability for the logistics and warehousing business [3]. The business world today is the era of structural change to the support e-Commerce / e-Trading and towards sustainability, which has caused many changes in the international trade and logistics market such as changing to Industry 4.0 / e-Logistics, including technology development for logistics [4].

1.1.2 Modern technologies in logistics systems

The Logistics System Development Strategy Division recognises the importance of the rapidly changing technology. This will benefit the adaptation of logistics operators as well as agencies related to the development of the country's logistics system to keep up with modern technologies such as internet of things (IoT) technology, data analysis with Big Data Analytics, and development to be friendly to the environment. Different types of technology for logistics development are compiled as detailed belows.

1.1.2.1 Internet of Things (IoT) for logistics

The use of IoT in the logistics process is widely accepted as it can reduce overall costs, increase security, accuracy and achieve high standards. The development of the IoT network in the next phase will have a continuously decreasing cost of equipment, allowing logistic service providers to have more opportunities to apply IoT to new business operations. However, the IoT system in logistics is still limited by the need to develop the IoT standards in logistics [4]. Benefits of IoT in logistics business are as follows:

1) *Checking transportation and inventory correctly*

It can be done by collecting information about product movements. The system will be able to report the delivery status to operators in the transportation route planning. Employee management, including warehouse storage locations via Radio Frequency Identification (RFID) and Global Positioning System (GPS).

2) *Increasing the transparency of the warehouse*

It can be done by tagging information on each pallet (Pallet) and can send the current condition and position, allowing for an analysis, planning, management, and product supervision efficiently.

3) *Intelligent transportation*

It can increase the value of transportation by means of innovative smart trucks that can collect information about routes planning and transporting times appropriately, which can increase operational efficiency, and reduce costs.

1.1.2.2 Artificial Intelligence (AI) in Logistics

AI is a technology that will change the way logistics services businesses to meet customer needs. In the future, AI will help entrepreneurs adjust their business operations proactively and can anticipate changes to increase efficiency in shipping.



Figure 1.3 The use of AGV at Yangshan Port in Shanghai, China [4]

Yangshan Port in Shanghai, China, is an example of using an automated port or an automated shipping port. **Figure 1.3** shows the use of AGV at Yangshan Port for container transportation to ensure efficient product transportation [4].

1.1.2.3 Big Data Analytics in Logistics

Big Data will be the main center of information that will play a role in creating an overview of the current situation for analysis in order to gain an in-depth information about various operational trends. The advantage of using Big Data in logistics is choosing the right transportation route. A selection of an appropriate transportation route has been analysed by correlating various data such as weather conditions, traffic and other factors. The result of this is the most effective real-time transportation management of goods to the destination, which allows logistics operators to specify the exact delivery time, as well as efficiently loading products into transport vehicles.

Big data systems can help increase resource efficiency while also reducing unnecessary costs in the supply chain. Big data can help increase the risk management of the supply chain, such as the alert system during the transportation process due to unexpected events such as accidents, the congestion of the destination to be sent to, such as the port of customs [5].

1.1.2.4 Automation and Robotics in Logistics

The development of automation and robots in the logistics process is more widely accepted due to the rapid technological progress combined with the consent to pay at a high price in order to improve service levels such as robots in the warehouse and autonomous vehicle. The growth of the E-Commerce market causes logistics service providers to operate businesses faster and more efficiently. It ranges from the processing of individual orders to the delivery of products to customers. Therefore, the use of automation and robots makes it faster and more flexible, especially in the automated warehouse that needs accuracy.

The use of warehouse robot to manage warehouse activities such as pallet arrangement, loading and unloading of trucks, packaging and system control will help increase efficiency in resource management. The automotive industry is an industry that has the potential to deploy automated warehouses in order to store auto parts and various equipment, including the management of picking up devices to assemble automobiles and transporting assembled cars to customers. An automotive industry will be the main industry that will bring more full robot systems into the future [4].



Figure 1.4 The AGVs move customers' orders around the Alibaba's warehouse [5]

Alibaba has brought robots to be used to transport goods inside the warehouse as shown in **Figure 1.4**. The automated robots are designed to meet the needs of every warehouse that needs to be transported from one location to another. In addition, intelligent robots can manage Packaging and can lift products weighing up to 1,000 kg.

1.1.2.5 Autonomous Vehicles in Logistics

Autonomous Vehicles are advanced robot technology. Currently, this technology is mainly used to increase the efficiency of storage, lifting, and sorting in the warehouse mainly in the form of Automated Guided Vehicle (AGV). The next development trend is the deployment of autonomous vehicles to transport products. Self-Driving Truck is a logistical innovation that will become a necessity for the transportation of goods and logistics providers in the future. Major automotive industry giants, such as Scania Daimler, Volvo Tesla, and technology companies, are accelerating the development of unmanned truck technology to reduce the rate of road accidents caused by human error [4].

1.1.2.6 Drone in Logistics

The use of drones can be utilised in the transportation and logistics industry to increase the efficiency of the transportation of goods to be more convenient and faster. It will help with Last Mile Delivery and can be used to quickly inspect warehouses, reduce shipping space limitations, and long-term transportation costs when compared to delivery by truck. The obvious benefits of using a drone are lower costs and faster shipping than road delivery as well as solving transportation labor shortages.



Figure 1.5 UPS driver sends the drone on its way to the customer [6]

The UPS has tested drone delivery by flying from the truck to the destination and returning to the truck in approximately 30 minutes, which can carry a maximum weight of 4.5 kilograms at a time (see **Figure 1.5**). The result is that it allows truck drivers to deliver multiple products and reach the recipient quickly, without having to reach a particular area of the remote area [4].

1.1.3 Adaption of Thailand to the e-Logistics

Thailand is an export oriented economy with exports accounting for around 18.9 percent of the country's GDP for 2018. As of September 4, 2019, Thailand exported \$144 billion worth of goods during the first seven months of the year 2019 dropping by -0.4% compared to the same period one year earlier [7].

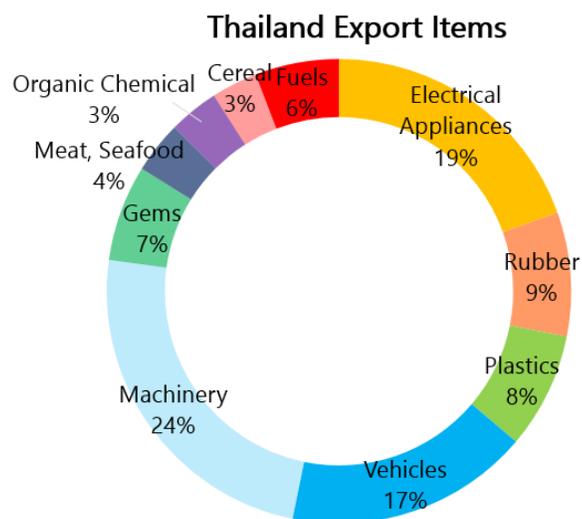


Figure 1.6 Ratio of Thailand Export Items in 2018 [Adapted from [7]]

The pie chart in **Figure 1.6** presents the percentage share of each export regarding the overall exports from Thailand during the year 2018. The country mainly exports machinery including computers (17.2 percent of total shipments), electrical machinery and equipment (14 percent), vehicles (12.2 percent), rubber (6.2 percent), plastics (5.8 percent), gems and precious metals (4.8 percent), mineral fuels including oil (4.2 percent). Agricultural goods, mainly meat and seafood preparations, account for 2.6 percent of total shipments. Organic chemicals and cereals contributed 2.5 percent and 2.3 percent of the country's export items, respectively [6]. Major export partners are China (12 percent), Japan (10 percent), the United States (10 percent), the European Union (9.5 percent) and the rest are exported to others countries include: Malaysia, Australia and Singapore as shown in **Figure 1.7** [8].

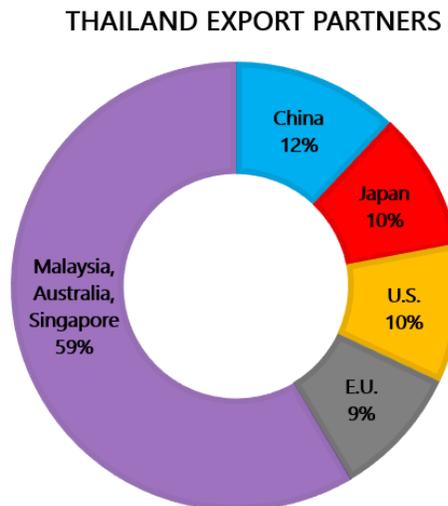


Figure 1.7 Shares of Thailand Export Partners (Adapted from [8])

The Thai government is well aware of the importance of logistics, particularly for competitiveness in the current strengthened free flow of the global trade. This is because we have been aware of the government's policy to push Thailand into a "**transportation hub in ASEAN and Asia**". Aside from cost and lead-time reduction, logistics is considered as a crucial factor for accomplishing competitiveness.

In the meantime, Thailand is in an appropriate position:

- 1) being a leader among Southeast Asia and Indochinese countries;
- 2) having a high Japanese intensive investment;
- 3) acting as the logistics hub in Southeast Asia;
- 4) having important manufacturing base in many areas; and
- 5) being a centre of ASEAN Economic Community (AEC).

Although Thailand has continuously invested in infrastructure development, whether it is ports, airports, roads and rail systems, but there is no linkage in each mode of transportation, lack of network systems and integrated logistics management systems, both collecting, distributing and transporting cargo both within the region and between regions. Furthermore, the important thing that will make Thailand becomes a logistics hub in the ASEAN and Asia region consists of many factors, especially the linkage of economic activities that are all systematically related to the logistics system [3].

1.1.4 Development of Thai logistics system to meet Thailand 4.0 policy

Thailand has placed a great importance on the development of logistics systems, especially the development of Thailand to be a logistics centre. Therefore, Thailand must accelerate the development of logistics systems to be able to link both locally and internationally and to increase competitiveness. For this reason, the government sector has set up a strategic plan for the development of logistics systems to be used as a model to develop the potential of the Thai logistics system to keep abreast of the civilization and support the Thailand 4.0's policy [6]. Apart from that, the Ministry of Transportation has issued a rule that the transport vehicle must be equipped with a GPS system, enabling the service to be expanded into a multi-model transponder, which link all transportations with the aim of reducing logistics costs.

The logistics system development strategy is consistent with the current National Economic and Social Development Plan and the 20-year national strategic plan. There are many discussions on the development of infrastructure in Thailand's development and strategic plans, such as water transport development, road transport, air transport or rail transportation for increasing the capacity and safety of cargo by developing a dual rail system which is a project that has been continuously discussed [6]. However, it appears that the operation is kept in its place, and there is no progress to be seen. It was suggested that the development of the Thai logistics system in the future will not

be much difference from what it is because the main modes of transportation still rely on the road transportation. Therefore, the public and private sectors should consider the technologies that could help supporting the transportation and warehouse management.

1.1.5 Strategic Plan of Government Agencies related to e-Logistics and Supply Chain

In the midst of digital disruption where modern technology has replaced old technology and led to new business models, the government has planned to develop the country to Thailand 4.0 by defining 10 target industries (S-Curve) to the future economic driving industry. Also, Thailand is currently implementing the 12th National Economic and Social Development Plan (2017 – 2021) [9]. This five-year plan is the short-term strategic plan in accordance with the 20-year strategic plan and reform (2017 – 2036) [10]. The transportation and logistics industries are industries which complement Thailand's geographically advantageous location, and that furthermore allow for the support and expansion of other industries.

The government therefore needs to formulate policies and promote logistics development to support the growth of industries that use advanced technology in production. It can be done by focusing on the development of modern technology such as the development of large data sources or Big Data by collecting state information that will benefit the business development of logistics service providers, promotion of research and development of technology and innovation in logistics to replace imports. Thus, Thai logistics service providers must adjust the business model to be up-to-date and be consistent with the changes in technology.

Logistics Industry is one of the new five future industries (New S-Curve) which is an industry that Thailand has the potential in production and caused by the changes in global manufacturing technology (see **Figure 1.8**). Thailand is an important transportation hub for multinational companies that set up production bases and sales networks in Indochina with a well-developed infrastructure and a center in the Greater Mekong Subregion (GMS). It is expected that Thailand's logistics cost falls at the rate of approximately 12% per GDP by 2021 [11, 12].

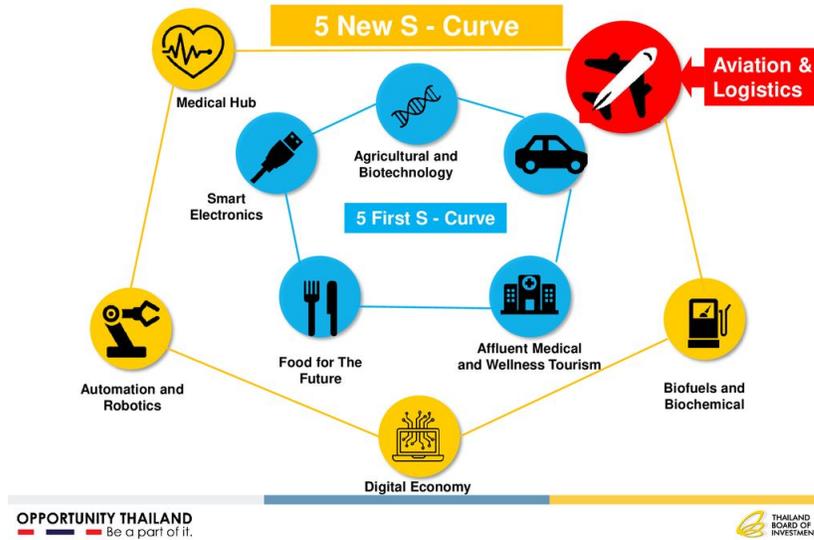


Figure 1.8 Five New S-Curve industries: Digital, Robotics and Automation, Aviation and Logistics, Biofuels and Biochemicals and Medical Hub [11]

1.2 Research Objective and Scopes

It is quite important to put a focus of this study on the logistics industry. This is because logistics industry is the source for the international competitiveness of the shipper in manufacturing industries in order to implement economic cooperation in distribution and logistics industry for Thailand.

The objectives of this research are as follows.

- 1) To survey strengths and potential obstacles to the successful of e-logistics and automated robots' implementation in logistics and supply chain industries in Thailand.
- 2) To comprehend the current situation and needs on logistics of existing Thailand and Japanese manufacturers, retailers, distributors, and their prospects for market opportunities of the logistics industry in Thailand.
- 3) To study the development of logistics for supply-chain optimization and an integrated logistics network, both locally and internationally in Thailand by which the movement of goods can be tracked.

1.3 Research Methodology

- 1) **In-depth interviews** will be carried out to collect the information on the current status and trend of the logistics and supply chain in Thailand from **30 representatives**;
 - Local, Japanese, and International Logistics Service Providers (LSPs)
 - Air Freight Forwarding (AFF)
 - Ocean Freight Forwarding (OFF)
 - Domestic Truckage / Cross Border (DT/Cross)
 - Customs Brokerage (CB)
 - Removal (R)
 - Warehouse and Inventory (WI)
 - Public Authorities (PA)
 - e.g. The Thai Federation on Logistics, Thai Transportation and Logistics Association, Thai International Freight Forwarders Association and Thai National Shippers' Council.
- 2) **Summary** of the current status, plans, strengths, obstacle potentials, needs and policies trends on logistics, and the automated technologies used in logistics and supply chain industries in Thailand will be presented, discussed and concluded.

1.4 Report Outline

In this report, the objective and scope of this study is defined in Chapter 1. Modern technologies that are able to upgrade Thailand's traditional logistics management system to become the ASEAN logistics hub is also described in this chapter. Consequently, the current government policies and supporting schemes in promoting logistics and supply chain are presented in Chapter 2. Accordingly, the in-depth interviews of current situations on e-logistics and supply chain in the viewpoint of logistics companies and organizations are summarized in Chapter 3. Successful case studies of e-logistics implementation are gathered and given in this chapter. Chapter 4 presents potentials and obstacles of e-logistics and supply chain and suggestions to government agencies. Finally, the key findings discussed in all previous chapters and overall conclusions of the research are summarized in Chapter 5. The list of the interviewees is provided in **Appendix A**

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Chapter 2

Government Policies on Logistics and Supply Chain

2.1 Current Government Policies and Supporting Schemes in Promoting Logistics

2.1.1 National Logistics Plan

The Thai government has recognized that logistics system is a crucial element in supporting economic activities and national competitiveness. In addition, the government has set a policy to push Thailand to be the "transportation hub in ASEAN and Asia". The government has launched a series of national logistics development strategy since 2003 to develop a logistics system and upgrade Thailand into the center of trade, services, and investment in ASEAN and Asia. The office of the National Economic and Social Development Board (NESDB) has set up the 3rd Thailand's Logistics Development Strategic Plan (2017-2021) which is consistent with the current National Economic and Social Development Plan [1] and the 20-year national strategic plan [2]. This strategic plan is focused on reducing problems and limitations, enhancing trade facilitation, and improving standards of logistics processes and human resource management in logistics and supply chain [3]. The important key points of the strategic plan are as follows:

Vision: "To enhance Thailand's logistics system and its position as a center of trade, services and investment in the ASEAN region as well as to increase its competitiveness"

Strategic planning:

- 1) Strengthen capability of the entrepreneur to take an advantage from the value added of supply chain and encourage to implement technology and innovation in logistics management.
- 2) Upgrade Thai trade facilitation efficiency to meet international standards.
- 3) Develop supporting factors such as improvement of standardization for personnel in the logistics area and establishing a collaborative network with the private sector to develop human resource management systems as well as logistics development monitoring and evaluation systems.

Objectives: To build Thailand’s competitiveness in logistics, enhance trade facilitation, increase Thai logistics service providers’ potential to conduct business domestically and internationally and develop the capacity of the country’s logistics personnel.

Indicators:

- 1) Thailand ranks higher on the international logistics performance index (International LPI) by 2020.
- 2) Thailand’s trade facilitation efficiency ranks higher by 2021 (Trading Across Borders).
- 3) Thailand’s logistics cost is at 12% per GDP by 2021.
- 4) Electronic import and export transactions increase by 100% by 2021.

Table 2.1 The 3rd Thailand’s Logistics Development Strategic Plan (2017-2021)

Strategic Issue	Strategy
1. Development of value-added supply chain systems.	1.1 Upgrade logistics and supply chain management for agriculture and industry to meet international standards. 1.2 Connect trading to E-Commerce. 1.3 Develop the potential of Logistics Service Providers.
2. Development of infrastructure and facilities.	2.1 Develop transport and logistics network infrastructure along strategic routes to connect the sub regions and trade gateways. 2.2 Develop a National Single Window System. Establish a central administrative agency to develop and monitor a central system to integrate data and expand the network to link with the Port Communication System at Laem Chabang Port, Bangkok Port, and Suvarnabhumi Airport. 2.3 Develop the E-logistics process: Support the reduction of import-export processing time. 2.4 Overcome international trade barriers.
3. Development of logistics support factors.	3.1 Develop logistics professional standards. 3.2 Develop logistics personnel to meet international standards, focusing on both upstream and downstream vocational or technical training. 3.3 Research and develop logistics innovation and technology. 3.4 Evaluate/follow up on international trade agreements and develop a database to evaluate the results of the country’s logistics system development.

Under the 3rd Thailand's Logistics Development Strategic Plan, there are flagship programs as shown in **Table 2.2** that the government has pushed to improve national logistics performance and to increase connectivity within sub-regional and ASEAN framework through domestic networks that connect economic corridors [4].

