Anchovy fisheries logistic system on Sunda strait coastal of Banten Province

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Abstract. The Sunda Strait coastal of Banten Province has a strategic location and potential for abundant fish resources. One type of fish resource whose production is relatively high and has high economic value is anchovy. Anchovies that are managed properly and responsibly will create jobs that can drive regional economic development and support the improvement of national food security. This study aims to determine the anchovy logistics system in the Sunda Strait coastal of Banten Province. The research was conducted in May-December 2019 on the coast of the Sunda Strait of Banten Province. The fisheries logistics system is formulated using a soft system management (SSM) approach and analyzed descriptively. The supply chain system of anchovy has four supply chain types. Anchovies logistic system needs to be improved to dry and sort fish and create a central warehouse. So the actors can find it easier to supply anchovy stocks and marketing and make cooperation agreements between the actors involved. Besides, it is required to conduct socialization and training on effective, efficient, and hygienic handling and anchovy processing and strengthening fishing institutions.

1. Introduction
The Sunda strait has a strategic location and potential for abundant fish resources. One type of fish resource whose production is relatively high is anchovy. The production number of anchovy in 2019 at the fishing port is just 30 tonnes, but the production from non-fishing ports reaches 1,840 tonnes [1]. Anchovy fishing technology is dominated by lift nets dominate anchovy fishing technology. Lift-net fishers generally do not land the catch at the fishing port or sell it directly in the middle of the sea to collectors (called langgan or pelele), so they are not all recorded at the fishing port [2].

Anchovy is a commodity that has high economic value so that its management and development can improve the regional economy because it can increase income and fulfill the nutrition and protein of the community. However, the development of anchovy fisheries in the coast of Sunda Strait of Banten is still facing various challenges, including fluctuations in fishing productivity, the distribution of production and consumption centers that are very wide, the dominance of small-scale fishing fleets, limited facilities, and infrastructure, and the upstream-downstream production system (logistic system) which has not integrated. This problem requires the attention of all fisheries stakeholders because it affects the availability and sustainability of fish supply, the disparity in the selling price of fish, and the quality of fish that reaches the consumers/fish processing unit.
Perishable characteristics of fishery commodities require special handling through by developing of a fisheries logistics system [3]. A good fisheries logistics system must support high fisheries productivity to provide multiple benefits for regional economic development. Anchovies that are managed properly and responsibly will create jobs that can drive regional economic development and support the improve of national food security.

This information is very important for the formulation of management strategies and the development of anchovy fisheries on the coast of the Sunda Strait. This research is expected to provide complete information about the anchovy logistic pathways to support the realization of sovereignty, independence, and food security in fisheries in Banten Province. The guarantee of availability, affordability, and sustainability of the anchovy fishery business in meeting public consumption and the fish processing industry will contribute significantly in support the realization of national food security and security, especially in providing healthy and quality animal protein. This study aims to determine the anchovy logistics system in the Sunda Strait coastal of Banten Province.

2. Methods
The research was conducted in May-December 2019 in anchovy fishery centers along the Sunda Strait of Banten Province. The main locations which are the study areas are Pandeglang Regency covers Sumur, Panimbang, and Citeureup Districts.

The research was conducted using a survey method. Research data collection was carried out through observation, in-depth interviews, and literature study. The primary data required for this research are anchovy fisheries actors, supply chain of anchovy, distribution channel, and marketing of anchovy.

The anchovy fisheries logistics system is formulated based on the soft system management (SSM) approach and was analyzed descriptively. The SSM approach steps are (1) identifying the logistical problems of anchovy fisheries, (2) problem solving and making a rich picture, (3) building a root definition, (4) developing a conceptual model, (5) comparing the conceptual model with the real world, (6) compile a corrective action plan and (7) implement an action plan [4]. The SSM results were then formulated to produce an ideal logistic system design for pelagic fisheries in the Sunda Strait. In this study, the SSM approach was limited to step 4 (compiling a conceptual model).

3. Results and discussion
The logistics system manages production, processing, transportation, storage, and marketing to create availability, price ranges, food security, maintain fish quality, and encourage the processing industry's growth and community growth. Anchovy fishery logistic routes on the coast of Sunda Strait have been identified starting from fish landing centers along the coast of the Sunda Strait at Pandeglang Regency. The anchovy production centers are located at Panimbang, Citeureup, and Sumur. The three locations contribute to the high production of anchovies and make Pandeglang Regency the largest anchovy producer in Banten Province.

