

## MAPPING FISHERIES COLD CHAIN IN WESTERN JAVA USING A VALUE CHAIN PERSPECTIVE

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**Abstract:** The fisheries sector is one of Indonesia's promising industries. This industry accounts for approximately 2.6 percent of total national GDP. However, fishery products are perishable and contribute to a total loss of approximately 40 due to the fishery cold chain implementation was not yet optimal. Cold chain facilities were out of reach for small fisheries due to the large investments required. The study aimed to describe the current state of fisheries cold chain implementation. In the fisheries value chain, value chain mapping was used to enable fact-finding and linkage between existing conditions, chain actors, and governance. The research was carried out in two areas: Banten and West Java. The research conducted 90 interviews with fishermen, 9 collecting traders, 6 big traders, and 6 transporters. The research found that there are numerous channels in the chain governance. These channels have different requirements and demands in both traditional and modern markets. Furthermore, the fisheries cold chains in both regions varied based on key features and the inclusion of small stakeholders in the business relation. In conclusion, limited cold chain infrastructures were utilized by the actors directly and indirectly for decent work and reduce poverty.

**Keywords:** cold chain, fisheries industry, SDG 1, SDG 8, value chain analysis

**Abstrak:** Sektor perikanan merupakan salah satu industri yang menjanjikan di Indonesia. Industri ini menyumbang sekitar 2,6 persen dari total PDB nasional. Namun, produk perikanan bersifat mudah rusak dan menyumbang total kerugian sekitar 40 persen akibat penerapan rantai dingin perikanan yang belum optimal. Fasilitas rantai dingin tidak terjangkau untuk perikanan kecil karena diperlukan investasi besar. Penelitian ini bertujuan untuk mendeskripsikan kondisi implementasi rantai dingin perikanan saat ini. Dalam rantai nilai perikanan, pemetaan rantai nilai digunakan untuk memungkinkan pencarian fakta dan keterkaitan antara kondisi yang ada, pelaku rantai, dan tata kelola. Penelitian dilakukan di dua wilayah yaitu Banten dan Jawa Barat. Penelitian dilakukan 90 wawancara dengan nelayan, 9 pedagang pengumpul, 6 pedagang besar, dan 6 pengangkut. Penelitian menemukan bahwa ada banyak saluran dalam tata kelola rantai. Saluran ini memiliki persyaratan dan tuntutan yang berbeda baik di pasar tradisional maupun pasar modern. Selanjutnya, rantai dingin perikanan di kedua wilayah bervariasi berdasarkan fitur utama dan keterlibatan pemangku kepentingan kecil dalam hubungan bisnis. Kesimpulannya, infrastruktur rantai dingin yang terbatas dimanfaatkan oleh para pelaku secara langsung dan tidak langsung untuk pekerjaan yang layak dan mengurangi kemiskinan.

**Kata kunci:** rantai dingin, industri perikanan, SDG 1, SDG 8, analisis rantai nilai

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## INTRODUCTION

The fisheries industry is an important sector in Indonesia's economic development and poverty reduction. Fisheries account for 2.6 percent of total national GDP, which totaled Rp. 385.9 trillion in 2018. (BPS, 2019). Production in the fishing industry has increased by 1.5 percent per year from 2015-2019 (KKP, 2020). At the same time, production is increasing, while national fish consumption is increasing by 8.6 percent per year. However, demand growth is being hampered by a high number of shrinkages. From the post-harvest stage until it is accepted by consumers, this is a global problem (FAO, 2011). Fish products are shrinking throughout the value chain due to a variety of factors such as the type of fish, physical characteristics (composition, weight, and shape), volume handled, season length, and geographic location. Spoilage and deterioration of fish products are more likely in many low-income countries due to high ambient temperatures, a lack of access to services, infrastructure, and basic technology, reliance on traditional smoking and drying techniques for preservation, and a lack of refrigeration facilities (HLPE, 2014).

