Chapter 2

A Geographical Simulation Analysis of Impacts of Vientiane-Hanoi Expressway

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Chapter 2

The Cold Chain in Thailand

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2.1. Preface

Introduction

The cold chain in Thailand report is a part of the 'research project for policy recommendations to ASEAN countries on the realization of higher value added of agricultural products', aiming to provide information and analysis regarding prospects of cold value chains in Thailand, especially those of the consumption of food and products.

Thailand is known as an agricultural country as the agricultural sector has the largest share in the Thai workforce of 11.27%, or 37.60 million people (National Statistical Office, 2018). In addition, Thailand has been promoted as 'Kitchen of the World' since 2005, meaning that Thailand intends to be a hub of food. Therefore, Thailand can be considered as a hub of agricultural supply, which means its food and fibre products are adequate to serve both domestic and international demand and consumption. This demonstrates that the food value chain is essential to Thailand's economy.

The part of the food value chain that needs temperature control is known as the cold chain. The cold chain plays an important role in preserving quality, extending shelf life, and ensuring the quality of products. Its processes help reduce food spoilage and waste from producers' farms to customers' tables. This leads to the ability to transport products to customers over longer distances and increased customer satisfaction. Moreover, it is an opportunity for participants in the chain to gain more benefits and reduce their damages and costs. Most products in the cold chain are temperature sensitive and perishable, such as agricultural products, livestock products, fishery products, processed food, chemical products, and other temperature-controlled products.

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The cold chain consists of stakeholders from various sectors participating in the entire chain, from upstream to downstream, such as farmers, manufacturers, wholesalers, transportation services, warehouses, and retailers. The cold chain contributes a massive value to Thailand's gross domestic product (GDP), especially the small and medium-sized enterprise (SME) sector. Thailand's Office of Small and Medium Enterprises' Promotion Report revealed that in 2017, Thailand's SME GDP value was 42.39% (6.55 million baht) of the total GDP of 15.45 million baht. Apart from SMEs in the non-agricultural sector, the rest of the non-agricultural sector is comprised of large enterprises (LE) 43.04%, and other enterprises 5.87%. It is interesting that GDP from large enterprises mainly runs Thailand's economy. Meanwhile, SME value is continuing to increase closer to the GDP related to large enterprises. Furthermore, the SME GDP growth rate has increased higher than the total GDP and LE growth rate, as shown in Table 2.1.

Table 2.1: Thailand GDP

GDP	Value, Growth Rate, and Proportion	2013	2014	2015	2016	2017
Total	Value (million baht)	12.91	13.23	13.75	14.53	15.45
	Growth rate (%)	2.7	1.0	3.0	3.3	3.9
Large enterprise	Value (million baht)	5.56	5.77	5.99	6.30	6.65
	Growth rate (%)	3.2	1.2	3.6	3.4	3.1
	Proportion to overall GDP (%)	43.07	43.61	43.56	43.36	43.04
Small and medium-sized enterprise	Value (million baht)	5.13	5.32	5.68	6.12	6.55
	Growth rate (%)	3.2	1.1	5.3	4.9	5.1
	Proportion to overall GDP (%)	39.74	40.21	41.31	42.12	42.39

Source: Office of SMEs Promotion (2018).

The cold chain has opportunities and challenges to gain greater value and development. However, there are also problems and obstacles that need to be regulated and supported for maintaining standards and improving operations. Thus, this research aims to conduct a case study of the cold chain in Thailand and summarise its results in this report.

The following part of the report consists of seven sections: 2.2. A general overview of the cold chain in Thailand that will show the current situation and demand in Thailand. 2.3. A compilation of the issues and challenges facing the development of cold chain production, including

government policies involved in Thailand's cold chain. 2.4. Statistics on imported and exported cold chain products showing the demand for cold chain logistics. 2.5. A discussion on the cold chain market in Thailand and the current temperature-controlled transportation and warehouse conditions in the country. 2.6. A business model of the cold chain with information from interviews as an overview and connection with the main players and users. 2.7. The expectation of government policy from an interviewees perspective on policy to control, regulate, and support the cold chain stakeholders, including their gathering. 2.8. A concluding summary of the report and issues that may encourage the utilisation and development of the cold chain.

Research methodology

This research is discussed with each stakeholder along the cold chain by focusing on three elements, including the developments, challenges, and policies in Thailand. The approaches of the research can be identified as follows.

Firstly, to review international research to gain an overview of the importance as well as the recent developments in the global cold chain network. There are many reviews of temperature management on agri-food products, so this step is helpful to understand the cold chain in detail.

Secondly, to identify the current situation of both demand and supply in Thailand by gathering secondary data. This data can show the trends and growths from the past until the present.

Thirdly, to interview cold chain stakeholders and related government agencies to identify major elements in the cold chain: namely, the demand for frozen foods and cargo, the activities and challenges of the main suppliers, as well as national policies in Thailand.

Finally, the information will be analysed and policy recommendations in the context of Thailand are provided. The research team hopes to investigate and find useful information on the cold chain that can provide beneficial guidelines for policymakers.

Survey

The research team conducted survey interviews from December 2018–January 2019. The sample comprised five enterprises, two government agencies, and one federation.

The five enterprises were of different sizes, large, medium, and small, and comprised those in the chilled/frozen food industry, logistics providers, and a trader, as shown in Table 2.2 and Table 2.3 below.

Table 2.2: Interview Survey of Logistics Providers and Logistics Users

Size[1]	Enterprise[2]		
	Producer	**Logistic Provider**	**Trader**
Small	–	• Rujoran Transport Co., Ltd.	–
Medium	–	• Eagles Air & Sea Co., Ltd. • CTI Logistics Co., Ltd	• Harmony Life International Co., Ltd.
Large	• Thai Union Group PCL.	–	–

Note: 1. Classified sizes by fixed asset criteria in Appendix: Table A.1.

2. Details of interviewees are in Appendix Table A.2.

Source: Authors.

Table 2.3: Interview Survey of Supporters

Government Agencies
Port Authority of Thailand
Department of Internal Trade
Federation
Thai Federation on Logistics

Note: Details of interviewees are in Appendix: Table A.2.

Source: Authors.

Information from the survey interviews will be analysed and reported in further sectors. The details include the demand for the cold chain, the government policies on the cold chain, and the activities of the main players of the cold chain in Thailand.

2.2. General overview of the cold chain in Thailand

The cold chain is the supply chain that requires the control of temperature, humidity, and environments. The control provides the proper conditions for particular products in the processes of the supply chain. Reviews describe definitions of the supply chain and logistics as follows, showing their connection to the core of cold chain logistics.

Waters (2003) states that a supply chain consists of a series of activities and organizations through which 'materials' (raw materials, components, finished products, people, information, paperwork, messages, knowledge, consumables, energy, money, and anything else needed by operations) move through on their journey from initial suppliers to final customers. Lummus et

al. (2001) describe a definition of logistics that involves planning, implementing, and controlling the flow and storage of goods and services from the point of origin to the point of consumption for serving customer requirements. In addition, Thipkaisorn (2010) refers to Stock and Lambert (2001) to show that logistics comprise of activities that include logistics communications, customer service, order processing, demand forecasting, procurement, inventory management, transportation management, warehousing and storage, reverse logistics, parts and service support, plant and warehouse site selection, material handling, and packaging and packing. Michigan State University (2016) concluded that logistics is a part of the supply chain process. The supply chain focuses on competitive advantage, while logistics focuses on meeting customer requirements.

Hence, cold chain logistics is the process of transporting perishable and temperature-sensitive products from producers to consumers. Products of the cold chain are mainly agricultural and food products. Therefore, the cold chain can refer to the food value chain with temperature control. The processes of cold chain logistics consist of post-harvest, warehouse and storage, distribution, retail, transportation, and management, as detailed in Table 2.4. The main parts of the processes are chilled and frozen transportation and cold storage. The goals of cold chains are extending shelf-life, keeping quality, and adding value. The benefits of cold chain logistics are for both producers and consumers. The cold chain also helps producers to reduce waste and the cost of operations. Moreover, it helps to enhance competitiveness through high-quality products, which results in higher revenues. The high-quality products serve customers' requirements and satisfaction and are of benefit to customers as well.

Table 2.4: Cold Chain Processes

Order	Parts	Processes
1	On-farm cooling	Shade, evaporation cooling, misting, and protective cover
2	Initial cooling	Forced air cooling, hydro-cooling, crushed ice, and vacuum cooling
3	Storage	Cold storage, compartmentalised chambers, and controlled atmosphere storage
4	Transportation	Air, marine, controlled atmosphere pallet, reefer containers, and modified atmosphere packaging
5	Distribution	Refrigerated trucks and small chilled vans
6	Retail	Chilling display cabinets
7	Consumer	Home refrigerators

Source: Kasetsart University (2016) referred to by Mahajan and Frias (2012).

The cold chain also plays an essential role in the food value chain through the enhanced delivery of temperature-sensitive food products from producer to consumers. The cold chain helps people to live with a better quality of life by enabling access to varieties of fresh, frozen, and ready-to-eat foods that are produced and prepared at longer distances from where they live. As such, the cold chain has an important role in ensuring food security.

Thailand has potential for the temperature-controlled food value chain. According to 'Thailand's Advantages', an article written by the Board of Investment of Thailand (BOI 2017a), Thailand's geographical and location advantages make Thailand a gateway to fast-growing country markets that have a massive demand for food, such as China, India, Viet Nam, Malaysia, and Singapore. The country also has a growing economy, competitive human capital, world-class infrastructure, and strong government support that make it one of the most attractive investment destinations.

In addition to being a gateway to fast-growing country markets, Thailand is also situated at the heart of Southeast Asia, which prospers from land connections with Cambodia, the Lao PDR, Malaysia, and Myanmar through various modes of transportation, such as road, river, sea, and rail. In addition, it is surrounded by the Pacific Ocean and India Ocean. Moreover, future infrastructure that is currently undergoing upgrading and construction include new international road networks, double-track railways, high-speed trains, and other routes. Meanwhile, it is located among plenty tropical food resources.

Thailand is an attractive investment destination due to its growing economy, as can be seen from its GDP growth, which has been increasing, and foreign direct investment (FDI) which was at 21% over the past six years. In addition, competitive human capital gives the benefits of the free flow of skilled labour, services, investment, and capital across the ASEAN Economic Community (AEC) as a single market since 2015. Moreover, the government's tax support has ranked Thailand as the 2nd lowest corporate tax rate in ASEAN and led to numerous free trade agreements (FTA).

Apart from these, the government designated the food industry (BOI, 2017b) as one of the 10 key growth engines for its "Thailand 4.0" economic model. The government has also cooperated with the private sector to set Food Innopolis as a district of investment for research, development, and innovation for promoting and enhancing the competitiveness of Thailand's food industry. In this way, Thailand aims to serve both domestic demand and demand from

countries around the world, especially for seafood and agricultural products, which are increasing in the volume of cold chain products, as will be discussed in detail in the following sections.

The current situation of cold chain logistics in Thailand

The study of the cold chain logistics situation is based on general logistics. Thailand's Ministry of Industry attaches great importance to logistics to be a part of the five targeted industries, called the 'New S-Curve Industry', namely robotics; aviation and logistics; biofuels and biochemicals; digital; and medical hub. The New S-Curve Industry is propelling Thailand's new engine of growth as part of its 20-Year National Strategy and National Economic and Social Development Plan No.12, which establishes a strategy for advancing infrastructure and logistics. Thus, logistics has been emphasised as an area for better performance by Thailand's government agencies and private sectors.