Catching anchovy is usually done with lift net fishing gear. Three types of lift net are used for catching anchovy; the boat lift net, the floating lift net, and the stationary lift net. Anchovy fishing at Sumur is dominated by boat lift net, floating lift net is dominated at Panimbang, and the stationary lift net is dominated at Citeureup. The lift net used to catch anchovy is presented in Figure 1.

![Figure 1](image1.jpg)

(a) Floating lift net  (b) Stationary lift net  (c) Boat lift net

**Figure 1.** Lift net fishing gear is used to catch anchovy.
The lift net in Panimbang is 130 units, 80 units at Citeureup, and 162 units at Citeureup. The principle of fishing with a lift net is applying light fishing technology with lift net webbing. The target fish species in the lift net are fish that have positive photo-taxis properties like anchovies. Due to this positive phototaxis, the fish will congregate in a light area so fishers can easily catch it [5].

The dimension of the stationary lift net ranges from 10 x 10 m to 13 x 13 m, with a depth of installation ranging from 10-20 m. The dimension of the boat lift net ranges from 17 x 17 x 20 m to 35 x 35 x 20 m. The floating lift net size is 5 x 5 x 15 m to 11 x 13 x 20 m. The trip length of the stationary lift net is one day fishing. The trip length of a small boat lift net is averaged six trips per month and during the peak season, as many as eight trips per month, with operating times per trip ranging from 2-4 days depending on the number of fish caught. Large boat lift net and floating lift net operating trips are generally 20 days per month. The anchovy is carried out by carrier boat every day [6].

Anchovy fishing activities have long developed in this area so that it has become one of the largest anchovy production centers in Pandeglang Regency and Banten Province. This condition is supported by the waters of the Sunda Strait, which is a fishing area for Sumur fishers. The waters of the Sunda Strait, which is the confluence of two water masses from the Java Sea and the Indian Ocean, cause these waters to become fertile and positively influence the productivity of anchovy fisheries in Sumur coastal Pandeglang to Serang [6].

The anchovy caught by lift net is usually taken and carried by a carrier boat. The catch carrier boat-based here is of two types: carrier boat (just transport ship) and carrier boat with boiling (boiler boat). Some anchovy is boiled on the boat, and on some are boiled on a processing unit (called sobong). Anchovy from the carrier boat is processed for boiling at sobong, and after that, it is dried. Anchovy has been boiled on the ship; then, the processing plant will only be dried in the sun (as presented in Figure 2).

**Figure 2.** Anchovy drying process at the processing unit.

The production of dry anchovy range from 41.7-140.5 tonnes per day. 1 kg of dried anchovy comes from 2.5-3 kg of wet anchovy. The capacity for each processor in Panimbang is around five quintals. If the number of anchovy processors is around 20 people, the dry anchovy production per day is around 100 quintals.

The anchovy caught by Citeureup fishermen is not landed at the Citeureup but landed in Panimbang. Anchovies are usually picked up and processed there. There are three processors in Citeureup, but these processors only process the leftover anchovy from those brought to Panimbang, with a capacity of approximately five quintals per day.

The anchovy production in Sumur can reach 1.2-5 tons per day, with a work period of 20 days, because Bagan can only operate during dark months. So fishers only go to sea for about ten days before and ten days after the full moon. The number of processors is about 26 people.

The price of anchovy is differentiated by type (size)—the price of large anchovies when wet is around Rp. 13,000 / kg, while for small anchovies, it is around Rp. 20,000 / kg. To get 1 kg of dry anchovies usually takes about 3.5 kg of wet anchovies. Meanwhile, to get 1 kg of dry for small anchovies, takes
about 2.5-3 kg of wet. It must be completely dry for large anchovies, while the conditions are medium-dry (not too dry and not too wet). The price of dried anchovies is around Rp. 80,000-85,000 per kg, large dried fish Rp. 30,000-60,000 / kg.

The anchovy in the Sumur area is not landed at the fish landing center (FLC) but directly at the collector. The retribution received by FLC is an estimated value of dried anchovy, where the amount is Rp. 150 per kg dry. The retribution collected is 6%, 3% comes from fishers, and 3% comes from collectors. Of the fees received by FLC, 4% goes to the local government to become locally generated revenue, and 2% goes to FLC managers.