To address the issue, the cold chain offers numerous advantages to the food industry, including fisheries. According to Kitinoja (2013), the cold chain system has several advantages for perishable foods, including reducing microbiological changes, reducing physiological changes, preventing browning and loss of texture, taste, and nutrients (biochemical changes), and reducing transpiration to reduce water loss and shrinkage (physical changes). Although the cold chain is an appropriate handling method for fisheries products, its application still faces a number of challenges. The cold chain is difficult to manage and operate. Because the cold chain faces a variety of challenges, including unpredictable environmental conditions, inadequate infrastructure, and the uncertainty of basic needs such as water and electricity availability (Joshi et al. 2009). These issues could be resolved with proper chain governance. The chain governance is determined by the value chain typology. Most of the time, the governance is related to the types of business in each chain governance.

We intended to identify structural factors influencing cold chain practices in fisheries industries, as well as review the implications of major trends for future concept and implementation. A value chain mapping

analysis approach was used to determine the conditions for the implementation of cold chain fisheries. The goals were to obtain information about the actors involved, identify an obstacle and a solution in the implementation of marketing activities, know the actors' location network, understand the interdependence between actors, and know the magnitude of the benefits or margins of each actor in an effort to increase the added value of a product.

Based on the Republic of Indonesia's Law No. 45 of 2009 on Fisheries, Fisheries are all activities related to the management and utilization of fish resources and their environment, ranging from pre-production, production, processing, and marketing, and are carried out within a fishery business system. Fisheries are classified into three types of businesses: capture fisheries, aquaculture, and fish processing.

Fish is a perishable food with a high shrinkage potential. In 2018, global capture and aquaculture produced 178.5 million tonnes of fish, with 88 percent of the catch going to human consumption (FAO, 2020). Fish is regarded as an important component of human nutrition, accounting for approximately 17% of global animal protein intake (FAO, 2020).

Policies that specifically regulate the national fisheries logistics system are already available in the fishery industry. The National Fish Logistics System (NFLS) or Sistem Logistik Ikan Nasional (SLIN) is a program developed by the Ministry of Marine Affairs and Fisheries (MMAF) or Kementerian Kelautan dan Perikanan (KKP), which refers to MMAF Regulation No 5 of 2014. NFLS aims to increase the capacity and stability of the national fisheries production and marketing system; to efficiently strengthen and expand connectivity among upstream, downstream, and marketing centers; and to improve the management efficiency of the fish supply chain, production materials, and tools, as well as information from upstream to downstream. Procurement, storage, transportation, and distribution are all part of NFLS. According to Presidential Regulation Number 59 of 2020 concerning the stipulation and storage of basic needs and important goods, fishery products are classified as basic necessities and must be managed optimally, beginning with controlling operating control in factories, inventory management, and logistics while maintaining product quality through a cooling system.

Since the early 1950s, cold chain technology has been used and developed in agricultural supply chains for meat, dairy, fish, and horticultural products in the United States and European Union countries (Kitinoja, 2013). A cold chain is a temperature-controlled supply chain that consists of an ongoing series of storage and distribution activities to keep a specific temperature (Shibata, 2016). The cold chain ensures that perishable food remains safe and fresh for consumption throughout the post-harvest process until it reaches the final consumer.

Temperatures must be carefully and continuously monitored and controlled at every stage of the supply chain to ensure food safety and quality. Costa and Clemente (2012) investigated the temperature-related nature of cold chain storage techniques used to reduce post-harvest losses and add value to products with a longer shelf life. Positive growth in the domestic fisheries and agricultural sectors has an impact on Indonesia's potential cold chain demand. This growth increases potential demand in the cold chain for food safety while decreasing food loss in the food supply chain. Aquatic products have a cold chain demand of 12.51 million tons, agricultural products have a demand of 2.90 million tons, and livestock products have a demand of 2.11 million tons (CIC, 2018). Because many agricultural producers recognize that the cold chain strengthens the supply chain of Indonesian fisheries and agricultural products.

There is a clear link between cold chain performance and product quality (Joshi et al, 2011). It is difficult to assess cold chain performance because cold chains differ from other types of product supply chains in certain ways. According to Wu et al. (2015), the performance measurement system can be carried out in a simple and traditional manner, but the cold chain of fishery products has its own unique characteristics. A well-defined performance measurement system can be used to help with goal setting, performance evaluation, and determining future actions at the strategic, tactical, and operational levels (Gunasekaran et al. 2001). Joshi et al. (2011) identified seven major categories that can be used to assess cold chain performance: cost, quality and safety, traceability, service level, Return on Asset (ROA), innovativeness, and relationship.

