IMPLEMENTATION OF FISH DISTRIBUTION QUALITY WITH COLD CHAIN SYSTEM (CASE STUDY: PRIGI TO TULUNGAGUNG)

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ABSTRACT

Prigi Nusantara Fishing Port is a port located in the south of Java Island. The production of fishermen's catches that can be landed at the Prigi Nusantara Fishing Port is 24,928,229 kg. It is necessary to have a management plan and identification of cold chain system distribution costs to maximize the distribution of catches, in this study, to the Tulungagung area. Cold storage also has an important role in the cold chain system. Thus, this study plans to identify the management process, identify distribution costs, and assess the role of cold storage. This research aims to identify the management process and distribution costs as well as assess the role of cold storage. The results of this management mapping plan are from fishermen to cold storage, cold storage processing, and transportation to markets and consumers. With a total cost of IDR 173,382,000/year, including operational costs of IDR 82,950,000/year and vehicle travel costs of IDR 90,43,000/year, using a Thermo King truck. Assessment of the role of government cold storage obtained a score of 45.8% while private cold storage obtained 43.6%. The role of cold storage is still not optimal for storing fish to stabilize prices.

Keywords: Fisheries, fishermen's catch, cold chain system, cold storage

Introduction

Indonesia is one of the largest maritime countries in the world. Located on the Asian continent, flanked by the Indian and Pacific Oceans, Indonesia consists of 17,504 islands, with two-thirds of the country's territory consisting of oceans. Indonesia's ocean area is 6.4 million km2. The land area is 1.9 million km^2. The vast area of the ocean shows that Indonesia is a very large Maritime Country (Statistics Center, 2021). As a maritime country, the marine natural resources produced are certainly very abundant. Mining resources, marine tourism energy, coral reefs, and capture fisheries resources [1], [2].

Captured fish resources are one of the leading resources produced by fishermen throughout Indonesia. The Ministry of Maritime Affairs and Fisheries (KKP) noted that Indonesia's marine capture fisheries production has increased from year to year [3]. The latest data in 2020, marine capture fisheries production reached 7.1 million tons (KKP, 2021). For East Java Province, the production of captured fish in 2017 was 395,254.64 tons, in 2018 it was 467,959.99 tons, in 2019 as much as 481,490.85 tons, and in 2020 as much as 395,254.64 tons [4]. Fish is one of Indonesia's marine wealth as an archipelago [5]. Therefore, most of the coastal residents are fishermen, ranging from small fishermen who only fish with makeshift equipment to fishermen who have many fishing boats, even though they are still small. Fishermen who have many fishing boats, even though they are

still simple. Most of these vessels are made with makeshift equipment and are not well structured [6], [7], [8].

Marketing of fishery products from PPN Prigi is in the form of fresh fish and processed fish products. Distribution destinations include local areas, namely Trenggalek, and inter-city distribution, including Tulungagung, Surabaya, Jombang, Malang, Nganjuk, and other cities. Fishery production from PPN Prigi is distributed in the form of fresh fish, frozen fish, and processed fish, which include Pindang fish, salted fish, fish flour, smoked fish, and other processed fish [9].

In addition to fish prices that tend to be uncontrollable, Prigi Beach fishermen cannot get maximum results. What can be known is that the above areas have a standard price that already meets the standard market price of the region; this is unfortunate because the potential of capture fisheries in the Prigi Coast region cannot be maximized.

Therefore, there needs to be a solution to enable fishermen's catches can be sold at maximum prices, and help the economy of Prigi Beach fishermen and the surrounding areas. This factor is very influential and formulating an integrated cold chain management or research from the time of capture to the hands of consumers with distribution from Prigi Beach to Tulungagung. As well as how the management mapping process and identification of distribution costs from the Prigi Beach area to Tulungagung using a cold temperature Thermo King truck, so that the quality of the fish can be maintained.

Prigi Perikanan Nusantara Port (PPN) has four cold storage units, consisting of three private and one government-owned. However, until now, the cold storage located at PPN Prigi has not functioned optimally, where only part of the cold storage is being used. This is because fishermen during the fish season, and fishery entrepreneurs, immediately sell the catch landed at PPN Prigi, even though the price is low. Based on this information, it is necessary to assess the role of cold storage in PPN Prigi, adjusted to the catch of fishermen.

Methodology

Research methodology is the basic framework of the stages of completing a thesis, which includes all activities that will be carried out to solve problems or carry out the process of analyzing research problems. The methodology used in this research is a case study and field research.

The data needed in this research process uses primary data and secondary data. Primary data is obtained from interviews based on questionnaires directly by respondents who know the conditions related to cold storage at PPN Prigi, and interviews directly with those who know the process of the fish distribution chain at PPN Prigi. Secondary data is obtained from private and government cold storage industry managers and reproduced with other sources such as journals, books, and others.

a. Problem Identification and Formulation

The initial stage in working on this research is to identify existing problems and also the formulation problems that will be resolved during this research. In addition, there are also problem boundaries whose function is to make the topic of discussion more detailed and not widespread, also this will make it easier for the author to analyze the problem.

b. Literature Study

A literature study is carried out by collecting various references to support the writing of this thesis. The necessary references can be found through various media, including books (cold chain fish, cold storage, fish cooling system), journal of Cold Chain System Simulation on Fish Distribution Chain to Measure Fish Quality Improvement in Semarang City), Paper (Cold Chain Fish), Article (Variation of iodine number with diesel fuel and biodiesel), final project (Cold storage fisheries in Indonesia), internet (cold chain fish, fresh and frozen fish quality, fisheries cold storage).

c. Data Collection

Data collection or retrieval is done by directly reviewing the research location to obtain the required data. Data collection in this study used a collection method in the form of purposive sampling. Purposive sampling is a method of taking respondents according to the characteristics determined by the researcher [6], [7]. The selection of respondents was carried out with the consideration that the respondent has an important position in the existing field at the relevant agency and has more knowledge in the field that is the object of research. Apart from the above data collection methods in writing this final project, it is carried out in 2 (two ways, namely:

1. Direct data collection (Primary)
   This direct data collection is done by methods:

   a) Direct interview
   Interviews were conducted with related parties in this final project, namely the manager of cold storage at PPN Prigi

   b) Survey of field conditions. Survey of field conditions at PPN Prigi.