The selling price of dried anchovy is IDR 85,000/kg. Dried anchovy produced will usually be sent to Jakarta to trading companies that are also the capital providers or have entered into trade cooperation with the processing unit owners. There are at least five trading companies that have collaborated with processors. The packaging of dried anchovy is usually packed with cardboard with a capacity of 25 kg, as shown in Figure 3. One delivery to Jakarta for each processor ranges from 7.5 to 9 tons, usually using a pickup truck or truck.

![Figure 3. Dried anchovy ready to be shipped to Jakarta.](image)

Anchovies are sold by producers to distributors at different prices depending on the season because, in certain seasons, many anchovies will be caught. Usually, the price is fixed even though the production is abundant. It is because the market for anchovy both at home and abroad continues to receive high demand.

Anchovy is usually brought to Jakarta by distributors or wholesalers, or agents to be sold to retailers. The distribution of anchovy already has regular customers. Usually, large traders come and carry out transactions at the processing business location. Some buyers come directly to the processing location and bring their transportation or transportation of anchovy. The producer delivers some to the place of the buyer. The price of anchovies delivered from producers to wholesalers, distributors, retailers is added to the cost of transportation and is also taken advantage of from the distribution process.

### 3.1. The anchovy logistic actors

Anchovy is a fishery product that has bright business prospects in Indonesia. The industry in anchovy processing is one of the developing industries in Indonesia. The distribution of anchovy still depends on the catch. If the catch is decreasing, the price of anchovy will increase. Anchovies are spread and marketed almost in all parts of Indonesia and even is one of the important export commodities, including Singapore, Malaysia, China, Taiwan, America, and Japan [7].

The supply chain is a series of productive activities from upstream to downstream that are interconnected and form a value chain. The supply chain consists of several elements and parties involved, either directly or indirectly [8]. Supply chain actors in anchovy fishery are lift-net fishers, catch carrier fisher, fishing unit owners, processors, capital owners, suppliers, distributors, wholesalers, and retailers. All supply chain actors carry out activities interconnected with operational activities to
produce dried anchovies that reach consumers. Anchovy fisheries actors on the coast of the Sunda Strait in Banten Province consist of:

1. Lift net fishers, consisting of boat lift net, floating lift net, and stationary lift net. The difference between them is based on lift net type and production capacity.
2. Catch carrier fisher is fishers whose job is to take the anchovy from the lift net fishers. Some catch carriers only transport the catch; others boil anchovies on board.
3. Fishing unit owners are boat and lift net owners, usually the capital provider for fishing.
4. The processing unit owners are processor who own a place for boiling and drying anchovies (called sobong). There are sometimes also owners who own a fishing unit and provide capital.
5. Capital owners, are actors who provides a capital loan to go to sea with the agreement that the resulting anchovy is sold to them. Sometimes these are also fishing unit owners, but some are collectors and distributors.
6. Suppliers (collectors) are actors who buy or receive dried anchovies from other processing units. The collector is sometimes the owner of the processing unit.
7. Distributor, usually in a trading business, is located in Jakarta, providing capital loans. Usually receive dried anchovy shipments from collectors. The supplier is also a seller who sells anchovies abroad (export).
8. The whole seller is traders who sell anchovies to retailers and the modern market.
9. The retailer is a trader who sells anchovies to local markets or consumers.

The capital owner in anchovy fishery consists of three types, the owner of a fishing boat, the owner of the processing unit, and the distributor. Some Sobong owners also own boats, so other people do catching fish. Distributors usually funding the operation of Sobong, so the dried anchovies are produced will be delivered to them. The supplies needed for fishing, including consumption, are borne by the owner. It is different from the lift net fishery in East Halmahera, where the owner does not bear the consumption cost [8].

Each processor generally has more than one fishing gear unit. The processor also has a ship that functions to tow lift net, a boat to pick up fish, and a boat to pick up fishers. It makes the anchovy fishery in the Sumur area the largest and most advanced among all locations in Banten Province.

3.2. The distribution of anchovy

The distribution and marketing of anchovies are carried out by collectors, distributors, and traders at various levels. Their role is very important because they usually determine the pricing of anchovies as owners or providers of capital. The distribution of anchovy is presented in Figure 4.

![Figure 4. Anchovy distribution line from the coast of Sunda Strait.](image-url)
The supply chain is a physical network, namely the nodes that supply raw materials, produce goods, or send them to end-users [9]. The lift net fisher on the coast of Sunda Strait consists of three groups: boat lift net fisher, floating lift net fisher, and fixed lift net fishers. There are usually stationary fishermen who sell their catch to the catch carrier, while the boat and floating lift net fisher usually take their anchovies by the catch carrier and take them to the processing unit. The types of anchovy supply chains are presented in Figure 5.