Table 2.2 Flagship programs under the 3rd Thailand's Logistics Development Strategic Plan

Issue	Program
Railway Infrastructure	<ul style="list-style-type: none"> - Construction of double track in six main rails linking Bangkok and main cities in the northeast and southern regions of Thailand to stimulate growth of modal shift of cargo from road to rail carriage.
Road Infrastructure	<ul style="list-style-type: none"> - Development of 4-lane road networks linking Thailand's key economic corridors and border areas in the special economic zones (SEZs) such as Chiang Rai, Tak, Mukdahan, Sa Kaew, Trat, Songkla. - Development of inland container depot / logistics park (freight village) in border provinces to support growing cross-border trade and investment.
Port Infrastructure	<ul style="list-style-type: none"> - Improvement of seaport on both Thai gulf and the Andaman Sea to cater to growing international maritime trade
Aviation Infrastructure	<ul style="list-style-type: none"> - Establishment of aviation industrial estates - Expansion of runways, free zones, and cargo carry capacity at Suvarnabhumi airport and Don Muang airport
Customs Clearance System	<ul style="list-style-type: none"> - Upgrading facilities at land customs border points, - Development of national single window system - Improvement of customs and trade regulations to accommodate paperless trading and international trade facilitation commitment to save time and costs for shippers and logistics service providers.
Human Resources	<ul style="list-style-type: none"> - Enhancement of human skills in logistics industry.
Capacity Building	<ul style="list-style-type: none"> - Arrangement of training and educational programs to provide insight information on trade, logistics, innovation, regulations - Organizing trade exhibitions and logistics business matching activities to strengthen and widen supply chain networks.

2.1.2 National's Greenhouse Gas Reduction Plan for 2021 - 2030 (Thailand's Nationally Determined Contribution Roadmap on Mitigation 2021 - 2030: NDC Roadmap 2021 – 2030)

The government agencies are well prepared for the reduction of greenhouse gas emissions. To further extend, the Cabinet has approved the National's Greenhouse Gas Reduction Plan for 2021 - 2030 (Thailand's Nationally Determined Contribution Roadmap on Mitigation 2021 – 2030: NDC Roadmap 2021 – 2030) for reducing greenhouse gases by approximately 20 percent or equivalent to 111 million tons of carbon dioxide equivalent (MtCO_{2e}) by the year 2030. The reason that the Cabinet has to accelerate the plan is because greenhouse gases have increased from 273,408 thousand tons of carbon dioxide equivalent (kt-CO_{2e}) in 2005 to 555,000 thousand tons of carbon dioxide equivalent or 555 million tons of carbon dioxide equivalent (MtCO_{2e}) in the year 2030 or equivalent to an average rate of increase of 2.8 percent per year (shown in **Figure 2.1**) [5]. Examples of projects and plans related to logistics and warehouse management under the National's Greenhouse Gas Reduction Plan for 2021 - 2030 are shown in **Table 2.3**.

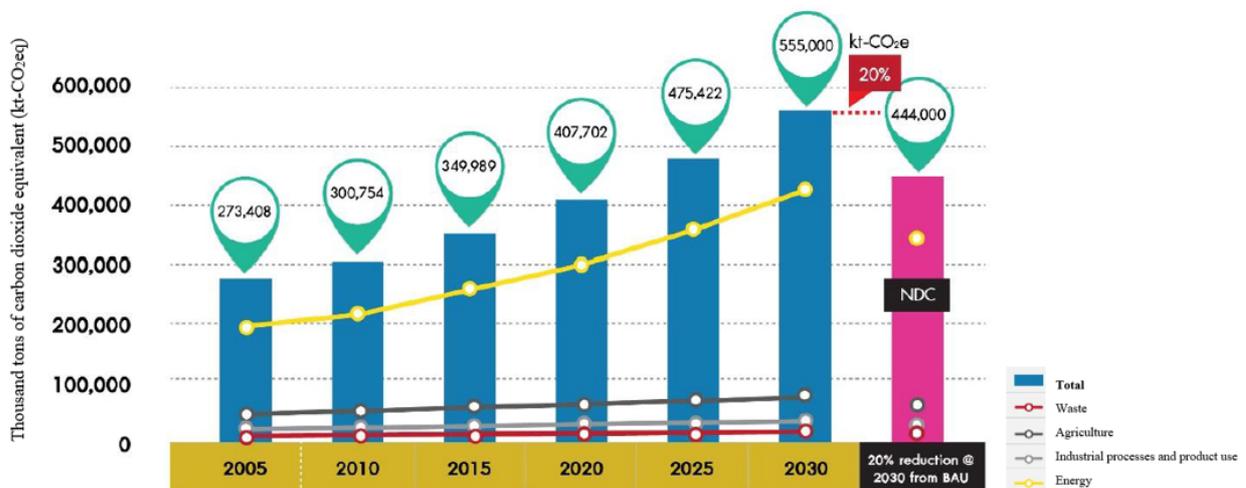


Figure 2.1 Expectation of the amount of greenhouse gas emission in Thailand from 2005 – 2030 in various business sectors [5]

From **Table 2.3**, it can be seen that the infrastructure development plans to support changing modes of transportation in rail transport consists of 32 double-track railway construction, construction of mass rapid transit and suburban trains for 20 routes, construction of 14 new railway lines and high-speed railway construction with the Eastern Economic Corridor (EEC) development. It can be seen that the development of infrastructure for changing the mode of transportation (Shift / Maintain) can reduce greenhouse gas by a total of

5.42 MtCO₂e. In addition, 7.721 MtCO₂e of greenhouse gases is estimated to reduce by logistics development projects under the national's greenhouse gas reduction plan for 2021 – 2030 [6].

Table 2.3 Project details related to logistics under the national's greenhouse gas reduction plan for 2021 – 2030

Project/Plan	Responsible Department	Budget (Million Baht)	Amount of CO ₂ reduction (MtCO ₂ e)
1. Development of infrastructure to support changing modes of transportation in rail transport systems		3,035,361.30	5.42
1.1 Construction of 32 double track railways	- State Railway of Thailand	463,015.00	1.47
1.2 Construction of mass rapid transit and suburban trains 20 routes	- Mass Rapid Transit Authority of Thailand	532,277.30	1.06
1.3 Construction of 14 new railway lines		501,690.00	0.09
1.4 Construction of high-speed trains + EEC, 4 routes		1,538,379.00	2.79
2. Promotion of freight management systems to save energy (Logistics Management)		80.00	0.19
2.1 Promotion of transportation management systems for energy saving (LTM)	- Office of Transport and Traffic Policy and Planning	60.00	0.19
2.2 Research and development of energy management transportation program (LTMA)	- Energy Policy and Planning Office	20.00	-
3. Promotion of freight management systems to save energy (Logistic Management)		634.00	0.611
3.1 Empty trip transportation management (Backhaul Management)	- Department of Land Transport	104.00	0.06
3.2 Development of Application and Platform for Real Time Truck Transport Management	- Office of Transport and Traffic Policy and Planning	39.00	-
3.3 Promoting the use of Application for the Backhaul Management	- Department of Alternative Energy Development and Efficiency	65.00	-
3.4 Establishing Distribution Center (DC)		500.00	0.241
		30.00	0.31

3.5 Establishment of an energy-saving driving training center in 5 regions nationwide			
4. Transportation Management System (TMS)		50.00	0.12
4.1 Developing and supporting transportation management systems	- Department of Alternative Energy Development and Efficiency - Department of Land Transport	50.00	0.12
5. Raising the standard of truck transportation management (Q Mark)		377.00	-
5.1 Raising the standards of truck transportation management to support increasing energy efficiency and reducing greenhouse gas emissions	- Department of Land Transport	52.00	-
5.2 Encourage truck operators to improve the quality of operations, according to the standard of truck transportation	- Office of Transport and Traffic Policy and Planning	130.00	-
5.3 Establishing the marketing needs of truck transportation standards		130.00	-
5.4 Monitoring and consulting with truck transportation operators' in implementing truck transportation standards.		65.00	-
6. Increasing energy efficiency and CO₂ reduction in Thailand's Cold Chain Logistics system.		286.00	-
6.1 Study of guidelines for increasing energy efficiency and greenhouse gas emissions of Cold Chain Logistics.	- Office of Transport and Traffic Policy and Planning	65.00	-
6.2 Changing substances in the cooling system in a Cold Chain Logistics truck to increase energy efficiency and reduce CO ₂ .	- Department of Land Transport	26.00	-
6.3 A refrigerant replacement truck pilot project in Cold Chain Logistics to increase energy efficiency and reduce CO ₂ .		195.00	-
7. Logistics System Development		-	-
7.1 Sustainable Logistics Management (Green Logistics) by the private sector	- Office of Transport and Traffic Policy and Planning	-	-

8. Development of infrastructure to support changing modes of transportation in water transportation systems		176,146.90	1.38
8.1 The 1 st phase and 2 nd phase of Single Rail Transfer Operator development at Laem Chabang Port	- Port Authority of Thailand	981.50	0.7935
8.2 Construction of elevated dams in the Chao Phraya and Nan rivers for 8.3 Sailing	- Marine Department	6,422.80	0.0812
8.4 Increasing the efficiency of the transportation system in the Pa Sak River	- Marine Department	2,162.90	0.0478
8.5 Development of ferry linking the upper Thai gulf	- Marine Department	591.70	0.001
8.6 The 3 rd phase of Laem Chabang Port development	- Port Authority of Thailand	155,834.00	0.4122
8.7 The 3 rd phase of Map Ta Phut Port development	- Industrial Estate Authority of Thailand - Port Authority of Thailand	10,154.00	0.041
	Total amount of CO₂ reduction (MtCO₂e)		7.721

2.2 Government Supporting Schemes

2.2.1 Investment Promotion by the Thailand Board of Investment (BOI)

The Thailand Board of Investment (BOI) is a government agency under the Prime Minister's Office which was established to promote investment in Thailand and Thai overseas investment by offering both tax-based and non-tax-based incentives since 1966. The BOI prescribes the investment promotion policies under the Investment Promotion Act No. 2 B.E. 2534, No. 3 B.E. 2544, and No. 4 B.E. 2560. Tax and non-tax incentives offering by the BOI are summarized in **Table 2.4** [7].

Table 2.4 Tax and non-tax incentives provided by the BOI

Tax Incentives	Non-tax Incentives
<ul style="list-style-type: none"> • Exemption/reduction of import duties on machinery (Section 28/29) • Reduction of import duties for raw or essential materials (Section 30) • Exemption of import duties on materials imported for R&D purposes (Section 30/1) • Exemption of corporate income tax on the net profit and dividends derived from the promoted activity (Section 31 and 34) • A 50% reduction of the corporate income tax (Section 35(1)) • Double deduction from the costs of transportation, electricity and water supply (Section35(2)) • Additional 25% deduction of the cost of installation or construction of facilities (Section35(3)) • Exemption of import duty on raw or essential materials imported for use in production for export (Section 36) 	<ul style="list-style-type: none"> • Permit for foreign nationals to enter the Kingdom for the purpose of studying investment opportunities. (Section 24) • Permit to bring into the Kingdom skilled workers and experts to work in investment promoted activities (Section 25 and 26) • Permit to own land (Section 27) • Permit to take out or remit money abroad in foreign currency (Section 37)

According to the Announcement of the Board of Investment No.2/2557: Policies and Criteria for Investment Promotion announced on December 3, 2014, the BOI has set the criteria for granting incentives by defining the incentives for investment into 2 types as follows [8]:

1) Activity-based incentives

Activity-based incentives are classified based on importance of activities, which are divided into 2 groups (see **Table 2.5**). In addition, the basic incentive shall grant for the investment in 4 core technologies in Section 8 (Technology and innovation development includes targeted core technology development such as development of biotechnology, nanotechnology, advanced materials technology and digital technology) and activities which support the development of targeted technology in Section 8. The criteria for granting the activity-based incentives for investment in each group of activities is shown in **Figure 2.2**.

Table 2.5 List of activity-based incentives

Group A: Activities that shall receive corporate income tax incentives, machinery and raw materials import duty incentives and other non-tax incentives.		
Subgroup	Eligible Activities	Incentives
A1	Knowledge-based activities focusing on R&D and design to enhance the country's competitiveness.	<ul style="list-style-type: none"> - 8-year corporate income tax exemption without being subject to a corporate income tax exemption cap. - Exemption of import duty on machinery. - Exemption of import duty on raw or essential materials used in manufacturing export products for 1 year which can be extended as deemed appropriate by the BOI. - Other non-tax incentives.
A2	Infrastructure activities for the country's development, activities using advanced technology to create value-added, with no or very few existing investments in Thailand.	<ul style="list-style-type: none"> - 8-year corporate income tax exemption, accounting for 100% of investment (excluding cost of land and working capital) - Exemption of import duty on machinery - Exemption of import duty on raw or essential - Materials used in manufacturing export products for 1 year which can be extended as deemed it appropriate by the Board - Other non-tax incentives
A3	High technology activities which are important to the development of the country, with a few investments	<ul style="list-style-type: none"> - 5-year corporate income tax exemption, accounting for 100% of investment (excluding cost of land and working capital) unless specified in the list of activities eligible for investment promotion that the activity shall be granted corporate income tax exemption without being subject to a corporate income tax exemption cap - Exemption of import duty on machinery

	already existing in Thailand.	<ul style="list-style-type: none"> - Exemption of import duty on raw or essential materials used in manufacturing export products for 1 year which can be extended as deemed it appropriate by the BOI - Other non-tax incentives
A4	Activities with lower technology than A1-A3 but which add value to domestic resources and strengthen the supply chain.	<ul style="list-style-type: none"> - 3-year corporate income tax exemption, accounting for 100% of investment (excluding cost of land and working capital) - Exemption of import duty on machinery - Exemption of import duty on raw or essential materials used in manufacturing export products for 1 year which can be extended as deemed it appropriate by the BOI - Other non-tax incentives
Group B: Activities that shall receive only machinery and raw materials import duty incentives and other non-tax incentives.		
Subgroup	Eligible Activities	Incentives
B1	Supporting industry that does not use high technology but is still important to the value chain.	<ul style="list-style-type: none"> - Exemption of import duty on machinery - Exemption of import duty on raw or essential materials used in manufacturing export products for 1 year which can be extended as deemed it appropriate by the Board - Other non-tax incentives
B2	Supporting industry that does not use high technology but is still important to the value chain.	<ul style="list-style-type: none"> - Exemption of import duty on raw or essential materials used in manufacturing export products for 1 year which can be extended as deemed it appropriate by the Board - Other non-tax incentives

Remarks:

Activities in Group B1 and Group B2 shall receive additional three-years corporate income tax exemption on the revenue in case of:

- Investment in automation or robotic system, the cap on corporate income tax exemption on the revenue of the project shall not exceed 50% of the investment capital (excluding cost of land and working capital).

- Investments in automation systems, the corporate income tax exemption cap will be raised to 100% of the investment, excluding land cost and working capital if the value of linkages to the Thai automation industry reaches at least 30% of the total value of the automation system.

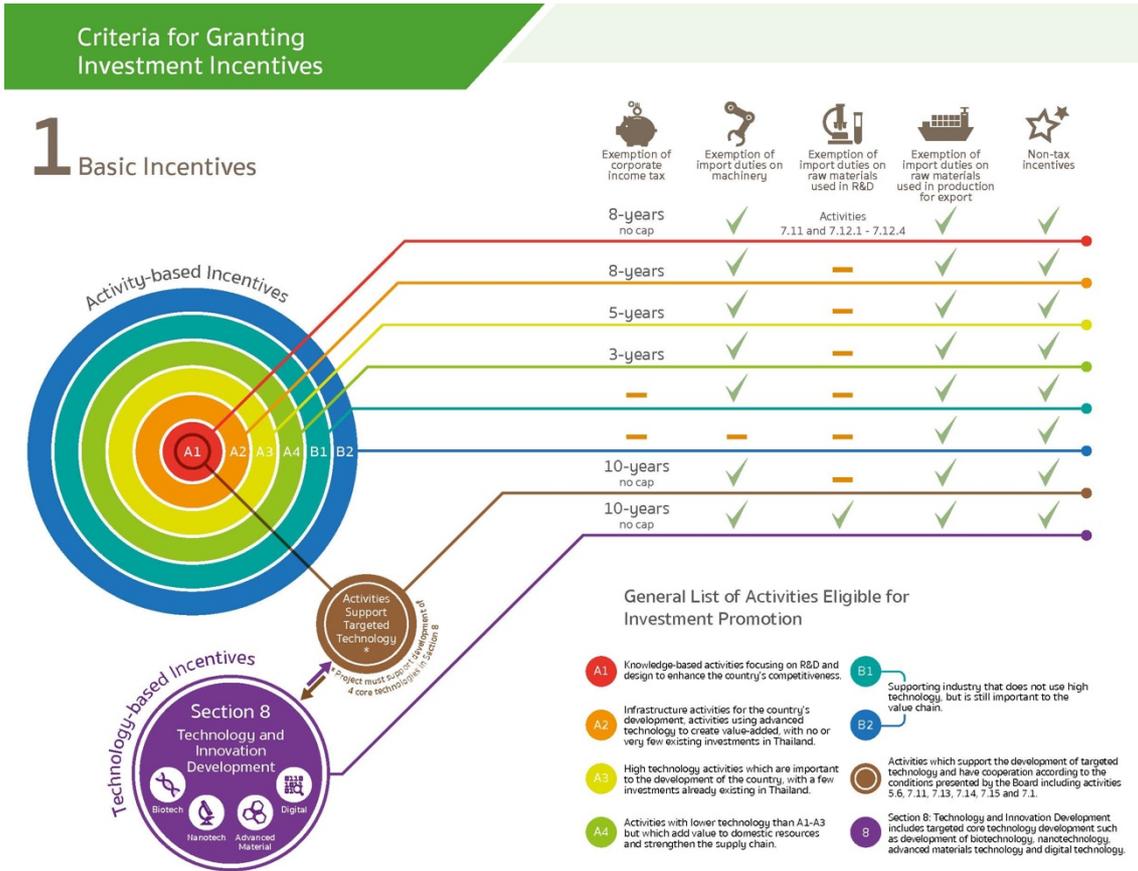


Figure 2.2 Criteria for granting the activity-based incentives [9]

2) Merit-based incentives

The BOI also offers additional incentives based on the merits of each project (See **Figure 2.3**) to stimulate more investment in activities that benefit the country or industry as follows:

Merit on competitive enhancement: Projects which invest in research and development in technology and innovation, donations to Technology and Human Resources Development Funds, educational institutes, specialized training centers, research institutes or governmental agencies in the science and technology field in Thailand, IP acquisition/licensing fees for commercializing technology developed in Thailand, Advanced technology training, development of local suppliers with at least 51% Thai shareholding in advanced technology training and technical assistance and product & packaging design shall receive additional corporate income tax exemption of up to 3 years, plus an additional tax exemption of up to 300%. Addition incentives and the criteria for granting promotion incentives under the merit on competitive enhancement is shown in **Figure 2.4** and **2.5**.

Merit on decentralization: Projects located in 20 provinces with lowest per capita income: Kalasin, Chaiyaphum, Nakhon Phanom, Nan, Bueng Kan, Buri Ram, Phrae, Maha Sarakham, Mukdahan, Mae Hong Son, Yasothon, Roi Et, Si Sa Ket, Sakhon Nakhon, Sa Kaew, Sukhothai, Surin, Nong Bua Lamphu, Ubon Ratchatani and Amnatcharoen (excluding border provinces in Southern Thailand and Special Economic Development Zones which have separate special incentive packages) shall receive additional incentives. For example, Projects with activities in Group A1 or A2 in these areas shall receive a 50% reduction in corporate income tax for 5 years, additional corporate income tax exemption of up to 3 years, double deduction for transportation, electricity and water costs for 10 years, and a deduction of 25% of the net investment cost of a project's infrastructure installation or construction costs. The criteria for granting promotion incentives under the merit on decentralization is shown in **Figure 2.6**.

Merit on industrial area development: Projects located within an industrial estate or a promoted industrial zone (see map in **Figure 2.7**) shall be granted an additional year of corporate income tax exemption. The criteria for granting promotion incentives under the merit on industrial area development is shown in **Figure 2.8**.



