

## Logistic Analysis of Fishery Cold Supply Chain

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**ABSTRACT:** As a country where two-thirds of its territory consists of oceans, the fisheries sector is one of the government's main programs. Fisheries, which is also an agricultural subsector, has great potential in developing the country's economy, which is shown by the increasing number of fisheries production from year to year. The increase in the production of fishery products, both raw and processed materials, must be balanced with an effective and efficient distribution system method to ensure the quality of the fish remains in good condition. Good distribution management of fish products by controlling product temperatures that remain low throughout the distribution process is known as cold supply chain management. This requires cold supply chain management to be handled well because it has a controlling effect on fisheries logistics costs. Some of the facts above are the background for this research through analysis of the logistics cost structure, including the obstacles faced by the cold chain supply chain for caught fish and the cold chain business prospects and obstacles faced by this industry. Analysis of the distribution process also involves a review of the refrigerated transport fleet. The methodology used in this study is a mix method which begins with the development and distribution of questionnaires related to logistics operations and fishing costs. Next, data collection was carried out through interviews with fishermen, collectors and traders on the north and south coasts of Java Island.

**KEYWORDS:** Fishery, Cold Supply Chain Management, Logistic Cost, Distribution, Transportation

### BACKGROUND

Fisheries is an economic activity which is focused on harvesting fish and other aquatic life. The purpose of trapping fish activity is for gaining profit and taking the earnings as income. Fisheries are very potential sub-sector of agriculture, It is showed by the increasing number of fisheries production from year to year. The Indonesian Central Bureau of Statistics' data showed that capture fish production in 2013 increased about 15.68% starting from 2009 to 2013 <sup>(2)</sup>.

The fisheries sector is now one of the special concerns of the Indonesian government to optimise the return of its wealth so that it has added value and contributes to state revenues and especially people's welfare. Judging from its development in general, the fishing industry in Indonesia is quite promising <sup>(3)</sup>. Based on the information from the Central Bureau of Statistics (BPS), in 2018, GDP of the fisheries sector contributed 2.6% of the total GDP.

This can be seen from the development of its production, which, on average, increased to 5.4% per year. While in 2014, the fisheries production only reached 19.2 million tons, in 2015, it increased to 20.4 million tons, up 6.4%. The same conditions also occurred in 2017 and 2018, where the production increased by 23.8 million tons and 25.0 million tons, respectively as per the following Table 1.

**Table 1. Production of fishery products of Indonesia based on its source, 2014-2018**

Type	Volume (tons)					Annual Average (%)
	2014	2015	2016	2017	2018*	
Capture Fisheries	6,436,00	6,678,00	6,580,00	6,600,00	6,930,00	-
Growth, %	0	0	0	0	0	1.52
Marine Fisheries	6,038,00	6,205,00	6,115,00	6,133,58	6,440,26	-
Inland Fisheries	398,000	473,000	465,000	466,413	489,734	-
Aquaculture	12,795,00	13,792,00	15,456,00	17,220,00	18,081,00	-
Growth, %	00	00	00	00	00	7.25

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Type	Volume (tons)					Annual Average (%)
	2014	2015	2016	2017	2018*	
Marine Culture	8,379,000	9,035,000	9,773,000	10,888,397	11,432,817	–
Pond, Brackish Water	2,345,000	2,428,000	3,012,000	3,355,761	3,523,549	–
Pond, Fresh Water	1,774,000	1,964,000	2,289,000	2,550,245	2,677,757	–
Cage Cultivation	200,000	221,000	204,000	227,283	238,647	–
Paddy Field	97,000	144,000	178,000	198,315	208,231	–
<b>TOTAL</b>	<b>19,231,000</b>	<b>20,470,000</b>	<b>22,036,000</b>	<b>23,820,000</b>	<b>25,011,000</b>	–
<b>Growth, %</b>	–	<b>6.44</b>	<b>7.65</b>	<b>8.10</b>	<b>5.00</b>	5.44

\* Preliminary value

Source: Ministry of Maritime Affairs and Fisheries (2018).

The cold supply chain is a part of the supply chain which is a group of connected activities of material or goods perishable-commodities that need to be stored in temperature-controlled containers across from supplier to the consumer. If cold supply chain management is handled properly, it will give the controlling effect on the logistic cost of fisheries. According to Tanuputri<sup>(5)</sup>, in an integrated system, the changing cost of a subsystem influences the others subsystem. If the increasing cost happens in one or some of the logistic activities, it will influence the tier of the distribution process.

Reflecting above, the number of increasing production should be completed with the right method of the distribution system to keep the fish quality in a good condition. The distribution of fish needs proper management because temperature determines the quality of the fish. This phenomenon related to the cold supply chain management. According to Waters<sup>(4)</sup>, every activity in cold supply chain management aims to keep the product temperature in low temperature during the distribution process.

This paper will analyze the distribution system, including land transport from supplier to the consumer in temperature-controlled containers.

### Problem Definition

This study to analyze of the logistic cost structure in the cold supply chain of capture fish and the prospects for cold chain business and the obstacles faced by this industry. Related to distribution process will be review on the refrigerated transportation fleets.

As an archipelago country, The territorial of Indonesian waters are contributing in supplying the needs of the world fishery products as reached 30% for 2014. With limitation on the Journal access and availability on the fisheries cold supply chain study, The scope location references will be limited to distribution in Java Island of Indonesia.

- a. The distribution process. the analysis of the logistic cost structure in the cold supply chain of capture fish for knowing the proportion of the logistic cost and finding the activities that can be controlled to minimize the logistics cost in the cold supply chain of capture fish.
- b. Accordingly, it is necessary to integrate an operational system including to review Third Party Logistic Selection and technology selection to improve key performance of the supply chain.