2. Indirect data collection (Secondary data)
   Secondary data collection is done by taking data sourced from the Prigi VAT Statistical Report, cold storage annual work report, performance report, and 10 respondents.

3. Fish distribution data
   Marketing of Prigi Beach fishery products in the form of fresh fish products or processed fish, including frozen fish. The distribution area covers the local area of Trenggalek and the surrounding cities.

4. Fishermen's catch
   The following are the top 9 fish productions landed at PPN Prigi are of pelagic fish species such as Tongkol Lisong (Bullet Tuna), Layang Deles (Shortfin Scad), Cakalang (Skipjack Tuna), Tembang (Deepbody Sardinella), Layur (Hairtails), Layang Anggur (Redtail Scad), Tongkol Krai (Frigate tuna), Tuna Madidihang (Yellowfin Tuna), and Tongkol Komo (Eastern little tuna) [9]

5. Government and private cold storage data
   After we know the number of fleets and how much the catch of fishermen is, knowing the capacity of government and private cold storage, this determination aims to find out how much the catch of fishermen can be utilized by cold storage in PPN Prigi.

d. Data Collection

After getting the necessary data is complete, the next step is data analysis and discussion, namely comparing the data that has been obtained from the most effective and efficient previous calculations.

1. Distribution chain from VAT Prigi to Tulungagung market.
   This analysis discusses how the distribution process chain from the Prigi VAT area to the Tulungagung market. It identifies the stages and mapping of distribution management, as well as which parties are involved in the distribution management process.

2. Cost analysis of fish distribution from Prigi Beach to Tulungagung.
   This analysis discusses how to identify the cost of fish distribution from Prigi Beach to Tulungagung. In this case, using truck transportation (truck Thermo King).

3. Analysis of the role of government and private cold storage
   This analysis discusses how much the role of cold storage in PPN Prigi both the government and the private sector through questionnaires, using the Likert scale method.

e. Data Collection

After analyzing the data, the next step is to conclude the data analysis and discussion. It is hoped that the conclusions can answer the problems that are the objectives of this thesis. In addition, suggestions are needed based on the research results to improve this research so that it is more perfect [10].

Result and Discussion

The success of a fishing operation cannot be separated from the facilities and infrastructure of a complex fishing unit. A fishing unit is a technical unit consisting of a fishing fleet, fishing gear, and fishermen.

The fish catch resources in PPN Prigi are strongly supported by the success of its fishing fleet structure (Figure 1). The fishing fleet operating in PPN Prigi consists of vessels measuring less than 10 GT up to 30 GT, and is dominated by vessels under < 10 GT with 490 vessels (73.80%).

The use of fishing gear is usually adjusted to the characteristics of the fishing area and the target catch. The types of fishing gear used by fishermen in PPN Prigi are hand line, purse seine, Tonda fishing rod, gill net, and seine.

The fishing fleet in PPN Prigi (Figure 2) in 2021 is 664 units, consisting of 449 units of Fishing Rods (67.20%), 2-boat Ring Trawlers 130 units (18.95%), Trolling Lines 67 units (9.77%), Gill Net 7 units (2.48%), Payang 7 units (1.02%) and 1-ship purse seine 4 units (0.58%). The highest number of fishing gear operating in Prigi waters, namely in 2021, was 664 units. This year was recorded in the period 2017 - 2021 as the year with the largest number of fishing fleets in the Prigi PPN, while the number of fishing gear operating was the highest.