Figure 2.3 Criteria for granting addition promotion incentives under the merit-based incentives [7]

2.1 Merit for Competitiveness Enhancement

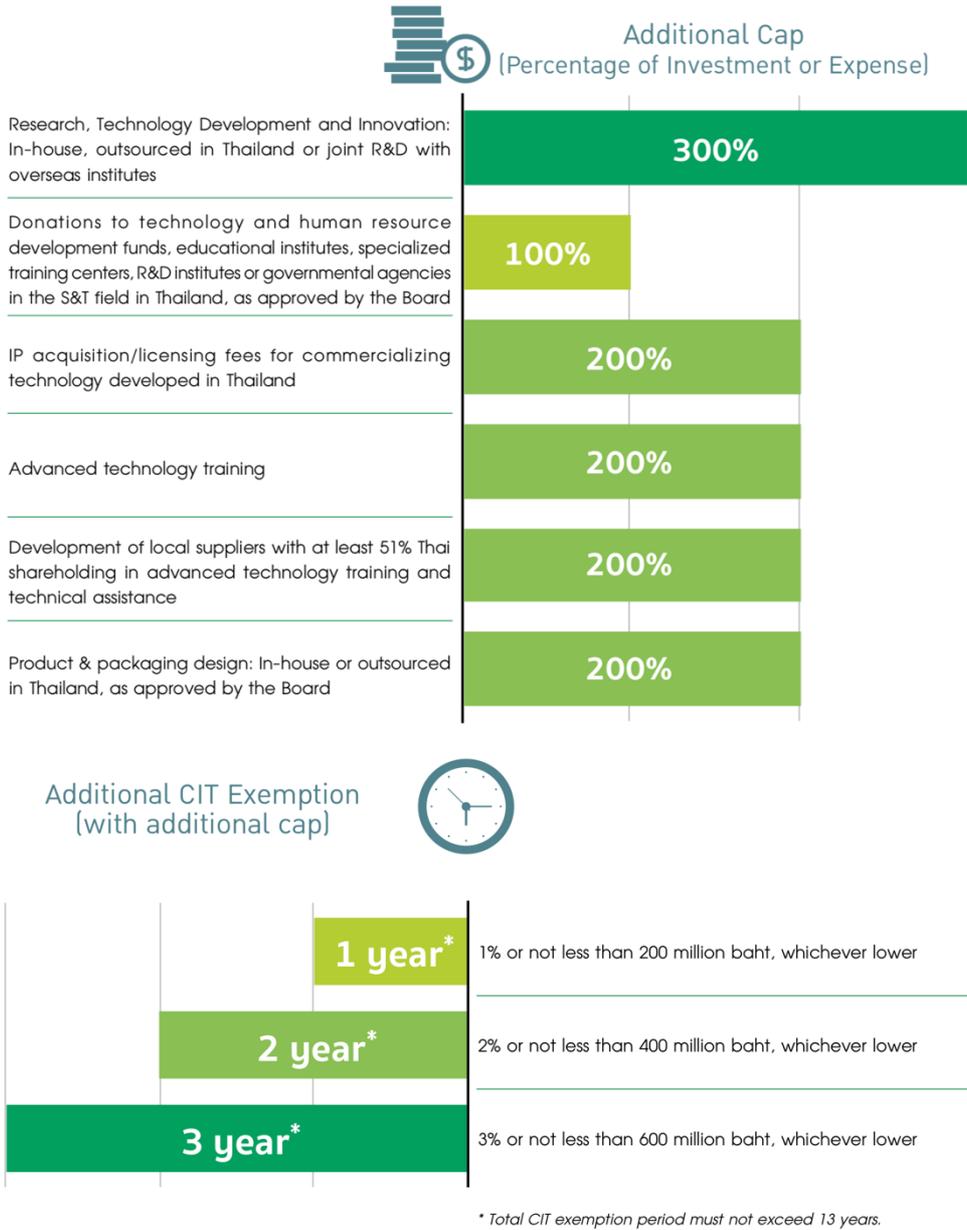


Figure 2.4 Additional incentives for competitiveness enhancement [7]

2.1 Merit for Competitiveness Enhancement (continued)

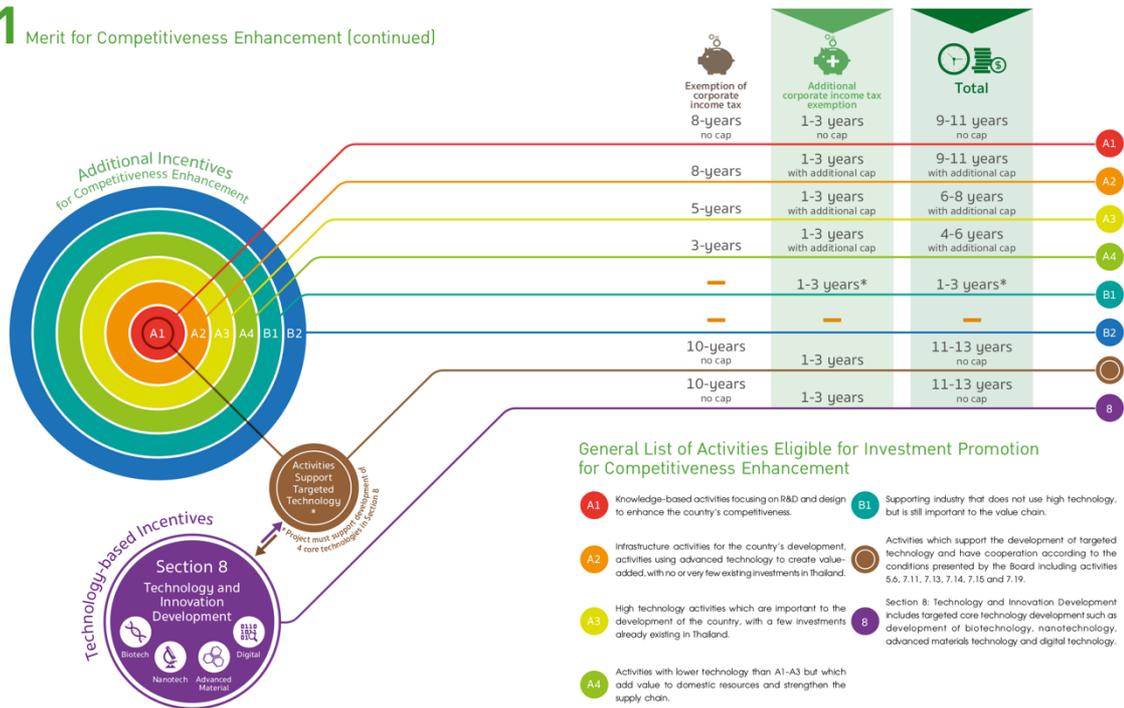


Figure 2.5 Criteria for granting addition promotion incentives under the merit on competitive enhancement [7].

2.2 Merit on Decentralization

Projects located in 20 provinces with lowest per capita income (see map on page 19) Kalasin, Chaiyaphum, Nakhon Phanom, Nan, Bueng Kan, Buri Ram, Phrae, Maha Sarakham, Mukdahan, Mae Hong Son, Yasothon, Roi Et, Sa Ket, Sakon Nakhon, Sa Kaeo, Sukhothai, Surin, Nong Bua Lamphu, Ubon Ratchathani and Amnatcharoen (excluding border provinces in Southern Thailand and Special Economic Development Zones which have separate special incentive packages) shall receive additional incentives, as follows:

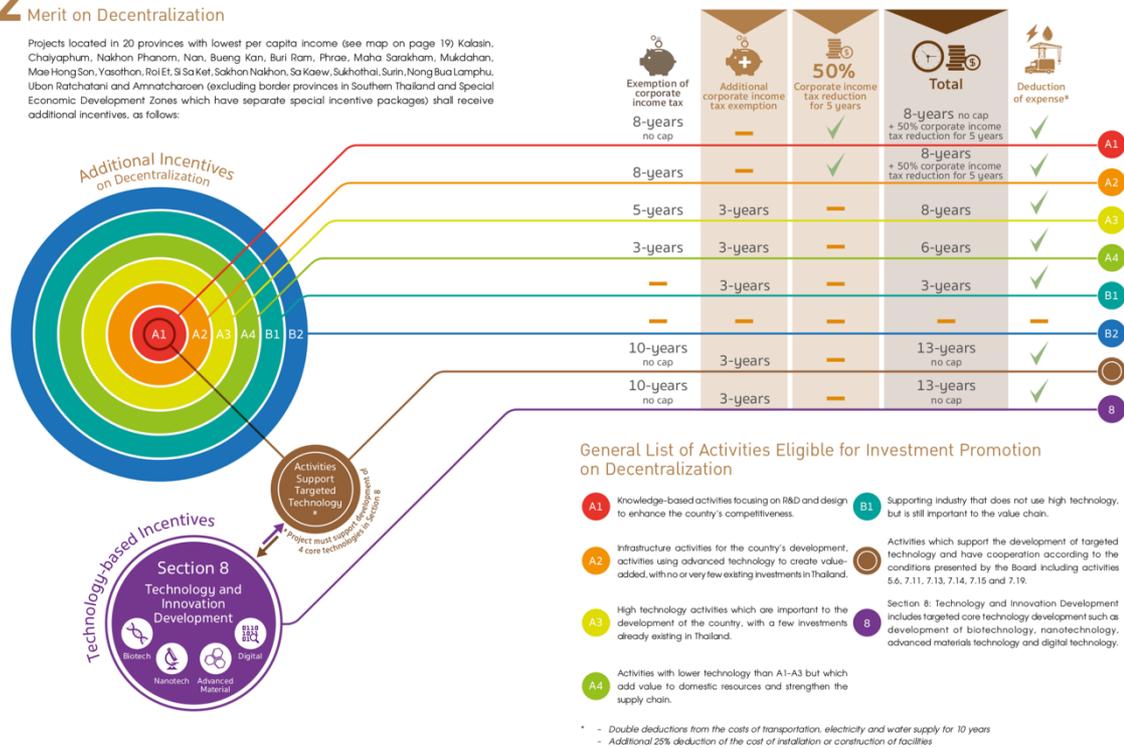


Figure 2.6 Criteria for granting addition promotion incentives under the merit on decentralization [7]

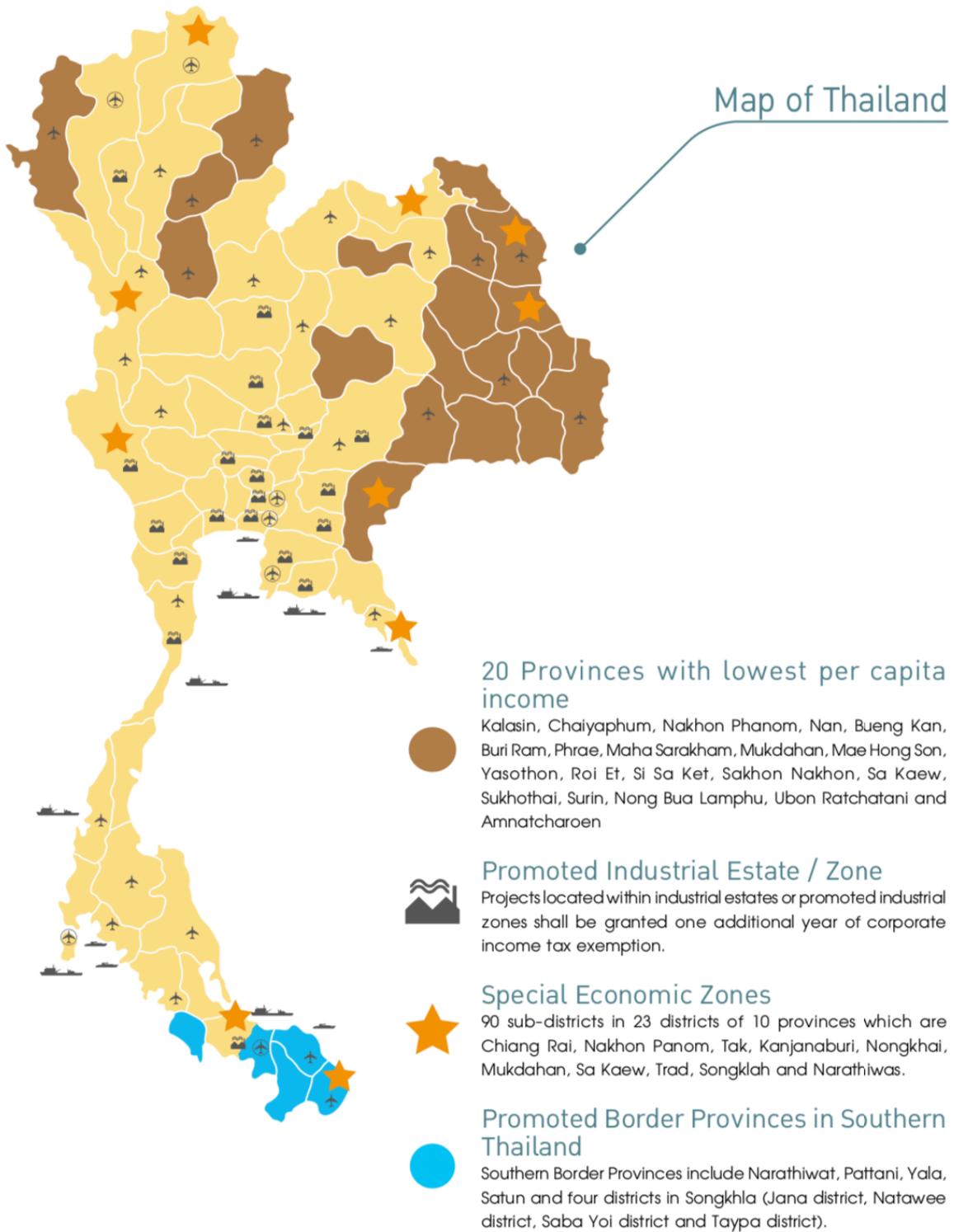


Figure 2.7 Map of Investment Promotion Zones [7]

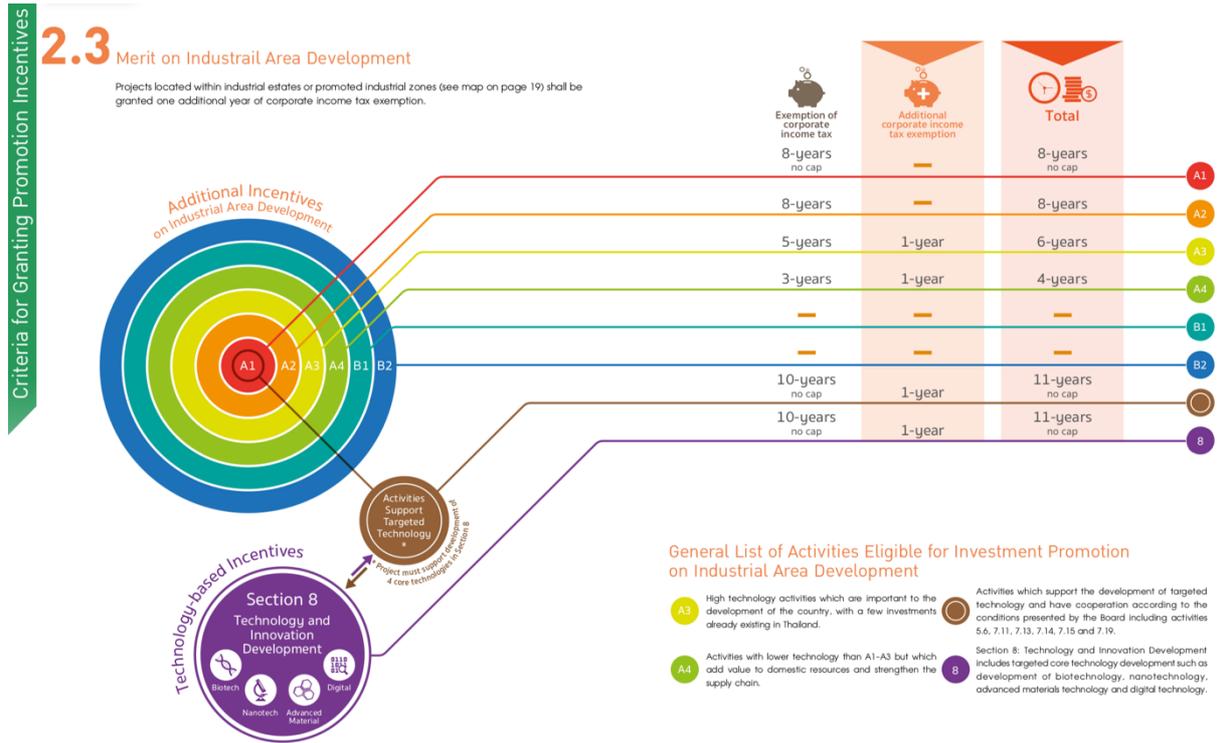


Figure 2.8 Criteria for granting addition promotion incentives under the merit on industrial area development. [7]

Some examples of the incentives offered by the BOI for the investment in logistics include [10]:

1) Manufacture and/or repair of rolling stock, parts or equipment for rail systems:

BOI’s incentives under the general list of activities for investment promotion ranging from group A1 to A3 (Applications must be submitted by Dec. 30, 2021 and projects meet the BOI’s requirements and conditions).

2) Mass transit systems and transportation of bulk goods:

A2: Rail transport

B1: Pipeline transportation (except water pipeline)

A2: Maritime transportation services

A3: Air transportation services

3. Logistics service centers:

B1: Logistics service’s distribution centers (DC)

A3: International distribution centers (IDC)

A3: Logistics Park

In addition, the BOI offers additional incentive packages for the investment in the promoted areas such as the Special Economic Zones (SEZs) and the Eastern Economic Corridor (EEC). Important additional incentives are as follows:

Incentive package of investment projects in the Special Economic Zones (SEZs)

The Special Economic Zones (SEZs) consist of 10 zones in Tak, Mukdahan, Sa Kaew, Trat, Songkla, Chiang Rai, Nongkhai, Nakhon Panom, Kanjanaburi and Narathiwat (see map in Figure 2.6). Logistics businesses in certain areas for SEZs may be granted 8-year exemptions on corporate income tax and an additional 50% reduction in corporate income tax for 5 years.

Incentive package for investment projects in the Eastern Economic Corridor (EEC)

New investment incentive package for investment projects in the EEC (2020-2021) which has started since January 2, 2020 is shown in **Figure 2.9**. Important additional privileges are as follows:

- Exemption of import duties on machinery and raw materials for production and R&D.
- Permission to own land for BOI promoted projects.
- Rights to lease of land for 50 years.
- 17 % personal income tax rate.
- Able to use foreign currencies in the Promoted Zones.
- One-stop service center to facilitate foreign investors.
- Work permits being issued for periods of 5 years.

According to the announcement of the Board of Investment No.2/2563, announced on Jan 15, 2020, applications must be submitted by the last working day of 2021. However, Projects located in the four promoted zones for specific industries (EECi, EECd, EECa and EECmd) are eligible for the incentives without an application deadline [11].