According to Thailand's Logistics Report, 2017, by the Office of the National Economic and Social Development Council (NESDC, 2018b), the logistics cost component consists of transportation costs, inventory holding costs, and logistics administration costs, respectively, by size regarding the value of each component.

The value of the total logistics cost has increased after the country's economic growth and the recovery of export and domestic demand as a result of increasing of industrial agricultural product and private investment. The proportion of the total logistics cost to nominal GDP has slightly decreased due to the decrease in inventory holding costs because of the better performance of inventory holding by entrepreneurs and the low interest rate from a monetary easing policy. Meanwhile, transportation costs have been increasing because entrepreneurs mainly use road transportation, which has a high unit cost. Moreover, infrastructure development projects, such as railways, waterways, and multimodal facilities, are under construction. Apart from these, the logistics administration costs are stable, as shown in Table 2.5.

Table 2.5: Logistics Costs

Logistics Cost	2013	2014	2015[r]	2016[p]	2017[e]
Proportion of total logistics cost to nominal GDP (%)	**14.2**	**14.2**	**14.0**	**13.9**	**13.8**
Total logistics cost (billion baht)	**1,776.6**	**1,876.7**	**1,917.7**	**2,020.6**	**2,125.0**
Logistics cost components					
● Transportation costs					
- Proportion to nominal GDP (%)	7.4	7.5	7.4	7.5	7.5
- Value (billion baht)	953.4	994.9	1,019.3	1,091.6	1,155.80
● Inventory holding costs					
- Proportion to nominal GDP (%)	5.5	5.4	5.3	5.1	5.0
- Value (billion baht)	713.9	711.2	724.1	745.3	776.0
● Logistics administration costs					
- Proportion to nominal GDP (%)	1.3	1.3	1.3	1.3	1.3
- Value (billion baht)	166.7	170.6	174.3	183.7	193.2

Note: e = estimated data, p = preliminary data, r = revised data.

Source: NESDC (2018b).

As can be seen in the above table, in 2017, Thailand's proportion of the total logistics cost to nominal GDP was estimated at 13.8% and showed a declining trend over the years through a reduction in inventory holding costs, while the international average was 10.9%. North American and European countries had the lowest percentages, at 8.6% and 9.5%, respectively, and the average for Asian countries was 12.7%.

The World Bank (2018) has been reporting a Logistics Performance Index (LPI) every two years. It stimulates awareness of developments in logistics performance and serves as a reference to propel policy. The LPI is the weighted average of six critical dimensions to benchmark the performance of countries through surveys of their partner countries' satisfaction, which is then analysed and presented as an overall LPI index score. The NESDC (2018a) reveals that Thailand's LPI rank improved by 13 places in 2018 compared with 2016. This ranks Thailand as 32nd of 160 countries overall as shown in Table 2.6, and 2nd of 10 countries in ASEAN after Singapore.

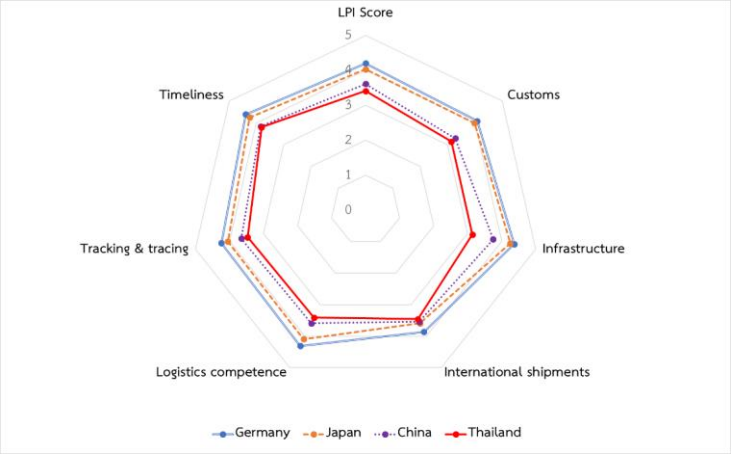
Table 2.6: Logistics Performance Index of Thailand in 2018

Index component	Rank /160	Score (1–5)
Logistics Performance Index (Overall)	**32** $^{+13}$	**3.41**
Policy Regulation (Input)		
1. Customs: The efficiency of the clearance process (i.e., speed, simplicity, and predictability of formalities) by border control agencies, including customs	36 $^{+10}$	3.14
2. Infrastructure: Quality of trade and transport-related infrastructure (e.g., ports, railroads, roads, information technology)	41 $^{+5}$	3.14
3. Logistics quality and competence: Competence and quality of logistics services (e.g., transport operators, customs brokers)	32 $^{+17}$	3.41
Service Delivery Performance (Output)		
4. International shipments: Ease of arranging competitively priced shipments	25 $^{+13}$	3.46
5. Timeliness: Timeliness of shipments in reaching a destination within the scheduled or expected a delivery time	28 $^{+24}$	3.81
6. Tracking and tracing: Ability to track and trace consignments	33 $^{+17}$	3.47

Source: World Bank (2018).

The highest LPI countries have high incomes and are located in Europe, such as Germany, the Netherlands, and the United Kingdom. The lowest LPI countries are mostly low-income countries, such as African countries. Germany remained first for three years from 2014–2017. Japan is the top performer in East Asia and the Pacific region. China has the best performance of the upper-middle income group, and Thailand ranks second after China. The LPI scorecard shown in Figure 2.1 presents a comparison of Thailand with countries that perform the best overall, by region, and by income group.

Figure 2.1: Thailand's LPI Scorecard Compared with Best Performance Countries



Source: World Bank (2018).

Thailand was evaluated in the Logistics Friendly Group (the first of five groups) but was still ranked last in the group. Thus, Thailand should take the World Bank's suggestion for the Consistent Group (second group). The Consistent Group should place priority on developing human resources skills, urban logistics, a dedicated logistics body, and a national data system. A second priority should be transportation infrastructure, green logistics, spatial planning, resilience, and a specific legal framework (NESDC, 2018a).

The suggestion conforms to the problems and obstacles of the cold chain in Thailand as stated by Kasetsart University (2016). There are five issues:

- Human resources: Cold chain staff lack the knowledge and skills for handling the proper conditions for keeping and transporting products with both Good Distribution Practice Standards and Good Storage Practices Standards.
- Infrastructure: There is insufficient and inefficient infrastructure for the demand for the cold chain in Thailand.
- Temperature control: Temperature tracking and checking need more organizing to achieve concrete systems.
- Standard of transportation: Cold chain products usually touch external air during transfer and transport. This may affect the quality of products and cause damage.
- Electricity control: Power distribution systems are unstable. This leads to unstable electricity, which is a resource of temperature control.

The suggested approaches for logistics performance development are expected to resolve the main problems and obstacles. The developed performance will serve logistics demand better, especially cold chain logistics, which is continuing to increase with the demand for cold chain products.

Demand for the cold chain in Thailand

The demand for fresh food and processed food is expected to increase due to high competition in the food industry. In order to support competition, effective logistics management is required. The food industry is interested not only in transportation cost reduction but also in food quality control for perishable goods. The cold chain is a logistics tool that is applied to extend the

saleable lifecycle of perishable goods and ensure that they do not perish in storage or in transit to their end destinations. As a result, the cold chain industry has increased over the years.

An increase in food demand requires more food transportation. The NESDC (2018b) reported that the growth rate of freight in Thailand in 2016 increased by 1.3%, as shown in Table 2.7. Service providers in the country have tended to increase because the domestic and international shipment types have increased slightly. This has been due, in particular, to road transportation, which is the main way of transporting domestic freight, followed by waterway, coast, railway, and air, respectively, while the marine way is the main method of international freight transportation followed by road, airway, railway, and mail, respectively. Cold chain logistics is a part of freight transportation. Therefore, cold chain logistics tends to increase.

Table 2.7: Freight Transportation Rate

Years	2012	2013	2014	2015	2016
Freight transportation growth rate (%)	**3.0**	**-1.0**	**4.0**	**3.3**	**1.3**
Freight transportation volume (1,000 tons)	**782,189**	**774,779**	**805,345**	**831,826**	**842,536**
● **Domestic**	**562,446**	**561,772**	**572,750**	**596,610**	**600,056**
- Road	458,781	458,828	465,020	482,358	486,743
- Railway	11,849	11,920	10,829	11,356	11,970
- Waterway	47,422	45,413	50,113	50,907	50,327
- Coast	44,263	45,441	46,673	51,872	50,894
- Air	68	120	115	117	122
● **International**	**219,743**	**213,007**	**232,595**	**235,216**	**242,480**
- Road	24,574	26,142	27,525	32,297	32,293
- Railway	103	97	80	126	222
- Marine	194,318	186,087	204,293	202,104	209,226
- Air	746	679	696	688	736
- Mail and others	2	1	1	2	3

Source: NESDC (2018b) referring to Ministry of Transport (2017).

For parts of customer demand, the demand for cold chain products has increased, as shown in Table 2.8. The average growth rate of imported cold chain products from 2013 to 2018 was approximately 5%, and the average rate of exported cold chain products also increased (by approximately 2%). As can be seen from the table, the increases in imported and exported cold

chain products change in the same direction as freight transportation. Therefore, the increase in cold chain products influences the increase in cold chain logistics.

Table 2.8: Growth Rates of Imports and Exports of Cold Chain Products (%)

Years	2013	2014	2015	2016	2017	2018	Average
Imports	0.55	3.47	3.44	11.34	6.55	3.31	4.78
Exports	-7.47	6.47	0.56	8.96	5.18	0.92	2.44

Note: Cold chain products consist of fresh, chilled, and frozen products of agriculture, livestock, pharmaceutical products, and fishery products and processed foods that are required to be kept at low temperatures. See Tables 12 and 13 for more details.

Source: Information and Communication Technology Center with Cooperation of the Customs Department (2018).

2.3. Development of cold chain production

Issues and challenges of cold chain logistics

As the second-largest exporter in ASEAN, Thailand plays an important role in the increasing supply chain in the region (ITA 2018), especially in terms of meeting the rising demand for cross-border logistics services. Additionally, Thailand's government vision for making Thailand the 'Kitchen of the World' has also led to significant investment in the development of a complete supply chain for food logistics. It has also led to an increase in the number of supermarkets and restaurants and triggered the demand for cold storage and transport systems to keep the products fresh and maintain their quality. Therefore, cold storage systems have been rising in utilisation by various companies to meet the demand for different products, such as meat, fisheries, and agricultural and food products.

According to the Agricultural Technical Cooperation Working Group of APEC's report, the High-Level Public–Private Forum on Cold Chain to Strengthen Agriculture & Food's Global Value Chain (2015), cold storage distributors in Thailand are growing in number. Thailand's cold chain operations are 'good' in fisheries and dairies/milk products, but 'poor' in fruits/vegetables. The implementation of the cold chain requires an enormous amount of capital to develop infrastructure, transfer knowledge, and change the management and operational practices of the entire supply chain to ensure success (Kitinoja, 2013). This is mostly lacking in the agricultural

industry of Thailand and other developing countries. The challenges facing cold chain development are as follows.

- Human resource development: Employees lack knowledge in cold chain transportation.
- Insufficient infrastructure: The infrastructure of the cold chain system is inefficient, e.g. inconsistencies in the power supply system and tracking temperature systems in storage and transportation are not enough to meet demand.
- High transportation costs: Temperature-controlled logistics cost approximately 3% more than normal transportation.
- Inappropriate and lack of institutional systems: There are issues on the inconvenience of customs clearances and unclear guidelines for temperature-controlled products.
- Lack of investment: Cold chain businesses use a large amount of money for starting their businesses.