### Framework

To analyze the logistic cost, according to mutia study<sup>(6)</sup>, quistionnaire was developed related to logistics operations and cost of capture fish. Then it followed by collection of data by interviewing fishermen, collectors, and the traders in the north and south coast of Java Island on May to June 2015 (according to the Table 2), a convenient and snowball sampling method was used. After all data collection finished, the next step was analyzing the cold supply chain of capture fish and presented in drawing. The logistics cost per kilogram per fisherman, collector, and trader were then computed according to the Table 3 followed by analyzing the logistics cost according to the proportion of each component of logistics cost<sup>(6)</sup>.

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**Table 2.** The coverage area of the object research

Area of fisheries	Province	District	Name of fishing port
North coast of Java Island	West Java	Indramayu	PPN Karangsong
	Center of Java	Pekalongan	PPN Pekalongan
		Tegal	PPP Tegalsari
East Java	Lamongan	PPN Brondong	
South coast of Java Island	West Java	Sukabumi	PPN Palabuhan Ratu
	Center of Java	Cilacap	PPS Cilacap
	DI Yogyakarta	Gunung Kidul	PPP Sadeng
	East Java	Trenggalek	PPN Prigi

**Table 3.** Activities in each component of logistic cost

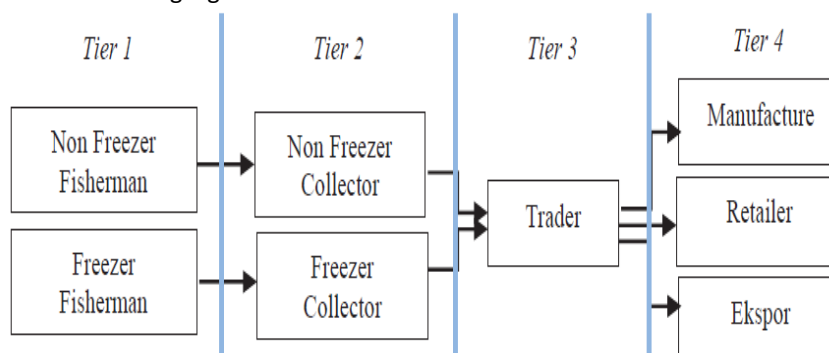
Logistics cost	Details
Procurement	Transportation cost of procurement the catch, purchasing supplies such as ice, fuel, oil, freon, salt, foods, and equipment. Also communication cost between collectors and fishermen, traders and fishermen, traders and collectors.
Material handling	Production cost, handling cost, depreciation cost of materials and handling equipment, loss of production, and labor salaries.
Transportation	Driver salaries, fuel cost, depreciation of the vehicle, and losses during delivery.
Maintenance	Depreciation and maintenance of the fishing vessel or vehicles, depreciation and maintenance of equipment like fishing gear and cold storage.
Inventory	The opportunity cost of inventory of supplies and losses during inventory.
Communication	Communication cost between fishermen and collectors, fishermen and traders, collectors and traders.

### The distribution process, the analysis of the logistic cost structure

#### Identification Cold Supply Chain of Capture Fish.

Fish is a perishable product, it needs specific management in the distribution process. The controlling starts by keeping the temperature low, about 1-4°C, so the fish quality will remain fresh till they come to the consumers.

The increasing number of production and consumption cause government and fish seller try to develop cold supply chain distribution network. Based on the observation, fish cold chain contains some activities with different characteristic for each of them<sup>(6)</sup>. It can be seen from the following Figure 1.



**Figure 1.** Cold Supply Chain of Capture Fish

- 1) Tier 1 (Fisherman). The fisherman does not have their own ships for sailing, they use other people's ship or collectors. The fishermen will not rent the ship, but they will use it based on a certain agreement. Fisherman activity starts from procurement activities, they are material procurement (eg: solar, gasoline, oil, ice/freon, foods, etc) for catching fish in the sea. Catchment fish activity is done by labor in the fishing ground during a week to 2 or 3 months using fishing gear and vessel with specific kind and capacity, depends on the grosstonase (GT). The inventory of fish is done in 2 kinds of fishing vessel, they are ice/non-freezer and using the freezer. Inventory using ice usually in ship < 30 GT, but the inventory using freezer is for a ship with > 30 GT. Therefore, fishermen consist of nonfreezer fisherman and freezer fisherman.

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- 2) Tier 2 (Collector). The collectors are categorized into two, the first is nonfreezer collector and the second is freezer collector. The difference between these collectors is the result quantity of fish catches. The collectors are people who receive all fish result from fisherman using their ship to be placed in TPI (fish auction center). Then, the income of fish collecting will be shared based on the appointment which is made before. The activity done by the collector is an activity after getting the trap or unloading and loading which is usually done by the porter with Rp 10,000/taking (100 kg). Besides, the collector also does an inspection activity included retribution payment in TPI, about 1-3% of the production number of fish. The auction activity does not spend much time, so the collector does not do material handling such as adding ice to fish.
- 3) Tier 3 (Trader). A seller is a person who does an auction of fish with the collector in TPI by selling a big number then sell them to the manufacturer, retailer, or exported. Activity which has been done by the trader consist of procurement (transportation to TPI and communication with the collector), inspection, inventory, shipping, and communication with next tier. Same as the collector, a trader also does the inspection activity included retribution payment in TPI about 1-3% from the production number of fish. After the auction, fish usually is sent to the next tier by adding ice with the specific amount in a fish box or by using a frozen container. However, the fish is not sent directly sometimes, and kept in the cold storage to make the fish fresh in a long period and it depends on the consumer order agreement.
- 4) Tier 4 (Consumer). The supply chain of the fishing port in the north and south coast of Java Island stops when the end consumer, that are manufacturer and retailer or end receiver accept the fish before it is processed, further consume directly or sell in a small number. The customer will buy fish from tier trader based on their needs.