![Figure 5. Anchovy supply chain on the coast of Sunda Strait.](image)

3.3. Anchovy supply chain and logistic problems

There are several problems in the distribution process of anchovy, starting from the capturing and processing to consumers, including:

a. Data collection systems from anchovy fisheries (catch and processed anchovy data) are not reliable and partial.

b. The weather heavily influences fishing and processing anchovy. Production will be hampered if there is rain or cloudy weather. The anchovy produced from this process is anchovies in dry conditions.

c. Product hygiene, where the location for drying fish and storing fish is carried out in an open space, causes the possibility of exposure to dust and the presence of animals in the drying and storage area.

d. Limited transportation, so the delivery of anchovy is carried out in groups. The car for delivering anchovy is only used tarpaulin covers. It is not yet using insulated transport cars for anchovy delivery. So that if it rains, it can cause the anchovy to get wet and damage its quality.

e. The dried anchovy is still sorted manually without paying attention to cleanliness (as presented in Figure 6).

f. Much dried fish are scattered and wasted during the drying and storage process so that the production of anchovies is not optimal.

g. There are no adequate anchovy storage facilities, such as cold storage, so that if the dried anchovy is produced, it gets moldy if stored for too long. In addition, microbiological damage in salted fish is because of the product's water activity value, temperature, and storage time [10]. Therefore, when production is low, it is not easy when there are not enough dried anchovies to be shipped to Jakarta or when production is high and requires storage before shipping.

h. The selling price of anchovy still relies on a capital owner (investor) who provides capital support. For example, investors provided ship assistance, fishing gear, and capital to process processes after the tsunami disaster. This condition causes investors to determine the selling price of anchovy.
Figure 6. The process of sorting dried anchovy is not following the standards.

3.4. The rich picture of anchovy supply chain

The way of expressing or describing real-world situations that are considered problematic, commonly used in SSM, is to use rich pictures. Based on the anchovy supply chain problem, then to express the problem situation in a rich picture. The researchers can convey problematic situations more freely through pictures, lines, signs, or special icons to comprehensively and comprehensively describe the situation at hand [11]. A rich picture of the situation of anchovy supply chain problems is presented in Figure 7.

Figure 7. A rich picture of the anchovy supply chain on the coast of Sunda Strait.

The rich picture (Figure 7) shows that many factors influence the problem of the anchovy supply chain. These factors are factors that cause an effective, efficient and sustainable supply chain management system to fail. Furthermore, a causal analysis was carried out using a fishbone diagram with relevant stakeholders based on the rich picture. Fishbone diagram analysis of the root causes of the anchovy supply chain is presented in Figure 8.
3.5. Root definition (CATWOE element)

Based on the rich picture and synthesis of the supply chain problems of the anchovy fisheries using fishbone diagrams, the most relevant system is then compiled to fix the existing problems by paying attention to the CATWOE element to analyze the transformation process.

The preparation of the root definition was made to make a conceptual model [12]. The root definition is a way to describe the system for the system modeling process [11]. Root definition tested and refined with the CATWOE analysis tool (C = customer, A= actors, T= transformation, W= worldview, O= owners, E= environmental constraint), as presented in Table 1. Root definition and CATWOE are a source of activity creation in the purposeful activity model of the anchovy supply chain system in the Sunda Strait coast of Banten Province, as presented in Figure 9. The anchovy logistics system comprises four subsystems: (1) the capture and processing subsystem, (2) the logistics network subsystem, (3) the quality control and assurance subsystem, and (4) the management subsystem.

Table 1. Result of CATWOE analysis.

| No. | CATWOE element | Description |
|-----|----------------|-------------|
| 1.  | Customer       | Fishers and buyers will benefit directly, while owners of transportation facilities will benefit indirectly. Suppliers, distributors, and wholesalers may experience a decrease in profits. |
| 2.  | Actor          | Fishers and processors will run the system. The government should encourage the development of information systems that regularly communicate buyers' and customers' needs. |
| 3.  | Transformation | - Fishers have a strong position in determining the price. -The system will improve the fishers to reach the supplies. |
- Handling and quality standards and products to have product quality standards tailored to consumer needs applied voluntarily.
- From uncoordinated to coordinated fishery activity.