## METHODS

Several methods were used in the study to investigate the cold chain implementation for fisheries in Western Java. West Java Province and Banten Province were chosen as research locations. We studied the condition of fisheries in Cirebon (12%) and Indramayu (64%) regencies in West Java because these two locations contributed the most to West Java's fisheries (KKP, 2020). Specifically, in Banten province, we evaluated the state of fisheries in Pandeglang and Serang regencies, which have the largest bodies of water in Banten.

To assess the cold value chains, the study conducted in-depth and semi-structured interviews with key stakeholders in the value chain. The questionnaires were adapted from Gereffi et al. (2005) on the value chain and Joshi et al. (2011) on cold chain performance capabilities. Previous studies from Williamson OE(2002), Kaplinsky and Morris, (2000), Gereffi et al., (2005), and Indrawan et al.(2018), Indrawan et al.(2020), Indrawan and Daryanto (2020), and Indrawan et al.(2021) were followed. The mapping process produced a variety of different flow diagram models based on the goals of each actor involved. The value chain analysis mapped the activities that generate added value, allowing it to be determined whether or not the existing activities were optimal.

The convenience expert sampling method was used to determine the number of samples. The convenience sampling technique is used to select the respondents who will be used to gain an overview of the cold chain's application. The criteria established for this respondent were the actors involved in the West Java region's fisheries value chain.

The samples were representative of the actors involved in the Western Java fishery value chain. The Head of the Nusantara Fisheries Port (PPN) Karangantu, Serang, is the first point of contact in the process of identifying value chain actors in Banten Province. While the initial entry point in West Java Province is through one of the major traders in Cirebon's Gebang District. Then, one by one, a number of respondents who were actors along the value chain were identified. From upstream to downstream, the value chain actors include fishermen, collectors, wholesalers, transporters, and retailers/exporters. For more details, see Table 1.

Tabel 1. A Representative Sample of Fishery Value Chain Actors in Western Java

Actor	Number of Sample	Location
Fisherman	90	Pandeglang,
Collecting Traders	9	Serang,
Big Traders	6	Indramayu,
Transporter	6	Cirebon,
Exportir	6	Greater Jakarta
Total	117	

## RESULTS

### Fisheries Value Chain Mapping in Labuan, Pandeglang-Banten

Pandeglang Regency had two value chains: fresh and frozen/processed fish. Fishermen sell their catch to collectors at Fish Auction Places (TPI) in the fresh fish value chain. TPI is a Department of Fisheries-managed facility. Labuan has three TPI facilities: Labuan 1, Labuan 2, and Labuan 3. As was customary, the traders financed the fishermen's needs and entered into a purchasing agreement with them. The traders sell their wares in Labuan and Cilegon, Banten, to both traditional and modern markets. Trading companies supply the HORECA, modern market (supermarket), and export market.

Fishermen, collector traders, TPI, retailers in traditional markets, processors, traders, HORECA, modern markets, and end consumers were among the actors involved in the fishery value chain in Labuan, Pandeglang Regency. Marketing channels were divided into two types: fresh product marketing channels and processed product marketing channels. A total of ten marketing channels were established, with six channels dedicated to fresh products and four dedicated to processed products. The marketing channels formed in the fishery value chain in Labuan, Pandeglang Regency are as follows.

Channel 1 : Fishermen – Collecting Traders – Small retailers (Traditional market) – End Consumers (Fresh Market)

Channel 2 : Fishermen – Collecting Traders – Big Traders – HORECA (Fresh Market)

Channel 3 : Fishermen – Collecting Traders – Big Traders – Modern Market – End Consumers (Fresh Market)

Channel 4 : Fishermen – Collecting Traders – Big Traders – Export (Process Market)

Channel 5 : Fishermen – Auction Center – Collecting Traders – Small retailers (Traditional market) – End Consumers (Fresh Market)

Channel 6 : Fishermen – Auction Center – Collecting Traders – Big Traders – HORECA (Fresh Market)

Channel 7 : Fishermen – Auction Center – Collecting Traders – Big Traders – Modern Market – End Consumers (Fresh Market)