## Logistic Cost Analysis

Logistic activities consist of six activities (sub-system), there are procurement activity, material handling activity, maintenance activity, inventory activity, transportation activity, and information activity <sup>(5)</sup>. Logistic cost measurement is one of the proper indicators to evaluate and control the logistic activity. The right way to control logistic cost is to identify the connection between cost and activity. This cost measurement mode is called as Activity-Based Costing (ABC) <sup>(7)</sup>. That sixth logistic cost will be counted mean on each tier by Rp/kg unit. Therefore the proportion of each activity will be known the total logistic cost. Logistic cost measurement focuses on tuna fish (*Euthynnus affinis*) which is a dominant fish in every fishing port, so it becomes a research object.

As per reference from Mutia proceeding <sup>(6)</sup>, In Table 4(a) and (b) show that cold supply chain logistic cost of capture fish by using non-freezer and freezer were dominated by material handling cost, they reach 46.70% (Rp/Kg 1,634.59) and 43.60% (Rp/Kg 1,798.52) from total logistic cost. The second highest percentage of logistic cost is on the procurement which is about 25.85% (Rp/Kg 904.66) and 36.89% (Rp/Kg 1,521.63). The third is transportation with percentage 15.19% (Rp/Kg 531.76) for non-freezer and 12.89% (Rp/Kg 531.76) for the freezer, based on total logistic cost.

**Table 4. Logistic cost of capture fish activities by using non-freezer vessel (a) and freezer vessel (b)**

Logistics activities	Cost Components	Mean	LB	UB	Logistic Cost Proportion non freeze (%)
Procurement	Fuel and drive salary	904.66	0.00	2,596.26	25.85
	communication*	0.00	0.00	0.00	0.00
<b>Total (Rp/kg)</b>		<b>904.66</b>			<b>25.85</b>
Material Handling	Fishing	1,184.10	0.00	0.00	33.83
	Post fishing	275.44	0.00	0.00	7.87
	Inspection	162.07	0.00	247.22	4.63
	Depretiation of equipment	9.74	0.00	22.93	0.28
	Loss of handling	3.23	1.06	7.57	0.09
<b>Total (Rp/kg)</b>		<b>1,634.59</b>			<b>46.70</b>
Maintenance	Maintenance of equipment	114.95	0.00	323.00	3.28
	Maintenance of vehicles	310.00	0.00	862.89	8.86
<b>Total (Rp/kg)</b>		<b>424.95</b>			<b>12.14</b>
Inventory	Opportunity cost of	<b>1.31</b>			<b>0.04</b>
Transportation	Fuel and drive salary	245.43	0.00	736.30	7.01
	Depretiation of vehicles	192.80	0.00	578.41	5.51
	Loss during delivery	93.52	0.00	280.56	2.67
	<b>Total (Rp/kg)</b>		<b>531.76</b>		
Information	communication**	<b>2.92</b>			<b>0.08</b>
<b>Total (Rp/kg)</b>		<b>3,500.18</b>			<b>100.00</b>

(a)

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Logistics activities	Cost Components	Mean	LB	UB	Logistic Cost Proportion non freeze (%)
Procurement	Fuel and drive salary	1,521.63	0.00	4,447.18	36.89
	communication*	0.00	0.00	0.00	0.00
	<b>Total (Rp/kg)</b>	<b>1,521.63</b>			<b>36.89</b>
Material Handling	Fishing	1,343.90	0.00	0.00	32.58
	Post fishing	230.83	0.00	0.00	5.60
	Inspection	182.69	0.00	300.83	4.43
	Depretiation of equipment	37.15	0.00	88.51	0.90
	Loss of handling	3.96	2.16	7.57	0.10
	<b>Total (Rp/kg)</b>	<b>1,798.52</b>			<b>43.60</b>
Maintenance	Maintenance of equipment	87.93	0.00	241.93	2.13
	Maintenance of vehicles	181.96	0.00	478.77	4.41
	<b>Total (Rp/kg)</b>	<b>269.89</b>			<b>6.54</b>
Inventory	Opportunity cost of	<b>1.05</b>			<b>0.03</b>
Transportation	Fuel and drive salary	245.43	0.00	736.30	5.95
	Depretiation of vehicles	192.80	0.00	578.41	4.67
	Loss during delivery	93.52	0.00	280.56	2.27
	<b>Total (Rp/kg)</b>	<b>531.76</b>			<b>12.89</b>
Information	communication**	<b>1.74</b>			<b>0.04</b>
	<b>Total (Rp/kg)</b>	<b>4,124.59</b>			<b>100.00</b>

(b)

\*communication cost from collectors to fishermen, and traders to collectors.

\*\*communication cost from fishermen to collectors, collectors to traders, and traders to the consumer.

As per above table we can see that transportation cost fall as the 3<sup>rd</sup> major logistic cost in the cold supply chain strategy. To note that, from Tier 3 (trader) to Tier 4 (consumer), the fish may not sent directly sometimes, and kept in the cold storage to make the fish fresh in a long period and it depends on the consumer order agreement.

Which become another challange, the abundant potential of fish catches is often constrained by the limited supporting means, of them is cold storage. The presence of cold storage at each distribution point is needed to extend the freshness of the fish for the buyer.

### Operation Land Transport Analysis

#### Land Transport Mode

The mode of transportation plays an important role in the delivery of fish cargo from its origin to the destination. The mode that will be used are 6 types, these six types have their own dimensions and advantages and disadvantages.