From the issues and challenges mentioned above, there is a need to find ways to erase the weaknesses, improve the strengths, and compete with the challenges of cold chain development. The Agricultural Technical Cooperation Working Group of APEC's report (2015) raised ways to develop the cold chain in Asia–Pacific economies as follows:

- Assist small-scale farmers (support for traceability systems and capacity building for participation in the global value chain).
- Improve infrastructure and develop a distribution services system.
- Train staff in the logistics field to obtain handling skills and knowledge for cold chain products and systems.
- Create an enabling environment for the private sector, especially SMEs, to lead businesses and create an environment connecting farmers, industries, and markets.

Cold chain development is strenuous, and it needs to be empowered by government policy and support.

Government policies

The Thai government gives priority to economic growth, which is affected by the value of products. Thus, the government is concerned about product quality and standards for enhancing value. At present, the government legislates acts and provides strategic plans as a policy for regulating and supporting the country's activities. The policies related to cold chain operations are in categories as follows.

- Guiding and Supporting Plan: A path for participants to be followed

Twelfth National Economic and Social Development Plan (2017–2021): The main plan for Thailand development from 2017 to 2021. The strategies responding to economics and logistics development are the four following strategies:

Strategy 3. Strategy for Strengthening the Economy and Underpinning Sustainable Competitiveness: Important keys to this strategy are building economic strength and competitiveness and emphasising the stabilisation of macroeconomic management, improving the efficiency of the financial sector, and maintaining fiscal discipline. In addition, the strategy also focuses on strengthening the sectors of the real economy, including agriculture, manufacturing, and services as both conventional income sources and the means of diversifying to new products and service activities in the future.

Strategy 7. Strategy for Advancing Infrastructure and Logistics: The goal of strategy 7 is to expand the capacity of infrastructure and logistics in the country, both in terms of quantity and quality, to support the expansion of urban areas and key economic zones, and to help improve the quality of life. Connectivity within the sub-region and the ASEAN community will also systematically be increased by building infrastructure networks to support areas alongside the economic corridors. Systems of management and regulation will be upgraded to meet international standards in order to increase operational effectiveness and safety whilst ensuring consumers' rights and providing equal and widespread access to basic infrastructure. Lastly, the country will support infrastructure-induced industries as well as logistics entrepreneurship and organisations that have the potential to expand their businesses internationally.

Strategy 9. Strategy for Regional, Urban, and Economic Zone Development: Key developments and activities are: (1) strengthening the existing production and service bases; (2) creating new production and service bases to generate income for people in all regions; (3) supporting the quality growth of urban areas; (4) developing and reviving the Eastern Seaboard areas to accommodate future industrial expansion; (5) enabling the sound management of border economic areas to attain sustainable growth and competitiveness; and (6) enhancing the efficiency of urban and regional development implementation mechanisms to deliver concrete outcomes.

Strategy 10. Strategy for International Cooperation for Development: This strategy focuses on adjusting domestic mechanisms towards integration; promoting creative, fair, and inclusive mechanisms at the sub-regional and regional levels; and refining Thailand's role with its neighbours in sub-regional and regional development.

The Third Strategy Plan for Logistics Development (2017–2021): This plan was created under the Twelfth National Economic and Social Development Plan (2017–2021) and aims to upgrade the logistics system in Thailand for becoming a centre of trade, service, and investment in the region. It consists of three strategies: (1) the development of value added in supply chain systems; (2) infrastructure and facilities improvement; and (3) development of logistics support factors for supporting the competitiveness and implementation of an organisation.

Supporting Plan for SMEs (2017–2021): There are three strategies for SME operation guidelines as follows: (1) support and development in separate issues, including upgrading technology, innovation, productivity, funding source support, promotion of national and international market access, and entrepreneur development; (2) support for SME capability in specific groups, including high-value start-ups, and encouraging SME network establishment and improvement of the SME foundation; (3) development and promotion of the SME mechanism to drive SMEs as a system, including improving tools for high-performance SME promotion.

- Product Producers: Rules to be regulated for making quality and standard products

Agricultural Standards Act, B.E. 2551 (2017): This act describes the meaning and requirements of the agricultural standard and explains the role of related organisations.

Agricultural Economics Act, B.E. 2522 (1979): Defines the wording of agricultural economics, agriculture development, agricultural economic area, agriculture policy; and explains the role of related organisations in agricultural economics regulation.

- Factories/Warehouses: Regulations for controlling operations in factories and warehouses

Regulation of the Ministry of Industry: Security Measurement Regarding Cooling System Using Ammonia as a Refrigerating Substance in Factory, B.E. 2554 (2011): This report provides details about cooling systems, such as the design, manufacturing, and installation of refrigeration systems, repair and modification of the systems, safety and maintenance of the systems, emission control, and emergency preparedness and response.

Warehouse, Silo and Cold Storage Act, B.E. 2558 (2015): Provides explanations about the authority of the committee for supervising warehouse silo and cold storage and serves as a guide for warehouse business, silo, and cold storage business operations, including: (1) the establishment of and applications for licences and the granting of licences; (2) supervision of warehouse business, silo business, and cold storage business operations; (3) liability of the operator of warehouse business, silo business, and cold storage business, and (4) appeal; detail of warehouse business, silo business, and cold storage specifically for maintaining good of subsidiary; and penalties.

- Transportation: Acts for the constraint of the transportation system, both domestically and internationally

Carriage of Goods by Sea Act, B.E. 2534 (1991): This act mentions the carriage of goods by sea, including: (1) defining the words that correspond to the carriage of goods by sea, (2) rights and duties of the carrier, (3) bills of lading, (4) rights and duties of the shipper, (5) liabilities of the carrier, (6) exclusions to liabilities of the carrier, and (7) limitations of the liabilities of the carrier and the calculation of damages.

All the policies mentioned above are summarised in Table 2.9. It provides information about the policies, related organisations, and the authorities of the organization. This information will be useful for stakeholders.

As can be seen, there are various government agencies responsible for control, regulation, and support activities related to the cold chain. This shows that the government places importance on the cold chain. Even though there is no specific agency in charge of it, the policies encourage cold chain development.

Table 2.9: Summary of Policies

Government Agencies	Sub-organizations	Acts and Policy Documents	Responsibility
Ministry of Transport	Port Authority of Thailand	Carriage of Goods by Sea Act, B.E. 2534 (1991)	Details of implementation of transportation by sea. For example, refrigerators and cold rooms need the arrangement to remain in proper conditions and ensure safety for the reception, carriage, and preservation of goods.
Ministry of Commerce	Department of Internal Trade	Warehouse, Silo, and Cold storage act, B.E. 2558 (2015)	Guidelines of warehouse, silo, and cold storage business operation.
Ministry of Agriculture and Cooperatives	The National Bureau of Agricultural Commodity and Food Standards	Agricultural Standards Act, B.E. 2551 (2017)	Q Mark standard for commercial vehicles for transporting products.
		Agricultural Economics Act, B.E. 2522 (1979)	The role of related organisations is in agricultural economic regulations for the efficacy of agricultural products. The scope of the role is to study and analyse the market system, transportation, market development, price, and demand of the products.
Ministry of Industry	Department of Industrial Works	Regulation of ministry of the industry: Security Measurement Regarding Cooling System, B.E. 2554 (2011)	Guidelines of the cooling operating system.
The Office of SMEs Promotion	–	Supporting Plan for SMEs (2017–2021)	Three strategies for guiding SME operation.
Office of the National Economic and Social Development Council	–	Twelfth National Economic and Social Development Plan (2017–2021)	Setting up four strategies responding to economics and logistics development.
	–	The Third Strategy Plan for Logistics Development (2017–2021)	Three strategies to upgrade the logistics system in Thailand for becoming the centre of trade, services, and investment in the region.

Source: Collected by authors.

2.4. Demand for the cold chain

Thailand's frozen food industry has grown in terms of market revenue due to the high sales of chilled and frozen canned products, especially seafood, with different fish types, shrimp, crustaceans, and others, such as processed chicken, processed fruits, and vegetables.

Thailand's frozen food market in term of consumption has been growing continuously by a yearly average of 9.8%, with a value of B15,700 million in 2015, an increase from 2011 of B10,800 million, as shown in Table 2.10.

Table 2.10: The Total Value of the Frozen Food Market in Thailand, from 2011 to 2015

Year	2011	2012	2013	2014	2015	Growth rate (%)
Frozen food market value (B million)	10,800	11,898	13,182	14,635	15,700	9.8

Source: Food Intelligence Center Thailand (2016).

The changing lifestyle of Thai consumers has also affected the increase in frozen food demand, especially in urban areas. This has been driving the demand for packaged convenience foods (including chilled canned products), as they are stored for a longer period of time because convenience foods are easy to make and take less time to cook. Additionally, rural areas have a high demand for convenient packaged food because the people there work outside, and they do not have time for cooking. Therefore, the demand for convenient packaged food options has been rising.

Statistics of imported and exported cold chain products

Cold chain product revenues have tended to grow on account of a rise in user demand. As seen in Table 2.11, the exported value of cold chain products increased from B444,904.96 million in 2012 to B509,779.07 million in 2018. Meanwhile, the import value also increased from B251,152.31 million to B331,261.48 million. The demand for cold chain products is expected to expand in the future. Leading frozen food manufacturers in Thailand have started to invest and expand their production capacity in order to meet the growing demand for cold chain products.

Table 2.11: Import and export values of cold chain products in Thailand

Years	**Value of cold chain products** (B million)	
	Imports	**Exports**
2012	251,152.31	444,904.96
2013	252,528.00	411,692.32
2014	261,293.44	438,331.63
2015	270,286.94	440,770.69
2016	300,935.91	480,247.42
2017	320,640.65	505,146.29
2018	331,261.48	509,779.07
Average	284,014.10	461,553.20

Source: Information and Communication Technology Center with Cooperation of the Customs Department (2018).

- Import of cold chain products

Considering the different types of imported cold chain products, as shown in Table 2.12, pharmaceutical products (hormones, vitamins, and medicines) are the most imported with an average of B99,002.01 million from 2012 to 2018. The majority of pharmaceutical products are imported from Germany (B13,745.70 million in 2018), followed by the United States (B13,178.8 million) and China (B12,670.60 million). Fresh, chilled, frozen, and processed aquatic animals have imports of B88,626.24 million on average, including (1) tuna at B42,602.59 million; (2) salmon, cod, trout, and mackerel at B9,706.34 million; (3) shrimp at B3,982.56 million; (4) squid at B10,440.03 million; (5) crab at B790.88 million; and (6) other processed aquatic products at B21,103.84 million. Tuna accounts for a large part of imports because manufacturers import tuna to produce canned and processed tuna products. The majority of imports are from Taiwan (B8,051.90 million). In addition, agricultural products have a high average import value; the average is B55,781.92 million. However, livestock and live plants have small import values of B39,726.22 million and B877.71 million, respectively.

- Export of cold chain products

In terms of exported cold chain products, as presented in Table 2.13, canned and processed food products have the highest average export value (B207,609.97 million), followed by livestock products (B106,148.64 million), aquatic products (B69,042.94 million), agricultural products

(B59,856.11 million), pharmaceutical products (B15,170.01 million), and live plants (B3,725.54 million), respectively. Thailand is a production base for fisheries and chicken. The majority of exported livestock products are chilled, frozen, and processed chicken exports (B82,176.18 million). The main suppliers of chilled and frozen chicken products in 2018 were Japan, China, and Malaysia, accounting for around half of the exported value. The majority of exported fishery products were chilled, frozen, and processed shrimp. The United States was the biggest importer of the products in 2018, followed by Japan and China, respectively.