Channel 8 : Fishermen – Auction Center – Collecting Traders – Big Traders – Export (Process Market)

Channel 9 : Fishermen – Collecting Traders – Processor – Modern Market – End Consumers (Process Market)

Channel 10: Fishermen – Auction Center – Collecting Traders – Processor – Modern Market – End Consumers (Process Market)

The fresh produce channel had more channels than the processed product channel (6 channels) (4 channels). Bentrong and mackerel are two types of fish in the fresh product line. For the fresh produce line, relatively simple cold chain equipment such as fiber or styrofoam boxes with varying capacities (30-70 kg) filled with ice is used. The mode of transportation for transportation and delivery used is also relatively simple, namely the type of pickup car, with the exception of delivery to modern markets, which is already carried out by wholesalers using refrigerated trucks (traders).

Tuna and layur were two types of fish that are commonly used in the processed product channel. Tuna is typically processed into frozen fish products, whereas Layur fish is typically processed into salted fish. The processed product channel was typically used for inter-island trade, such as Padang, West Sumatra. Frozen fish products were also supplied from outside the region, such as Jakarta and Demak, in addition to being sourced from local fishermen. These frozen fish products were transported and distributed using refrigerated trucks, and they are then stored in cold storage with an average capacity of 2 tons by local traders. Cold storage was an asset that each trader owns, and in Labuan, three traders had these facilities. Wholesalers typically target frozen fish products on a larger scale for export.

The existing cold chain facilities in Labuan, Pandeglang

Regency included a cold storage facility with a capacity of 10 tons and an ice factory with a capacity of 8 tons per day, both managed by the Coastal Fishery Port (PPP) Labuan. This facility was available to fishermen and traders at a fee. However, because the caught fish was directly marketed in fresh condition, most fishermen do not use cold storage.

### **Fisheries Value Chain Mapping in Karangantu, Serang-Banten**

The Serang district in Banten province is a fisheries area with ties to regional trade. Serang City, like Pandeglang Regency, had two value chains for fishery products: fresh fish and frozen/processed fish. The difference was that all fish caught by fishermen in Karangantu weighted and noted at the TPI located at the Nusantara Fisheries Port (PPN). Fishermen, collector traders, TPI, retailers in traditional markets, Traders, HORECA, modern markets, and end consumers were the actors involved in the fishery value chain in Karangantu, Serang City. The marketing channels formed in the fisheries value chain in Karangantu, Serang City are as follows.

- Channel 1: Fishermen – Auction Center – Collecting Traders – Small Retailers (Traditional Market) – End Consumers (Fresh Market)
- Channel 2: Fishermen – Auction Center – Collecting Traders – Big Traders – HORECA (Process Market)
- Channel 3: Fishermen – Auction Center – Collecting Traders – Big Traders – Modern Market – End Consumers (Process Market)
- Channel 4: Fishermen – Auction Center – Collecting Traders – Big Traders – Exort (Process Market)

The frozen fish products channel was common practices because PPN Karangantu has cold chain facilities, beginning with the ice factory, Air Blast Freezer (ABF), and Cold Storage. Furthermore, because of their proximity to DKI Jakarta, many fish products from Serang City were distributed to a variety of areas in Jakarta. TPI freezed the caught fish using ABF and store it in cold storage. PPN Karangantu had an ABF with a capacity of 3 tons and a cold storage with a maximum capacity of 20 tons. Collectors were charged a fee for processing their fishery products. The cost of freezing using blast freeze was approximately IDR 700,-/kg/ freezing process, and the cost of storing in cold storage was approximately IDR 26,-/kg/day. The frozen fish

distributed to trading companies (traders). Collectors' mode of transportation, on the other hand, remains simple: a pick-up truck. An ice factory was another cold chain facility in Karangantu. The ice factory at PPN Karangantu was built in 1976 on 240 m<sup>2</sup> of land and began operations in 1978. The installed engine capacity of the ice factory at PPN Karangantu was 30 tons per day, but the current production capacity was only 13 tons per day. The current production capacity was insufficient to meet the needs of the fishing community, which averages 40 tons per day.