##### a) *Truk Thermoking*

This type of truck is a box truck that has a cooling system in it. This truck has different types of sizes. What is used is the same size as the 20ft container reefer. for the dimensions of this truck will be described in the following Table 5.

**Table 5. Thermoking Truck Dimensions**

Dimensi Truck Thermo King			
Dimensi	Panjang	5.758	m
	Lebar	2.352	m
	Tinggi	2.385	m
Massa Jenis Ikan Beku	300	kg/m3	
Total Muatan Ikan	8.24	Ton	



**Figure 2. Thermoking Truck**

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### b) Common Truck

This truck is often found in everyday life. The truck has an open tub behind it and can hold a coolbox and plastic drums for up to two stacks. This truck is better known as the fuso ankle truck which usually has double tires behind (6 tires in total). The dimensions of this truck will be explained in the following Table 6.

**Table 6. Common Truck Dimensions**

Dimensi Truck Engkel Fuso			
Dimensi	Panjang	5.994	m
	Lebar	2.444	m
	Tinggi	1.796	m
Kapasitas Truck	72	Box	
Total Muatan Ikan	3.06	Ton	
Kapasitas Truck	88	Drum	
Total Muatan Ikan	3.74	Ton	



**Figure 3. Common Truck**

### c) Reefer Container Truck

This truck is commonly found in the port area. This type of box is separate from the truck, so it can be moved easily. The size of this reefer container generally consists of two types, namely 40 ft and 20 ft. For the example used is a reefer container measuring 20 ft, this size is likened to a thermoking truck. For the dimensions of the reefer container will be explained in the following Table 7.

**Table 7. Common Truck Dimensions**

Dimensi Reefer Container			
Dimensi	Panjang	5.758	m
	Lebar	2.352	m
	Tinggi	2.385	m
Massa Jenis Ikan Beku	300	kg/m <sup>3</sup>	
Total Muatan Ikan	8.24	Ton	



**Figure 4. Reefer Container Truck**

### Price of new refrigerated fleet/trucks

Based on the survey at a dealership of Mitsubishi conducted by CIC <sup>(3)</sup>, the price of new refrigerated truck varies greatly depending on the carrying capacity of each truck and the type of cooler used, such as for four-wheeled trucks with FE 71 110 type with Thermoking SV 400, it is sold atRp400 million per unit. While trucks of the same type with different cooling brands (Starkool SK



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350) is sold for Rp370 million per unit. Trucks with type FE 74 HDF 125 PS 6 BAN with SV 600 ThermoKing cooling machines are sold at Rp510 million. The Hwasung HT-250 cooling machine is sold at a price below of Rp495 million. The same type of car with Denso FS-32 cooler is sold for Rp485 million per unit. The following Table 8 is an overview of the prices of new refrigerated trucks of several types.

### *Government policy on storage and transportation that uses temperature control or cooling system*

The key government policy regarding storage and transportation that uses temperature control or cooling system is Presidential Regulation No. 71 of 2015 stating determination and storage of basic commodity and important goods. This policy indirectly supports the role of warehousing to ensure the smooth management of basic commodity and important goods.

Types of basic commodities and/or important goods as intended include livestock and fisheries products: beef, broiler, chicken eggs and fresh fish (milkfish, bloated and cod/tuna/skipjack).

**Table 8. Price of new refrigerated truck, 2018**

Truck Brand	Type	Cooler	Price (Rp'000)
MITSUBISHI	FE 71 110 PS 4 BAN	THERMOKING SV 400	400,000
	PS 110 PS 4 BAN	THERMOKING SV 400	405,000
	FE 71 L 110 PS 4 BAN	THERMOKING SV 400	425,000
	FE 71 110 PS 4 BAN	STARKOOL SK-350	370,000
	PS 110 PS 4 BAN	STARKOOL SK-350	375,000
	FE 71 L 110 PS 4 BAN	STARKOOL SK-350	395,000
	FE 73 110 PS 6 BAN	THERMOKING SV 600	480,000
	FE 73 HD 110 PS 6 BAN	THERMOKING SV 600	490,000
	FE 73 110 PS 6 BAN	STARKOOL SK-550	460,000
	FE 73 HD 110 PS 6 BAN	STARKOOL SK-550	470,000
	FE 74-S 125 PS 6 BAN	THERMOKING SV 600	505,000
	FE 74-S 125 PS 6 BAN	STARKOOL SK-550	480,000
	FE 74 HDF 125 PS 6 BAN	THERMOKING SV 600	510,000
	FE 74 HDF 125 PS 6 BAN	HWASUNG HT - 250	495,000
	FE 74 HDF 125 PS 6 BAN	DENSO FS - 32	485,000
	FE 74 HDF 125 PS 6 BAN	THERMO FROZEN RG	475,000
	FE 74 HDF 125 PS 6 BAN	STARKOOL SK-350	470,000
	FE 74 S LONG 125 PS 6 BAN	THERMOKING SV 600	525,000
	FE 74 S LONG 125 PS 6 BAN	HWASUNG HT - 500	505,000
	FE 74 S LONG 125 PS 6 BAN	DENSO FS - 42	495,000
	FE 74 S LONG 125 PS 6 BAN	THERMO FROZEN RG	485,000
	FE 74 S LONG 125 PS 6 BAN	STARKOOL SK-550	480,000
	FE 84 HDL 136 PS 6 BAN	THERMOKING SV 600	550,000
	FE 84 HDL 136 PS 6 BAN	HWASUNG HT - 500	530,000
	FE 84 HDL 136 PS 6 BAN	DENSO FS - 42	525,000
	FE 84 HDL 136 PS 6 BAN	THERMO FROZEN RG	515,000
	FE 84 HDL 136 PS 6 BAN	STARKOOL SK-550	510,000
	COLT L 300	BOX FREEZER	255,000
	COLT L 300	THERMO FROZEN	260,000
	COLT L 300	THERMOKING	285,000

Source: Survey by author.