Key features	Investment Incentives	Targeted activities			
		Section 8	A1	A2	A3
1. Standard tax package	Tax holidays	10 Years (no cap)	8 Years (no cap)	8 Years	5 Years
Human resource development programs (additional tax incentives)					
2. Investment projects which are engaged in human resource development programs	Tax holidays	2 Years (no cap)	-	-	-
	50% reduction of CIT	-	3 Years	3 Years	3 Years
Projects located in the four promoted zones for specific industries (EECi, EECd, EECa and EECmd) OR industrial estates and promoted industrial parks					
3. Investments located in EECi, EECd, EECa and EECmd	Tax holidays	1 year (no cap)	-	-	-
	50% reduction of CIT	-	2 Years	2 Years	2 Years
OR					
3. Investments located in industrial estates and promoted industrial parks.	Tax holidays	1 year (no cap)	-	-	1 Year
	50% reduction of CIT	-	-	-	-

Figure 2.9 Investment incentive package for investment projects in the Eastern Economic Corridor (2020-2021) [11]

2.2.2 Research and Development Funding

There are three public funding agencies that provide grant for the research and development on logistics and supply chain which are:

- The National Sciences and Technology Development Agency (NSTDA)
- The National Innovation Agency (Public Organization) (NIA)
- The Program Management Unit for Competitiveness (PMU C)

1. National Science and Technology Development Agency (NSTDA)

The National Science and Technology Development Agency (NSTDA) is a funding and research organization under the Ministry of Higher Education, Science, Research and Innovation (MHESI) which was established as an autonomous government agency since 1991. NSTDA's roles in the promotion of science include research and research funding, technology transfer, human resources development and science & technology infrastructure. NSTDA offers 4 programs to support the research and development on logistics and supply chain which are:

1) Technology and Innovation Implementation Programs

These programs include NSTDA Testing Labs, Technology Licensing Office (TLO), Innovation and Technology Assistance Program (ITAP), and Research Gap Fund Program

(RGF). The objective of this program is to provide SMEs with an access to technical experts, testing labs and university research projects, to incentivize businesses to perform R&D and to connect enterprises to NSTDA research centers. ITAP program, under NSTDA, is an industrial technology support program for SMEs to help them meet the challenges in introducing technology-based products and processes by proving experts to identify technical solutions and consultation and reimbursing the expert expenses of up to 50% of project cost with the maximum of 400,000 Baht. Research Gap Fund (RGF) is a project that provides financial support up to 75% of qualified expenses for SMEs to access university research projects to create new products or businesses.

2) Business and Entrepreneurial Acceleration Programs

NSTDA provides the support to promote entrepreneurship in technology businesses through Business Incubation Center, NSTDA Investment Center and Startup Voucher. The Startup Voucher is a scheme for assisting startups to expand their markets by providing a voucher up to 75% of qualified expenses at the maximum of 800,000 Baht per project.

3) Research and Development Investment Promotion Measures

The Thai Government has issued measures such as 300% tax exemption for R&D expenses to encourage the private sector to perform R&D. NSTDA has been appointed as a certifying body for research, development and innovation projects submitted for tax privileges by companies since 2002.

4) Human Resource Development Program

STEM Workforce is a program to support 10 S-curve industries targeted by the government which include aviation & logistic industry. The program provides grants for graduate students to work on the projects of university faculty members or researchers in public organizations who has a collaborative research project with industry partners in 10 targeted industries [12].

National Innovation Agency (Public Organization) (NIA)

National Innovation Agency (Public Organization) (NIA) is a funding agency which was established since 2003 to conduct activities that accelerate innovation in industry and business. In fiscal year 2020, NIA offers two programs to support the innovation development on logistics and supply chain which are:

1) Open Innovation Program

The NIA provides “Innovation Coupon” for SMEs and startups (owned by Thai at least 51%) to develop commercial-scale prototype and industrial-scale prototype related to

transportation and logistics. NIA will support 75% of the total project budget (up to 1.5 million Baht grant for 100% consultation, lab-testing and operational cost, 50% of material, equipment and technology-licensing cost). The project that proposes for the support must be the collaboration between SMEs and innovation service provider (ISP).

2) Mandatory Innovation Program: NIA provides financial support 75% of the total project budget (up to 5 million Baht) for experienced medium and large entrepreneurs (owned by Thai at least 51%) to develop commercial-scale prototype and industrial-scale prototype related to the logistics innovation for agriculture solution.

In addition, NIA plans to launch other supporting programs, for example, **Thematic Innovation Program** which NIA provides financial support 75% of the total project budget (up to 10 million baht) for 3-years experienced SMEs that invest in smart logistics innovation to solving problems related to agricultural transportation and transportation in e-commerce system. The NIA also provides financial support 75% of the total consultation cost (up to 1 million Baht grant for the consultation cost) under **Managing Innovation Development (MIND) Credit Program** [13].

Program Management Unit for Competitiveness (PMU C)

The Ministry of Higher Education, Science, Research and Innovation set up a new funding agency to respond for the research grant related to smart logistics called “Program Management Unit for Competitiveness (PMU C)” since 1 November 2019. PMU C will provide the research grant for smart logistics technology that increase the competitiveness of the manufacturing and service sectors. In addition, the research grant providing by PMC C will focus on supporting cooperative plans or joint ventures with end users, such as SMEs and industry. PMU C announced a call for research proposal of the fiscal year 2020’s research grant under theme of “Technology Localization for Future Transportation System (Future Mobility)” since 26 February 2020 [14].

2.3 Adaptation of Thailand Toward an e-Logistics

2.3.1 Thailand’s National Infrastructure Development Program

The Thai government has committed US\$ 25.2 billion to 36 projects for rail and road upgrades, public transport improvement, airport expansion and seaport development nationwide. On-going major development plans are

- Development of U-Tapao airport.

- Upgrading of Sattahip, Laem Chabang, and Map Ta Phut port.
- Construction of High-speed and double-track railways
- Expansion of Bangkok's public transport network.

In addition, to promote the EEC as a leading ASEAN economic zone which is expected to drive additional infrastructure investment projects worth US \$43 billion by 2021 [10].

Regarding to the investment promotion by the BOI, 56 projects which invested in logistics and supply chain from 48 companies have been approved by 2019. List of promoted companies by BOI are summarized in **Table 2.6** [15].

Table 2.6 List of companies which invested in logistics and supply chain project under the investment promotion by the BOI.

Company Name	Province (Office)	Product
1. ANI Logistics Ltd.	Phra Nakhon Sri Ayudaya	- International Distribution Center (IDC) - Warehouse - Water Transportation
2. Aikai Logistics (Thailand) Co., Ltd.	Bangkok	- International Distribution Center (IDC)
3. Alconix Logistics (Thailand) Ltd.	Bangkok	- International Procurement Office (IPO)
4. Burapa Frozen and Logistics Co., Ltd.	Chiang Mai	- Cold Storage Truck; Cold Storage Room
5. Chaiyanan Bangplee Parkland Co., Ltd.	Bangkok	- Logistic Park
6. Cimc Logistic Service (Thailand) Co., Ltd.	Chon Buri	- Container; Container Repair
7. Delfingen Siam Co., Ltd.	Samut Prakan	- Corrugated Tubes for Automotive; Textile Sleeve
8. Fair Textile and Logistics (Thailand) Ltd.	Samut Prakan	- Yarn Dyeing; Dyeing
9. Hi-Tech Kabin Logistics Corp., Ltd.	Bangkok	- Industrial Estate
10. Honda Logistics Asia Co., Ltd.	Phra Nakhon Sri Ayudaya	- Warehouse (Automotive); Packaging Product Distribution Center
11. Inet - Logistics Co., Ltd.	Khon Kaen	- Software
12. International Logistics Park Co., Ltd.	Samut Prakan	- International Distribution Center (IDC)
13. Katoen Natie (Thailand) Ltd.	Rayong	- Logistics

14. KLM-Logistic Co., Ltd.	Nonthaburi	- Wheel (Vehicle); Screw
15. Konoike Cool Logistics (Thailand) Co., Ltd.	Samut Prakan	- Cold Storage
16. KTP Logistics Co., Ltd.	Surat Thani	- Water Transportation
17. Logistics Alliance (Thailand) Co., Ltd.	Rayong	- Warehouse - Distribution Center (Hemaraj Eastern Indus. Estate:Rayong) - Distribution Center (Chonburi/Rayong)
18. Lucky Star Logistics Co., Ltd.	Samut Prakan	- Cold Storage Truck
19. Melco Logistics (Thailand) Co., Ltd.	Bangkok	- International Distribution Center (IDC) - Distribution Center
20. Nippon Express Nec Logistics (Thailand) Co., Ltd.	Bangkok	- International Procurement Office (IPO)
21. NP Marine Logistics Co., Ltd.	Bangkok	- Water Transportation
22. Otax Electronics (Thailand) Co., Ltd.	Prachin Buri	- Electronic Equipment Parts; Metal Parts for Electronic Products; Plastic Parts for Electronic Products
23. OTT Logistics (Thailand) Co., Ltd.	Samut Prakan	- Distribution Center
24. Pacific Logistics Pro Co., Ltd.	Samut Sakhon	- Cold Storage Truck
25. Paisarnroj Logistics Co., Ltd.	Samut Sakhon	- Cold Storage Truck
26. Parame Logistics Co., Ltd.	Chiang Mai	- Cold Storage Trailer
27. Pitichai Logistics Co., Ltd.	Phra Nakhon Sri Ayudaya	- Cold Storage
28. PTT Polymer Logistics Co., Ltd.	Bangkok	- International Distribution Center (IDC)
29. SCG Logistics Co., Ltd.	Bangkok	- Water Transportation
30. SCG Logistics Management Co., Ltd.	Bangkok	- Loading/Unloading Facility (Cement Powder) - International Distribution Center (IDC) - Water Transportation - Loading/Unloading Facility
31. SCG Nichirei Logistics Co., Ltd.	Bangkok	- Cold Storage; Cold Storage Truck
32. Siam Eastern Logistics Terminal Co., Ltd.	Samut Prakan	- Logistic Park
33. Siam South China Logistics Co., Ltd.	Chaing Rai	- Loading/Unloading Facility

34. SMC Logistics Co., Ltd.	Samut Sakhon	- International Distribution Center (IDC)
35. SME Factory Co., Ltd.	Bangkok	- Logistic Estate
36. SNS Logistics Co., Ltd.	Chon Buri	- Distribution Center
37. SWS Logistics & Marketing (Thailand) Co., Ltd.	Bangkok	- International Procurement Office (IPO)
38. Thaveevong Logistics Co., Ltd.	Songkhla	- Cold Storage; Cold Storage Truck
39. Ticon Logistics Park Co., Ltd.	Bangkok	- Flatted Factory - Logistic Park
40. Toshiba Logistics (Thailand) Co., Ltd.	Pathum Thani	- Warehouse - Stock Capacitors
41. Translogic Consulting and Service Co., Ltd.	Bangkok	- Logistic System Software
42. TTK Logistics (Thailand) Co., Ltd.	Chon Buri	- International Distribution Center (IDC)
43. TVS Logistics Siam Co., Ltd.	Bangkok	- Trade and Investment Support Office - International Distribution Center (IDC)
44. Vantac Amata Logistics (Thailand) Co., Ltd.	Chon Buri	- International Distribution Center (IDC)
45. V-Serve Logistics Ltd.	Bangkok	- International Distribution Center (IDC)

2.3.2 5G National Development in Thailand

5G technology is expected to support the e-logistics and supply chain, for example, inter-vehicle data transfer and linking of vehicles and digital infrastructure to provide more precise data for traffic control systems. Ministry of Digital Economy and Society and Thailand's National Broadcasting and Telecommunications Commission (NBTC) is responsible for the preparation and development of 5G technology in Thailand. Timeline of 5G development in Thailand is shown in **Figure 2.10**. The Digital Economy and Society Ministry is pushing for the adoption of 5G technology by 2020, especially in the Eastern Economic Corridor (EEC). **Figure 2.11** shows 5G testbed at EEC digital (EECd/Digital Park Thailand) for preparation of 5G technology to support industries in EEC [16].

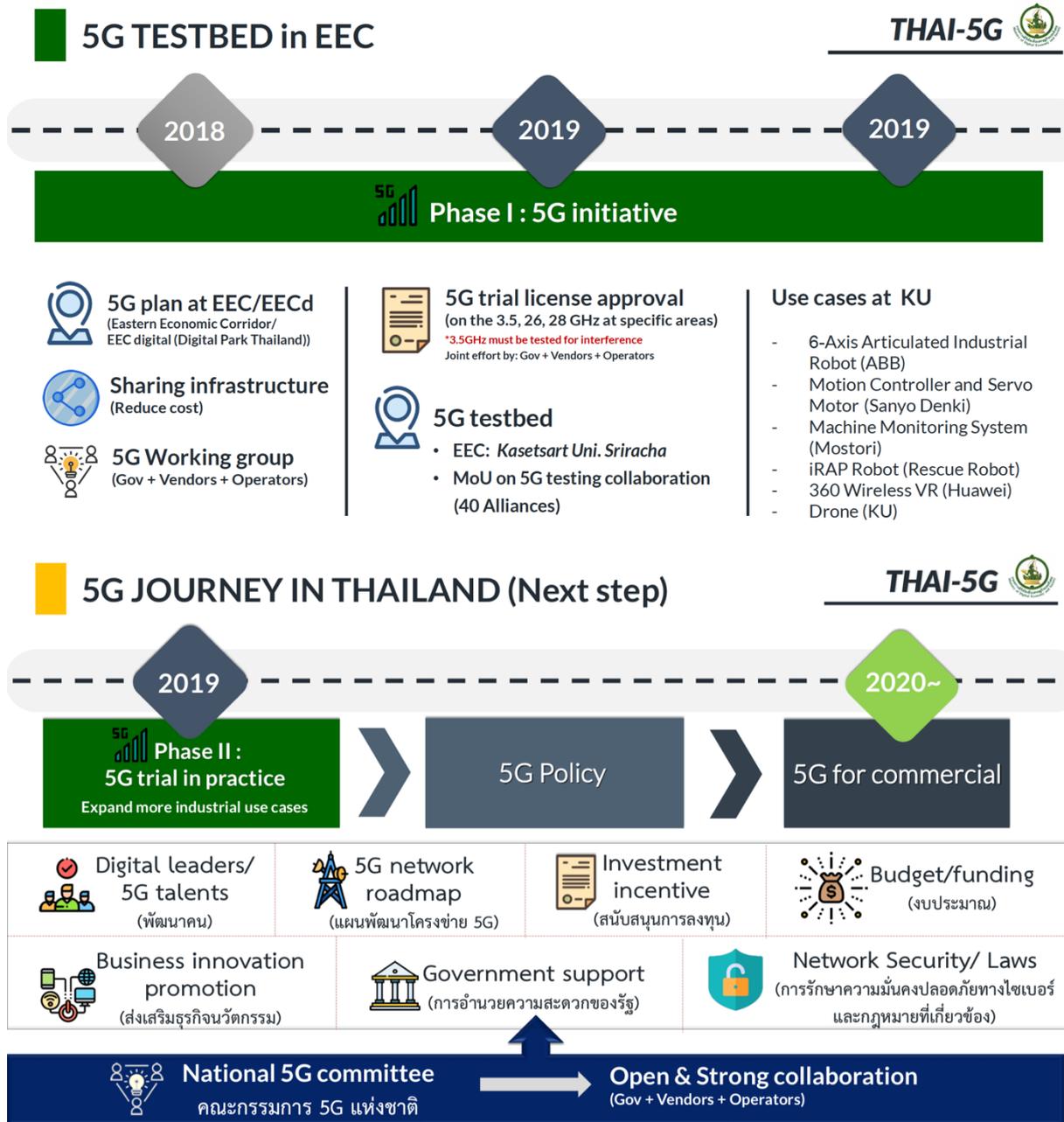


Figure 2.10 Development of 5G technology in Thailand [16]

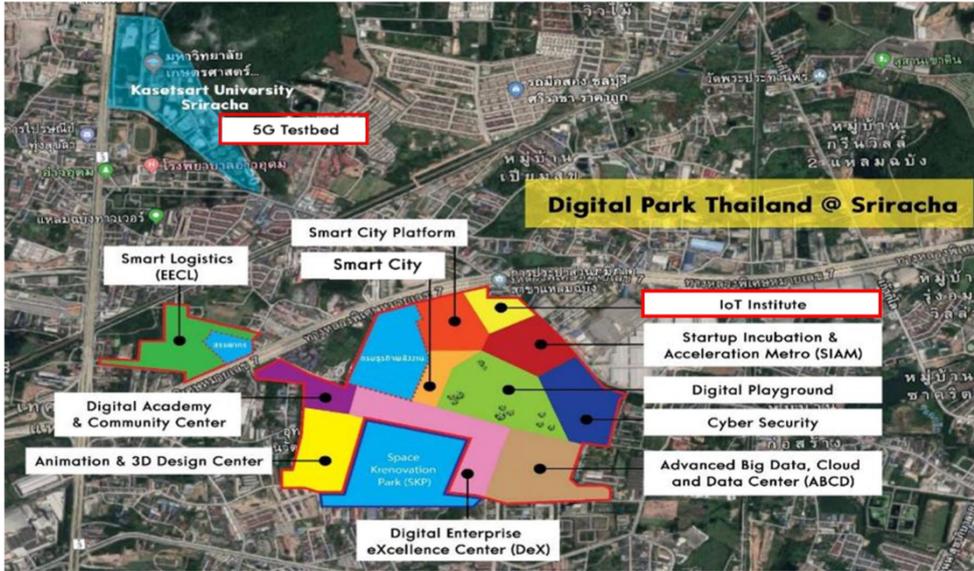


Figure 2.11 5G testbed at EECd [16]

BATTLE FOR THE AIRWAVES **5G**

Spectrum	Licences for auction	Bidders	Minimum price per lot (million baht)	Bid increment per round (million baht)	Combined winning prices (billion baht)	Winning bidders
700MHz	3	AWN, TUC, CAT	8,792	440	51.4 (3 licences)	<ul style="list-style-type: none"> CAT (2 licences) AWN (1 licence)
2600MHz	19	AWN, TUC, CAT	1,862	93	37.43 (19 licences)	<ul style="list-style-type: none"> AWN (10 licences) TUC (9 licences)
26GHz	27	AWN, TUC, DTAC, TOT	423	22	11.62 (26 licences)	<ul style="list-style-type: none"> AWN (12 licences) TUC (8 licences) TOT (4 licences) DTAC (2 licences)
Total	49				100.52 (48 licences)	

Source: NBTC

BKPGraphics

Figure 2.12 List of winning bidders of the 5G license auction in Thailand [18]

NBTC held the 5G license auction for four spectrum ranges of 700 MHz, 1800 MHz, 2600 MHz and 26 GHz on Feb. 16, 2020. The five bidders were Advanced Info Services (AIS), True Corp, Total Access Communication (DTAC), TOT and CAT Telecom. **Figure 2.12** shows lists of winning bidders of each spectrum license [17]. AIS announced the strategic plan

of 5G after winning the auction to hold the most amount of 5G in all 3 spectrum ranges: 700 MHz, 2600 MHz, and 26 GHz. 2600 MHz and 26 MHz will be applied to support the transformation of business and industry. The first phase of the AIS strategic plan of 5G is intended to expand 5G into the EEC area, which AIS already tested 5G in the EEC area such as U-Tapao Airport, Laem Chabang Port, Amata Nakorn, etc. [18]

2.3.3 Research & Development in e-Logistics

The example of success cases of Thailand's research & development projects in e-Logistics under the government supporting schemes are as follows:

NSTDA by the Technology Business Incubation Center (BIC) together with Panus Assembly Co., Ltd., the operator in the transportation business sector, initiated the Panus Thailand LogTech Award since 2017. The objectives of this award are to search and encourage logistic startups in Thailand. After that, Panus Assembly Co., Ltd. established the PANUS Logistics Innovation Fund which is a Corporate Venture Capital (CVC) fund that aims to support Thai logistics technology (LogTech) startups. Currently, the PANUS Logistics Innovation Fund has jointly invested with 2 startups that have Logistics Intelligence (LI) capability:

- LogiSenses Co., Ltd., which operates hardware logistics intelligences for fleet management using IoT-GPS boxes
- Crest Kernel Co., Ltd. which operates Software Logistics Intelligence for high-performance transportation management.