As previously mentioned, the cold chain industry in Thailand is needed for food transportation in both imports and exports. As a result, Thai food processors are also developing more packaged, convenient foods (e.g. chilled, frozen, and instant food) to meet the demand of domestic and foreign consumers, leading to the growth of cold chain logistics businesses, which will be explained in the next section.

Table 2.12: Import Value of Cold Chain Products in Thailand

Cold Chain Products	Imports Value of Cold Chain Products (B million)							
	2012	2013	2014	2015	2016	2017	2018	Average
Aquatic products	87,263.83	87,538.18	79,398.55	75,459.30	90,802.14	98,828.98	101,092.73	88,626.24
Tuna	51,609.52	49,257.18	36,695.96	30,562.08	41,168.26	45,424.29	43,500.85	42,602.59
Salmon, cod, trout, and mackerel	9,494.95	8,844.58	9,668.94	9,048.45	9,437.01	11,326.50	10,123.95	9,706.34
Shrimp	2,359.84	3,482.72	4,029.18	3,688.46	4,275.27	5,003.69	5,038.75	3,982.56
Crab	321.54	277.14	447.85	565.33	905.98	1,241.00	1,777.31	790.88
Squid	6,267.34	9,155.93	9,911.42	10,450.93	12,679.14	12,064.76	12,550.72	10,440.03
Other aquatic products	17,210.64	16,520.63	18,645.20	21,144.05	22,336.48	23,768.74	28,101.15	21,103.84
Agricultural products	39,743.54	42,395.69	44,182.04	58,351.07	69,094.81	70,359.70	66,346.59	55,781.92
Fresh and processed fruits	22,982.49	24,143.25	24,877.97	32,260.22	36,621.25	36,083.32	32,284.37	29,893.27
Fresh and processed vegetables	14,648.32	15,880.84	17,149.77	23,913.99	29,862.28	31,945.58	31,764.32	23,595.01
Fruit and vegetables juice	2,112.73	2,371.60	2,154.31	2,176.86	2,611.27	2,330.80	2,297.90	2,293.64
Livestock products	33,098.81	33,681.41	41,833.74	37,235.95	38,564.22	45,205.77	48,463.62	39,726.22
Meat	14,268.62	13,872.01	15,897.13	17,421.59	22,149.36	24,631.05	28,127.77	19,481.08
Dairy products	18,830.19	19,809.40	25,936.61	19,814.36	16,414.86	20,574.72	20,335.85	20,245.14
Live plants	785.50	680.00	593.30	693.10	1,064.10	1,077.40	1,250.60	877.71
Pharmaceutical products	90,260.63	88,232.72	95,285.81	98,547.52	101,410.64	105,168.80	114,107.94	99,002.01
Total	251,152.31	252,528.00	261,293.44	270,286.94	300,935.91	320,640.65	331,261.48	284,014.10

Note: Live plant consist of HS 0601, 0602, and 0603

Source: Information and Communication Technology Center with Cooperation of the Customs Department (2018).

Table 2.13: Export value of cold chain products in Thailand

Cold Chain Products	Export Value of Cold Chain Products (B million)							
	2012	2013	2014	2015	2016	2017	2018	Average
Aquatic products	87,225.40	63,581.28	67,557.27	59,207.44	70,814.94	71,515.07	63,399.02	69,042.92
Fishes	25,453.20	19,938.06	21,984.29	19,956.00	20,332.98	18,897.54	17,429.55	20,570.23
Shrimp	46,285.91	29,924.15	29,594.72	25,368.39	36,887.16	38,148.70	33,173.26	34,197.47
Other crustaceans	2,081.34	2,848.29	4,019.21	3,541.44	3,139.63	1,255.29	1,146.55	2,575.96
Squid	13,118.85	10,694.85	11,775.31	10,186.95	10,307.07	12,006.94	10,949.38	11,291.34
Other aquatic products	286.11	175.93	183.74	154.65	148.10	1,206.60	700.27	407.91
Agricultural products	36,878.33	38,756.89	48,087.22	52,137.05	62,565.28	85,679.56	94,888.44	59,856.11
Fruits	29,635.69	32,012.66	40,725.41	44,635.26	54,492.24	76,700.49	85,181.35	51,911.87
Vegetables	7,242.64	6,744.23	7,361.81	7,501.79	8,073.04	8,979.07	9,707.09	7,944.24
Livestock products	83,906.94	85,363.02	98,035.88	108,276.68	114,352.19	119,767.33	133,338.46	106,148.64
Meat	68,058.46	67,300.53	74,909.50	81,913.30	89,908.10	96,981.13	101,568.00	82,948.43
Chicken	67,751.36	66,799.69	73,965.21	81,190.02	89,112.92	96,024.68	100,389.40	82,176.18
Duck	136.75	211.66	589.33	455.02	526.43	654.92	700.04	467.74
Pork	170.35	289.18	354.96	268.26	268.75	301.53	478.56	304.51
Dairy products	4,763.51	5,544.15	5,904.29	6,605.52	7,123.23	7,506.63	7,742.18	6,455.64
Other livestock products	11,084.97	12,518.34	17,222.09	19,757.86	17,320.86	15,279.57	24,028.28	16,744.57
Canned and processed foods	220,960.19	207,070.73	207,221.96	202,453.82	212,209.51	207,020.53	196,333.05	207,609.97
Live plants	3,426.00	3,461.40	3,585.10	3,637.40	3,979.80	3,904.30	4,084.80	3,725.54
Pharmaceutical products	12,508.10	13,459.00	13,844.20	15,058.30	16,325.70	17,259.50	17,735.30	15,170.01
Total	444,904.96	411,692.32	438,331.63	440,770.69	480,247.42	505,146.29	509,779.07	461,553.20

Note: Several items listed in the table are inconsistent with Table 2.12 due to the issue of data unavailability. Other livestock products include bones, eggs, and edible parts of animals. Canned and processed foods include fruits, vegetables, and seafood.

Source: Information and Communication Technology Center with Cooperation of the Customs Department (2018).

Demand for Cold Chain Logistics

Laemchabang Port and Bangkok Port are the two main transhipment ports of Thailand that offer universal services in order to exchange goods worldwide. The Port Authority of Thailand reported that from 2007 to 2017, the volume of reefer containers from those two ports, both imported and exported, was fluctuating. The exported volume was greater than the imported volume by on average 1.6 times. If we consider both the imported and exported volume from 2015 to 2017, the volume slightly increased, which means the import and export values tended to rise. Trends in the import and export volume are shown in Table 2.14.

Table 2.14: The Volume of Imported and Exported Reefer Containers

Years	Total of the Reefer Volume (TEU[1])	
	Import	Export
2007	133,193.50	216,593.00
2008	152,877.75	228,188.00
2009	159,118.00	248,012.00
2010	134,578.25	229,090.00
2011	131,360.00	233,234.00
2012	152,590.00	254,876.25
2013	152,340.00	238,446.75
2014	120,526.00	203,257.00
2015	129,466.00	187,398.00
2016	139,378.00	215,968.00
2017	152,103.00	233,438.00

TEU = twenty-foot equivalent unit (1 TEU≈2.16 tons).

Source: Port Authority of Thailand (2018).

As mention above, imported and exported values of cold chain products from 2012 to 2017 tended to increase because consumer behaviour changed. The increase in chilled and frozen food demand led to the growth of cold chain logistics, including cold storage, reefer containers, and freight transportation. The Port Authority of Thailand reported the numbers of reefer containers as follows in Table 2.15. As can be seen, the total number of reefer containers increased in the last three periods, both for imports and exports.

The cold chain logistics market is expected to grow in volume terms on the back of the transportation of food, pharmaceuticals, and healthcare products. Moreover, the demand for food products is also increasing across the globe, which will further create demand for cold chain logistics.

Table 2.15: Number of Import and Export Reefer Containers (Box)

Years	Import				Export			
	20-ft container	40-ft container	45-ft container	Total	20-ft container	40-ft container	45-ft container	Total
2007	12,416	60,382	6	72,804	15,737	100,419	8	116,164
2008	12,013	70,411	19	82,443	13,520	107,334	–	120,854
2009	13,802	72,658	–	86,460	15,736	116,138	–	131,874
2010	9,716	62,421	9	72,146	13,280	107,815	80	121,175
2011	9,964	60,698	–	70,662	12,906	110,164	–	123,070
2012	10,596	70,997	–	81,593	13,910	120,473	9	134,392
2013	9,678	71,313	16	81,007	12,849	112,791	7	125,647
2014	6,726	56,900	–	63,626	8,795	97,231	–	106,026
2015	6,365	59,698	–	66,063	7,810	89,794	–	97,604
2016	8,652	65,363	–	74,015	10,168	102,900	–	113,068
2017	10,319	70,892	–	81,211	12,598	110,420	–	123,018

Note: The payload of the 20-ft reefer container is around 20 tons; the 40-ft reefer container is around 25 tons, and the 45-ft reefer container is around 29 tons.

Source: Port Authority of Thailand (2018).

2.5. The cold chain market in Thailand

This section consists of two parts: chilled and frozen transportation and cold warehouses. Both parts focus on the current business overview and the results obtained from interviews to provide an understanding of the cold chain market in Thailand.

Chilled and frozen transportation

Chilled and frozen transportation is a major activity that delivers raw materials and products to the production process or customers in good quality. According to the Department of Business Development, as shown in Table 2.16, active companies that provide chilled and frozen transportation by road numbered 51 companies with a total registered capital of B122 million

in 2019. Four companies had foreign joint investment and the other companies were local companies. There was significant annual growth in total revenue of 43% from 2015 to 2016. It is possible that chilled and frozen transportation will grow significantly in the future.

Table 2.16: Overview of the Chilled and Frozen Transportation Business Group in 2019

Business Profile	Detail
Active company	51 companies
Registered capital	B122 million
Joint investment	**Foreign:** 4 companies (8%) **Local:** 47 companies (92%)
Revenue of active companies	**Year 2015:** B3.31 million **Year 2016:** B6.36 million **Year 2017:** B6.03 million

Note: Data as of 24 January 2019, business code: 49331.

Source: Department of Business Development (2019).

Table 17 presents the number of cold transport operators in Thailand by vehicle type. Most operators use a refrigerated mini truck, which accounts for 96%, including those with a tail lift and without tail lift at 23% and 72%, respectively. The other types (trailer and semi-trailer) only comprise 5%, implying that the refrigerated mini truck is the most common vehicle.

Table 2.17: Number of Refrigerated Vehicles Operators in 2019

Vehicle Type	Number of Operators
Refrigerated trailer	8
Tail-lift refrigerated semi-trailer	4
Refrigerated semi-trailer	3
Refrigerated mini truck	244
Tail-lift refrigerated mini truck	79
Total	**338**

Note: Data of cold transport companies that were certified Q-Mark by Department of Land Transport in Thailand.

Source: Department of Land Transport (2019).

According to an interview with a small-scale logistics provider who operates chilled and frozen transportation and makes body trucks, the proportion of frozen and chilled trucks accounts for

83.5% and 16.5%, respectively. There are two types of vehicle, which are six-wheel and ten-wheel trucks. The purchase price of a new six-wheel one starts from B2.10 million to B2.50 million; the ten-wheel one is around B3.5 million to B4.1 million. In addition, second-hand trucks are also in use, with a price for a six-wheel from B0.85 million to B1.2 million, and ten-wheel from B1.50 million to B2.20 million.

Thailand also has a tool to promote a level of service in freight transport, known as the service quality standard for truck operation, or Q Mark. If operators have already registered their vehicle with the Department of Land Transport (DLT), they can voluntarily request the DLT to certify for the Q Mark certificate. Furthermore, DLT has implemented a Q Cold Chain program, which is an extended standard of the Q mark, to enhance the quality of transportation of agricultural and food products. The Q Cold Chain is about setting up a common quality standard of temperature-controlled transport. The Q mark statistics, however, are not published at present. If the related body improves their data collecting methods and makes them open to the public, this will be a great benefit in the future.