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This occurred slightly in 2020, amounting to 608 units, because there were not many private fishing industries that entered the Prigi PPN environment, and the cause of the coronavirus outbreak that has hit many fishermen, experiencing financial disruption, as well as the cycle of changes to normalization after the virus outbreak that hit the Prigi Beach area in particular.
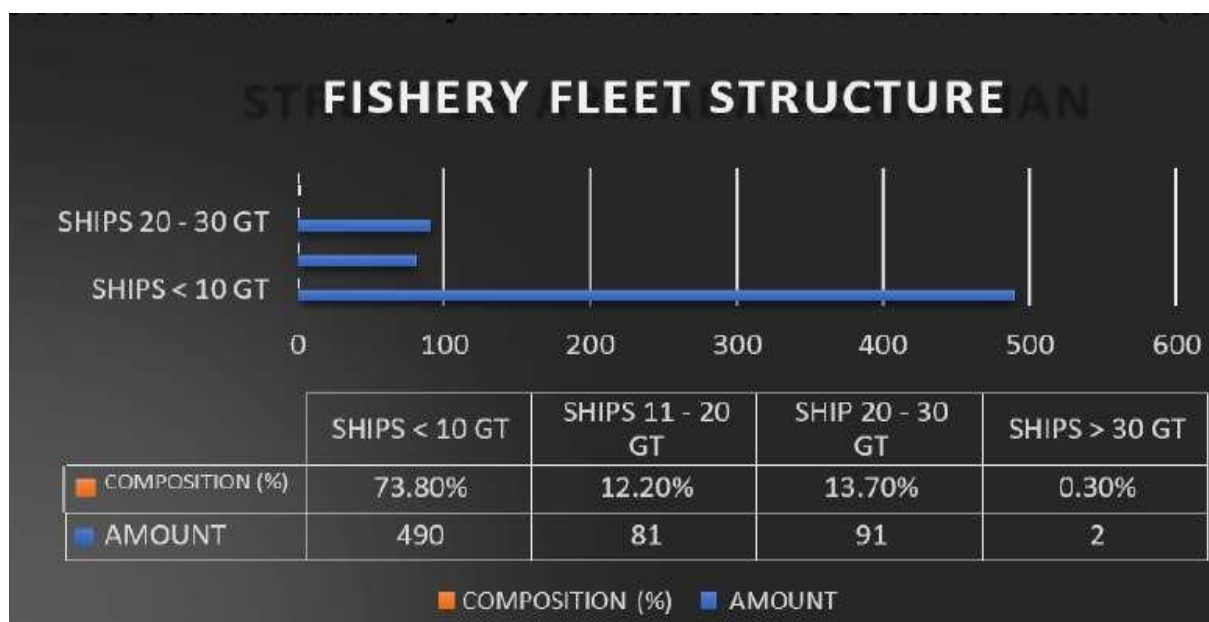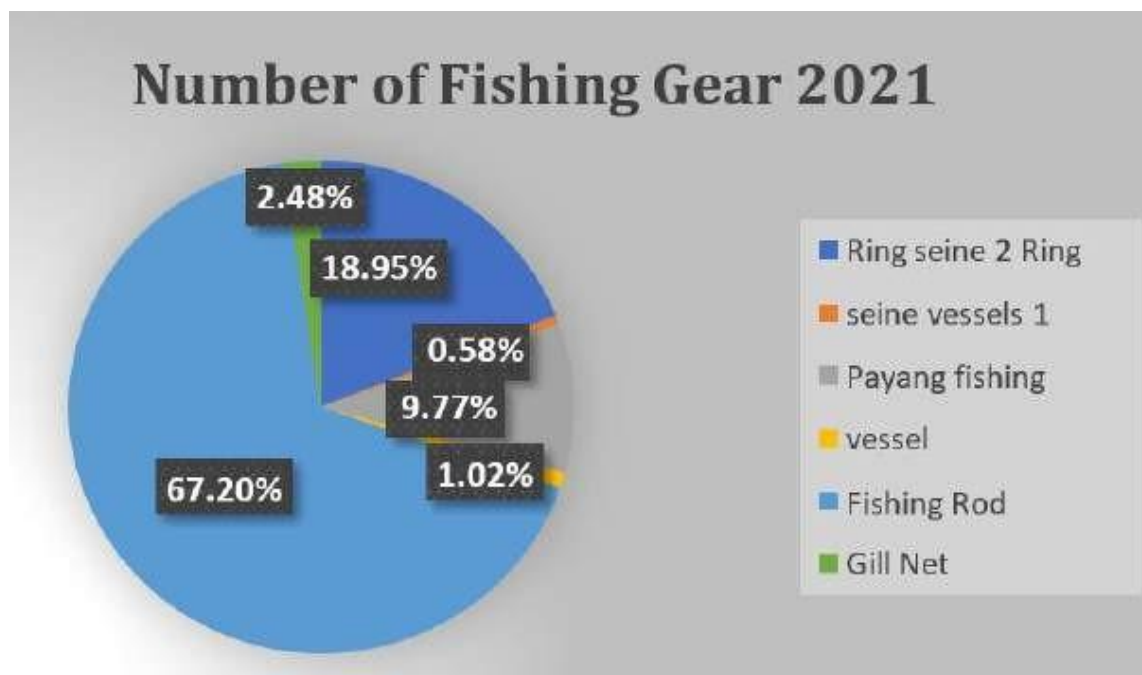

Figure 1. Fishing Fleet Structure

Figure 2. Number of Fishing Gears in 2021

In 2020, the recorded volume of fisheries production landed at PPN Prigi was 28,822,884 kg. with a production value of Rp. 198.339.137.750. while in 2021 it will be 24,928,229 Kg with a production value of IDR. 219,419,964,000, so this year there was a decrease in the volume of fisheries production of 3,894,655 Kg or 13.51% due to a significant decrease in the volume of the Deles Fly species, namely 70%, while the production value increased by Rp. 21.080.826.250 or 10.63% because fish prices tend to be stable. In the period between 2017 and 2021, 2019 was also the year

with the highest production amount and production value, namely Rp. 233,308,498,100 and 28,472,852 kg, while the lowest was in 2017, namely the production amount was 4,165,068 kg with a production value of Rp. 79,243,899,200 (Figure 3). Catch productivity has fluctuated from year to year. The biggest decline occurred in 2017 which was quite drastic. Based on information obtained from the management of PPN Prigi and fishermen, this is thought to be because in that year many fishing fleets did not go to sea. The number of fishing fleets that do not go to sea is due to the issue of tsunami waves that often occur in the southern waters of Java, affecting the productivity of fishermen.