### **Fisheries Value Chain Mapping in Juntinyuat, Indramayu-West Java**

Juntinyuat, Indramayu's value chain followed the same path as Labuan, Pandeglang's. This location had two value chains: fresh fish and frozen/processed fish. Fishermen sold their catch to traders at the TPI in the fresh fish value chain. The Fisheries Service of Indramayu Regency manages this TPI, which is located in Glayem Village, Juntinyuat District, Karangsong, Indramayu District, and Tegalagung, Karangampel District. In practice, many traders financed fishermen's who needed supports during the fishing process, requiring fishermen to only sell their catch to these traders. There were also traders who only sell to traditional markets in the area, as well as those who sell to modern markets in Indramayu and even outside the area. Trading companies typically supplied modern markets (supermarkets) and export markets for the purpose of going to HORECA (Traders).

Fishermen, collector traders, TPI, retailers in traditional markets, processors, traders, HORECA, modern markets, and end consumers were among the actors involved in the Juntinyuat, Indramayu Regency fishery value chain. The marketing channels formed in the fishery value chain in Juntinyuat, Indramayu Regency are as follows.

- Channel 1: Fishermen – Collecting Traders – Small retailers (Traditional market) – End Consumers (Fresh Market)
- Channel 2: Fishermen – Collecting Traders – Big Traders – HORECA (Fresh Market)
- Channel 3: Fishermen – Collecting Traders – Big Traders – Modern Market – End Consumers (Fresh Market)
- Channel 4 : Fishermen – Collecting Traders – Big Traders – Export (Process Market)

- Channel 5 : Fishermen – Auction Center – Collecting Traders – Small retailers (Traditional market) – End Consumers (Fresh Market)
- Channel 6 : Fishermen – Auction Center – Collecting Traders – Big Traders – HORECA (Fresh Market)
- Channel 7 : Fishermen – Auction Center – Collecting Traders – Big Traders – Modern Market – End Consumers (Fresh Market)
- Channel 8 : Fishermen – Auction Center – Collecting Traders – Big Traders – Export (Process Market)
- Channel 9 : Fishermen – Collecting Traders – Processor – Modern Market – End Consumers (Process Market)
- Channel 10: Fishermen – Auction Center – Collecting Traders – Processor – Modern Market – End Consumers (Process Market)

The fresh produce channel had more channels than the processed product channel (6 channels) (4 channels). For the fresh product line, relatively simple cold chain equipment, such as fiber or styrofoam boxes of varying capacities, was used (30-70 kg). Pickup trucks were used for transportation and delivery, with wholesalers only delivering to modern markets using refrigerated trucks (traders). The purpose of the processed product channel in Juntinyuat, Indramayu Regency was to supply frozen fish to inter-regional markets such as Muara Angke, Jakarta.

### **Fisheries Value Chain Mapping in Gebang, Cirebon-West Java**

The research in Cirebon focused on the fishery value chain in the Gebang District. The fishery value chain in this location was the same as in the districts of Indramayu and Pandeglang. This location had two value chains: fresh fish and frozen/processed fish. Fishermen sold their catch to traders at the TPI in the fresh fish value chain. The Cirebon Regency Fisheries Service managed this Fish Auction Place. In practice, many traders finance fishermen's for fishing process, requiring fishermen to only sell their catch to these traders. The traders then sold their products through

various channels, including traditional markets, modern markets in Cirebon, and even markets outside the region. Trading companies supplied modern markets (supermarkets) and export markets for the purpose of going to HORECA (Traders).

Fishermen, collector traders, TPI, retailers in traditional markets, processors, traders, HORECA, modern markets, and end consumers were among the actors involved in the fisheries value chain in Gebang, Cirebon Regency. The following is a marketing channel formed in the fisheries value chain in Gebang, Cirebon Regency.