The cold warehouse

In 2015, the total capacity of both public and private warehouses in Thailand was approximately 18.62 million metric tons. Conventional warehouses were dominant, accounting for 82%, while silo and cold storages were around 13% and 5%, respectively, as shown in Table 2.18 below.

Table 2.18: Capacity of Warehouse, Silo, and Cold Storage in 2015 (million metric tons)

Type	Warehouse	Silo	Cold Storage	Total
Private	9.52	0.62	0.18	10.33
Public	5.81	1.73	0.76	8.30
Total	**15.33**	**2.35**	**0.94**	**18.62**

Source: Transportation Institute Chulalongkorn University cited from the Department of Internal Trade (2015).

Moving on to the number of operators, half of them were warehouses, cold storage was about 34%, and silos were 12%, as shown in Table 2.19. When compared to the capacity of cold storage, it is implied that each operator has a little capacity.

Table 2.19: The Number of Total Warehouse, Silo, and Cold Storage Operators in 2019

Type	Number of Operators
Warehouse	976
Silo	226
Cold Storage	632
Total	**1,834**

Note: Data as of January 2019.

Source: Department of Internal Trade (2019).

There are 165 active companies with a registered capital of B10,218 million. Of these, 13% are foreign joint ventures, and the rest are local companies. The nations that jointly invest the most in Thai companies are Japan and China. The revenue of this business group decreased by approximately 9% per year from 2015 to 2017. The details are shown in Table 2.20.

Table 2.20: Overview of the Cold Warehouse Business Group in 2019

Business Profile	Detail
Active company	165 companies
Registered capital	B10,218 million
Joint investment	**Foreign:** 23 companies (13%) **Local:** 142 companies (87%)
Revenue of active companies	**Year 2015:** 20.77 million baht **Year 2016:** 17.32 million baht **Year 2017:** 17.60 million baht

Note: Data as of 24 January 2019, Business Code: 52101.

Source: Department of Business Development (2019).

As seen in interviews with the companies, there are variations in the capacity and size of the companies. In the case of the frozen seafood exporter sample, the area was 36,705 square meters with a maximum weight of 15,412 tons, while the space of the cold chain logistics provider sample was 4,788 square meters with a weight of 3,320 tons. In this context, the cold

chain logistics provider is a company that provides controlled-temperature transport. Table 2.21 shows that the area and the capacity of the logistics provider are higher than the frozen seafood exporter.

Table 2.21: Details of the Cold Warehouses from Respondents in 2019

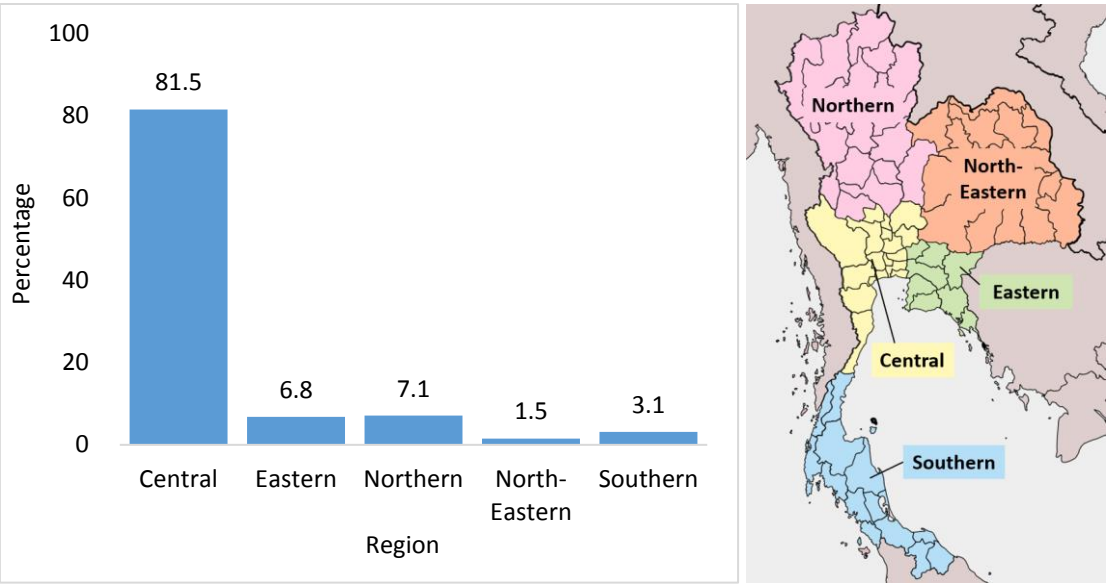
Detail	Chilled	Frozen	Ambient	Total
The frozen seafood exporter				
Area (Sq. metres)	1,186	2,655	947	4,788
Capacity (tons)	824	1,844	652	3,320
Cold chain logistics provider				
Area (sq. metres)	–	12,385	24,320	36,705
Capacity (tons)	–	4,377	11,035	15,412

Source:-Authors.

The main technology used in the company is the systems, applications, and products (SAP) system and Warehouse Management Software (WMS) program to control stocks. The system's function is to allow the organisation to manage the business operations across procurement, financial, inventory, manufacturing, and relating activities. In addition to the SAP, the internal organisation is able to share related information within the organisation as well. Similarly, the WMS facilitates users to manage stocks efficiently and is compatible with a barcode system.

According to the geographical warehouse data in Figure 2.2, cold warehouses are mainly in the Central part; then the North and the South in Thailand. The Central region is the commercial area because it is near a source of production and international ports. The Central region has a number of cold storage facilities and chilled and frozen transport services that can facilitate cold chain production, import, and export. Furthermore, the cold warehouse will increase significantly in 10 years, especially in the Northeastern region (Transportation Institute Chulalongkorn University, 2015).

Figure 2.2: The Capacity of Cold Storage in Thailand by Region



Source: Transportation Institute Chulalongkorn University (2015).

In conclusion, the number of registered cold chain businesses in Thailand is low, both in the transport and warehouse industries. For cold chain transport, a refrigerated mini truck is a common vehicle. Meanwhile, the capacity of cold storage is less than the warehouse largely, and most of the storage is located in the Central part of Thailand. This is because the main ports that are shipment hubs are located mostly in the Central part. For more on the business model overview of the cold chain, the next section will consider the process of each stakeholder from upstream to downstream.

2.6. A business model of the cold chain

There are various types of enterprises or companies that need temperature control in their operations. These are the stakeholders of the cold chain. The research plan separates stakeholders into three groups for the interview. The stakeholder groups are representatives of parts in the chain from upstream to downstream, including producers, logistics providers, and traders. Each group has a different core operation.

Business model overview

The information from the interview shows how each type of stakeholder needs temperature control and demonstrates the business model of the cold chain in Thailand. An overview of the business model will be described in three topics consistent with the stakeholder group as follows.

- Producer

The producer is in the upstream part on the chain and is the agriculturist and food manufacturing industry that produces agricultural products. The agriculturist is a first producer, such as a farmer, fisherman, or rancher. They are responsible for producing, harvesting, and collecting supplies of fruits, vegetables, aquatic animals, and livestock for manufacturing. The manufacturer is the next producer receiving the supply from the agriculturist, who then processes it into a processed and final product.

Thai Union Group PCL is a representative sample of the producer group as a large producer due to having numerous subsidiaries and associated companies domestically and internationally. The subsidiaries and associated companies are Thai Ruamsin Patana Industry Co., Ltd., Songkla Canning PCL., Okeanos Food Co., Ltd., Chicken of the Sea brand, King Oscar brand, John West brand, and other subsidiary companies. The principal factory is located in Samutsakorn province. The factory mainly produces canned tuna, pouch tuna, and canned sardines.

The cold chain is necessary for manufacturing for preserving the input supply in transportation from the shore and customs to the factory and keeping them in cold storage during the production process. The main input supply, which is fish, mainly comes from the Republic of Korea, Japan, and Taiwan. The company mostly uses factory-owned normal temperature trucks. As the fish supply is usually frozen as a pack of ice at the boat at the origin, the factory typically keeps a supply in their cold storage. However, the factory uses third-party logistics companies (3PLs) in oversupply periods. At that time, the supply is greater than the capability of the trucks and cold storage. The selection criteria for the 3PLs are quality of service, price, responsibility, and traceability. The expectations of the 3PLs are timeliness, accuracy, and completeness. The factory emphasises human resource development by training on transportation and product management both for normal and temperature-controlled products. Moreover, the factory also creates the work instructions in various languages for the nationalities of its labour force to

ensure understanding. This affects the accuracy of their work. Additionally, the company is working with local fishermen to support them.

- Logistics provider

The logistics provider is in the midstream part of the chain. They provide transportation and warehouse services. The core business of transportation is providing the service of sending a supply, material, or product between the producer, warehouse, distribution centre, shipment, and customer. Also, the core business of the warehouse is the service of storage of products for producers and traders that do not have suitable space or warehouses to store their products.

Representative samples of the logistics provider group are Rujoran Transport Co., Ltd. as a small provider, Eagles Air & Sea Co., Ltd. and CTI Logistics Co., Ltd. as a medium provider. The size of the enterprises tells us the capital size, which indicates the capacity of the service operations. The logistics providers have different kind of services, such as trucks and warehouses in various temperatures, such as ordinary temperatures, refrigerating, and freezing. Even though the type of service does not depend on the enterprise size, the cost of temperature-controlled trucks and warehouses are higher than ordinary ones.

The logistics providers are usually located in the city centre, manufacturing area, border, sea-river port, airport, or other significant locations. They typically make contracts with large traders. Standards are essential to the logistics provider as a guarantee of their services. Thus, they are incentivised to make their services along with the standards that are required by the client and authority. The client requires standards for the contract, while the authority requires standards as a regulation. The standards control and regulate hygiene, laws, driver qualifications, and necessary technology, such as temperature controllers and GPS. Nowadays, most of the trucks used in transporting goods are location traceable by GPS and have temperature traceability. They are controlled and operated by well-trained staff.

- Trader

The trader is in the downstream part of the chain. Moreover, it is the closest group to the consumer as the core business of the trader is selling products to the consumer directly. The

traders are modern traders, shops, restaurants, and producers that sell their products to the consumer without an intermediary. The products that traders sell are final products, semi-finished products, ready to cook products, ready to eat products, and other consumable products.

Harmony Life International Co., Ltd. is the representative sample of the trader group as a medium trader. The company has owned an organic farm in Nakhon Ratchasima province. The products of the company are fresh vegetables and processed products, such as herbal tea, noodles, jams, soaps, and other goods. The products are mainly sold domestically at their shop and restaurant in Bangkok, called Sustaina Organic Shop Restaurant. Also, they send products to other modern trade shelves, such as Big C, Lotus, the mall, Tops Supermarket, and local health shops. Moreover, their noodle product is an ingredient for the MK restaurant. The company mainly exports herbal tea, spice, and processed organic product to Singapore, Hong Kong, Taiwan, and the United States.

Their temperature-controlled products are fresh vegetables and jams. Thus, the company only uses a company-owned truck to transport their products domestically from the farm to their warehouses, offices, restaurants, and partners' places in Bangkok. There are two zones separately in their warehouse; the normal temperature zone and chilled zone. The company uses large freight forwarders as 3PLs for transporting unperishable products. The selection criteria for 3PLs are hygiene, timeliness, accuracy, and safety. The company is exceedingly concerned about their products. Thus, they train staff to use trucks and storage that are both normal and temperature controlled.