Distribution and marketing of fishery products from PPN Prigi consists of fresh fish products and processed fish products (Figure 4). The distribution destination area includes the local area, namely Trenggalek, and also inter-city distribution, including Tulungagung, Surabaya, Jombang, and other cities. Fisheries production from PPN Prigi which was distributed in the form of Fresh Fish amounted to 10,807,487 kg (43.35%), Frozen Fish 2,359,669 kg (9.47%), and processed fish which included Fish Pindang 9,227,443 kg (37.02%), Salted Fish 1,937,857 kg (7.77%), Fish Meal 26,450 kg (0.11%), smoked fish 565,463 kg (2.27%) and other processed products 3,860 kg (0.02%).
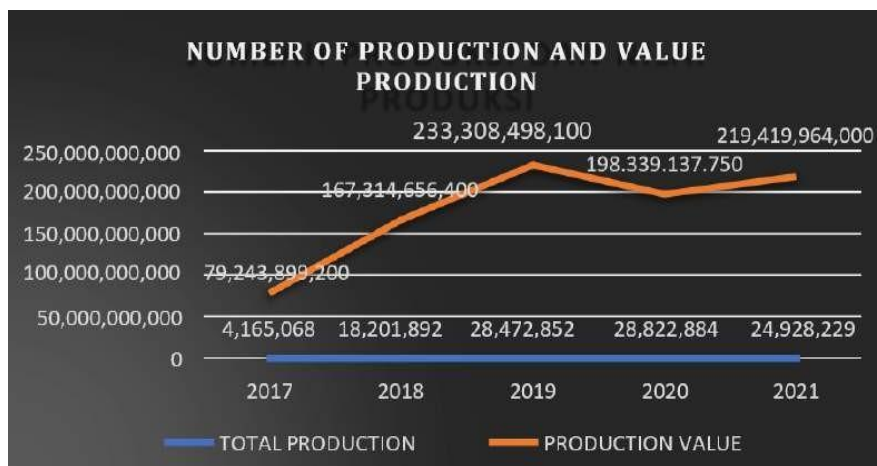

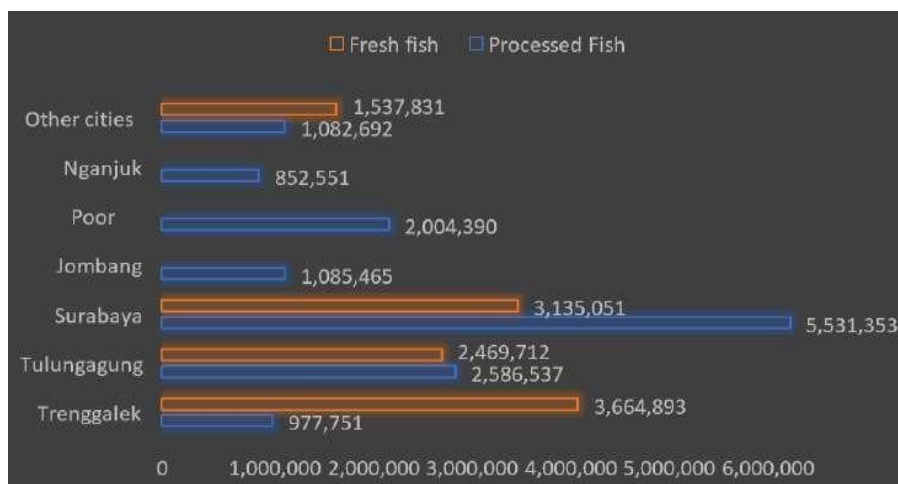**Figure 3.** Production Amount and Production Value

Figure 4. Distribution of Prigi VAT Fishery Products

The concept or pattern of distribution of fish catches before entering cold storage (Figure 5). There are several parties involved in the marketing of caught fish at PPN Prigi, ranging from collectors, dealers, large traders, small traders, and retailers to consumers. Collectors are traders who collect or buy caught fish from fishermen, while dealers are

collecting traders with larger capital and scale than collectors. Besides being able to buy fish directly from fishermen, dealers can also collect catches from collectors. Wholesalers are also collector traders, but are engaged in a larger and wider business sector with legal entities and have been organized such as supermarkets, supermarkets,

and wholesale supermarkets. Retailers are stall traders or kiosk owners, vegetable vendors, restaurants, hotels, and caterers who can buy fish from large traders. Consumers are final consumers who buy fish caught for consumption and not for resale.

Marketing of fish catches by fishermen in PPN Prigi can be done directly or indirectly. Direct marketing is carried out by fishermen to large traders, while for consumption, fish marketing channels are carried out by large traders, as well as retailers, to end consumers (household consumers). Indirect marketing is done through intermediaries (collectors, dealers, wholesalers, and retailers). Indirect distribution patterns vary, using one to four intermediaries. So that each intermediary can take advantage, the more intermediaries result in the price of fish obtained by

the final consumer will be higher (Hermawan, 2018). Apart from the above concept, fishermen also have the right to distribute their catches directly to consumers without any intermediaries.