- Channel 1: Fishermen – Collecting Traders – Small retailers (Traditional market) – End Consumers (Fresh Market)
- Channel 2: Fishermen – Collecting Traders – Big Traders – HORECA (Fresh Market)
- Channel 3: Fishermen – Collecting Traders – Big Traders – Modern Market – End Consumers (Fresh Market)
- Channel 4 : Fishermen – Collecting Traders – Big Traders – Export (Process Market)
- Channel 5 : Fishermen – Auction Center – Collecting Traders – Small retailers (Traditional market) – End Consumers (Fresh Market)
- Channel 6 : Fishermen – Auction Center – Collecting Traders – Big Traders – HORECA (Fresh Market)
- Channel 7 : Fishermen – Auction Center – Collecting Traders – Big Traders – Modern Market – End Consumers (Fresh Market)
- Channel 8 : Fishermen – Auction Center – Collecting Traders – Big Traders – Export (Process Market)
- Channel 9 : Fishermen – Collecting Traders – Processor – Modern Market – End Consumers (Process Market)
- Channel 10: Fishermen – Auction Center – Collecting Traders – Processor – Modern Market – End Consumers (Process Market)

### **Mapping of Fishery Cold Chain Activities**

In general, each actor in the value chain performed cold chain activities to the best of their ability. This activity was carried out to maintain the cold chain's performance in order to achieve the expected quality of product results. According to reports, there were seven categories used to assess cold chain performance. The mapping of cold chain activities in terms of performance categories yielded the following results (Table 2).

According to the mapping results, the majority of cold chain activities necessitate costs for procurement, delivery, and operations. Shipping costs were related to product distribution needs, including loading and unloading activities, while procurement costs were related to the need to purchase refrigerated equipment, while operational costs were related to all costs of activities that arise, such as electricity, rent, labor, equipment maintenance, and other operational costs.

Cold chain activities related to product quality and safety included actor training as well as certification fulfillment. Both were required to increase the perpetrators' knowledge in order to improve the quality

and safety of their products. Furthermore, there were other key activities in the fishery value chain that aim to maintain product quality, such as product checking and packaging.

In terms of cold chain activities undertaken to improve service quality, perpetrators used refrigerated vehicles to extend delivery range. Furthermore, actors chose strategic locations to facilitate access. Some actors also participated in training to improve their abilities. The most important characteristic shared by all fishery value chain actors was the assurance of product availability, so that customers will have no difficulty obtaining the product.

This process was found in cold chain activities related to product traceability in actors with a larger business scale, such as wholesalers, HORECA, and exporters. Meanwhile, for small-scale actors such as fishermen, collectors, and retailers, this traceability activity was typically carried out using a simple method, namely physical product inspection.

Tabel 2. Cold chain activity mapping results

Activity	Performance Factor						
	C	QS	S	T	ROA	I	R
Purchase of refrigerated box	√	√	-	-	√	-	-
Purchase of ice cubes	√	√	-	-	-	-	-
Sailing supplies	√	-	-	-	-	-	√
Air Blast Freezer (ABF) rental/investment	√	√	-	-	√	-	√
Cold Storage rental/investment	√	√	-	-	√	-	√
Reefer truck rental/investment	√	√	√	-	√	-	√
Land rental/investment	√	-	√	-	-	-	-
Loading & unloading cost	√	-	√	-	-	-	√
Shipping cost	√	-	√	-	-	-	-
Labor wages	√	-	√	-	-	-	√
Electricity	√	√	-	-	√	-	-
Equipment maintenance	√	√	-	-	√	-	-
Training	√	√	√	-	-	-	-
Certification	√	√	√	-	-	-	-
Product stock	-	-	√	-	√	-	√
Product checking	-	√	-	√	-	-	-
Product processing	-	-	-	-	-	√	-
Product packaging	-	√	-	-	-	-	-
Product sale	-	-	√	-	√	-	√

Note: C(Cost); QS(Quality & Safety); S(Service); T(Traceability); ROA(Return on Asset); I(Inovation); R(Relationship)

Current refrigerated facilities, both public and private, were still underutilized. Actors such as fishermen, collectors, and retailers currently used simple equipment because they made same-day sales to increase the flow of money. Large-scale actors' business practices, such as wholesalers, HORECA, and exporters, exhibited high utilization. In terms of margin, the actors mostly bargained in the buying and selling process, whereas the new contract process was applied to actors such as wholesalers, HORECA, and exporters.

In the cold chain, innovation was only found in the form of product diversification. This process was carried out in order to increase the added value of the product as well as to extend its life. A pattern of relationships between actors was also formed during this cold chain activity; typically, the actors had relationships with other actors who are exactly one level above or below them.