LogiSenses Co., Ltd., and Crest Kernel Co., Ltd. jointly launched “LogiSenses”, a business that developed a logistics management platform with intelligent technology (LI: Logistics Intelligence). LogiSenses is the first car GPS services with Narrowband Internet of Things (NB-IoT) technology in Thailand, which is supported by AIS. LogiSenses started trial service for Ground Support Equipment (GSE) at Suvarnabhumi International Airport and will expand to all major airports in Thailand and other types of transportation vehicles [19].

In addition, NSTDA supported technology startups in Thailand by granting 12 scholarships to develop AI innovation prototypes for industrial uses under the AI Innovation JumpStart project. Some prototypes in this project are expected to be applied to e-logistics and supply chain, for example, AI for storage/retrieval system of container (Bua Soft Development Team), AI for drug warehouse (HOSPITAL-AI Team) and AI for automatic navigation drone

(OZT Robotics team). These startups will be continuously supported by NSTDA through Business Incubation Center and Technology Assistance Program (ITAP) [20].

The NIA has provided grants to 5 SMEs and startups in developing e-logistics & warehouse innovation. List of companies and technologies that received research grants from NIA is summarized in **Table 2.7**. These developed innovations have been launched to the market.

Table 2.7 List of companies that received research grants from NIA.

Company	Technology
1. Absolute Solution Co., Ltd.	Automotive Vehicle Logistic System
2. Eureka Design PCL.	Automated Storage/Retrieval System
3. Gen Serv Co., Ltd.	AGV System
4. FastShip Co., Ltd.	Automotive Vehicle Logistic System
5. E-Empowerment Co. Ltd. (MyCloudFulfillment)	Logistics & Supply Chain Management

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Chapter 3

Current Situations on e-Logistics and Supply Chain in the Viewpoint of Logistics Companies and Organizations

In this chapter, basic information of the interviewees, which are categorized into three groups based on their function in the logistics business, is presented. Then, the current situations on their adaptation, perception and preparation toward the e-Logistics and supply chain are summarized and elaborated as per their respective groups. Successful case studies of the implemented e-Logistics and supply chain related technologies are thereafter highlighted, including their impacts on energy saving and greenhouse gas mitigation. Finally, the summary of the key content is given at the end of this chapter.

3.1 Basic Information of Interviewees

As mentioned in **Figure 1.2** in Chapter 1, roles in logistics business can be categorized by their functions into 7 roles, namely, air freight forwarding (AFF), ocean freight forwarding (OFF), domestic truckage and cross boarder (DT/CB), customs brokerage (CB), removal (R), warehouse and inventory (WI), and public authorities (PA). For the analysis in this study, the roles of key stakeholders are regrouped based on their shares in total logistics cost in Thailand and their types of implemented technologies into 3 main groups; Logistics Service Providers (LSPs) or also known as Third-Party Logistics (or 3PL), which represents the former five roles, Warehouse and Inventory (WI) and Public Authorities (PAs).

As observed in **Figure 3.1**, in 2017 the transportation cost shared the majority (54%) of the total logistics in Thailand, which is represented by the LSPs group. The common e-logistics technology implemented by this group is the route optimization. Another 37% of the total logistics cost is contributed by the WI group, which focuses on warehouse and inventory management systems. The PA group is defined for nonprofit organizations, which can be either government or private organization. The PA helps promoting efficient logistic system and conveying feedback from logistics SMEs to the government.

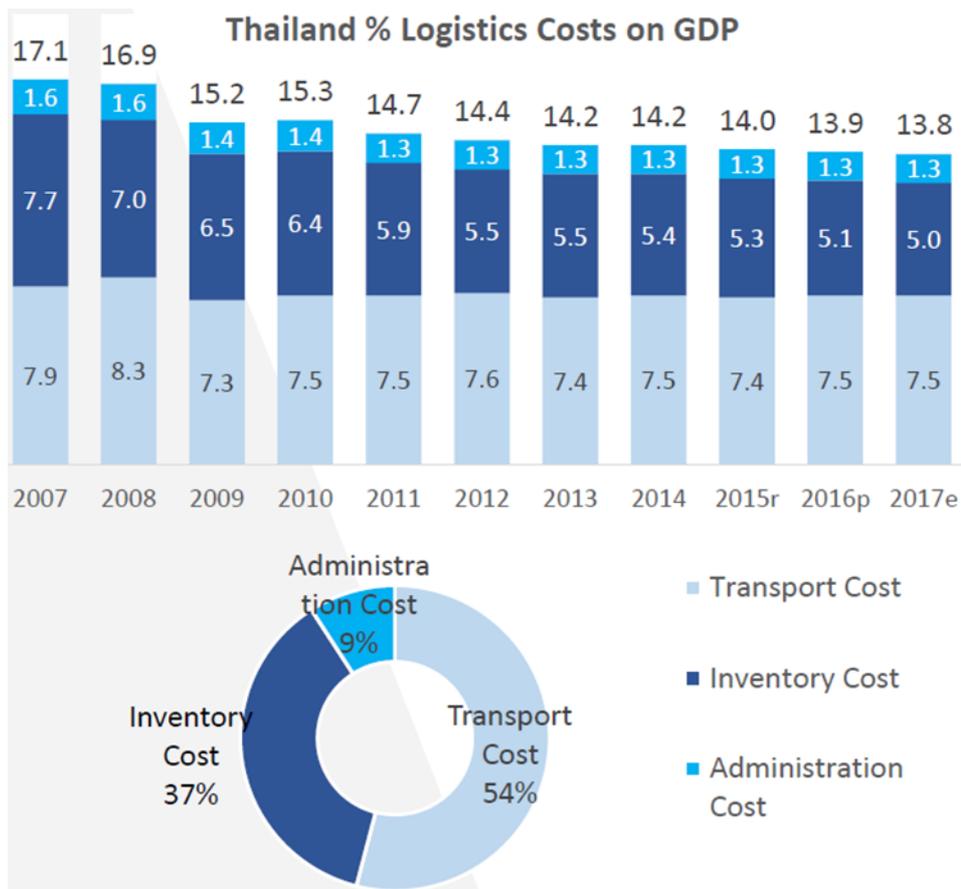


Figure 3.1 History of Thailand's logistics cost and the shares of different types of logistics cost in 2017 [1]

Of the 30 interviewees, 25% (8 interviewees) are from the LSPs group, 16% (5 interviewees) are from the WI group, 28% (9 interviewees) operates as both LSPs and WI, and 31% (10 interviewees) are from the PA group. Detail of the interviewees, including their affiliations, positions, and roles is listed in **Appendix A**.

3.2 Logistics Service Providers (LSPs)

In Thailand, 81.1% of domestic cargo traffic in 2017 was conducted via the road mode of which the cost per distance (cost/km) was about 3 times and 2 times higher than that of the water and rail modes, respectively (see **Figure 3.2**). This was one of the major factors that made the Thailand's logistics cost expensive (c.a. 14% of the GDP), as compared to other developed countries (about 7%). According to LSPs interviewees, the Gross Profit Margin (GPM) of their business is relatively low (<5-8%), but the volume is huge and the growth is continuously consistent (5% on average). As a result, to increase their profit, LSPs are forced

to focus on the road-mode route optimization in order to increase transport efficiency, safety, traceability and thus the cost reduction.

Thailand's infrastructure			Cargo Traffic ('000 tons)		Transport cost, avg.
			Domestic	Import/Export	
 Road	National Highway Motorway & Expressway Rural & Local road	99,774 km. 225 km. 357,223 km.	486,743	32,293	1.72- 2.02 THB per ton-km
 Water	International Deep Sea Ports - Containers Waterways	6 10M TEUs 3,999 km.	101,221	222	0.64-0.65 THB per ton-km
 Rail	Inter-city In Bangkok and vicinities	5,652 km. 123 km.	11,970	209,226	0.93-0.95 THB per ton-km
 Air	Airports - Aircrafts (2014) - Scheduled airlines (2014) - Scheduled inter'l routes	36 624,169 137 266	122	736 (excl. 3 of postal & courier)	10 THB per ton-km

Figure 3.2 Transportation modes and their contributions in Thailand's logistics system [1]

The common e-logistics and supply chain technologies that have been implemented by LSPs are

- Rules based route optimization system by which desired criteria such as speed control, safe parking area, and driving hour limit can be set as inputs in a software.
- Internet of things (IoT) and Global Positioning System (GPS) by which LSPs can track their goods and trucks.
- E-document: orders, receipts and customer's feedbacks can be done and collect in electronic formats. This includes delivery documents processed via the customs.
- Electronic Seal (E-Seal) is a hardware used to track goods across borders, send data in real time via GSM network. It is also used to ensure that the cargo would not be open until it arrives its destination.
- iTrust technology is used for trading the Electronic Air Waybill (e-AWB) to the destination and checking the ownership of the product or document.

With these technologies, a control center can communicate with truck drivers, send instructions and suggestions to the drivers, track down the delivery, and receive customer's feedbacks via a smart phone.

In the future, more advanced e-logistic and supply chain technologies are expected to be implemented by LSPs. These incoming technologies include:

- Machine Learning or Artificial intelligence (AI) system for better and more adaptive route optimization.
- Big data for risk management. The data itself can also be sold to other third party companies. For example, the data of the coordinate at which accidents occur frequently is valuable to insurance companies.
- Robotic Process Automation (RPA), which is also known as “BOT”, can conduct filing, ordering and processing 2 times faster than a skillful human without errors. With RPA, unnecessary cost caused by human errors can be avoided. According to an interviewee, one RPA can replace 3 workers.
- Block chain by which transaction data will be secured and the processing and tracking time will be reduced immensely, especially at the customs.

The currently implemented and the future e-logistics and supply chain technologies for LSP and their possible impact on transport energy saving and greenhouse gas mitigation, considered based on their direct impacts, are summarized in **Table 3.1**.

Table 3.1 A summary of the currently implemented and the future e-logistics and supply chain technologies for LSPs.

Technology	Transport Energy Saving	GHG Mitigation	Remarks
Rules-based route optimization system	✓	✓	Directly increase transport efficiency, reduce fuel consumption and thus the GHG emission
IoT and GPS			Track goods and trucks
E-document		✓	Reduce the use of paper
E-seal			
iTrust		✓	Reduce the use of paper
Machine learning or AI	✓	✓	Further improve transport efficiency
Big data	✓	✓	Avoid traffic or accidents
RPA			Reduce processing time and human errors
Block chain			Increase data security

At present, most interviewees mentioned that the government policies are not, neither the driving force nor support to their e-logistics technology implementation. The reasons for their e-logistics technology implementation have been mainly due to the need in efficiency improvement and cost reduction so as to increase their competitiveness over other market competitors. The interviewees expressed their concern that even though the government has a specific national logistics development plan, i.e., Thailand's 3rd Logistics Development Strategic Plan (2017-2021) by NESDB, but the executional plans and policies to achieve the goal are not clear and concrete. They also concerned that the government's plan will not be continuously executed.

Some interviewees believed that the EEC policy would have a limited impact on Thai logistics business. The EEC would have an effect on E-commerce more, especially on the SMEs who conduct B2C (business to consumer) business, but it would not affect much on B2B (business to business) conducting players. Nevertheless, other interviewees had a different opinion on the effect of EEC policy. They believed the EEC policy and its related financial incentives would result in a significant penetration of Chinese logistics companies into the Thai logistics market. As a part of the Chinese economy expansion, not only Chinese E-commerce business would come to Thailand, but also its vendors and the LSPs of those vendors would join the expansion in Thailand. The local SMEs are likely to be the most suffered stakeholders in this circumstance.

All interviewees agreed that the government must invest in the development of railway mode logistics. Otherwise logistics cost reduction cannot be reduced effectively. Typically, a government should first develop river docks (like in Vietnam) as the water-mode transportation is the least expensive mode, followed by the railway-mode development. However, in the case of Thailand, the road-mode transportation is dominating and shares a very high contribution of 81% of the total domestic cargo traffic. Improving the railway-mode before the water-mode will have an immediate significant impact on Thailand's logistics cost reduction.

Some LSPs stated that they have not yet adopted or invested substantially in e-logistics technologies. There were two major reasons; few competitors and lack of investment fund. LSPs that have certain customers and suppliers have a few competitors and are needless to spend a large or immediate investment in e-logistics development. Although there is no dominant player in overall Thai logistics business, there are still leading companies in different logistics sectors. For a small LSP, difficulty in the development of route optimization software can be a major barrier to the enhancement of the company's competitiveness. This is mainly due to the lack of investment fund and connection to the software developers.

Besides adopting e-logistic and supply chain technologies, LSPs should also consider to reform or diversify their roles in the logistics business. For example, if an LSP believes that B2B business in Thailand becomes saturated, but B2C business is going to expand with a high growth, the LSP may consider to collaborate or joint venture with another LSP who is an expert in the B2C business.

3.3 Warehouse and Inventory (WI)

Warehouse and inventory management is very important for the logistics system because it has an impact on the supply chain. The obvious advantage of warehouse management is that it creates value added to the customers' services such as labeling, packaging, sorting. The growth of warehouse operations is expected to continually increase, especially in the central and eastern districts. The reason is due to the increase of manufacturing and industrial zones of the country, the expansion of industrial and factories producing various products such as frozen food factory, processed food and agricultural products, and consumer products.

As presented in **Figure 3.1**, the cost related to warehouse and inventory management shared 37% of the total logistics cost in 2017. To reduce their management cost, most large companies have already implemented at least a few automation and robotics systems into their warehouse. The common e-logistics and supply chain technologies that have been implemented by WI managing companies are

- Enterprise Resource Planning (ERP) is business process management software that allows an organization to use a system of integrated applications to manage the business and automate many back office functions related to technology, services and human resources. ERP software typically integrates all facets of an operation — including product planning, development, manufacturing, sales and marketing — in a single database, application and user interface [2]. According to the interview, the most trusted ERP by large WI managing companies is the German SAP ERP.
- Automated guided vehicle (AGV). Probably the most commonly used technologies among Thai WI managing companies at present. AGVs are used to deliver parts or goods from station to station in a production line.
- Automated Storage / Retrieval System (ASRS) by which goods or parts can automatically be stored in or retrieved from warehouse racks using a robot arm.
- Warehouse Management System (WMS) is a software and processes used to control and manage warehouse operations from the time goods enter a warehouse until they

move out. In other words, WMS facilitates warehouse operations from goods receipt, inventory tracking, slot allocation, selection and packaging, and document preparation and reporting to internal employees and customers. Advantages of automated warehouse management are as follow:

- Effective delivery planning that makes use of an efficient analysis and planning of storage and distribution of products in the warehouse.
- Workers can always work consistently and maintain work efficiency without causing fatigue.
- The company can reduce many labors in handling goods.

Most large interviewed companies stated that they and their partners developed and customized their own WMS to meet their specific demand.

- Transportation management system (TMS) is a system aiming to communicate with other parties who deliver goods to/out of a warehouse. Cooperating with other systems like WMS, an efficient TMS can result in reduction in inventory reserve cost, storage area and waste of waiting.

In the future, the ultimate goal of WI development is to become a “fully automated” or “dark” warehouse in which workers are no longer required. However, the fully automated warehouse is not likely to be built within the next 5 – 10 years, according to the interviews. This is because the technology itself is over their current needs. Some newly built warehouses had been designed to meet the capacity growth for the next 10 years.

The currently implemented and the future e-logistics and supply chain technologies for WI managing companies and their possible impact on transport energy saving and greenhouse gas mitigation, considered based on their direct impacts, are summarized in **Table 3.2**.

Interviewees mentioned that cold chain warehouse renting business, especially for foods, has rapid growth recently. Such business would be a perfect target to adopt the automation and robotics systems in their warehouse in which operating condition is below the freezing point and contamination must be controlled. They also mentioned that labor-intensive WI managing companies such as manufacturers in electronics business have not yet implemented automation and robots much due to their nature of delicate manufacturing processes. Considering the current economic situation, such WI companies need to be more careful on the technology investment.

Similar to LSPs, the WI managing companies introduced automation and robotics system mainly due to their need in competitiveness enhancement, not related to the government policies and plans on logistics development.

Table 3.2 A summary of the currently implemented and the future e-logistics and supply chain technologies for WI managing companies.

Technology	Transport Energy Saving	GHG Mitigation	Remarks
ERP	✓	✓	Improve efficiency, minimize wastes
AGV			Mainly aim to reduce labor and errors
ASRS			Mainly aim to reduce labor
WMS	✓	✓	Improve efficiency, minimize wastes
TMS	✓	✓	Improve efficiency, minimize wastes
Dark warehouse	✓	✓	Most efficient, but not likely to be implemented soon

3.4 Public Authorities (PA)

Currently, the logistics and supply chain industries are faced with the change that is caused by digital disruption such as the utilization of machines to replace humans in a warehouse or integrating drone technology with the cloud system for real-time data collection and online processing.

The President of the Thai Federation on Logistics (Thailog), gave an emphasis on **an importance of the personnel development**, particularly in the field of logistics in order to create opportunities so as to compete at international level. In this regard, Thai logistics operators are able to increase their competencies with ASEAN countries by integrating relevant professional standards to be used as a guideline for human resource development in their organization to truly meet the needs of customers. Aside from personnel development, Thailog highlights **the creation of value-added in food and beverage supply chain**. It seems that current transportation can adapt technology in order to increase the value of food and beverage products through processes of cooling, packaging and labeling.

The President emphasizes **the importance of integrating cooperation between the three related agencies, namely government, private and educational sectors**. The private sector determines the characteristics of the logistics personnel to be in line with the operations and develop the skills of the personnel by operating the real work continuously. Likewise, the educational sector should be responsible for producing graduates and updating the curriculum to be in line with the needs of the logistics operators. Above all, the government must support the private sector to be able to produce standardized products and differentiate products consistently.

The research team had the opportunity to interview the Manager Director of ITrade (Thailand) Co., Ltd, one of Thai International Freight Forwarders Association (TIFFA)'s subsidiaries. The International Freight Forwarders Association (TIFFA) has been established for over 30 years. There is a total of 231 members (99% of which are small-medium sized Thai companies), which comprises logistics service companies, Multimodal Transport Operator (MTO), Freight Forwarder, Shipping Line and Warehouses. These members provide logistic services through 3 channels: land (trucks and trains) / waterways (ships) / air (airplanes) to exporters and importers.

The current situation of the Thai logistics business is increasingly **impacted by online purchases**, making logistics service providers find the ways to cope with the growth of e-commerce. Nowadays, the big logistics companies have already speeded up the development of technology to help in the management. However, Thai logistics service providers are **not yet ready to invest in various infrastructures** toward the development of software or platform. Thai logistic service companies only have computers, servers and software, but if they want to link information with airline companies such as Thai Airways, they are not able to do so, causing opportunity loss. The Thai International Freight Forwarders Association encourages its members to use technology in their management systems to enhance competitiveness and stimulate the adoption of digital systems to support the needs of business partners. The association is also one of the first departments that implement the use of an electronic document with customs clearance (e-Customs) and the airline's Electronic Air Waybill (e-AWB) operations in order to reduce paper-based work and make data encryption more secure.

Current developments of TIFFA towards e-logistics:

- 1) **Development of software and platform for the TIFFA members** to use at a reasonable price. However, research and development costs are required during development and after development processes. Therefore, the organization needs concrete support from the government.
- 2) **Development of IoT systems**, especially in cross-border operations to increase service value. He said the logistics service providers must improve their knowledge in order to understand how to apply technologies to the business. TIFFA EDI Services uses technology to increase the efficiency of cross-border transportation. In addition, TIFFA EDI Services has collaborated with foreign manufacturers to use the technology related to Electronic Seal (E-Seal) systems to transport goods across borders. Electronic seal technology or e-Seal technology helps in tracking cargo. It also helps in tracking container information for international shipping. This E-Seal system has a battery compartment and a Sim Card in order to send data in real time via GSM network. Members of the TIFFA can use the E-Seal system to increase service value for their customers.
- 3) The last promotion is the **development of block chain systems** to identify ownership of products and the development of the e-AWB system.