The above are details of each type of business model that is obviously connected by temperature control. Next will be a discussion on its connection.

Connection of the cold chain

The cold chain connects stakeholders by temperature control in different ways due to the different core operations of each stakeholder as a tool to maintain the condition of supply from the origin to the end of the chain.

The temperature control process properly begins at the farm or in the middle of the ocean right after the supply is picked up from its origin, to maintain the original condition as much as possible. Then, it is sent to a receiver, who has an influence on valuing and pricing the supply. A supply in good condition gets high compensation or payment. The receivers could be the manufacturing industry, warehouses, distribution centres, traders, or consumers.

The manufacturing industry receives materials supply as an input. It is then processed into an output, which is the processed and final product. While waiting for processing and sending, they keep the supply and product in the cold storage. After the process ends, they send the output to the warehouse, distribution centre, trader, and consumer. The trader receives the processed and final food product from the producer. They keep the products in cold storage for stocking. They put the products on a temperature-controlled shelf to display and wait for selling to the consumer.

Temperature-controlled transportation and warehouses are intermediate in the chain. Thus, they are in the middle between stakeholders. The operator of the transportation and warehouse could be the producer, trader, or logistics provider depending on the deal and contract since some producers and traders play the transportation and warehouse operator roles at times. This is to support their core operations, unlike the logistics provider, whose core business is providing transportation and warehouse services. The producers and traders that own numerous temperature-controlled transportation and warehouse facilities are mostly large- and medium-sized as the standard temperature control needs high capital or investment and operation. Thus, they only use 3PLs when there is an oversupply for their capacity.

Because of the high investment costs in the chain, stakeholders are finding ways to reduce the operating costs. In the case of a farm, the farmer tends to have temperature control by using natural cold weather at night and dawn and protects the supply with leaves to save costs. In addition, stakeholders reduce their costs by taking advantage of locations by building an office, manufacturing, distribution centre, and warehouse near the origin of supply, infrastructure facility, and customers.

This describes the connection of the cold chain, which shows that each stakeholder could play more than one role. Each part in the chain adds value to the product by processes. Thus, the consumer at the end of the chain can get the product from stakeholders who are playing in any

part of the chain, such as farmers, factory shops, modern traders, restaurants, and others, depending on their needs on the value of commodities.

Main players and users of the cold chain

The interviewees provided the names of player and user companies of the cold chain in Thailand, such as JWD, SCG, the Heritage, Harpers, Excel, and other companies. Also, the research team studied the Data Warehouse of the Department of Business Development (DBD) to find the main players and users of the chain. The methods focused on sorting the revenue which is declared in the financial budget together with the business type reported by registered legal persons in the latest year.

The DBD applies the Thailand Standard Industrial Classification (TSIC) from the Ministry of Labour, which referred to the United Nations Statistics Division's International Standard Industrial Classification (ISIC). This is a principle to establish a TSIC business code into 21 sections from A to U. Transportation and storage are in section H, which consists of the various types of businesses involved. However, this study focuses on road transport services of freight by refrigerator vehicles, which in H49331, and Refrigerated storage activities in H52101.

The road transport services of freight by refrigerator vehicles activity (H49331) refer to the main players of transportation in the chain as shown in Table 2.22. In 2017, this activity earned a total revenue of B587 million, and there are 29–56 operators declaring their revenue to the authority.

Table 2.22: Main Players of Transportation in the Cold Chain

Order[1]	Legal Person Name	Legal Person Type[2]	Size[3]	Location (Province)	Revenue (baht)[4]	Proportion[5] (%)
1	P.M. Distribution	Co., Ltd.	S	Nonthaburi	128,898,353	21.97
2	Paramee Logistics	Co., Ltd.	S	Chiang Mai	111,788,683	19.05
3	2299 Trading	Co., Ltd.	S	Chiang Mai	68,766,000	11.72
4	Konoike Asia (Thailand)	Co., Ltd.	S	Samut Prakan	48,861,610	8.33
5	3G Shipping Agent	P'ship. Ltd.	S	Surat Thani	40,529,740	6.91
6	Pattara Logistics	Co., Ltd.	S	Bangkok	32,356,394	5.52
7	Teerasak Transport	P'ship. Ltd.	S	Bangkok	26,119,970	4.45

Order[1]	Legal Person Name	Legal Person Type[2]	Size[3]	Location (Province)	Revenue (baht)[4]	Proportion[5] (%)
8	R.P.A.168 Transport	P'ship. Ltd.	S	Nakhon Pathom	21,996,194	3.75
9	NTP Fishery Enterprise	Co., Ltd.	S	Phangnga	15,602,885	2.66
10	Lan Ya Mo Transport	P'ship. Ltd.	S	Saraburi	13,709,878	2.34

Note: 1. Order by revenue sorting in the same business from large to small amounts, 2. Co., Ltd.: Company Limited, P'ship. Ltd: Partnership Limited, 3. Classified by DBD referred to criteria in Appendix: Table A.1., 4. The revenue of 2017, 5. The Proportion of the legal person's revenue to total revenue of the business (%). Data as of 1 March 2019.

Source: Department of Business Development (2019), and Bank of Thailand (2019).

The main players in cold storage as shown in Table 2.23, are the refrigerated storage activities (H52101). In 2017, total revenue was 8,355 million baht, and there are125 of 168 operators that declared their revenue to the authority.

Table 2.23: Main Players of Storage in the Cold Chain

Order[1]	Legal Person Name	Legal Person Type[2]	Size[3]	Location (Province)	Revenue (baht)[4]	Proportion[5] (%)
1	Chiangmai Frozen Foods	Pub. Co., Ltd.	L	Bangkok	1,407,707,964	16.85
2	Bangkok Seafood	Co., Ltd.	L	Samut Sakhon	832,099,337	9.96
3	Pacific Cold Storage	Co., Ltd.	L	Samut Sakhon	581,400,591	6.96
4	Thai Yokorei	Co., Ltd.	L	Bangkok	459,649,107	5.50
5	JWD Pacific	Co., Ltd.	M	Bangkok	268,884,471	3.22
6	Piti Center Cold Storage	Co., Ltd.	L	Ayutthaya	227,605,624	2.72
7	Bangkok Cold Storage Service	Co., Ltd.	L	Samut Prakan	225,554,787	2.70
8	Thai Max Cold Storage	Co., Ltd.	L	Samut Prakan	204,587,773	2.45
9	Thepmanee Cold Storage (Mahachai)	Co., Ltd.	M	Bangkok	191,135,459	2.29
10	Konoike Cool Logistics (Thailand)	Co., Ltd.	L	Samut Prakan	176,967,353	2.12

Note: 1. Ordered by revenue in the same business from large to small amounts; 2. Pub. Co., Ltd.: Public Company Limited, Co., Ltd.: Company Limited; 3. Classified by DBD referring to criteria in Appendix: Table A.1.; 4. Revenue for 2017; 5. The proportion of the legal person's revenue to total revenue of the business (%). Data as of 1 March 2019.

Source: Department of Business Development (2019), and Bank of Thailand (2011).

Regarding the mentioned main players by interviewees and the report from the Data Warehouse, it appears that the common main players are JWD Pacific (5) and Pacific Cold Storage (3). They are subsidiaries of JWD InfoLogistics Public Company Limited, as shown in their Annual Report 2018. Therefore, the research team explored the cold chain clients of JWD InfoLogistics as shown on their website to demonstrate the main users of the chain in Table 2.24.

Table 2.24: Main Users in Cold Chain, Clients of JWD InfoLogistics

Legal Person Name[1]	Legal Person Type[2]	Size[3]	Location	TSIC Business Code[4]	Business Type[4]	Registered LP.[5]	Revenue Declared LP.[5]	Legal Person Revenue[4,6]	Total Revenue in the Business(baht) [6]	Proportion[7] (%)	Order[8]
Kingfisher Holding	Co., Ltd.	L	Bangkok	C10210	Processing and preserving of fish and fish products, fresh, chilled or frozen	8	7	1,677,278,789	6,192,548,417	27.09	2
DuckKing	Co., Ltd.	M	Chacho-engsao	C10120	Slaughtering and packing of poultry	65	55	1,483,992,727	115,305,598,946	1.29	14
Kibun (Thailand)	Co., Ltd.	L	Bangkok	C10292	Manufacture of fish, crustaceans and molluscs sausages, ball and other similar products	29	20	2,112,544,969	6,809,262,623	31.02	5
Uni-President (Thailand)	Co., Ltd.	L	Bangkok	C10303	Manufacture of fruit or vegetable juices	265	213	1,812,713,612	20,242,452,223	8.96	5
Thai Union Group	Pub. Co., Ltd.	L	Samut Sakhon	C10751	Manufacture of frozen prepared meals and dishes	132	81	27,547,974,282	66,520,650,597	41.41	1
C.P. Group: CPF (Thailand)	Pub. Co., Ltd.	L	Bangkok	C10802	Manufacture of prepared feeds for farm animals	299	214	139,997,608,000	393,894,362,839	35.54	1
C.P. Group: Charoen Pokphand Foods	Pub. Co., Ltd.	L	Bangkok	C10802	Manufacture of prepared feeds for farm animals	299	214	45,825,743,000	393,894,362,839	11.63	2
Betagro	Pub. Co., Ltd.	L	Bangkok	C10802	Manufacture of prepared feeds for farm animals	299	214	43,233,729,269	393,894,362,839	10.98	3
Siam Winery	Co., Ltd.	L	Samut Sakhon	C11029	Manufacture of other wines	71	51	3,080,826,981	3,319,177,947	92.82	1
Maruha Nichiro (Thailand)	Co., Ltd.	S	Bangkok	G46312	Wholesale of fish and fish products	876	523	531,448,100	56,218,014,232	0.95	19
Thai Green Nation Corporation	Co., Ltd.	S	Bangkok	G46319	Wholesale of other food products	3,462	2,013	510,235,552	200,004,465,549	0.26	61
Sea Value	Pub. Co., Ltd.	L	Samut Sakhon	G46109	Wholesale on a fee or contract basis of a variety of goods	6,120	3,316	137,238,240	38,764,497,720	0.01	651
Damco Logistics (Thailand)	Co., Ltd.	S	Bangkok	H52292	Freight forwarding and customs agent activities	3,616	2,460	1,643,840,386	92,274,544,852	1.78	9
The Minor Food Group	Pub. Co., Ltd.	L	Bangkok	I56101	Restaurants activities	13,874	7,761	5,370,712,446	215,511,144,881	2.49	8

Note: 1. Legal Person data is general data for public services and cannot be used for reference in a law; 2. Pub. Co., Ltd.: Public Company Limited, Co., Ltd.: Company Limited.; 3. Classified by DBD referring to criteria in Appendix: Table A.1.; 4. Collected from the financial budget report that the legal person declared in the latest year; 5. The number of registered legal persons with operating status; 6. Revenue for 2017; 7. The proportion of the legal person's revenue to the total revenue of the business (%); 8. Ordered by revenue in the same business from large to small amount. Data as of 3–4 March 2019. Source: Department of Business Development (2019) and Bank of Thailand (2011).

The main players mentioned above are Betagro, CPF, Kingfisher, Thai Union, and Sea Value, which correlate with key players in the food processing companies in Thailand's food industry as reported by BOI (2017b). The main users mostly are large-size enterprises for the main players of cold storage. Meanwhile, the main players of temperature-controlled trucks are small-sized enterprises. This conforms to the interview that mentioned that large transportation providers make subcontracts with small and medium logistics providers. This is how the different size players support each other to serve the demand for services from users, which is continuing to rise as shown in the demand for cold chain logistics. Moreover, it could imply that cold storage needs a higher investment cost than temperature-controlled trucks.