The regulation also states how to manage stocks and logistics by optimising inter-island trade, monitoring stock availability in the warehouse and port, providing and optimising distribution facilities, coordinating with relevant ministries and heads of non-ministerial agencies in the provision of transportation modes and coordinating with ministers and heads of non-ministerial government institutions related to the provision of stocks and reserves of certain basic commodities controlled by the government.

### *Major players of cold chain transportation rental company in Indonesia*

There are eight main players in cold chain transportation rentals in Jabodetabek. PT Armada Container Indonesia (PT ACI) was established in 2007 and is located in Cakung, East Jakarta. The reefer containers of PT ACI consist of various types from 10 feet, 20 feet to 40 feet.

Another company that quite exists in cold chain transportation is PT Hwasung Thermo Indonesia (PT HTI). In Indonesia, the presence of PT HTI is represented by PT Hwasung Thermoindo, which is the sole distributor of Hwa Sung cooling machines for the Indonesian market, which has been operating since 2014. The type of cooling unit owned by PT Hwasung Terminindo according to information is four-wheeled, six-wheeled, and 10-wheeled Mercedes-Benz and Fuso trucks. In addition, there are also car-type refrigerated transportation, namely, Suzuki Carry, Daihatsu Granmax and L300.

PT Wira Logitama Saksama or Wira Logistic is also a company that rents refrigerated transportation throughout Indonesia. This company which was founded in 1996 and has many branches in Indonesia also has several kinds of warehouses with dry, cold storage, frozen and chiller rooms.

PT ASSA Transport is a company that also serves refrigerated transportation rentals. The company, which was founded in 1985, serves the shipping of various kinds of products such as fish, chicken, meat and processed products such as fillets, nuggets, meatballs and sausages that serve almost all islands in Indonesia.

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Table 9. Refrigerated Transportation Rental Company in Jabodetabek, 2018

No.	Name of Company	Established	Location
1	Armada Container Indonesia, PT	2007	Jakarta
2	ASSA Transport, PT	1985	Tangerang
3	Hwasung Thermo Indonesia, PT	2014	East Java
4	Manggala Kiat Ananda, PT	1996	Tangerang
5	MgmBosco Logistic, PT	1995	Bekasi
6	Raficon Sarijaya, PT	2005	Jakarta
7	Selaras Mandiri Raya Trans, PT	2010	Tangerang
8	Wira Logitama Saksama, PT	1996	Bekasi

### *Number of fleet/trucks of rental company to load low-temperature goods*

In its operation, most companies that rent refrigerated fleets use trucks of varying sizes. The number of truck fleets owned depends on the extent of distribution reach and the number of customers owned by the company.

PT MGM Logistics is a company that has experience in the refrigeration transport business. Currently, it has a large enough fleet of trucks reaching 720 trucks spread across several branches such as Surabaya, Banjarmasin and Makassar. Based on the information obtained, the distribution of PT MGM Logistic cooling products reached almost 100 cities in Indonesia with 200 customers.

Likewise, with PT WiraLogitamaSaksama or Wira Logistic, it has around 300 vehicle fleets serving the market in Java region.

### **Third Party Logistic Selection Analysis**

#### *Business model by cold chain players in Indonesia*

As stated previously, there are two models of cold chain business player, namely those that are used alone (integrated), and those that are fully leased. The main function that is used alone is to store its own products, either temporarily or for long periods of time as stock.

Companies with business models like this are usually integrated with the company's main activities and become supporting its operational activities. So that the activities of storing and shipping goods or distribution are carried out by the company itself in accordance with the business activities of the company. Examples of integrated business models are the ice cream industry, importers of meat, fruit, vegetables and food and exporters of fish or seafood.

But sometimes it is also leased to other parties, but the space offered is limited. An example of an integrated company is PT Dharma Samudera Fishing Industries which engaged in the fisheries sector and PT Unilever Indonesia Tbk. which produces the Wall's ice cream brand.

Whereas for the leased one, there are two types of companies, namely logistics & forwarders, transportation companies, and companies that specifically engaged in the rental of cold storage, among others are PT Wahana Cold Storage and PT Pluit Cold Storage. <sup>(3)</sup>

#### *Cold third-party logistics (CTPLs) approach*

In the developing nations, the amount of food losses in fruits and vegetables supply chain is very high; on the other hand, logistics and transportation cost is also very high. In the agricultural sector, as example in asia, India's production outcome has a significant impact on global food security. In contrast, a survey was done by the World Economy forum in 2011 among the 142 countries in the world for positioning infrastructure reliability and adequacy. The result of the study showed that India position 89 ranks of 142 countries ([www.weforum.org](http://www.weforum.org)). The overall production and distribution system depends on the nation's infrastructure to transport and stock billions of tons of food every year.

The factors identified for a CTPLs selection procedure <sup>(8)</sup> are Knowledge and Information technology management; Budget and Government approvals; Safety, security, comfort, convenience, and aesthetics view; Maintenance Management; Refrigerator and loading capacity. The details are given in Table 10. Findings between other developing economies can be compared to draw necessary inferences. Also, this study is focused on the CSCM (cold supply chain management) of vegetable and fruits; it can be expended for the meat supply chain, fish supply chain, and Halal supply chain.