Fishery product production from PPN Prigi is in the form of fresh fish products and processed fish (Figure 5). The distribution destination area includes the local area, namely Trenggalek, and inter-city distribution, including Tulungagung, Surabaya, Jombang, and other cities. Fisheries production from PPN Prigi which was distributed in the form of Fresh Fish amounted to 10,807,487 kg (43.35%), Frozen Fish 2,359,669 kg (9.47%), and processed fish including Pindang Fish 9,227,443 kg (37.02 %), Salted fish 1,937,857 kg (7.77%), Fish Flour 26,450 kg (0.11%), Smoked Fish 565,463 kg (2.27%) and other processed products 3,860 kg (0.02%).
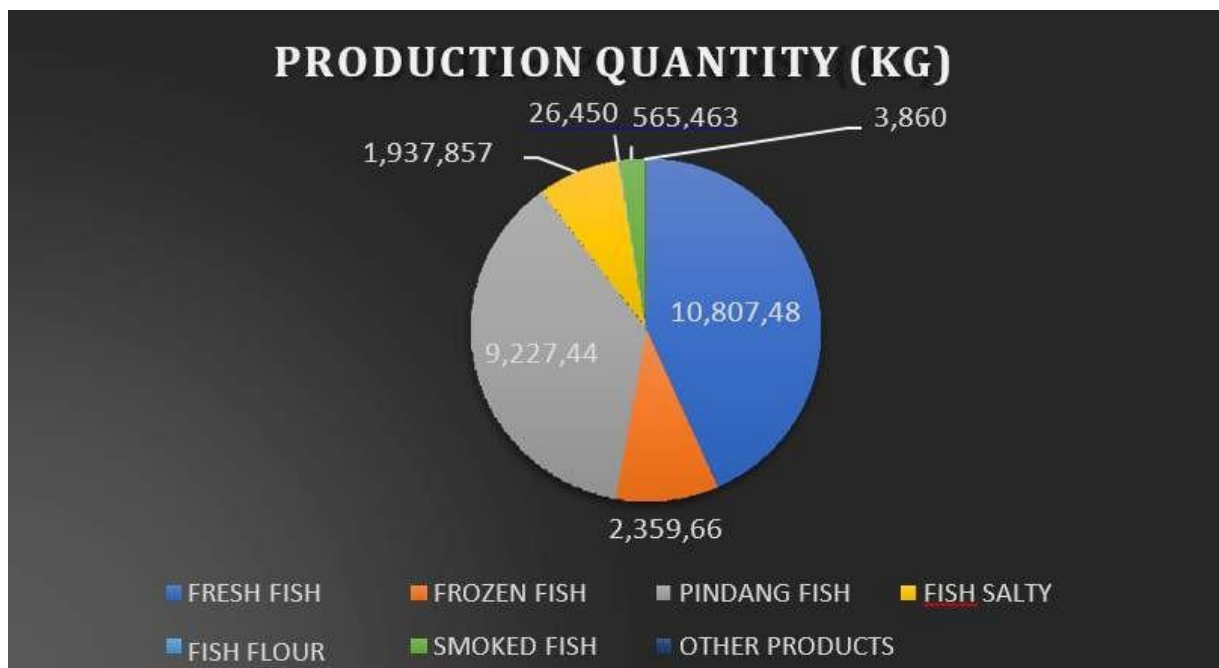

Figure 5. PPN Prigi Processed Products

Next is a fish distribution chain mapping model. This mapping consists of, among other things: starting from the fishermen's catch, then transportation to the cold storage place, then the processing process in cold storage, then transportation to the market, and finally into the hands of consumers. This mapping model aims to maintain the quality of fish during the distribution process while the fish is frozen and the quality is maintained [10].

The delivery process, in this process, consists of two stages, namely from the fish auction place to the cold storage place using private transportation (pick up) and from the cold storage place to the

Tulunganunng market using government-owned transportation (Thermo King truck). First, from the fish auction place to the cold storage using a pick-up vehicle with a capacity of 1500 kg at a distance of 1 km. Where one trip takes 4.6 hours, including loading and unloading. The total cost of a pick-up vehicle, consisting of operating costs and annual voyage costs, is IDR 55,529,920. Next is delivery from the cold storage place to the Tulungagung market using a Thermo King truck transportation with a fish storage temperature during the distribution of (-11) – (-12) °C with a capacity of 6000 kg over a distance of 60 Km. Where 1 trip takes 5 hours, including processing, loading, and

unloading. The total cost of a Thermo King truck vehicle, consisting of operating costs of IDR 82,950,000 and voyage costs of IDR 90,432,000 per year, is IDR 173,382,000.

The potential for capture fisheries in PPN Prigi reaches 24,928,229 Kg. Of the total catch by fishermen, no more than 9% can be used in cold storage. So far, catches in the form of fish, shrimp, and other biota are often sold directly by fishermen without any technological touch, namely cold storage, which functions for freezing and cooling, as an effort to maintain the quality of fishery products. The advantages of using cold storage are guaranteeing supplies of materials for the continuity of factory operations, extending the life of stored products, contributing to reducing unemployment through employment, training facilities, internships, and development of science and technology in the field of fishery product processing to increase economic value, regional income, and regulating distribution and stabilizing prices.

The Nusantara Prigi Fishing Port has four units of fish cooling and freezing facilities (cold storage), consisting of one owned by the government and three owned by the private sector. There are currently only two active cold storage units operating, each with an Air Blass Freezer (ABF) and cold room. The cold storage owned by the government has a capacity of 100 tons, consisting of one ABF room unit with a load of 50 tons and a 100-ton cold room. Meanwhile, privately owned cold storage has a capacity of 300 tons, consisting of four Air Blass Freezer (ABF) units with a capacity of 5 tons each and a 300-ton cold room.