A considerable amount of Thai and foreign investment by users gives more opportunities to the players, especially the small and medium players. In addition, the opportunity and support to solve problems and overcome obstacles may encourage these companies to be more successful and grow to be large companies in the future.

2.7. Expectations of government policy

There are numerous Thai government agencies involved in providing comprehensive policies to support the cold chain. The agencies separately work on their mission and plan to consult, promote, and provide services for the entire cold chain's stakeholders. This section will discuss the cold chain policies in terms of regulation and support in three parts: regulatory policy, supporting policy, and private sector networking. The main ideas are according to the survey interviews given by the stakeholders' perceptions.

Regulatory policy

There is no specific agency responsible for the cold chain. However, there are integrated policies to regulate the chain and unite the agencies for working together. There are main agencies that take the core responsibility and there is a committee from other agencies involved. The regulatory policy regarding the cold chain was established with objectives to raise the standards and quality of the products. It enhances the competitiveness of enterprises. Moreover, it

ensures food safety and security. Examples of outstanding cold chain regulatory policy are the Q Cold Chain Standard project and the Warehouse, Silo, and Cold Storage Standard policy.

- The Q Cold Chain Standard Project

The DLT affiliated with the Ministry of Transport takes the core responsibility of the Q Cold Chain standard project. It is a further extended policy of the Quality Standard for Truck Operators, known as the Q Mark standard. The Q Mark standard for commercial vehicles is used in transport goods and products. The Q Cold Chain standard is a pilot plan tested in January 2019. Eligible in the pilot plan are Q Mark certified enterprises. They were evaluated by the draft of Quality Standards for Temperature Control Truck Operators. Logistics Time Magazine (2019) refers to the director of the DLT's statement and reveals that the objectives of this project are to develop the potential and create an opportunity of competitiveness for operators of temperature-controlled transportation to achieve higher efficiency and sustainability. The evaluation approach of the Q Cold Chain standard focuses on four key factors: the operation of transport, hygiene, the standards and maintenance of cold storage, and human resource development.

- Warehouse, silo, and cold storage policy

The Market System Promotion and Administration Division subordinate of the Department of Internal Trade affiliated with Ministry of Commerce takes the core responsibility regarding the Warehouse, Silo, and Cold Storage Act (2015). This act leads the division's work on issuing the standards for warehouse, silo, and cold storage. Moreover, the division is ordered to study, analyse, and provide advice to support and develop entrepreneurs to reach the standard. The standard helps to reduce the cost of waste and gain competitiveness. Also, the duty of this division includes the issuing and withdrawal of licences for operating, and it also regulates and controls warehouse, silo, and cold storage enterprises under the laws. The standard is now still at the department level, which is being administrated and pushed by the department to be at the national level in the near future. The national standard must be agreed by stakeholders in the country and administrated by a central organisation, which could be private or public. Currently, there are more than 100 operators certified by this standard. The certified operators consist of approximately 75% of Thai SMEs.

The mentioned regulatory policies are voluntary regulations. They contribute to positive results and consequences. However, there are still problems and obstacles that affect the stakeholders regarding regulatory policy enforcement, insufficiency of concrete support, and entrepreneur's administration and management. Details referring to the survey interviews are listed in seven categories as follows.

Human resources

- Lack of efficient human resources in cold chain operation.
- Small entrepreneurs and farmers rarely use cold storage to help in handling and seasonal value adding. Most of them sell agricultural products immediately after being harvested, due to liquidity necessity.
- Drivers have deficient English skills and legal knowledge for working across borders.

Operation costs

- Operation costs are high due to fluctuations in the gasoline price, but the logistics service price cannot be adjusted along with the gasoline price consistently.

Infrastructure

- The random product check area is not a temperature-controlled area, which causes discontinuities in products' temperature-controlling.
- Road construction causes congestion on roads. This affects delays in product delivery, especially cold chain products that are affected by timeliness.
- The delays may result in higher transportation costs and the disorder of management.
- Traffic jams in urban areas affect the timeliness of product transportation in many routes, such as factory–distribution centre, port–distribution centre, distribution centre–retail, and other routes.

Investment

- Cold storage and its facilities need high capital investment.
- There is uncovered special support by the Office of the Board of Investment (BOI) in terms of tax exemption for investment in temperature-controlled trucks and cold

storage. The BOI exemption depends on the investment amount/expenditure for enhancing competitiveness.

Customs

- The inconvenient and complicated import declaration process partly causes delays during the shipment process from the port to the factory in some cases.
- Clear numbers of export products, such as herbs, spices, and tea, are usually not consistent among staffs' discretion. The wasted time and loss of tax refund benefits the partners of exporters.

Institutional systems

- Certified enterprises get excessive examinations and regulations to achieve and maintain the certification. Meanwhile, some uncertified enterprises claim their products as organic. This makes it unequal for certified enterprises.
- There is a problem in collecting data on cold storage as some enterprises are not co-operating to reveal information.

Logistics prohibition

- For certain time periods, such as the new year holidays and Thai new year holiday (in April), the government has prohibited ten-wheeled trucks and more from providing transport services in five major routes to reduce accidents. If the transport operators want to use trucks in these periods, the operator must seek permission on a case-by-case basis. This affects the cold chain in terms of the lack of products on shelves in a regional area.

As can be seen, the problems and obstacles from the stakeholder's perspective are related to the concerned issues on the report of the Logistics Performance Index (World Bank, 2018) and the High Level Public–Private Forum on Cold Chain to Strengthen Agriculture & Food's Global Value Chain (Agricultural Technical Cooperation Working Group of APEC, 2015). Apart from that, hearing stakeholders' perspectives and expectations will be useful for further additional supporting policies.

Supporting policies

Regarding the problems and obstacles mentioned above, the entrepreneurs from the survey interviews are expecting the following supporting policies.

- Research for value-adding to cold chain products regarding accrediting qualifications and R&D development.
- Support small and medium-sized enterprises to participate in commodities trade fair exhibitions abroad. Regarding the high cost of participation, this support will enhance the competitiveness of SMEs in promoting their products.
- Approach and attract skilled staff working in the cold chain to solve the lack of human resources in the business.
- Achieve prompt road construction facilitates to improve the timeliness and costs of cold chain transportation products.
- Attract investment support for logistics SMEs in the cold chain, such as low-interest loans for purchasing temperature-controlled trucks and building cold storage.
- Regulation for the cold chain is necessary, but entrepreneurs think that more regulation will create more complications for their operation. Thus, entrepreneurs currently prefer supporting policies more than regulatory policies, especially for SMEs.
- Plans for handling unexpected situations, for example airport disruptions for trading and transportation, particularly cold chain products that matter by the hour.
- Need a specific agency to support the cold chain, especially SMEs. This can be a group of government staff, government outsourcing, cooperation between government agencies, finance organisations, or the private sector.
- Require more convenient customs processes, such as e-payments and e-documents for simplicity and speed of operations.
- Consider building resting spots for truck drivers so they can take a rest. That may help to reduce the accident rate and human resource cost.
- Intense investigation and control of uncertified standard enterprises and products to prevent impersonation and falsifications.

Most of the expected policies are recognised and emphasised by the government. This can be seen in Table 2.25, which refers to seven categories of problems and obstacles.

Table 2.25: Policies Supporting the Cold Chain in Thailand

Problems and Obstacles	Supporting Policy
1. Human resources	● Thailand Professional Qualification Institute is a public organisation coordinated between the private and public sectors. The institute creates frameworks and evaluation criteria to standardise each level of professional qualification. In addition, it strengthens all occupation groups to make their standards a reference for human resources development in each group. Its aims are improving the Thai workforce's competitiveness in terms of skill and knowledge and preparing the workforce to meet the market's qualification requirements (Thailand Professional Qualification Institute, n.d.). According to the interviews, currently, the Thai Federation on Logistics, the Ministry of Internal Trade, and network companies are participating in developing the professional cold chain course.
2. Operation costs	● The Fuel Fund is a fund for solving oil and gas problems organised by the Energy Fund Administration Institute. The aim is ensuring a beneficial outcome for all stakeholders, especially low-income citizens, as Thailand is a fuel importer that is unable to adjust fuel price, and fuel price is naturally fluctuating. (Energy Fund Administration Institute, n.d.) (General Prayut Chan-o-cha, 2014)
3. Infrastructure	● The Eastern Economic Corridor (EEC) is a strategic plan under Thailand's economic model called Thailand 4.0. The EEC is an area of development that extends from the Eastern Seaboard Development Program. The main objective of this plan is the incentive to investment which upgrades Thailand's industries and leads to Thailand's economic growth in the long term. The Infrastructure Development Implementation program is one of eight programs in the plan. It focuses on development and introducing seamless transportation. The approach provides the necessary linkages for air, land, rail, and sea routes. The outcome supports transportation in terms of cost and time reduction. (Eastern Economic Corridor, n.d.)
4. Investment	● The BOI is a government agency responsible for incentive investment, both inbound and outbound. The aim is enhancing Thailand's competitiveness and overcoming the 'middle-income trap' and sustainable growth challenges to Thailand's competitiveness. The approach is or incentive investments that are tax incentives and non-tax incentives. Tax Incentives are exemptions from income tax and reductions in duties for specific materials and machinery with conditions. Non-tax incentives are related to permission for ownership for foreign investors and bringing skilled experts into the kingdom. (BOI, n.d.)
5. Customs	● The National Single Window (NSW) is a policy organised by the sub-committee of the National Logistics Development Committee. The NSW facilitates electronic data and information sharing. Moreover, it is integrated between government to government partnerships (G2G), government to business partnerships (G2B) and business to business partnerships (B2B). Its goals are reducing the national logistics cost, increasing competitiveness, facilitating inland and cross border goods' transportation, and supporting import, export, and logistics. (Thai Customs Department, n.d.)

Problems and Obstacles	Supporting Policy
	● Port Community System development at Laemchabang Port, Bangkok Port, and Suvarnabhumi International Airport, this project is under the Strategy Plan for Logistics Development. The objectives of this project are setting the main system to administrate and manage products and container status traceability, certification documents and license examination, transaction, products, and containers moving permission in electronic form. (Phensawang, 2018)
6. Institutional systems	● The SMEs Promotion Act established the Office of SMEs Promotion (OSMEP) in 2001 as a government agency. The office's responsibility is coordinating the working system and leading policy to promote SMEs, focusing on issues such as the following: - Improve laws and regulations for SMEs according to the SMEs Promotion Master Plan and SMEs Promotion Action Plan - Ensure the achievement of SME operation for both public and private sectors, domestically and internationally - Develop knowledge and databases for SMEs as policy recommendations and promotion (Office of SMEs Promotion, n.d.a)
7. Logistics prohibition	● Reliability of the logistics system is part of the approach of Thailand's logistics development stated by NESDC. The reliable approach is public relations, obstacle adjustment to international trade, and risk management, as detailed as follows: - Public relations: participating in international logistics seminars for present significant logistics development and increasing public relations channels, such as making media projects and the Strategy Plan. - Obstacle adjustment to international trade: Government to government trade negotiations, such as cross-border transport agreements, bilateral free trade negotiations, and trade facilitation agreements. - Risk management: Plan for handling unusual situations for continuous operations, such as political, natural disaster, and neighbouring country policy changes. (NESDC, 2018a)

Sources: See citations in this table.

This may imply that those policies are unrecognised or inaccessible by stakeholders. Meanwhile, some supporting policies are planned for further adoption. Apart from the policy regulation and support, the private sector networking of the entrepreneurs in the businesses can help reduce problems and obstacles. This can lead to development by giving practical information, negotiations, and the network's agreement to policymakers.