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S. no.	Criteria	Brief description	Sub-criteria	Author
1	Knowledge and Information technology management(KITM)	Knowledge management is a function of information generation and dissemination, sharing information, and filtering to store valuable knowledge. Quality of knowledge and information management plays a crucial role in global competition. Technological developments in RFID and communication have made knowledge management more reliable.	KITM1- Inbuilt Radio frequency identification device (RFID) system KITM2- Security system KITM3- a Communication facility KITM4- Parking and sensor facility KITM5- Customization competencies KITM6- Reliable technology for roads conditions	Gunasekaran et al. (2002), Irani et al. [70], Heydari et al. [62]
2	Budget and Government approvals (BGA)	Increase in budgetary requirements due to increase in fuel prices and the cost of consumable parts is a standard parameter in CSCM. In India, the Ministry of Food Processing Industries (MoFPI) is taking all essential steps to increase investments in the food industry by easing government approval process. However, finance availability and minimising total cost are the primary concern.	BGA1- Low fuel consumption BGA2- Easily and readily available the spare parts with minimum cost BGA3- Best price in the second-hand market/resale market BGA4- Low-cost consumable parts BGA5- Easily finance availability BGA6- Government clearance and approvals	Singh et al. [134], Agrawal et al. [2], Singh and Sharma [133], Baykasog'lu et al. [13], Kumar and Singh [82], Fu and Yin [47], Choy et al. [32] Zhu et al. (2017), Jabbour and Jabbour (2016)
3	Safety, security, comfort, convenience, and aesthetics view (SSCA)	Safe steps must be followed while handling the food as one cannot smell, see or taste dangerous bacteria. Safety norms need to be followed rigorously at all stages of the supply chain. Driver comfort can be ensured through proper AC facility, proper cabin space, and aesthetics.	SSCA1- Comfortable cabin space SSCA2- Smooth and comfort driving SSCA3- Air-conditioned facility inside the cabin SSCA4- Interior and aesthetics view SSCA5- Perishable food and safety norms SSCA6- Safety and Security features for accidents	Singh et al. [132], Agrawal et al. [2], Thakker et al. [143], Ho et al. [63], Elhedhli et al. [37]
4	Maintenance Management(MAM)	Maintenance management brings focus on various facets of the supply chain, capacity facilities, and service station. Maintenance cost should be minimised by increasing service locations, on-time delivery, and other necessary measures.	MAM1- Large numbers of the service station and capacity facilities MAM2- Low maintenance cost MAM3- Free service for a maximum period or extended period facility MAM4- Maximum guarantee and warranty period MAM5- After sales and service support MAM6- On-time delivery after sales and service	Singh et al. [132], Singh and Sharma [133], Miller et al. [98], Kumar and Singh [82]
5	Refrigerator and loading capacity (RELC)	In CSCM, various products require different temperature, which makes temperature control more crucial. Trucks must have flexible adjustments for different loading requirements as per ISO requirements. Advanced digital data logger to measure temperature and loading has become popular these days.	RELC1- Efficient precooling and temperature variability-controlling equipment facility RELC2- Electronic Data Logging Monitor RELC3- Easy Installation and modification facility in the truck RELC4- Quality and ISO certificates (such as 9000; 16000; 14000; etc.) RELC5- Standard operating policy and procedures as per Govt. policy RELC6- Temperature and loading display facility	Singh et al. [132], Agrawal et al. [2], Baykasog'lu et al. [13], Thakker et al. [143], Ho et al. [63], Singh and Sharma [133], Gunasekaran and Negi [57],

### Cold 3PL Key Performance Indicator

Third-Party Logistics Providers (3PL) face a great pressure in order to meet its clients' needs: customers demand a high level of time and place value for their deliveries, at lower prices, making the last mile activity not only a challenge whilst meeting the client's requirements but likewise in managing the profitability and the financial balance of the operation <sup>(9)</sup>.

- Capacity.** Total loading capacity of the fleet of vehicles (in terms of volume or weight)
- Claims due to quality fails.** Percentage of customer claims that resulted from damaged or lost items of fish product. Keep the product at a temperature as per requirement so as to prevent the quality of the product from the potential of thaw and damage.
- Order to delivery cycle time.** The average elapsed time from the moment the order is ready to the reception by the customer (includes loading/unloading). Pay attention to the loading and unloading time of goods performed by your 3PL so that the condition of the fish product remains in a frozen condition.
- Product changeover time.** Change in the fish product weight range or type the economic activity the product belongs to during a certain period of time.
- On-time delivery performance.** Percentage of orders received on time (date and hour) defined by the customer. As such, making sure that packages are shipped and delivered on time is critical. A slow order fulfillment process can cost your business a lot of potential revenue in the long run.
- Shipping Accuracy.** Fast shipping is wonderful, but if packages routinely go to the wrong place, then it doesn't matter. Under most circumstances, shipping accuracy is not a KPI that highlights wonderful 3PL performance. Rather, it is a KPI to be monitored because if it slips below 99%, you have a big problem on your hands because a lot of packages are being shipped to the wrong address
- Order Accuracy.** Similar to shipping accuracy, packages do not just need to go to the correct address. They need to contain the correct items. Making sure the right items go to the right people is critical, and if this slips below 99.8%, then you need to find a company with better order accuracy.
- Inventory Accuracy.** Both the receiving process and the order fulfillment process can be error-prone. When this gets out of hand, inventory levels may not be accurate anymore. If inventory levels are too inaccurate for day-to-day use, that indicates that the 3PL is not making the best use of its warehouse management system. Without accurate inventory levels, it's tough to forecast revenue or estimate demand, so making sure your 3PL keeps inventory levels accurate is important.

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9. **Supplier performance index.** It measures the supplier's performance in a specific period of time, as a percentage.
10. **Loss and Damage frequency.** Number of loss and damaged during transportation, in relation to the total number of fishery products transported.