The process of handling fish and storing fish in cold storage is carried out by workers provided by service users who will store the caught fish in cold storage. The Prigi Archipelago Fisheries Port (PPN) only provides officers who record the type of fish and the weight of the fish that will be stored in cold storage. Before entering cold storage, the caught fish go through several handling processes, including when the fish arrives, the fish must be washed first after the fish is clean, then put in a fiberglass box for temporary storage with ice cubes given to it to maintain temperature. the fish remains stable. Next, the fish are sorted according to type and size and then placed in a van/pan with a capacity of 1 pan containing 10 kg of fresh fish. After sorting, the fish are put into the ABF room for freezing. Freezing 1 ton of fish takes 4 to 4.5 hours. Freezing fresh fish is usually done for 14 to 16 hours per day (until the fish is frozen) with a

Table 1. Government Cold Storage Performance

No.	Year	Quarterly	Production Capacity Cold Storage (Ton)	Cold storage capacity (Tons)
1	2017	1	0	100
		2	41	100
		3	49	100
		4	72	100
2	2018	1	0	100
		2	7	100
		3	5	100
		4	29	100
3	2019	1	0	100
		2	41	100
		3	49	100
		4	16	100
4	2020	1	0	100
		2	57	100
		3	10	100
		4	0	100
5	2021	1	0	100
		2	0	100
		3	62	100
		4	31	100

Description: 1 (January, February, March), 2 (April, May, June), 3 (July, August, September), 4 (October, November, December).

temperature range of -25°C to -40°C. After the fish is frozen, the fish is then put into a cold room with a temperature range of (-17°C) to (-30°C) until the desired storage time.

Assessment of the role of cold storage capacity can be determined by production in the period 2017 - 2021 for government cold storage and 2020 - 2021 for private cold storage (Table 1 and Figure 6).

The performance results of the government's cold storage capacity based on the weight of fish stored during the period 2017 - 2021, from the first to the fourth quarter, showed that none of them reached the cold storage capacity of 100 tons. Most storage was only in the fourth quarter of 2017, with a total storage production of 72 tons. The availability of fish in the first quarter of 2017-2021 is 0, which means that fish is not available in cold storage.

The results of the performance of private cold storage capacity based on the weight of fish stored during the period 2020 - 2021, from quarters one to four, show that none of them reached a cold storage capacity of 100 tons. The largest storage was in 2020 in the fourth quarter with a capacity of 84 tons. In 2020, in quarters one to three, the production capacity did not exceed 50% of the cold storage capacity. This also occurred in the second to fourth quarter of 2021, with fish availability not reaching 50% of the cold storage capacity (Table 2).
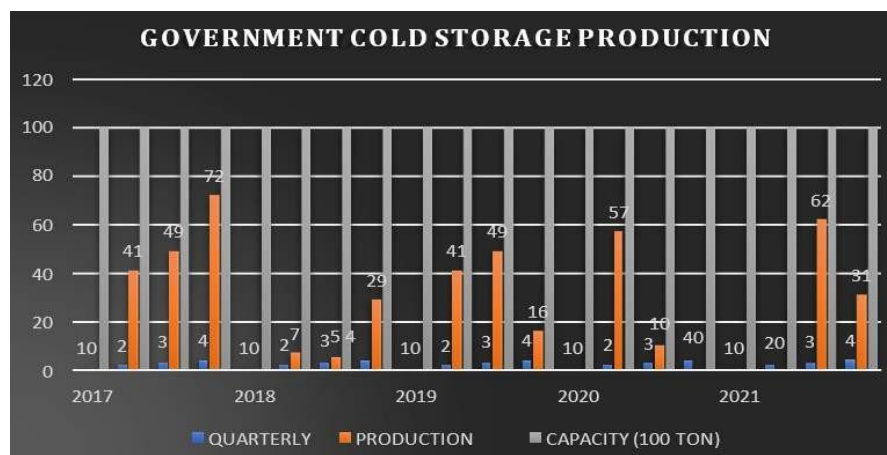

Figure 6. Government Cold Storage Production

Table 2. Private Cold Storage Performance

No.	Year	Quarterly	Production Capacity Cold Storage (Ton)	Cold storage capacity (Tons)
1	2020	1	27	300
		2	24	300
		3	12	300
		4	84	300
2	2021	1	50	300
		2	34	300
		3	7	300
		4	9	300

Description: 1 (January, February, March), 2 (April, May, June), 3 (July, August, September), 4 (October, November, December).

Cold storage role assessment calculation:

$$\text{Length of interval class} = \frac{\text{range}}{\text{many interval class}}$$

Description:
Range = Highest score – The lowest score

Highest score = total number x highest score
= 15 x 5
= 75

Lowest score = total number x lowest score
= 15 x 2 (government) 1 (private)
= 30 (government)
   15 (private)

Based on the formula, the length of the interval class is:

Length of the interval class = $\dfrac{75-30}{5} = 9$ and $\dfrac{75-15}{5} = 12$

Average score of the government's cold storage role =
$$\dfrac{(12x5)+(8x4)+(27x3)+(28x2)+(0x1)}{5} = 43,6$$

Average score of the role of private cold =
$$\dfrac{(12x5)+(8x4)+(27x3)+(28x2)+(0x1)}{5} = 45,8$$

Analysis of the role of cold storage capacity is also carried out using a Likert scale based on the parameters observed by looking at the secondary data obtained. All parameters are arranged in the form of a matrix with a score of 1 to 5. Each parameter will be assessed according to the criteria that have been compiled. The results of the assessment of the role of cold storage can be seen in the table below.

The results of the assessment of the role of government cold storage obtained a calculation score of 45,8, while private cold storage amounted to 43,6 (Table 3). The score states that the role of cold storage is still not maximized to store fish in PPN Prigi.

Meanwhile, private cold storage shows the same thing as cold storage owned by the government; no production reaches a capacity of 300 tons or the highest 100% storage value, namely 84 tons (Figure 7). Fish availability in quarters 1 to 3 in 2019 was below 50%. This also happened in the 2nd quarter to the 4th quarter of 2020, where fish availability was below 50%.