Private sector networking

Apart from the policies, government agencies have been encouraging entrepreneurs to gather as groups, associations, federations, unions, cooperatives, and other networks. However, some of them are driven to gather by entrepreneurs themselves. The main objectives of networking are connecting and empowering enterprises in the same business. Examples of interesting private sector networking in the cold chain are the Thai Federation on Logistics and the Warehouse, Silo, and Cold Storage Association.

- The Thai Federation on Logistics

The Thai Federation on Logistics (2010) narrated their history and was founded to be responsible for the national logistics development of the private sector in 2004 by a recommendation from the Thai Chamber of Commerce and the Thai National Shippers' in the national seminar of the Chamber of Commerce. The aims of its founding are to enhance efficiency and the concrete benefits of Thailand logistics. The federation was founded from a cooperative between organisations that perceives the importance of the logistics role for the nation's development. In addition, it is equipped with the intention to improve the quality of the logistics system concerning equality and competitiveness in the international market. The federation consists of 16 organisations, which are listed in Table 2.26.

Table 2.26: Organizations Comprising the Thai Federation on Logistics

1	Thai National Shippers' Council
2	The Thai Chamber of Commerce
3	The Federation of Thai Industries
4	The Thai Bankers' Association
5	Thai International Freight Forwarders Association
6	Bangkok Shipowners and Agents Association
7	Thai Airfreight Forwarders Association
8	Thai International Cargo and Container Terminals Association
9	Thai Shipowners' Association
10	Thai Authorized Customs Brokers Association
11	Thai Transportation & Logistics Association
12	Association of Thai Software Industry
13	Thai Logistics and Production Society
14	Foundation of Logistics and Transportation (Thailand)
15	Supply Chain Management Association of Thailand
16	Airline Cargo Business Association

Source: Thai Federation on Logistics (2010).

- The Warehouse, Silo, and Cold Storage Association

The Warehouse, Silo and Cold Storage Association is a non-governmental organisation. The association was founded in 2008 by five leading companies: Chainavee Coldstorage Co., Ltd., Nim See Seng Cold Storage Co., Ltd., Passapop 999 Co., Ltd., CTI Co., Ltd., and Tong Hua Buayai Co., Ltd. The association was approved as a registered association under the Trade Association Act (1966) with excellent support from the Department of Internal Trade. The main objectives of the association are promoting, supporting, and developing the warehouse, silo, and cold storage business. An election is conducted every two years by members to decide the management committee of the association (Thai Franchise Center, 2014). An interview with the Director of Promotion and Market Mechanism Development Unit, the Department of Internal Trade revealed that nowadays, members of the association comprise approximately 50% of registered enterprises in the warehouse, silo, and cold storage business. Most of the members are SMEs. The department plans to convince more enterprises to participate in the future, especially, large enterprises. The department is open to listening to voices from the association and other entrepreneurs in the business, especially in the process of deciding on the policy that affects them.

Networking leads to developments. It helps to strengthen bargaining power with superior power organisations concerning policy and finance, such as governments and clients. The benefits of networking provide more advantages to small size enterprises than large size ones. This relates to the study on the Participation in Development by Goulet (1989). Thus, the networking of enterprises cooperating with supervision support from policymakers will drive efficient development.

In conclusion, policies play a dominant role in providing support and enforcing regulations to the cold chain. Moreover, private sector networking strengthens it. Hence, regulation, support, and private sector networking are essential factors for cold chain development.

2.8. Conclusion

After collecting primary data by interviewing five enterprises, two government agencies, and one federation, and secondary data by conducting research on useful sources, the result appears that Thailand has potential in the temperature-controlled food value chain, which is the cold

chain. However, there are strengths to be enhanced, a weakness to erase, an opportunity to reach, and a threat to eliminate.

The strength is the advantage of the country's location, a growing economy, competitive human capital, infrastructure, and strong government support. This is implied by a rising GDP and FDI growth rate, the flow of skilled labour over the AEC, the construction of international infrastructure networks, and planning for development under the 20-year national strategy framework and Thailand 4.0 model. These strengths aim to promote Thailand to be a nation of stability, prosperity, and sustainability, and a developed country according to the Sufficiency-Economy philosophy, which is propelled by innovations. They encourage Thailand to be a gateway to massive food demand in the region, a destination of investment, and a kitchen of the world. The strengths also support the cold chain potential of the country. As evidenced by the LPI, Thailand is a logistics friendly country, and it has occupied the 2nd rank in ASEAN and 32nd among 160 countries. Also, the value of the total logistics cost was expected to continue to increase to B2,125 billion in 2017, which means a rise in demand for logistics. Moreover, 338 certificated temperature-controlled truck operators and 632 cold storage operators are serving demand domestically and internationally.

The rising demand for food products that induces demand for cold chain logistics is an interesting opportunity. From 2013–2018, the cold chain's import growth rate was 4.78%, and the export rate was increasing at 2.44%. In 2018, the import value of cold chain products was B331,261.48 million, while the export value was B509,779.07 million. The highest value of imports was for pharmaceutical products, while canned and processed food products, including fruits, vegetables, and seafood had the highest value of exports. Stakeholders of the chain have been getting benefits from this opportunity. The stakeholders that are the main players of cold storage and the main users of cold chain logistics are large-size entrepreneurs, while the main players of the temperature-controlled trucks are small enterprises, which make subcontracts with the large players. Thus, more investment in the cold chain provides many opportunities for players and users, especially the main players, which are the SMEs.

The high cost of logistics is evidently a weakness of the cold chain in Thailand. In 2017, the logistics cost to nominal GDP was 13.9%, which was higher than Asia's average (12.7%) and the international average (10.9%). However, Thailand's cost has been decreasing over the years.

This is because stakeholders are finding ways to reduce it by taking advantage of natural cold weather at night and dawn and locating near suppliers and consumers.

Examples of threats or obstacles to the cold chain in Thailand mentioned by stakeholders from the interviews were insufficient and inefficient of skilled human resources, infrastructure, institutional systems, customs, and investment. The expectations on supporting policy regarding those obstacles included R&D development for adding value to cold chain products, supporting small and medium-sized enterprises to participate in the trade fair, and making skilled human resources. Others included low interest for investment, plans for handling the unexpected situations, specific agencies to support the cold chain, more convenient customs processes, and resting spots for truck drivers. In addition, uncertified standard enterprises may cause low-quality products due to intense investigation and control. Most of the expectations are currently noted and emphasised by the government. The outstanding regulatory policies are the Q Cold Chain Standard Project and Warehouse, Silo and Cold Storage Policy, which is a voluntary regulation.

Examples of supporting policies that affect the cold chain are developing the professional cold chain course of the Thailand Professional Qualification Institute and infrastructure development of Eastern Economic Corridor. In addition, incentive investments of the Office of the Board of Investment, the National Single Window (NSW), the Office of SME Promotion, and Logistics Development Plan would be favourable, as well as private sector networking to engage the benefits of activities in the business. However, some policies are unrecognised or inaccessible by the stakeholders. Meanwhile, some supporting policies are in the plans for further adoption. Also, the private sector networking of enterprises cooperating with supervision support by the policymakers and proper regulation will drive efficient development. Outstanding private sector networks are the Thai Federation on Logistics and the Warehouse, Silo and Cold Storage Association.

Regarding the study, there are issues and suggestions that may encourage the cold chain's utilisation and development. They may be useful to policymakers for considering supporting the stakeholders and consumers:

- Educate consumers to realise the nutritional value of varieties of food and how the cold chain works for them, especially the utilisation of traceability.
- Encourage consumers to classify products among certified standards products and normal products to prevent confusion between certified and uncertified standards products. For example, nowadays many consumers are confused about organics vegetables and hydroponic vegetables.
- Establish a specific organisation to support stakeholders in the cold chain. Due to the current situation, numerous agencies are taking part in it. Thus, the specific organisation will be a one-stop service, which would reduce the cost of time and processes of the cold chain operation. Moreover, it will stimulate the fast growth of development.
- Save costs through resource management and through sharing. Separating resources in temperature-controlled trucks and cold storage into various temperature zones to handle more than one type of product at a time could save operation costs. For example, in one trip, a truck could carry many kinds of products that need a different temperature to control. In addition, sharing the resources with other companies will make a value backhaul and prevent from a trailer from being empty, known as “deadhead”.

The cold chain utilization and development provide benefits to the cold chain stakeholders as financial compensation, primarily to SMEs, especially agriculturists. They are in the upstream part of the chain and usually struggle with financial problems and seasonal fluctuations. The cold chain value-adds their products so they can get higher returns, which helps to reduce poverty. Consumers also get the benefits of cold chain utilisation and development in terms of better life quality regarding food accessibility, availability, utilisation, and stability for food security. This is consistent with the objectives of Thailand’s national strategy development, the ASEAN Integrated Food Security Framework and Strategic Plan of Action – Food Security (SPA–FS) and Vision and Strategic Plan for ASEAN Cooperation in Food, Agriculture and Fisheries 2016 – 2025 (VSP–FAF).

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Appendix

Table A.1. Size of Enterprises

Enterprise	Number of employees (person)			Fixed asset (million baht)		
	Small	Medium	Large	Small	Medium	Large
Production	≤50	>50 – 200	>200	≤50	>50 – 200	>200
Wholesale	≤25	>25 – 50	>50	≤50	>50 – 100	>100
Retail	≤15	>15 – 30	>30	≤30	>30 – 60	>60
Service	≤50	>50 – 200	>200	≤50	>50 – 200	>200

Source: Small and Medium Enterprises Promotion Act. B.E.2543 (2000) cited by the Department of Business Development (n.d.b).

Table A.2. List of interviewees

No.	Enterprise	Type	Address	Interviewee Name & Position
1	Thai Union Group PCL.	Producer	72/1 Moo 7, Sethakit 1 Rd., Tambon Tarsrai, Amphur, Muangsamutsakorn, Samutsakorn 74000	- Suwan Pusrichan: Assistant General Manager - Chaiyaporn Saksupanara: Assistant Plant Manager
2	Rujoran Transport Co., Ltd.	Logistic Provider	81/1 Moo 9, Bang Kaew, Muang Samut Songkhram, 75000	- Pirach Siripermpool: Chief Executive Officer
3	Eagles Air & Sea Co., Ltd.	Logistic Provider	12 Soi ICD 5, Chaokunthaharn Road, Khlong Sam Prawet, Ladkrabang, Bangkok 10520	- Wallapa Stirachavarn: Chairperson
4	CTI Logistics Co., Ltd.	Logistic Provider	CTI Tower 31st floor, 191/2-5 Ratchadapisek Rd., Khlong Toei, Bangkok 10110	- Pasu Unhanandana: Chief Operation Officer
5	Harmony Life International Co.,Ltd.	Trader	16/3-4, Soi On-Nut 74/1 On-Nut Rd, Kwan Pravej, Khet Pravej, Bangkok 10250	- Export and Delivery Manager
6	Port Authority of Thailand	Government Agency	444 Tarua Road, Klongtoey, Bangkok 10110	- Pol.Sub.Lt.Montree Lergchumniel: Managing Director, Laem Chabang Port and Acting Director General Port Authority of Thailand - Mr. Komol Sribangplinoy: Director Bangkok Port

				- A representative of Chiang Saen Port
7	Department of Internal Trade	Government Agency	563 Nonthaburi Rd. Bang Krasor, Muaeng Nonthaburi 11000	- Somchai Rattanasupa Director of Promotion and Market Mechanism Development Unit, Ministry of Internal Trade
8	Thai Federation on Logistics	Federation	99/126 Moo 16, Bang Kaeo, Bang Phi, Samut Prakan, 10540.	- Wallapa Stirachavarn: President

Source: Authors.