### Main users of cold chain service

#### *Food processing company*

As mentioned before, the cold chain is also very much needed in various industries, including food processing industries. The processed food industry is very dependent on the cold chain system.

PT So Good Food Manufacturing, initially named PT Japfa Osi Food Industries, was established in Jakarta on May 25, 1994. The distribution of all products produced by the company is directly handled by the parent company, PT So Good Food, previously named PT Supra Sumber Cipta.

PT Charoen Pokphand Indonesia Tbk., initially named PT Charoen Pokphand Indonesia Animal Feed, was founded in 1967. On December 6, 1990, the company was renamed to PT Charoen Pokphan Indonesia Tbk. In 1995, PT Charoen Pokphan Indonesia established a company named PT Charoen Pokphan Indonesian Chicken Processing Plant (PT CPIT–CPP) as a slaughterhouse and chicken meat processing industry. The distribution of all products produced by the company is directly handled by the parent company

#### *Trading Company*

PT Sumber Alfaria Trijaya Tbk., known as Alfamart, is one of the trading companies that need cold chains to store chicken products, meat, beverages and other processed foods. Alfamart is supermarket chain that has many branches in Indonesia. For this kind of company, renting refrigerated fleets trucks of varying sizes is more efficient.

#### *Distribution Company*

PT Unilever Indonesia Tbk. is the largest distribution company that also requires cold chains for the produced products. Unilever produces food, drinks, cleansers and body treatments. Unilever has more than 400 trademarks, and its products are well-known in Indonesia such as Lux, Magnum, Dove, Margarine, Rexona, Sunsilk, Lifebuoy, Clear, Rinso, Molto, Wall's ice cream, Blue Band, Surf and so on. For this kind of company, renting refrigerated fleets trucks of varying sizes is more efficient

#### *Retail Company*

In line with the rapid growth of retail business networks in major cities in Indonesia in recent years, encouraging goods storage services in cold storage has increased. Most retail networks in Indonesia have a number of outlets spread in several locations; thus, there must be standardisation of goods in all outlets. This requires handling the availability of goods in a professional and timely manner.

However, some retail networks only have limited cold storage space to accommodate their trading commodities, including frozen food products, drinks, ice cream, fruit, meat, fish and so on. With the limited capacity of its own cold storage, several large-scale network retailers then rent logistics facilities for cold storage space.

### Technological analysis for cold supply chain

#### *Development of cargo equipment for cold storage fishery products*

Cold storage for fishery products is needed to optimise the temperature and quality of freshness of the fish. The optimisation is done by tracking the real-time temperature of the frozen fish. The real-time temperature of fish is used as input information on the energy needed for temperature and environmental conditioning that fish need to maintain quality and freshness.

Frozen fish need to be stored in suitable conditions to maintain its quality. Usually, frozen fish are stored in cold storage. This storage is the main stage of preservation and freezing method. The temperature normally recommended for cold storage is generally -30°C to -60°C, depending on needs.

To get an appropriate cold chain system, there are four critical stages that must be observed, namely, handling on the initial process, storing and processing when arriving on land, handling when transporting to the destination place and handling on loading and distribution systems to consumers.

In developing fish handling devices with cold chains, there are various system elements that must be met. First, the sensor is used to measure the temperature of the product and the environment. This temperature measurement is the key to preventing damage to fish. In further development, sensors are also used to measure humidity, moisture content and freshness of fish products. Second, the transmitter system is used to transmit/send data information to communications networks. Transmitter usually has become one package in the sensor and battery. Last, communication networks are used to build connections among supply chains. The technology that is developing in the digital era and is compatible with cold chain communication networks, among others, is the Internet of Things (IoT). Development Internet networks now allow users to perform monitoring and handling of aquaculture

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wherever and whenever. IoT is also a device that can be used long term because future Internet networks will be increasingly widespread and evenly distributed.

*LOCUS - intelligent system to transform logistics operations in digitalization*

Case Study PT Agro Boga Utama to use LOCUS system <sup>(10)</sup>

PT Agro Boga Utama is a distributor and manufacturing company that provides a variety of high-quality halal frozen products such as beef, chicken, seafood, and vegetables, just to name a few. With a commitment to outstanding customer service, exceptional product quality, and competitive prices, PT Agro Boga Utama serves 100+ cities with 19 hubs across Indonesia (Jakarta, Java, Bali, Sumatra, Sulawesi, and Kalimantan). In addition to that, the company also has 7,400 partners with 1,500 products.

To adapt to the ever-changing needs of customers, PT Agro Boga Utama incorporated Locus solutions to continuously innovate their services and delivery of products. The company was looking for an efficient and intelligent system to transform logistics operations in digitalization. With the help of Locus, PT Agro Boga Utama automated operation delivery planning, creating a trackable delivery system to support company-owned and managed fleets of refrigerated trucks so that the product integrity is maintained no matter the distance or time traveled. Before Locus, the operation team struggled with planning, which was done manually, with no visibility on the movement of the trucks and the delivery status once the trucks left the warehouse. Manual planning takes and spends a lot of time on operations, which means picking the order from the warehouse is delayed. Other than that, GPS tracking via dashboard and digitization on apps help to record the actual time and delivery status on a real-time basis.