4. Worldview
Trust that this system will provide potential to improve the situation that has been going on by fishers for many years, and it has been proven that fishers provide supplies and receive a fair price for the product. Furthermore, the system can increase productivity, quality, and value. This system will encourage solidarity, and as a result, the fisher's welfare will increase.

5. Owner
All supply chain actors will be involved in the system. The system will be owned by fishermen, processors, and the community public. Although not the owner of the issue, fisheries agencies, fishing port managers, and cooperatives can help facilitate this change.

6. Environmental constraints
- Support for change will emerge from fishers, processors, and communities. Resistance to change will come from supply chains that have exploited the powerlessness of fishermen, such as investors, suppliers, and trade.
- The fish landing center officers, fishery extension workers, fisheries agencies have not been optimally empowered and have not mastered the quality management system well and the limited supporting facilities in making direct approaches to fishers, fish processors, and transporters.

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**Figure 9.** Conceptual model of anchovy logistic system at the coast of Sunda Strait.

Based on the problems described above, recommendations for the logistics management of anchovy on the coast of the Sunda Strait are:

1. Improve the processing and storage processes to produce anchovies that meet export quality and are not constrained during the rainy season by building a greenhouse and cold storage.
2. There is a need for socialization and counseling to fishers and owners of anchovy processing facilities related to effective, efficient, and hygienic handling and processing of anchovy and sorting fish based on the quality of the anchovies produced.

3. Many anchovies are scattered and wasted during the drying process, so a container or drying place is needed to accommodate and prevent the anchovy from falling or being scattered (using waring or a tighter base), so the loss of production can be avoided.

4. Support from local governments and related agencies and the private sector is needed regarding adequate closed areas for the drying and storage of anchovy.

5. It is necessary to establish a central warehouse shipping information system (Figure 10) for anchovy as a form of a one-stop selling system so that actors (fishers, processors, and buyers) can find it easier to supply anchovy stocks and marketing, as well as make cooperation agreements between the actors involved. It will be very useful to support a good and transparent production, distribution and marketing process. It will also provide accurate data and information related to anchovy production. This system can take the form of an institution where the members combine anchovy processors or fishers. The delivery of anchovies to Jakarta is carried out simultaneously using the concept of less container load (LCL), where one shipping place is used together to reduce distribution costs. In this central warehouse, anchovy will be grouped based on type, size, and quality. This grouping will cause the production volume of anchovies to be more so that delivery does not require a relatively long time. This system will also support the same price for anchovies. So, when entrepreneurs or consumers need information about prices, production volumes, sizes, types, and quality of anchovy, it is enough to access the central warehouse.

![Figure 10. Concept of central warehouse shipping information system.](image)

The central warehouse is very important for developing anchovies in the future. Supply chain management contains material flow and information flow. Supply chain management must take care of the materials flows from production sources to the consumer end. On the flow of information, information technology allows supply and demand data quickly to get and can increase a product's level details [13]. Supply chain management reduces costs; however, perhaps the most important thing is that supply chain management can provide excellent competition with more demanding and critical responsiveness to consumers. Supply chain management is a concept already considered established and has been widely adopted to gain an edge competitive [14].

The institution's establishment is an effort to overcome the problem of information gaps and the weak bargaining position of fishers and processors on the selling price of fish [8]. The distribution of fishery products must be optimal to reduce costs. Fishery products involve high complexity in the supply and
distribution chain, from production to consumers. Maintaining nutritional value is very important so that quality and benefits are maintained, and avoid fish damage or disease. This leads to the final quality of the fish in the hands of the customer.

4. Conclusion
Catching anchovy in the Sunda Strait is carried out by lift net (boat, floating, and stationary lift net). Supply chain actors in anchovy fishery are lift-net fishers, catch carrier fisher, fishing unit owners, processors, capital owners, suppliers, distributors, wholesalers, and retailers. There are four types of anchovy supply chains on the coast of Sunda Strait. Management model anchovy fishery is reflected in the conceptual/purposeful model human activity system. The anchovy logistics system comprises four subsystems: (1) the capture and processing subsystem, (2) the logistics network subsystem, (3) the quality control and assurance subsystem, and (4) the management subsystem.

Anchovies logistic system needs to improve processing (drying and sorting fish) and create a central warehouse for an integrated logistics system. The central warehouse will be very useful to support a good and transparent production, distribution, and marketing process. It will also provide accurate data and information related to anchovy production. It is also required to conduct socialization and training on effective, efficient, and hygienic handling and anchovy processing to meet export quality and strengthening fishing institutions.

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