In this regard, the association not only promotes the efficient use of digital systems, but also co-founded the 1TRADE project, a large data center platform that connects all departments related to both domestic and international logistics. TIFFA EDI Service Group is currently working on the development of the **Electronics Marine Insurance (EMI) system** for cargo insurance and it is expected to be done by the mid of the year 2020. The 1TRADE project consists of 3 main components which are

1. **Preparation of electronic documents**
2. **Intelligent Technology or IoT**, which can be separated into 2 parts which are
 - 2.1 GPS and Platform for tracking and analyzing the data
 - 2.2 Bluetooth Low Energy (BLE) for trading
3. **iTrust technology**, which can be used for the trading the Electronic Air Waybill (e-AWB) to the destination and checking the ownership of the product or document.

Thai logistics operators must adapt themselves to upgrade towards e-Logistics. Though, there are still many limitations in order to upgrade the Thai logistics industry to e-Logistics such as:

- 1) Linking various information into the same database**
- 2) Unclear executive's perspective towards the adaptation of technology**
- 3) Shortage of manpower**
 - This results in higher expenses because the company has to hire outsource companies to develop the system.
- 4) A slow adaptation to technology changes**
 - The government must accelerate the development of a logistics platform with the aim of helping Thai small and medium-sized logistics operators.
 - The government may provide opportunities for foreign companies to find key partners in Thailand to develop a platform related to logistics.
- 5) Unfair competition**
 - The government should develop and monitor a fair competition mechanism for foreign investors who receive special privileges from BOI packages or EEC campaign and domestic LSPs who try to develop their own technology.
- 6) Price dumping of some LSPs**
 - The government must strictly regulate the price dumping.
- 7) Establishment of trade remedies measures** to protect the domestic LSPs who suffer from the unfair competition and the price dumping.

In conclusion, most of public authorities agree in the same direction that the personnel development in the field of logistics is needed. Besides, the Thai logistics operators should therefore adapt themselves and get ready to increase technological capabilities in all aspects in order to compete with foreign companies. Also, corporate executives need to change their mindsets and consider the importance of investing in technology to develop the logistics industry and meet the needs of the new generation of customers who choose to buy products through online channel (e-Commerce). In addition, the government may provide opportunities for foreign companies to find key partners in Thailand to develop a platform related to logistics. The urgent measures that the government must accelerate is the development of a logistics platform with the aim of helping Thai small and medium-sized logistics operators.

3.5 Successful Case Studies of e-Logistics Implementation

3.5.1 Daikin Industries (Thailand)

Daikin Industries (Thailand), Ltd (DIT) is located in the AMATA CITY industrial estate, Chonburi, Thailand. DIT had a revenue of 47,115 million Baht in 2017. DIT consists of both warehouses and manufacturing lines at which more than 3 million air-conditioners are manufactured a year and distributed to both domestic and Asia and Oceania regions (see **Figure 3.3**).

DIT is reasonably considered as one of the best case studies that implement e-logistics and supply chain as well as automation and robotics system in its plant very efficiently. The technology adoption by DIT is so efficient that it has received the “Thailand Prime Minister Awards” many times in the last decade, e.g., 2014 for logistics (SCM), 2016 for energy management, and 2018 for the best industry. Some of e-logistics and supply chain implemented in DIT plants and warehouse and their impacts are highlighted below



Figure 3.3 Shares of Daikin air-conditioners distributed to different regions [3]

DIT introduces **AGVs** to transport air-conditioner parts from warehouses to the production lines. Parts from suppliers are delivered into a warehouse at which workers who receive instruction from warehouse management software (**WMS**) pick and drop required parts into AGVs. AGVs then deliver the parts to production lines at which operators will assemble the air-conditioners as instructed. The WMS will synchronize number of parts used and deducted from the inventory. In this way, part delivery inside DIT factories become more efficient and the labor force can be reduced.

In 2018, DIT invests in collaborative robots with built-in vision for leak inspection. With this technology, all air-conditioners assembled in DIT factory are fully inspected for refrigerant

leak as well as high voltage checking. This increases reliability of DIT's product, production efficiency, and reduce human errors and product claims.

DIT employs “milk-run” transportation. Together with transportation management software (TMS) and the WMS, suppliers are suggested and guided to deliver parts under “just-in-time” production condition, i.e., the delivery truck must not arrive at DIT's warehouse earlier than 15 min before the appointment, and must leave the warehouse not later than 15 min after a suggested dropping time. All communication between customer via sales company, DIT factory and warehouse, and suppliers are linked together, as show in the information flows (Figure 3.4.). An ERP plays an important role in optimizing orders and process management. DIT selects the German SAP-ERP. These e-logistics and supply chain technologies make DIT's production more efficient, increase production capacity, reduce wastes (Muda), and decrease inventory space and costs. Suppliers also get benefits from DIT's technologies; no waste in waiting time, no traffic at the factory, which finally contribute to the energy saving and GHG emission mitigation.

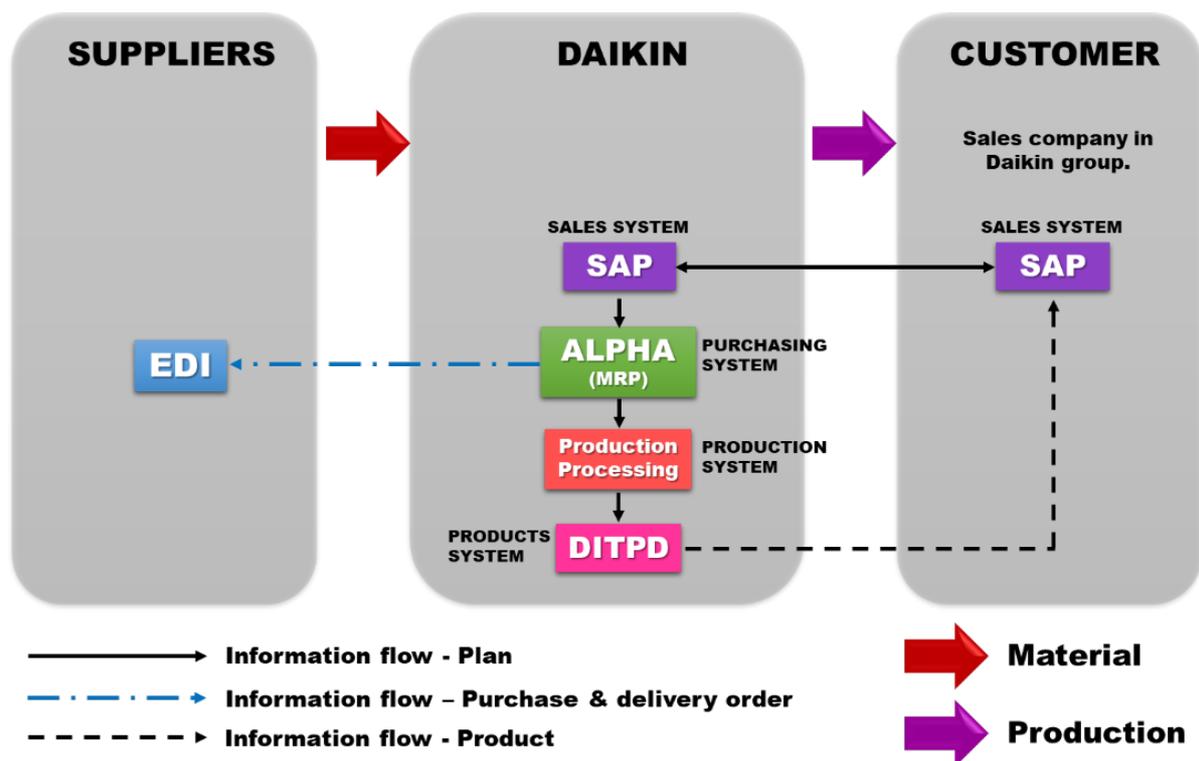


Figure 3.4 Information flow in DIT's factory and warehouse [4]

DIT also uses the environmental friendly **E-documents** with its suppliers, which tremendously reduce paper uses, paper work, and space for document storage.

With the integration of these technologies and management, the DIT can efficiently operate to meet the customer's demand growth while maintain its number of employees and postpone construction of new additional plants. In 2017, the DIT production capacity had increased, resulting in the increase in revenue by 35.4% from 34,787 million Baht in 2016 to 47,115 million Baht [4]. Nevertheless, the number of permanent employees and the subcontractors had been maintained at c.a. 2,500 each (5,000 employees in total); 4,500 employees in 2016, 5,000 employees in 2017, and 4,800 employees in 2018 approximately) [4]. During our plant visit at DIT in 2019, instead of constructing a new factory, the company had doubled its production lines from the unused inventory reserve space that is acquired from the technology implementation and better warehouse management. According to the DIT interviewee, this result reduces inventory reserve cost by more than a hundred million Baht a year, let alone the postponed investment and operating costs needed for the new factory.

3.5.2 SCG Logistics

The SCG Logistics, Co. Ltd., is a company under Siam Cement Group (SCG), Co. Ltd (Public) who is responsible logistics businesses of the group. The SCG logistics is one of the largest logistics companies in Thailand with an annual revenue of about 20 billion Baht in 2018 with an amazing growth of 30%, according to our interview (**Figure 3.5**). The SCG logistics provides a variety of logistics services, including domestic truckage and cross boarder (DT/CB), customs brokerage (CB), removal (R), warehouse and inventory (WI), and cold chain business. Thus, it basically functions as both LSPs and WI.

The SCG Logistics does not own a single truck, but it acts as a third party who provides support systems and specialists to its subcontractors. Currently, there are about 8,500 – 10,000 trucks collaborating with the SCG Logistics. The distance that company has to cover is 7 million km/year, which is equal to 90,000 trips/month and 250,000 orders/month. 90% of its business is the B2B mode of which 80% are for domestic transportation and 20% are for overseas and across border transportations.

Generally, to increase a company's net profit by reducing operating costs, it can be done by either improving company's efficiency or decreasing number of employment. As a SCG's policy, the SCG Logistics chooses to do the former. In order to increase the company's competitiveness, efficiency, safety and thus, to reduce cost, time, error, and waste, the SCG Logistics has planned to invest 800 million Baht in the next 5 years (2019-2023) for the implementation of e-logistics and supply chain technologies. As of 2019, 200 million Baht was already invested in the hardware of the project.



Figure 3.5 Meeting with SCG Logistics's Managing Director.



Figure 3.6 SCG Logistics's control center at Bang Sue District.

In its LSP business, the SCG Logistics has established its transportation control center at its headquarter in the Bang Sue District, Bangkok (**Figure 3.6**). With this control center, only 4 skilled operators or engineers are required to control and supervise all 10,000 trucks operating throughout Thailand in real time. An in-house **rule-based route optimization** is used to supervise truck drivers for the economically best route, warning of proper parking areas, and warning of limited driving hours via driver's smart phones and **GPS** systems. For safety's sake, if drivers violate SCG Logistics's rules or turn off their cell phone for whatever the reason, they will be automatically warned by the system. If they continue to violate the rules, their respective subcontractors will be fined and received other penalties.

In the near future, with the development of 5G network, the SCG Logistics plans to employ a **face recognition system** to detect drivers' face and their eye-blinking rate, which could imply whether the drivers are asleep or not. The goal is to avoid accidents and losses.

The SCG Logistics also introduces **Robotic Process Automation (RPA)**, which is also known as "BOT". The "BOT" can conduct filing, ordering and processing 2 times faster than a skillful human without any human errors. With the RPA, unnecessary cost caused by human errors can be avoided.

For its warehouse business, the SCG Logistics has implemented technologies like **AGV** of Siemens, **ASRS** of Daifuku (Thailand), **WMS**, **supply chain management** software of JDA in its regional warehouses. In conclusion, the SCG Logistics is one of the most adaptive companies to the e-logistics era who also possesses sufficient investment fund.

3.5.3 Café Amazon Warehouse

The Café Amazon group is a company under PTT OR, Co. Ltd. (Public), which is in charge in coffee and bakery business. The Café Amazon is the biggest coffee brand in Thailand in terms of the number of branch and coffee bean roasting capacity. As of 2019, Café Amazon has more than 2,800 branches in Thailand with rapid expansion of branches in many neighboring countries such as Laos and Cambodia. To sustain such enormous number of branches, it has to roast 15,000 kg of coffee bean/day at its roasting center at Wang Noi, Phra Nakhon Si Ayutthaya Province.

As the company grows, the Café Amazon Group has experienced the problems of limited storage space which caused a delay in delivery and high shipping costs. Additionally, management through several small warehouses, including subcontractor's warehouse became inefficient and costly. For these reasons, the Café Amazon Group has planned to develop its new distribution center (DC), which is designed to be almost fully automated warehouse.

According to the director of for Amazon Plants and Distribution Center Management Project, the new distribution center will be located at the company's Wang Noi plant, right next to the roasting plant. The new distribution center will be with an area of more than 25,000 square meters to store the products of Café Amazon such as coffee beans, coffee-making equipment, glass, straw, and other products of the PTTOR's retail businesses. It is designed to serve for the next 10 year demand with the current growth at 3-4% per year. The operation in the distribution center will be 80% with automation and 20% with conventional labor force for very small size retails. Polytech, Co. Ltd. is the system integrator (SI) of the distribution center project, which is expected to be fully operated in the Q4/2020.

The new distribution center will have an **automated storage and retrieval system (ASRS)** that can run both horizontally and vertically for storing and distributing goods off the shelves under the command of the **Enterprise Resource Planning (ERP)** and **Warehouse Management System (WMS)** as required by the user. The Café Amazon Group also uses the German **SAP-ERP**. Consequently, it is possible to check the location of the product storage with high accuracy and check the status of all products in a real time. It seems that the Café Amazon Group has prepared to cope with business fluctuations in the new disruptive technology era.

In addition to the above mentioned automation systems that the company has introduced, there are also many types of automation and robotics systems that work together such as sorting box products, **automated palletizer, automated depalletizer, automated conveyor,** automated guided vehicle (**AGV**), and etc. There is also a transportation management system (**TMS**) that is involved in both the inbound process and outbound process. Originally, The Café Amazon Group hired subcontractors for good transportation, but at present, the company has performed transportation by itself. This makes it possible to rule out transportation management by the company. In the past, the company would send products in separate boxes to each zone, but in the future, the company will add the receiving points in the middle of the way between the origin point and the receiving destination. The TMS of the Café Amazon Group is an in-house system developed by another brother company, PTT digital, Co. Ltd.

Radio Frequency Identification (RFID) helps employees know the exact inventory location, increase the accuracy of product selection and distribution process, and prevent theft when moving products along the supply chain.

Artificial Intelligence (AI) Technology is used to specify the appropriate vehicle size for product delivery, calculate the most efficient route for transportation to reduce shipping

costs, record products in and out of the inventory in order to evaluate business performance, and handle large volumes of cargo in warehouses with limited spaces.

All of which are expected to make the logistics system in the new distribution center more efficient, more accurate, faster, safer, and are worth the investment. 5% of the total cost (equivalent to more than **100 million Baht a year**) is expected to be saved due to less transportation cost and less inventory management cost.

Similar to other large logistics company, the new distribution center plan of the Café Amazon Group is driven by its own internal need of efficiency and competitiveness enhancement. Government's policy or incentives have insignificant influence on the company's technology investment plan. Surprisingly, the company has filed a request for BOI's financial incentives, but the BOI rejected its request for the reason that this policy will not effective for a company that implements automated warehouses to serve its internal businesses.



Figure 3.7 Meeting with PTTOR's Director for Amazon Plants and Distribution Center Management Project

The director (**Figure 3.7**) also added that there is now more competition in design and installation service providers, which is known as system integration (SI). The main characteristics of each device are applied together, known as an integrated system that meets the needs of each business at a more worthwhile investment. We can conclude that automated

systems for warehouses are considered new technology for Thailand. It has a direct impact on the SI, such as the shortage of skilled workers in this field. Therefore, it is very imperative that the government has a policy that clearly promotes the production of personnel in this field in order to drive this 4.0 continuously and steadily.

3.5.4 Energy Saving and Greenhouse Gas Emission Mitigation

Energy saving was estimated based on an assumption that the number of trips for goods transportation by trucks would be reduced due to better logistic management using e-logistic technologies and marketplaces. Data of registered trucks of overall private logistics enterprises was obtained from the Transport Statistics Sub-Division, Planning Division, Department of Land Transport. The number of vehicles (trucks) registered in Thailand as of 31 January 2020 was 809,612 units. It was assumed that 70% of the trucks would be in use, therefore, the reference case of energy consumption and CO₂ emission was from 566,728 trucks in 2020. If the fuel (diesel) consumption per truck was 29,620 Liters per year, the daily average diesel consumption was 81.15 Liters per day (for two round trips a day, approximately). Assuming 5% of the trucks using diesel would be cancelled due to “Truck sharing” among freight forwarders in land transportation, about 28,336 trips of trucks per day could be reduced. However, one of the interviewees expected 10% of the trucks could be reduced because of better logistic management.

Annually, it was estimated that the trips would be reduced by 8,500,800 trips for 300 operating days per year. As the diesel usage of a truck was 41 Liters per a round trip, the reduction in diesel consumption would be approximately 345 million Liters per year in 2020 or 2.05% of the total diesel consumption by trucks. This energy saving was equivalent to 338 ktoe per year. At a diesel price of 25.68 Baht/Liter, the fuel cost saving would be 8,861 million Baht per year.

In the environmental aspect, the Emission Factor (EF) of diesel (moving) is 3.2988 kg CO₂e per kg of diesel. Therefore, it was expected that the reduction of CO₂ emission would be 0.947 million tons of CO₂e per year. If the number of registered trucks increased by 2,000 trucks per year, it was forecasted that from 2021 – 2030, CO₂ emission mitigation would be 10.60 million tons of CO₂e for 10 years, higher than the expected Thailand’s target of cumulative reduction of CO₂ until 2030 at 7.721 million tons of CO₂e.

3.6 References

- [1] Office of the National Economic and Social Development Board (NESDB), 2017.
- [2] <https://www.webopedia.com/TERM/E/ERP.html>
- [3] <http://www.daikintha.com/corporate-information/history>
- [4] Plant visit with The Federation of Thai Industries, Daikin Industries (Thailand), Ltd., on March 13, 2019.

Chapter 4

Potential and Obstacles of e-Logistics and Supply Chain

In this chapter the potential and market opportunities of logistics in the supply chain are discussed, especially the potential of e-Logistics. Then, the current support and obstacles of e-Logistics regarding the government policies are reviewed. However, there are five factors affecting transformation context on Thailand logistics development. Consequently, the e-logistics aggregator and e-logistics marketplace might be crucial for logistic development. Finally, the suggestions to both government agencies and Thai LSPs are discussed.

4.1 Potential and Market Opportunities

Nowadays, technology has developed exponentially so that impact of digital technology is larger and faster. Technology is transforming virtually in every business sector; i.e. (1) All the world information and media are online, (2) Mobile device helps people reach to one another anywhere and anytime at much faster, (3) Cloud computing could put a supercomputer into the pocket. Therefore, digital disruption becomes closer. The mindset to run business should be adapted to the internet century, making thing even more comfortable. Therefore, the conventional logistics is being transformed into e-logistics according to their potential and opportunities in logistics development.

4.1.1 Potential

Thailand's geographically advantageous location among ASEAN Member States, as seen from Figure 4.1, allows for the expansion of logistics business. Thailand is the door to Cambodia-Laos-Myanmar-Vietnam (CLMV) that creates 3 trillion Baht on the market value. The economic integration among several countries; i.e. Free Trade Agreement (FTA) and Customs Union, expands the trading and investment, manufacturing, and employment. It also enhances competition and reduces fixed cost. Thai government, therefore, needs to formulate policies and promote logistics development in order to support the growth of industries that use advanced technology in the production.

Owing to Belt and Road initiative, Thailand could change the country's role from an exporter of agricultural products to create value-added on imported goods from neighboring countries and export to the third countries.