### How to adopt the Technology

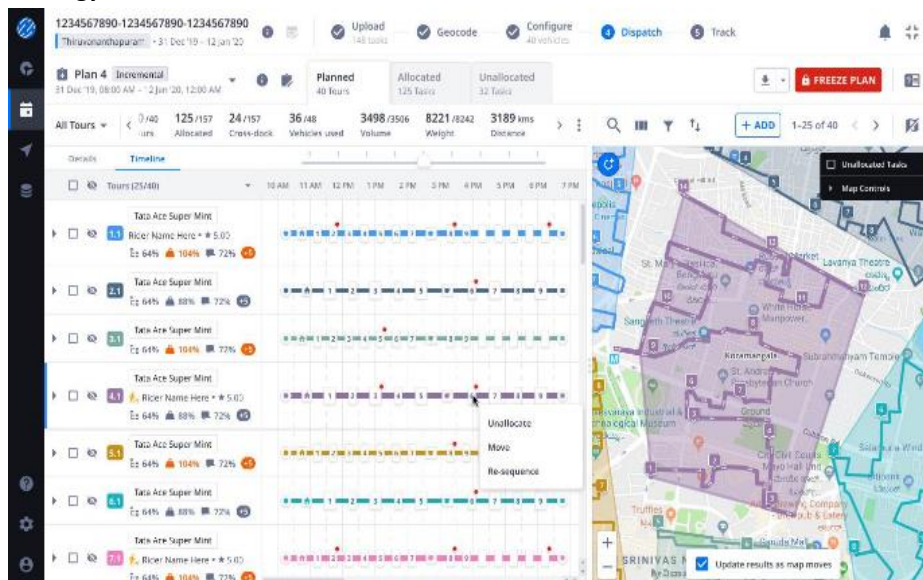


Figure 5.a. Thermoking Truck

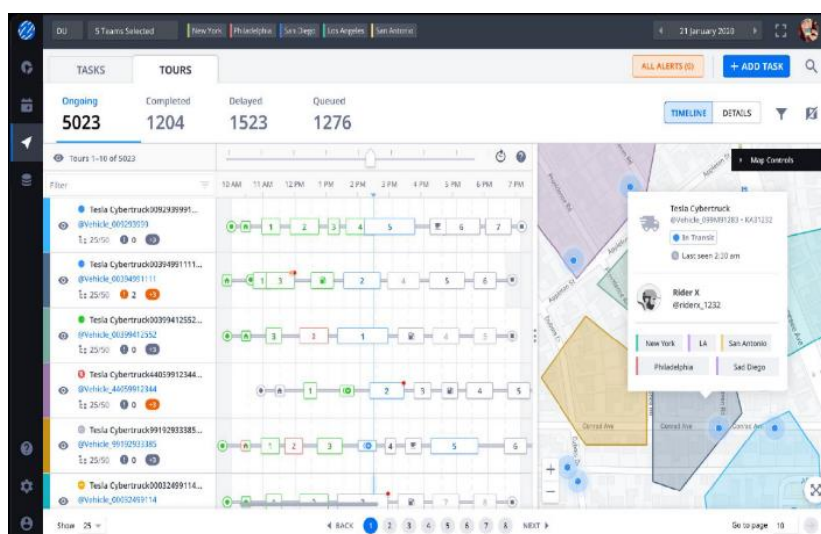


Figure 5.b. Thermoking Truck

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Locus implemented DispatchIQ and TrackIQ, enabling end-to-end automation of the company's distribution planning. Driven by a proprietary geocoding engine and Machine Learning algorithms, Locus solutions enabled efficient planning of delivery routes and effective scheduling of orders.

Locus acts as a complete Transport Management System, helping the company plan, execute, and streamline its entire supply chain, starting from managing the customers, drivers, locations, sellers & acting as a machine learning platform.

### Optimized Route Planning

Locus' proprietary geocoder-enabled systematic planning of delivery routes is based on three different metrics - geography, time, and vehicle. It also provides a single screen view of the distribution plans and helps in defining crisp timelines for deliveries.

### Dynamic Shipment Allocation

Locus ensures that shipments are automatically assigned to the most optimal delivery route and the rider best suited for it.

### Machine Learning and Track and Trace

With proprietary learning algorithms, Locus learns from on-ground execution, which helps in refining all plans to be generated.

### Tracking Deliveries on a Single Platform

Tackled client's pain point with a hawk-eye view of on-ground operations for real-time tracking. With Locus, it only takes 10-60 seconds to track a shipment or a truck location and its status, which is about 10-20 times faster than the original 'calling' method. Intelligent real-time alerts based on SLA breaches, battery levels, and customer interactions lead to proactive operation management.

### Digitization via the app

Drivers use the LOTR mobile app to record the shipment statuses. Delivery status is updated on the app on a real-time basis, and ePOD (electronic proof of delivery), including photos, signature, and cancellation/partial delivery reason, is generated for better visibility.

## CONCLUSION

1. In general, the cold chain industry in Indonesia continues to experience growth, given the rapid development of its industrial user such fisheries, processed food, and so on.
2. Based on total logistics cost, the percentage of freeze chain 43.60% (Rp/Kg 1,798.52); on material handling activity, on procurement activity 36.89% (Rp/Kg 1,521.63); transportation activity 12.89% (Rp/Kg 531.76); maintenance activity 6.54% (Rp/Kg 269.89); inventory activity 0.03%; and information activity 0.04%.
3. Cold chain business player, namely those that are used alone (integrated), and those that are fully leased. The main function that is used alone is to store its own products, either temporarily or for long periods of time as stock. Companies with business models like this are usually integrated with the company's main activities and become supporting its operational activities ie. Food processing companies, while for trading, Distribution and retailer company, due to variety of the product and wide range of service that offered, For this kind of company, renting refrigerated fleets trucks of varying sizes is more efficient.
4. As a company growing every year, the requirement to have transport system/software to deliver more accurate, reliable and real-time data for analysis. This included a higher control and better monitoring of the units. Expected deliverable increase the delivery SLA, reduced the number of vehicles in use and digitization of the delivery process for better control and accuracy.

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