The total comparison of cold storage production with the total cold storage capacity at the Nusantara Prigi Fishing Port from 2020 - 2021, government-owned and privately owned, does not even reach 100% of the total cold storage capacity. The highest production occurred in the 4th quarter of 2020, namely 84 tons. This production still did not even reach 50% of the total cold storage capacity. The lowest production occurred in the 2020 – 2021 period, quarter 3, with a production capacity of 22 tons, with production not reaching 20% of cold storage capacity.

The role of cold storage in PPN Prigi can be increased by looking at the large fish production and seasonal factors of superior fish species to stabilize prices. There are 3 superior fish groups, the first group is tuna and skipjack. The fishing season only occurs during the eastern season and can be released for the transitional season II, in the same season the second group of superior fish consisting of swallow, Lemuru, and Layur fish can be stored in the transitional season II and released during the western season, while for the third group of superior fish consists of Slengseng fish, Tembang fish and Selar fish, the fishing season occurs throughout the year from the western season to the eastern season, this third group of superior fish can be released in every season.

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Table 2. Cold Storage Capacity Role Assessment

| No.	Criteria	Assessment Score	
		Cold storage government	*Cold storage private*
1	Fish production in cold storage increases every year	3	2,8
2	Every eastern season (fish season) the cold storage is always full	2,4	2,4
3	Cold storage production reaches capacity every fish season	2,2	2,4
4	Cold storage production reaches capacity every fish season	2,4	2,4
5	Every month the cold storage sells/releases fish	2,4	3
6	In the western season, cold storage continues to operate	2,4	2,8
7	Fish availability remains during the lean season	2,4	1,3
8	Every year per quarter cold storage production reaches 50%	2,4	2
9	Cold storage can slow down the spoilage of stored products	5	4,8
10	The fish stored are large pelagic fish.	4	2,4
11	Cold storage industry business opportunities are getting better	3	3
12	The quality of fish stored in cold storage is fresh	2,6	4,6
13	The production that cold storage does is sufficient	2,4	2,4
14	Market demand for fish in cold storage is always met	2,4	2,2
15	Fish prices increase during the lean season	4,8	4,6
	Total	45,8	43,6
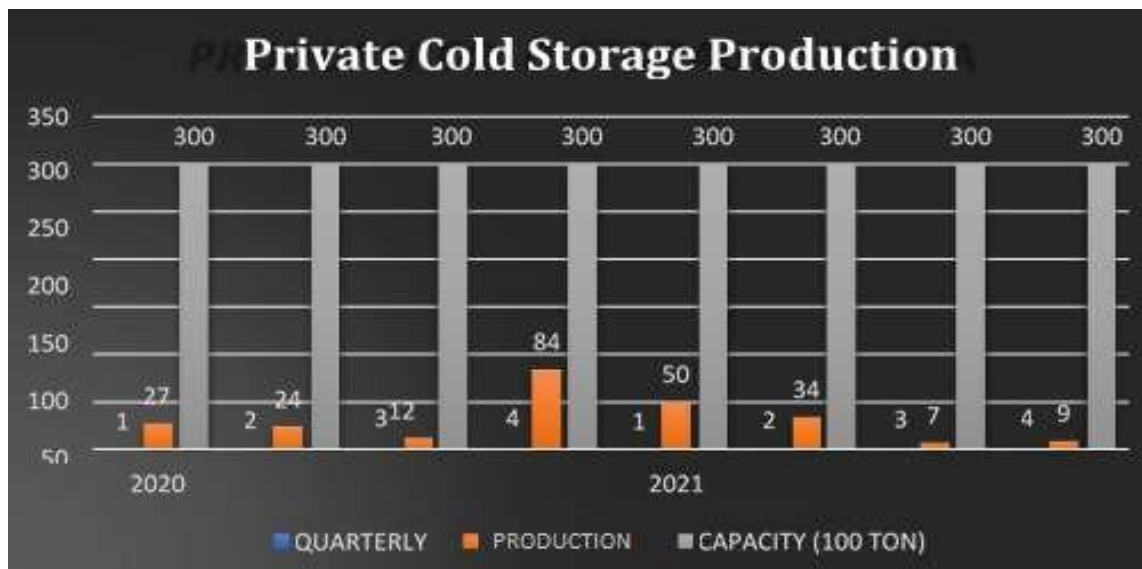
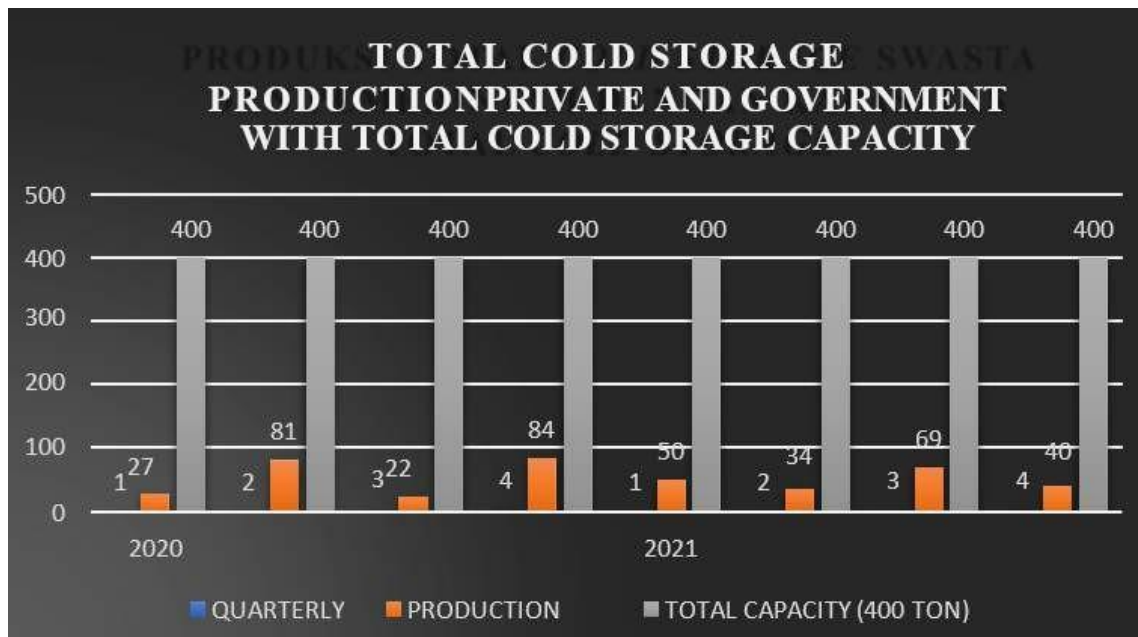**Figure 7.** Private Cold Storage Production