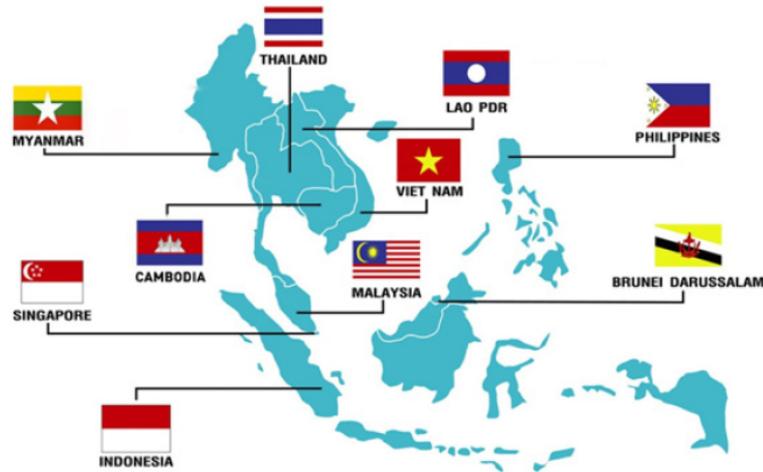


Figure 4.1 Thailand geography among ASEAN Member States [1]

Thailand has concrete strategy for national development from the government. The National Development Plans of Thailand related to logistics is the NESDB's Thailand Logistics Development Strategic Plan #3 (2017 – 2021), aiming to develop on (1) Value-added of supply chain system, (2) Basic infrastructures and facilities, and (3) Supporting scheme for logistics.

The logistic development enhances expansion of the country's strategic goal to become the "Logistics Hub" of the Greater Mekong Subregion. This would enable the linkage between domestic and international activities while upgrading the country's logistics system toward world standards. Thailand expects foreign investors turning to invest in various areas throughout the country. The other plans that boost the potential of logistics development are Eastern Economic Corridor (EEC) and Special Economic Zone (SEZ).

The national logistics plans will support both of industrial and logistics sectors. The government has accelerated the investments in basic infrastructures, the marine and road-transport networks, the cross-country motorway projects, the double-track railway, and the international trading gateway.

In 2019, before the COVID-19 crisis, the development of the Thai economy is potentially stable. This was a good sign for Thailand to become the regional logistics market that attracts investors in the long run. The infrastructure of Thailand has been developed in various areas. The development of the domestic's infrastructure and logistics system enhance connecting to other regions in the country while expanding the opportunity to connect with the neighboring countries.

Thailand has progressively development of industrial estate that require standardized logistic systems. Most of the industrial estates are located in Eastern Thailand, about 50 from

59 estates, while the EEC has been implemented 4 – 5 mega projects. The efficient logistics management plays an important role in manufacturing division so that the application of technologies in logistics management is crucial.

For land and sea transportation, Laemchabang Port is the main gateway for the goods import-export of EEC, where the “Smart Port Management System” as infrastructure for data integration among involved parties has been developed. The transportation of the export and import at Laemchabang Port is “Multi-modal” among air-sea-train operation. Smart Port Management helps to increase the efficiency of intelligent transportation by linking the import-export multimodal transportation at Laemchabang Port. The container management would be convenient so that increasing service quality as well as reducing logistic cost, traffic, and pollution. Unfortunately, the traffic congestion due to road construction outside the Laemchabang Port might cause obstacles to transportation into the port.

Although logistics cost in Thailand is rather high, instead, this means “large gap to improve” or “worth to invest”. Currently, the development of logistics innovation and technology involve e-commerce and e-payment. The Business to Customer (B2C) logistics in Thailand has geared up because of the expansion of e-commerce. Although, there is growth of e-commerce business, but transportation-related businesses are gradually impacted by online purchases. For better entire service, value-added on last-mile delivery is important.

The national logistic policy is opened for the experienced LSPs from overseas to support the Thai’s manufacturers and customers. The open logistic market for an investment of overseas logistics company induces both pros and cons to Thai logistic development. The positive impacts are, for example, more alternatives, lower service cost with higher quality, access to specific skills and expertise, and reducing risk in operation. The overseas/multinational LSPs has professional management, however, they normally put a focus on supporting e-Commerce whose companies have growth drastically. If the multinational LSPs decide to use outsources from the local LSP companies, it would be a positive influence on the overall Thai logistics development as well.

Among an extreme competition, however, there is no obviously major market controller in logistic business. Therefore, joint venturing and company merging could enhance more opportunity for an investment in terms of technology support.

In addition, Thailand becomes “Aging Society”, so that the logistic business need adaptation to fulfil increasing elderly person’s requirement on online health service, medicine order, medical equipment and service. There will be an increasing need for cold chain logistics for medicine and medical equipment delivery to the patient and elderly person. The customer

needs not only delivery, but also additional services e.g., cleaning, appliances repairing, technological support, and preliminary medication. Therefore, the logistics industry should upgrade the unskilled labor to the re-skilled worker.

The businesses related to food processing or cold chain storage system can still grow because domestic and foreign consumers have purchasing power. The cold chain for food products also has the potential to grow. By chance, the cold chain warehouse requires the implementation of automation and robotics system, because of low-temperature constraints, and awareness on contamination. Thailand has encouraged the development of smart warehouses by offering special privileges (tax exemption up to 8 years together with levying 0% import duties on machinery). Thus, the overall growth of cold chain is 4-5% annually, that is high potential to develop logistics technology to support the value-added of food and beverages.

In the viewpoint of environmental concern, green logistics would reduce fossil fuel consumption for goods transporting and transferring in warehouse or container yard. The use of larger container/vessel for international transportation results in economy of scale, convenient and efficient goods transfer. The intermodal container, a large standardized shipping container, is suitable for intermodal freight transport that can be used across different modes of transport, ship-rail-truck, without unloading and reloading their cargo [2].

Considering potential or obstacles to e-logistics, two key players are discussed in the next section called “**e-Logistic Aggregator**” and “**e-Logistics Marketplace**” in the disruption and transportation era.

(1) e-Logistics Aggregator

E-logistics aggregator provides e-commerce shipping solutions that a group of agents from this company is responsible for processing all the operational components such as storage and transportation. Digital technology enhances new business models so that giant overseas LSPs could raise their trades based on “Sales Digitization” while “Logistics Startup” plays an important role as “e-Logistics Aggregator”. This is a win-win relationship between giant overseas LSPs and E logistic aggregators that focus on “e-fulfilment” of last-mile delivery for the retail e-commerce enterprises. The e-logistic aggregators have to collaborate together with the giant logistic LSPs for efficient delivery.

Most of the land transportation enterprises have not yet been a partnership with the e-logistics aggregator that established from the B2C e-commerce. Since 2017, there are at least four logistics aggregators for online merchants in Thailand: aCommerce Co, Shippop Co,

Giztix and SME Shipping Co, providing one-stop delivery for online merchants [3]. Shippop, a local logistics aggregator startup, mentioned that domestic e-logistics market in 2019 was jump 15% in value from 31 billion baht in 2018.

The major players in the B2C logistics are the Thailand Post and the giant overseas LSP. However, most of the Thai LSPs still in B2B logistics market. However, one interviewee from the Thai National Shippers' Council (TNSC) forecasts that the market share of Thailand Post will reduce to lower than 50% in the coming few years.

Nowadays, circulation trend of e-logistics aggregator is predicted to increase by the amount of 70% - 84% annually following the growth of B2C. It is forecasted that e-logistic aggregators sales will increase to 3,500 Million Baht in 2020 due to the potential of this new business model in market penetration. The B2B market in Thailand tends to grow exponentially by 10% - 12% annually during the year 2020 – 2027.

Manufacturers has changed their behavior to further accept digital technology for business. The growth of online shopping is driving demand for logistics services with many players and price structures [3]. Door-to-door transportation in Thailand tends to grow as people purchase things via an online channel. Therefore, online logistics service would have bright future that the logistic aggregator could recently expand their service into the B2B market.

In the future, the logistics aggregators in B2B market will bring their multinational LSP partners into B2B as well. Consequently, these multinational LSP could access to client base of Thai minor manufacturers to serve last-mile delivery to their customer, and fulfil the needs of online merchants. This would definitely affect the local LSP.

(2) e-Logistics Marketplace

Thai Logistics has so many enterprises among high competitions, especially land transportation. Thai freight forwarder enterprises are facing difficulty to compete with multinational LSP in B2B goods distribution business. Multinational LSPs normally focus on approaching large manufacturer themselves while using logistics aggregator to gather minor manufacturers.

Thailand has expensive transportation costs compared to many countries. The e-Logistics Marketplace creates large opportunities for Thai LSPs among high competition in the digital era, and act as linkage between products owners and LSPs. They can negotiate transportation cost and conditions via an online platform. The e-Logistic marketplace gathers all orders for

transportation services throughout the country. Consequently, it is possible for market mechanism using “Truck Sharing” efficiently.

Based on an interview with the director of logistics section from Yan Wal Yun, the company could reduce transportation and opportunity cost due to backhaul (i.e., a sharing of truck with their suppliers) in two cases; (1) Truck sharing to reduce backhaul of goods delivery with 1-2 suppliers by carrying raw material back (saving 200,000 Baht/year), (2) Truck sharing to reduce backhaul of 4-5 raw material suppliers from Nakornsawan and Nakornratchasima with their product delivery (300,000 Baht/year). This demonstrates that the information sharing and strengthen network among manufacturers and their suppliers help reducing logistics cost significantly.

The major problem of Thai LSPs in competitiveness with multinational LSPs is lack of online service throughout the country. Thai LSPs could approach customer only in local and nearby areas, lead to inefficient transportation operation and high cost. The cause of low efficiency is partial trucks freight or empty truck in return trip. The small enterprises encounter higher logistic cost because of long distance freight forwarding that is inefficient resource management.

If the local freight forwarders in each area create a network for data sharing on the transportation order, all enterprises in the network would have many benefits from a reduction of transportation cost by 5% - 15%. However, networking among freight forwarders has been conducted a long time ago, the delivery efficiency has been enhanced just a certain degree. However, it is difficult to distribute benefit to the network members with appropriated and justified cost estimation, especially if the network leader is the freight forwarder or truck owner himself.

All these problems can be managed well by using an online platform to create freight forwarder and truck owners network. One example is the success case of “e-Logistics Marketplace” in US. The Uber Freight has been developed to be a network leader by gathering freight orders throughout the country. AI and Big Data were the key mechanism for “Dynamic Pricing Model”. The suitable freight price was calculated real-time, therefore, E Logistic Marketplace can reduce delivery cost and provide benefit to all network alliances. This would be an important mechanism enabling small freight forwarder to be competitiveness impartially with large LSP.

The business model of e-Logistics Marketplace has high potential which would enable benefits to all network alliances. Currently, Thailand has 1-2 startups using e-Logistics Marketplace pattern. The Kasikorn bank research center [4] has expected that the e-Logistics

Marketplace in Thailand will dramatically expand within next 5 years, following the growth of B2B e-Commerce. Therefore, a part of manufacturers tends to change their behavior. They are going to perceive digital technology for goods delivery to merchants.

The overseas LSPs have advantages on international freight because of collaborated distribution centers that enable large truck transporting between distribution centers and consequently small truck/pick up delivery from distribution center to destination. The e-Logistics Marketplace will provide local LSPs to have higher efficiency than multinational LSPs in case of provincial freights; e.g. agricultural product, fishery product, and goods distribution from wholesalers to retailers.

In the future, when the e-Logistics Marketplace successes in the market, circulation and management efficiency will increase. Thai freight forwarder or LSP will be able to maintain their client base in B2B logistic market. The reason is that Thai LSPs have strength over giant overseas logistics companies in agile operation and lower overhead expenses and hidden cost.

If the provincial freight of e-Logistics Marketplace has better efficiency, the overseas logistics companies would rather subcontract to the minor freight forwarder within the platform to perform their provincial freight. The transportation from distribution center to destination has less economies of scale and require lot of experiences. It is not worthwhile for overseas LSPs to perform overall operation themselves.

Although, e-Logistics marketplace would create much benefit to Thai LSPs significantly, some SMEs would get the best from e-Logistics marketplace. Thai LSPs who are not partnership with the e-Logistics marketplace will lose the competitiveness. The important factor that affects the partnership of Thai freight forwarder with the foreign companies is skill and ability on digital technology for business; e.g. an implementation of GPS to their Trucks possibly for real-time monitoring of goods by the network. Therefore, it is recommended that the minor freight forwarders should accept digital technology to be a part of their business and always look for channel to be partnership with any e-Logistics Marketplace.

Thai LSP business who has growth among intense competition must adjust and employ technology for management. To be the winner of battlefield in Digital Disruption era, they are not only being technology user but also investing in digital technology. However, Thai LSP is usually facing difficulties to develop toward leader or global LSP as stated by TNSC administrative manager.

4.1.2 Market Opportunities

Considering market opportunities of logistics business. The comments from interviewees and the announcement by the Director of the Commercial Affairs Department of GIS led to five trends of transportation and logistics work in 2020 as the followings [5]:

(1) **Digital logistics:** Logistic administration by digital data. Data is an important variable to win over the competitors. Therefore, transformation to the digital operation is inevitable because digital is affecting the day-to-day administration in the business. Due to the visualized whole supply chain, the information in digital system enhances better and faster decision-making. Similarly, it would enable the control of fast change nowadays.

(2) **Real-time supply chain visibility:** Business owner has to learn about real-time data, e.g. location and amount of goods, transported time. IoT sensors must be used to follow transportation, i.e., routes, delivery locations, and special conditions, to fulfil customer requirements with the controllable cost of business as soon as possible. The data communication in business would help enhancing the decision-making and forecasting the order and supply chain management for the best efficiency.

(3) **Consolidation of goods:** Goods will be gathered from various companies in transportation by land-sea-air for cost-saving. This enhances logistic operation to be much more stable and sustainable. Market and freight size in transportation has drastically changed since everything can be purchased online. Amount of goods to be delivered has growth dramatically, therefore, the size of goods loading should be reduced to facilitate fast delivery.

(4) **Artificial and Augmented Intelligence (AI):** AI will replace a repeating task of human that could be operated by the system to acquire better and quantitative order. Though some tasks definitely require human skill, therefore, a new trend is emerged called “Augmented Intelligence” integrating human and AI to work together. The human intelligence is imitated, while human intellectual capacity is extended and embedded into the software, e.g., enlarged memory of order, perception, forecasting, problem-solving, decision-making, to understand human requirements and increasing data connections capability. For example, logistics planning needs to input human created data, i.e., action plan, the responsibility of customer service section, flexibility in operation that required human experiences, feeling, and common sense. These human data are further combined with AI’s data analysis and evaluation. AI will

predict and try to understand what will happen in the future and help to analyze results from the decision that has been made based on the learning of historical data. The predicted results from a decision in various directions improves preparation for solutions of those circumstances.

(5) **Data Standardization and Predictive Analytics Platform:** Platform technology for risk assessment and single data management is a tool for logistics big data gathering in the digital world. The logistic business should understand the operation of solution platform and apply for 1) improving transportation management efficiency, 2) upgrading performance of truck freights, and 3) reducing fuel consumption. These activities were already done by the Pharkphoom Logistics Limited Partnership (PPL), as mentioned by the Managing Director. Information forecasted by platform would indicate patterns of risk and opportunity based on data in the system. It should be flexible for additional input conditions; e.g., accidents, fuel consumption, truck maintenance, expenses, transportation routes, optimal parking locations, etc. To enhance better performance, the representative from LTFT (Land Transportation Federation of Thailand) suggested that the Ministry of Commerce should provide an open platform that composes of a few number of functions for automatic truck tracking and communication with truck driver.

The logistic development towards e-Logistics has not only provided the potential and opportunities but also facing the obstacles. The current obstacles are discussed in the next section.

4.2 Current Obstacles

Thailand is geographically located in the center of ASEAN. Among ASEAN countries, there is an intense competition with neighboring countries and possibly degraded economic system of neighboring countries. According to the implementation of government policy, inefficient strategic plan and discontinuous operation might cause obstacles to the development of logistics toward e-logistics.

4.2.1 The Government Policies

The government policies are either the driving force or obstacles to e-logistics technology implementation. Referred to evaluation of the Strategic plan (2017 – 2021), after half-plan, the results were not successfully achieved as discussed in the followings [6];

- (1) The KPI (Key Performance Index) do not cover all strategic aspects. Some government agencies do not collect data that result in a lack of supportive database.
- (2) Some government agencies have not paid attention to logistics development. They have inadequate understood, communication, deployment, information dissemination within the agency themselves.
- (3) The determination of the role, duty, responsibility is not obviously announced led to overlapping roles.
- (4) There are different standards, rules, disciplines, laws that bring about delay process and operation, and also cause problems in data communication.
- (5) The government agencies and state enterprises have inconsistency targets that result in discontinuous of logistics development.
- (6) There are no supporting policies to synchronize “Shift mode” and “Multimodal” transportation as well as obsolete regulations on infrastructure development that cause delay of implementation period.
- (7) Budget allocation for logistics development is only part that contributes to inefficient development and discontinuous project operation.

The transformation of existing logistics industry to modern logistic based on activities of government agencies, state enterprises and private sectors are affected by several factors discussed in the next section.

4.2.2 Factors affect Transformation to Thailand Logistics Development

Transformation context on Thailand logistics development includes 5 factors: Political factors (P), Economic factors (E), Social factors (S), Technological factors (T) and Environmental factors (En). Politics and International economic (P) highly affect followed by effect from technological, economic, environmental and social [6].

4.2.2.1 Political factors (P)

Uncertainty of politics and International economic (P) highly affect Thailand’s Logistic development due to fluctuated trading and investment that slowdown the domestic economics. For example, the US-China Trade War affects Thailand in terms of slowdown economic, and consequently reducing export-import with US. The US counter measures lead to relocation of suppliers/vendors to the country not affected by US-China Trade war. This negative impact leads to a reduction of foreign order, production capacity, manpower due to Lay off, and

certainly freight and related activities. Moreover, the suspend benefits under the Generalized System of Preferences (GSP) for Thailand of US has shocked among local exporters, as they are staggered from the domestic economic downturn and baht appreciation [7].

Another example, the effect from British Exit (Brexit) brought about short-term impact on import/export of Thai products. However, fluctuation of UK pounds and Thai Baht resulted in higher export price and reducing demand for Thai product.

Although Thailand has a national logistic plan but lack of harmonized, obvious and continuity action plan. Most of the government agencies work simultaneously without collaboration. Laws, regulations and procedures related to logistics are out of date and need transformation immediately to be consistent and up-to-date. In addition, there were suspicious top officials in the Government having ties with big business corporations, and government policies deemed favorable to such businesses [8].

The outdated laws and enforcement related to logistics lead to disadvantage on competitiveness of the country in the commercial sector and decrease potential to be ASEAN “logistic hub”. In addition, domestic laws related to commercial cannot protect Thai business, e.g., retail laws, tax collection laws, stock trading, the regulation to prevent nominee on transactions who avoid restrictions, etc.

4.2.2.2 Economic factors (E)

The multinational economics has decelerated because of not only trade war but also COVID-19. Year 2020 is already being defined by the outbreak of the coronavirus. COVID-19 has already killed 3,831 (as of 9-Mar-2020) and infected at least 110,337 globally [9]. Although, the investment from China is huge, such as Alibaba. However, during past 2-3 months, China economy has been braked and affected by 42%, due to the spread of COVID-19.

The economic factor influences the demand on international trades and logistics. Moreover, the weakness on operation of Special Economic Zone (SEZ) affects the transportation and logistics activities. Considering an investment situation in the 10 SEZ, the investor has worried about an availability of utility and accessible suppliers, especially SEZ nearby border that might face weakness in operation. Although, the 10-year measure (e.g., reinstated corporate income tax of 10% down from 20%), has been offered for investment projects located in the 10 SEZs, not much interested investors are required to register with the Finance Ministry (due December 31, 2020).