### **Managerial Implications**

The cold chains of fish were discovered to be variable. In terms of business models, the value chain approach provides a framework for upgrading related to actor behavior participation in fisheries cold chain initiatives in each chain governance. Based on their coordination mechanism, chain governance can choose between four types of upgrading, including process upgrading, product upgrading, functional upgrading, and chain upgrading (Gereffi et al., 2005). Process improvement can be applied throughout the chain by improving the freezing process in fisheries to avoid cross-contamination and meet food safety regulations. Product enhancement can be accomplished by developing a new fisheries product for the export market. In their cold chain coordination mechanism, extended actor activity can set up functional upgrading to take one or more chain stages. The final type of upgrading is chain upgrading, which entails shifting to a different industry. The type of chain governance that needs to be improved will determine the appropriate upgrade. Because the findings show that the value chain approach provides information about actors' relative influence on other people's decision-making, we propose that the upgrading should increase the incentive to support cold chain practices. Diverse goals in chain governance could be scaled up by combining a set of comprehensive chain upgrades that balance chain actors' goals.

The current cold chain practice in the fisheries value chain is no thought given to the interaction of value chain actors in order to increase fishermen participation. The main task at hand is to raise cold chain awareness throughout the Western Java fisheries value chain. It should create incentives for chain actors to participate in designing and carrying out upgrades to improve fisheries supply chain practices. It is preferable if chain actors, particularly chain leaders, join the government's efforts voluntarily, aided in the long run by incentive mechanisms. The action strategy should include fishermen in the cooperative by emphasizing their incentives to actively participate in value chain upgrading.

On the other hand, by changing the incentives for smallholder inclusion, the Western Java fisheries value chain could significantly improve its cold chain usage. Improving chain coordination in the global value chain also contributes to the creation of incentives to encourage chain actors to participate. The enforcement of regulations is the final issue concerning measures to increase the supply chain of fisheries in a specific cold chain implementation. Regulation enforcement is critical in moving beyond voluntary behavioral changes. Campaigns such as education and advertising for fisheries cold chains are another way to raise awareness among chain actors.

As a result, in order for fisheries cold chains to be implemented and businesses to compete in the global market, chain actors must first understand the food system and the demand for fisheries supply chain practices among export consumers in order to develop a strategy (Indrawan and Daryanto, 2020). Furthermore, different types of trade businesses should be considered in order to develop a better strategy for improving food safety practices in the chain governance (Indrawan et al., 2020). This means that the cold chain strategy must be developed based on knowledge of the food system, which is a complicated requirement for entering the international market.

These findings indicate that, in the context of value chain governance, value chain upgrading is identified as an important factor that could stimulate cold chain usage in the global value chain. According to the study by Indrawan and Daryanto (2020), the cold chain system as a value chain upgrade could protect producers in the global market

## CONCLUSION AND RECOMMENDATIONS

### Conclusions

The mapping of fishery value chain in the western part of Java provides an overview of the current state of the cold chain application for fisheries industry. The mapping results can be used to identify the various actors involved, the flow of fishery products, and the main cold chain activities. These identifications could be utilized to find the problem of cold chain implementation. The outflow of products was to meet the demand of their own region (local). The majority of the actors in cold chain activities used simple equipment such as an ice box made of fiber or styrofoam. To supply products to traditional markets, simple cold chain equipment was commonly used. HORECA and exports had used cold storage facilities and refrigerated trucks to transport products to the modern market.

### Recommendations

This research was conducted under restrictive conditions due to the ongoing Covid-19, so there were numerous limitations. This study only provides an overview of the current application of cold chain fisheries, implying that more research on cold chain development strategies is required.