Figure 8. Total Production with Cold Storage Capacity 2020 – 2021

Comparison of private cold storage production with total cold storage capacity (Figure 9). It can be seen from the graph above that the comparison of private cold storage production with the total cold storage capacity in the Prigi fishing port states that no production has reached 50%. The highest production occurred in 2017 in the 4th quarter with a production of 72 tons. The lowest production occurred at the end of 2020 and the beginning of 2021, with a production of 0. With this factor, it is possible that fishermen stored their catch in the cold storage government property. This can be seen in Figure 6, where the government cold storage produces fishery products.

The assessment of the role of government cold storage obtained a calculation score of 45.8, while for private cold storage, it is 43.6. This score states that the role of cold storage is still not optimal in terms of availability to support the capture fisheries industry in PPN Prigi. This is because many local fish entrepreneurs buy the fish they catch and market it directly at that time. This social phenomenon means that cold storage in PPN is not optimally utilized according to its function. Efforts to develop fisheries businesses by improving the quality of products marketed at regional to international levels certainly require the role of cold storage in its operations.
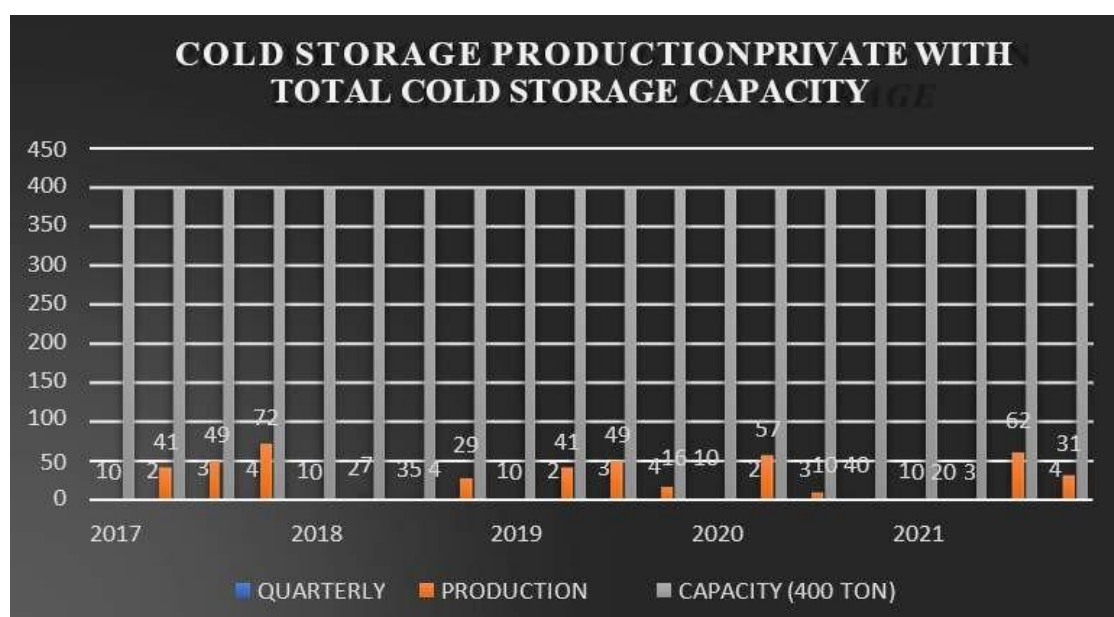

Figure 9. Comparison of Private Cold Storage Production with Cold Storage Capacity in 2017 – 2021

Conclusion

From the research that has been done, the following conclusions are obtained: Mapping the supply chain management process of the distribution system from the cold storage factory to the Tulungagung market and surrounding areas using a Thermo King truck with a capacity of 6 tonnes. Mapping of the supply chain management process using land routes (Existing), starting from the cold storage factory to the Tulungagung market, for a frozen processed fish product. Mapping the identification of distribution costs from the PPNPrigi cold storage factory using truck Thermo King transportation with a total cost of Rp 173,382,000 / year, including operational costs of Rp 82,950,000 / year and vehicle travel costs of Rp 90,432,000 / year. Based on the production and capacity of cold storage and assessment of the role obtained, numbers 45.8 and 43.6 indicate that the role of cold storage in PPN Prigi is not optimal.

Acknowledgments

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