Since the Logistics Industry is one of the new five future industries or New S-Curve, the industry has potential in production and effected by the changes in global manufacturing technology (**Figure 1.8**) [10]. Due to supportive policy on new S-curve industries, the Thai industries tend to change from labor-intensive logistics to technological-based management. Thai logistics can go even further because of the new s-curve. Also, there are trends of alliance/partnership on transportation and logistics industry.

Multinational logistics company normally have higher service efficiency and frequencies, and larger transportation network that affects the structure of delivery market. The multinational companies are ready to enter the market in Thailand because they have three components; Investments, Platform and Technology, as stated by the Senior Vice President of JWD. The Thai logistics company could survive, by finding a key partner from a multinational company, having both technology and platform.

The investment of overseas company leads to disadvantages to Thai company because of their Non-Asset Based LSP operation that would prefer subcontractors. This would be a negative effect on Thai LSPs having unsustainable development. Some interviewees mentioned that Thai LSPs who are not well adjusting themselves, would not able to be their partner. They could just be subcontractors.

During the industrial revolution, the average life span of SME is reduced from 75 years to 7 years, that shorten period for adjusting to follow digital trends. Though more than half of Thai logistic companies have noticed on digital disruption, they still have no clear idea on strategic plan for their self-adjustment.

Thai small LSPs normally have computers, servers and software that cannot link with airline companies that lead to opportunity loss. Investment on digital technology for logistic management need high cost that is unaffordable. Thai logistics service providers are not yet ready to invest in technologies and tools. Some companies familiar with MS Excel, and never employed the ERP-SAP. Also, they are not yet ready to invest in various infrastructures due to insufficient investment capacity. The demand and supply of products and raw materials fluctuated. Therefore, Thai LSPs must adjust themselves to these situations by investment in digital technology for real-time monitoring. However, the mindset of the top executive's members is very important for decision making.

Thai logistics SMEs who lack ability to be a principle logistics service provider, and lack of fund to invest, would play the role of subcontractors without negotiation power. Moreover, it is expected that payment and salary would be normally low because of an unfavorable employment contract.

In the viewpoint of the digital era, a novel application is available for easily money transfer. One interviewee stated that the medium players such as TIFFA as freight forwarder would be disturbed by Blockchain, one of the disruptive technologies launched in 2009. Blockchain is the “Internet of Value” creating digital scarcity. It is considered the 2nd generation of internet following the 1st generation TCP/IP. In brief, Blockchain is a decentralized database that is very difficult to modify. The digitized value could be sent to the downstream receiver without a copy left in the computer of the sender. The Blockchain is a free market, enabling the technology company to understand customer behavior. In addition, the waterway shipping would prefer “Blockchain” for collecting and organizing their transportation economically and precisely.

4.2.2.3 Social factors (S)

Technology that replace human worker leads to lay off and consequently induces social problems. The large logistic companies might have no policy on lay off and have to delay employing automation and industrial robot. The state enterprises and large companies usually have a powerful labor union. They cannot easily lay off worker and replaced them by technology. On the other hand, the manufacturers are facing challenges in the development of automated robots to assist in the provision of automotive logistics services.

The aging society would reduce manpower in work-force age gradually. The workers from neighboring countries are normally needed for non-skilled jobs. Fortunately, the logistic industry might change their strategy to employ a potential experienced or elderly person.

There is economic expansion of major and minor cities according to trading and investment development. The urbanization always requires a city transportation system and logistics. In Fact, the development of infrastructure would affect traffic congestion and transportation management, results in unexpected higher logistics cost.

The logistic industry is lack of skilled and proficiency manpower, especially employees who are suitable to business sector and possibly apply their knowledge to operate appropriately. In order to offer better solutions to the customers, the logistics employees must understand service capabilities, and have adequate soft skills to deliver an effective communication skill with their colleagues. Therefore, logistics personnel training must be developed to build knowledge and skills for their operation personal to meet logistic business requirements. Thai education develops people to be software writer only. Therefore, Thailand is currently lack of skilled labors who have both vision and imagination. The improvement of curriculum related to logistics in higher education is also necessary.

According to the interview with 1Trade Managing Director, the TIFFA has collaborated with various logistics companies to establish a school that focuses on specialized teaching in logistics and warehouse management. They provided International Transportation and Business School (ITBS) that has offered many courses on transportation management for interested parties. TIFFA also received educational funding from the Department of Skill Development under the human resource development project.

4.2.2.4 Technological factors (T)

The logistics business is currently highly competitive, especially the competition in the B2C market because there are numerous multinational companies. During the past 5 years, most of logistics enterprises have rather a low margin at around 8% - 15%. Thai LSPs have been facing high competition due to expansion of investment from the large and oversea/multinational LSPs. The multinational LSPs have changed from the exporter for industrial manufacturers to the domestic goods distributors, which much effect most of Thai LSPs in Business to Business (B2B) market. Those oversea LSPs has integrated digital technology with their logistics technology in “Operations digitalization” for better efficiency; i.e. (1) Automatic system in their distribution centers, (2) Realtime monitoring for delivery status, (3) Estimation for appropriate storage capacity, (4) Route optimization. All of these technologies make the overseas LSP higher advantages, with increasing margin capacity 5 – 6%. Definitely, the Thai land transportation enterprises in B2B market are facing serious competition.

Thai SMEs in logistics industry is normally labor-intensive and lack of skilled worker and a skilled specialist to implement advanced technologies as well as an automation system. Moreover, Thailand is facing a shortage of skilled workers who can perform various tasks, i.e. System Integrator (SI). SMEs might have difficulties to seek for the right SI or software developer. The automotive industry also lacks of specialist in the field of logistics services.

In addition, the delicate tasks e.g. electronics assembly are labor-intensive that impossible for industrial robot or not worth for investment. Therefore, the government agencies should create the stage or platform for matching between Thai LSPs and those technologists and SI.

The existing wholesale and retail might not survive due to the expansion of e-Commerce and digital trading. E-commerce demands the manufacturing of various products with small volume. Package and conveyor, function to maintain and arrange goods within limited space efficiently for entire delivery to destination safely, increases logistic cost. The LSPs must adapt

their transportation and storage from large volume using pallet to small packaging/parceling. Thai LSPs should considerably provide up-to-date conveyer and packaging size.

The public sector usually regulates and drive policy for better efficiency and cost reduction. The e-Government services have been increasingly implemented technology to be deployed in public service by online and paperless communication. Therefore, Thai LSPs have to adjust their services toward these current activities.

According to cold chain logistics, the development of warehouse and temperature-controlled transportation is necessary. Food and beverage producer always pay attention to warehouse construction, purchasing of truck/trailer, investment on IT, and stable refrigeration system. Therefore, they usually look for an expertise in the field of logistic management for better workflow and lower logistic cost. This would be an opportunity for the qualified LSPs in cold chain logistics, on the contrary, it would be a threat for the rest.

4.2.2.5 Environmental factors (En)

The trends on green logistics involve size reduction on a vessel for e-Commerce and for easier distribution. The material for packaging tends to environmental friendly to suit 3R (Reduce, Reuse, Recycle). Therefore, warehouse activities are transformed to electricity or hybrid, including technology and innovations for better accuracy and efficiency. To fulfil customer requirement, the manpower reduction and further lay-off workers is inevitable.

The discussion on potential, opportunities, and obstacles above reviews advantages and disadvantages of development from conventional logistics toward e-Logistics, and leads to the suggestion to the Government Agencies in the following section.

4.3 Suggestion to Government Agencies

The interviewees from various Thai LSPs have mentioned that there are a number of policies from the government related to logistics development or enhancement, but each of which were not been implemented successfully. There are 4 categories of suggestions from most of the interviewees that consistent to the evaluation from Burapa University, i.e., suggestions for development on (1) Value added of supply chain system, (2) Infrastructure and facility, (3) Support scheme for logistics, and (4) Integration Among Government Agencies – State Enterprises – Private Sectors [6].

4.3.1 Suggestions for Development on value added of supply chain system

The development of logistic industries and logistic trading system would help enhancing the development of Thai LSPs. They should easily be adapted and responsive to the up-to-date dynamic transformation and the development of cyber security with a confidence on an e-Commerce. The “LSPs Network” should be reinforced by supportive “Business Matching” between domestic LSPs and motivate overseas LSPs as partnership. The networking between manufacturers and the local LSPs should be supported as well.

The competitiveness of Thai LSPs could be upgraded sustainably by improving laws and regulations related to logistics or harmonization of laws if possible. The out-of-date laws and regulations related to Thailand logistics should be revised; e.g., Carriage of Goods by Sea Act B.E. 2534 (A.D. 1991), Land Transport Act B.E. 2522 (A.D. 1979), International Air Carriage Act B.E. 2558 (A.D.2015), and The Multimodal Transport Act B.E. 2548 (A.D.2005), etc.

Ministry of Transportation has played an important role in logistics development plan. The support from their “Government Administrators” for goods delivery is crucial; i.e. Marine Department (MD), Department of Land Transport, Department of Airports, Department of Highways, Department of Rural Roads, and recent Department of Rail Transport (established since April 2019). The interviewees mentioned that the government officers should strengthen their knowledge and have an understanding of laws enforcement, seriously and strictly. The knowledge must be transferred between public and private sector efficiently.

Not only the government administrators but also the state enterprises under the Ministry of Transportation are playing important roles; e.g., State Railway of Thailand (SRT) that the State Railway Workers Union has much negotiation power, Port Authority of Thailand (PAT), Mass Rapid Transit Authority of Thailand (MRTA), Expressway Authority of Thailand (EXAT), the Airports of Thailand Public Company Limited (AOT), and Airport Rail Link Co., Ltd. There are complaints from several interviewees on the mindset of SRT that much delay the e-document processing, which sometimes all processes required almost 3 weeks.

The interviewees also suggested revisions of trade restrictions policies to the Government due to complicated and time-consuming customs procedures that are too stringent. The reduction of trade restriction would enable the operation of transportation efficiently.

Moreover, the government should enhance and support regulation/custom formality to facilitate trading and to improve “National Single Window (NSW)” network connectivity of B2B (Business to Business) and G2B (Government to Business) because B2G (Business to Government) and G2G (Government to Government) have been already connected.

Government should accelerate the development of facilities tools, equipment and personal. The purchasing process improvement enhances easier and faster service, upgrading speed of document processing using technology, and development of data management by information technology.

Once the infrastructure is ready for transportation, commercial facilities such as the data linking system between government agencies and businesses must be ready. The distribution networks must speed up as well as domestic and international distribution centers to enhance its efficiency in terms of service costs.

In addition, to be up-to-date with the current situation, improving “Tax system” would enable international trading, and enhance international trading negotiation in the issues on reducing or eliminating NTB (Non-Tax Barriers) with important business-partner countries e.g. BIMSTEC (Bengal Initiative Multi-Sectoral Technical and Economic Cooperation) and GMS (Greater Mekong Subregion).

4.3.2. Suggestions for Development on Infrastructure and facility

Interviewees from both public authorities and private companies have highly recommended that Thailand must accelerate the development of transportation, including road, marine, rail, and air services. The rail transportation is a key part of domestic transportation. Investment on railway mode logistics would reduce logistics cost effectively. The rail transportation must be successfully developed to be a back bone of Thai logistics. The interviewee from PTT Logistics mentioned that petroleum products delivery by one train can replace 25 trucks, and estimated to reduce logistics cost to only 1/15 depending on operation. Therefore, PTT has conducted the feasibility study on the “Track and Trace” platform for the locomotive.

The existing infrastructure must be utilized intensively and efficiently, especially railway system. The government has to focus on the development of monorail systems into double tracks, although some manufacturing sectors are not influenced by such double tracks.

The “Shift Mode” can reduce road transport and connection to the other modes of transportation, rely on modes of transportation with lower costs, such as railways or waterways. The development of new and efficient airplane route would support expansion of air freight as well.

Considering Special Economic Zones (SEZ), Thailand still has a center of prosperity in many areas such as Nong Khai, Udon Thani. Therefore, it has an opportunity for the development of strategic trade routes and new economic towns for manufacturers and Logistics

Service Providers. However, the supporting scheme must be provided to convince the investors into the SEZ; i.e. availability of utility and accessibility to suppliers. The new economic towns are being therefore speed up for manufacturers and LSPs.

The development of logistics facilities (i.e., in-land port, frozen warehouse in Southern Economic Corridor (SEC), and distribution center in major provinces) should be enhanced. The state agency on cross border trading and logistic must be formulated to gather knowledge, preparing manual for trading enhancement on regulation and procedure.

4.3.3. Suggestions for Development on support scheme for logistics

Valuable manpower is the key driving factor in the development of logistics industry. The logistics personnel training must be developed to gain knowledge. The skills improvement is also needed. The personal in both manufacturing and business sectors must be enhanced and supported to strengthen their “Manpower” performance to meet international standard. They can re-skilled their knowledge with appropriate curriculum development to produce efficient personal qualitatively than quantitatively.

The next supporting scheme is focused on the consistency in the Government policies. The regulations and laws have to be more flexible as mentioned by several interviewees. The government sector should push on policy and support logistic operation appropriately. The government should support research and development (R&D) on logistic innovations, and enhance development of logistic and supply chain personal. The R&D helps to develop that “Dynamic Logistic Database”. The academic R&D activities on innovations and technology is required to support logistics in both manufacturing and agricultural sectors.

The government agencies themselves must continuously enhance and support data gathering and information dissemination, leading to standardized data management system.

4.3.4. Integration Among Government Agencies – State Enterprises – Private Sectors

There should be developing mechanism to reinforce investment plan of government agencies and state enterprises into similar direction properly, e.g. Mechanism of “Action plan” or “Budget allocation plan”, especially an investment on infrastructure involving operation of state enterprises. Not only the government policy needs to be implemented but also an actual and accurate data should be shared to other state enterprises and private sectors.

Linkage between representatives from government agencies to state enterprises and to private sectors must be carried out continuously and regularly by means of; coordination, data

connection and sharing, data analysis, public hearing stage, and continuous follow up and support.

4.4 References

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Chapter 5

Conclusion

Logistics companies in Thailand have advantages in many ways compared to neighboring countries, owing to the Kingdom's central geographical position. The continued growth of e-commerce business has made demand for logistics space and has created significant changes in the supply chain and logistics operations in Thailand. Many Business-to-Customer (B2C) logistics companies have launched their cost-effective and high-quality logistics services in the country and brought domestic end-to-end delivery to the market. Apart from that, many companies have established central warehouses, along with smaller drop off and pickup points across the nation, in order to sustain the rise in e-commerce's demand, creating a greater convenience and a quicker process to deliver to their consumers, at much lesser cost. The logistics market in Thailand consists of global and local players, with a significant number of global players in the market. Local Thai logistics companies are dominated by global players. Each of these global players would prefer to use their domestic logistics service providers. To withstand the competition with international players, domestic logistics companies have to find the global key partner so as to manage the risks.

Thailand's Logistics Development Strategy (2017-2021) is focused on development of value-added supply chain systems, infrastructure and facilities, and logistics support factors. BOI provides privileges to foreign investors to support further logistics and transport infrastructure development, investment in the Special Economic Zones and EEC (Packages of tax incentives, general incentives, and assistance relating to smart visas and work permits). NSTDA, NIA and PMU C are funding agencies that provide financial support for research and development in e-logistics and supply chain. Thai government has committed to invest in logistics, transport infrastructure development, human resource development and e-logistics' research & development.

To improve efficiency, safety, reliability, and traceability of their operations, and to reduce their operating costs and wastes, and thus enhancement of their competitiveness in Thailand' logistics market, the LSPs currently focus on route optimization while the WIs focus on warehouse and inventory management system. For large companies, current government policies do not have neither significant positive nor negative impacts on their e-logistics and supply chain development plans. They are driven by customer's demand and competition in the market. On the contrary, local logistics SMEs are having difficulties in adapting themselves

toward the e-logistics era, mainly due to the lack of investment fund and expertise support. The government is asked to improve railway mode infrastructures as soon as possible. Otherwise, logistics cost is hardly to reduce below 10% as that in developed countries such as the US and Singapore. The government must also initiate a human resource development plan for supporting the e-logistics and supply chain technologies.

Logistics market in Thailand is rather large, approximately 2 Trillion Baht annually, however, there is no dominant players. To further extend, logistics cost in Thailand is still high, roughly 14% of the country's GDP, making a large gap for improvement and investment.

Political factor is the most influencing factors on the investment on logistic development, followed by technological, economic, environmental and social factors, respectively.

Current government policies and strategic plans have not yet been implemented. Some interviewees strongly requested that the Thai government must geared up on the improvement of railway mode infrastructure; otherwise, logistics cost is hard to be reduced to < 10%. Also, the development of human resource for e-logistics is a must now.

Besides investment on infrastructure, the government is being asked to evaluate and modify obsolete laws and regulations and create the connection between B2B and G2B to work closer with private investors.

Appendix A

List of the Interviewees and Their Organizations

Note that some information of interviewees is omitted as per their requests.

No.	Organization	Position	Role
1	Skyfrog, Co. Ltd.	Managing Director	DT/Cross
2	SCG Nichirei Logistics Co., Ltd.	Executive Member	DT/Cross
3	Sammmitr PTG Pro Truck Solution Center Co., Ltd.	Sale Representative	DT/Cross
4	B.S. Transport Partnership Limited	President	DT/Cross
5	Pharkphoom Logistics Limited Partnership (PPL)	MD	DT/Cross
6	Advanced Info Service Co. Ltd (Public)	Senior Engineer	DT/Cross (NSP)
7	ANJI-NYK	Vice President	DT/Cross, AFF, OFF
8	Eagles Air & Sea (Thailand) Co., Ltd.	Manager	DT/Cross, AFF, OFF, CB, WI
9	CJ Logistics (Thailand) Co., Ltd.	Managing Director	DT/Cross, AFF, OFF, CB, WI
10	SCG Logistics	Managing Director	DT/Cross, CB, WI
11	Ruk Siam Social Enterprise Co., Ltd.	Partner	DT/Cross, R
12	MOL	Assistant General Manager	DT/Cross, R, AFF, OFF, CB, WI
13	JWD Co. Ltd (Public)	Senior Vice President	DT/Cross, R, AFF, OFF, CB, WI
14	PTT OR, Co. Ltd (Public)	Assistant Manager of Logistics Management	DT/Cross, R, AFF, OFF, CB, WI
15	Yan Wal Yun Co., Ltd.	Managing Director	DT/Cross, R, AFF, OFF, CB, WI
16	PTT OR, Co. Ltd (Public)	Business Director (Cafe Amazon)	DT/Cross, WI

17	Diakin (Thailand) Co., Ltd.	Plant Manager	DT/Cross, WI
18	Thai International Freight Forwarders Association (TIFFA)	Managing Director	PA
19	National Innovation Agency (NIA)	Innovation Developer	PA
20	Thai Federation on Logistics	President	PA
21	Thai Transportation and Logistics Association	President	PA
22	Thai National Shippers' Council (TNSC)	Executive Director	PA
23	Department of Foreign Trade	Director, Import Administration and Origin Certification Division	PA
24	Thailand Greenhouse Gas Management Organization (Public Organization)	Manager, Approval and Monitoring Office	PA
25	Land Transportation Federation of Thailand (LTFT)	Committee	PA
26	Senate Committee on Commerce and Industry	Advisory	PA
27	Thailand Science Research and Innovation (TSRI)	Deputy Mission Director	PA
28	TAS Logistics Co., Ltd	Sale Manager	WI
29	Menam Mechanika Co., Ltd.	Sale Manager	WI
30	Polytech	President	WI
31	DELTA Electronics (Thailand) Co. Ltd (Public)	Regional Business Director	WI
32	Bangkok Metropolis Motor Co., Ltd.	Manager	WI