## REFERENCES

- [BPS] Badan Pusat Statistik. 2019. *PDB Nasional*. Jakarta: BPS.
- [CIC] Capricorn Indonesia Consult. 2018. *A Cold Chain Study of Indonesia*. Kusano E, editor. *The Cold Chain for Agri-food Products in ASEAN. ERIA Research Project Report FY 2018*. Jakarta: ERIA.
- Costa JMC, Clemente E. 2012. *Refrigeration and Cold Chain Effect on Fruit Shelf Life*. Boca Raton: CRC Press.
- [FAO] Food dan Agriculture Organization. 2011a. *Global Food Losses dan Food Waste: Extent, Causes, dan Prevention*. Rome: FAO.
- [FAO] Food dan Agriculture Organization. 2020. *The State of World Fisheries dan Aquaculture 2020: Sustainability in Action*. Rome: FAO.
- Gunasekaran A, Patel C, Tirtiroglu E. 2001. Performance measures and metrics in a supply chain environment. *International Journal of Operations & Production Management* 21(1/2):71–87. <https://doi.org/10.1108/01443570110358468>
- Gereffi G, Humphrey J, Sturgeon T. 2005. The governance of global value chains. *Review of International Political Economy* 12(1):78–104. <http://dx.doi.org/10.1080/09692290500049805>
- Gereffi G, Fernandez-Stark K. 2011. *Global value chain analysis: A primer*. North Carolina: Center on Globalization, Governance & Competitiveness (CGGC), Duke University.
- [HLPE] High Level Panel of Experts on Food Security and Nutrition. 2014. *Food Losses dan Waste in the Context of Sustainable Food Systems: A Report by the High Level Panel of Experts on Food Security dan Nutrition of the Committee*. Rome: World Food Security.
- Joshi R, Banwet DK, Shankar, R. 2009. Indian cold chain: Modeling the inhibitors. *British Food Journal* 111(11):1260-1283. <https://doi.org/10.1108/00070700911001077>
- Joshi R, Banwet DK, Shankar R. 2011. A Delphi-AHP-TOPSIS based bench marking framework for performance improvement of a cold chain. *Expert Systems with Applications* 38:10170–10182. <http://dx.doi.org/10.1016/j.eswa.2011.02.072>
- Indrawan D, Rich KM, van Horne P, Daryanto A, Hogeveen H. 2018. Linking supply chain governance and biosecurity in the context of HPAI control in Western Java: A value chain perspective. *Frontiers in Veterinary Science* 5(94). <https://doi.org/10.3389/fvets.2018.00094>
- Indrawan D, Cahyadi ER, Daryanto A, Hogeveen H. 2020. The role of farm business type on biosecurity practices in West Java broiler farms. *Preventive Veterinary Medicine* 176:104910. <https://doi.org/10.1016/j.prevetmed.2020.104910>
- Indrawan D, Daryanto, A. 2020. Food control and biosecurity roles in the global value chain: Supporting producers or safeguarding consumers?. *IOP Conference Series: Earth and Environmental Science* 519(1):12040. <https://doi.org/10.1088/1755-1315/519/1/012040>
- Indrawan D, Christy A, Hogeveen H. 2021. Improving poultry meat and sales channels to address food safety concerns: Consumers' preferences on poultry meat attributes. *British Food Journal* 123(13):29-546. <https://doi.org/10.1108/BFJ-04-2021-0362>
- Kaplinsky R, Morris M. 2000. *A Handbook for Value Chain Research*. Brighton: University of Sussex, Institute of Development Studies.

- Kitinoja L. 2013. Use of cold chains for reducing food losses in developing countries. *Population* 6(123):5-60.
- [KKP] Kementerian Kelautan dan Perikanan. 2020. *Koridor Logistik Perikanan: Peraturan Menteri Kelautan Dan Perikanan Republik Indonesia Nomor 5/PERMEN-KP/2014 Tentang Sistem Logistik Ikan Nasional*. Jakarta: KKP.
- [PP] Peraturan Presiden Republik Indonesia. Peraturan Presiden Republik Indonesia Nomor 59 Tahun 2020 Tentang Penetapan dan Penyimpanan Barang Kebutuhan Pokok dan Barang Penting.
- Shibata Y. 2016. Cold chain trends. *Appliance Design* 64(2):14-26.
- [UU] Undang-Undang Republik Indonesia. Undang-Undang Republik Indonesia Nomor 45 Tahun 2009 Tentang Perikanan.
- Wu W, Deng Y, Zhang M, Zhang Y. 2015. Performance evaluation on aquatic product cold-chain logistics. *Journal of Industrial Engineering dan Management* 8(5): 1746-1768. <http://dx.doi.org/10.3926/jiem.1784>.