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Analysis of the Effectiveness of the Tilapia Fish Supply Chain in Supporting the Development of Fisheries Entrepreneurship in Pinrang Regency

Rivaldi Sukman[1], Sudarmi[1], Agus Syam[1,*]
[1]Universitas Negeri Makassar
*Correspondence: agus.syam@unm.ac.id

Abstract: This study aims to analyze the effectiveness of the tilapia supply chain in supporting the development of fisheries entrepreneurship in Pinrang Regency and to identify the product flow, information flow, and financial flow that occurs in each supply chain actor. This study uses a qualitative approach with the Supply Chain Operations Reference (SCOR) method. Data were obtained through observation, in-depth interviews, and documentation of tilapia farmers, distributors, and retailers using a snowball sampling technique. Data analysis was carried out through the stages of data reduction, data presentation, and drawing conclusions based on indicators of operational efficiency, responsiveness, quality, cost, and innovation. The results show that the tilapia cultivation process in Pinrang Regency is carried out in two stages: nursery and grow-out. The supply chain involves farmers, distributors, retailers, and end consumers. Product flow occurs from farmers to consumers, financial flow flows from consumers to each supply chain actor, while information flow occurs two-way through the exchange of information regarding prices, demand, quality, and product availability. Although the supply chain system has been running quite well, there are still obstacles such as price fluctuations, changes in water quality due to weather conditions, and distribution distances that affect operational efficiency and product quality. Research findings indicate that improving coordination between supply chain actors, managing cultivation quality, and improving distribution systems play an important role in increasing supply chain effectiveness while supporting the development of fisheries entrepreneurship in Pinrang Regency.

Keywords: Financial Flow; Information Flow; Product Flow; Supply Chain; Tilapia.

A. Introduction

Indonesia is the world's largest archipelago, with approximately 17,504 islands and a coastline of 104,000 km. Indonesia's maritime territory covers approximately 3.544 million km², or approximately 70% of the country's total area (Indonesia, 2009). This geographical location makes the fisheries sector a strategic sector with significant potential to support national economic growth. According to Undang-Undang Dasar No. 45 of 2009, fisheries encompass all activities related to the management and utilization of fish resources, from production and processing to marketing, carried out within a fisheries business system (Agus, 2018). Despite its vast resource potential, the welfare of fisheries business actors, particularly fish farmers and fishermen, remains relatively low (Latif et al., 2025). One reason for this is the lack of integration of production systems from upstream to downstream, resulting in suboptimal business efficiency and added value for key players (Tahir et al., 2025).

One approach to improving the efficiency of the fisheries business system is through the implementation of supply chain management (Haque et al., 2023). Supply chain management is a process that integrates the planning, coordination, and control of all activities within the supply chain to meet consumer needs cost-effectively (Jacobs & Chase, 2024). This concept focuses not only on product flow but also encompasses the interconnected flow of information and finances, from raw material suppliers to the final consumer (Wang et al., 2024).

In practice, supply chain management for fishery commodities still faces various challenges (Chea et al., 2023). Frequent problems include uncertain harvest times, fluctuating fish prices, unstable product quality, and weather and climate factors that impact the cultivation process (Suleha et al., 2025). Furthermore, the distance between fish farmers and marketing locations, as well as suboptimal harvest and post-harvest handling, also impact fish quality and the timely fulfillment of customer demand (Islam et al., 2026). These various conditions contribute to suboptimal supply chain performance, necessitating a performance measurement system capable of evaluating the efficiency and effectiveness of each activity within the supply chain (Azrul et al., 2025). Performance measurement aims to support strategy development, performance evaluation, and decision-making at the strategic, tactical, and operational levels (Jufri et al., 2024).

In line with previous research, supply chain performance measurement is necessary as a basis for evaluating and improving distribution systems to increase the efficiency, effectiveness, and competitiveness of fishery commodities (Syahputra et al., 2023). According to Efani et al. (2024), performance measurement is a process for assessing the level of efficiency and effectiveness of an activity, thus identifying aspects that need to be maintained or improved.

One freshwater fishery commodity with significant development prospects in Indonesia is tilapia (Oreochromis niloticus). Tilapia is a widely cultivated commodity due to its high economic value, relatively fast growth, and increasing market demand (Najib et al., 2024). The increase in public fish consumption is also supported by the Movement to Promote Eating Fish (Gemarikan) program launched by the Ministry of Maritime Affairs and Fisheries. This situation makes tilapia cultivation a sector with the potential to increase community income while meeting national food needs.

Pinrang Regency is one of the regions in South Sulawesi Province with significant potential for tilapia cultivation. Tilapia cultivation products from this area are marketed through distributors to meet consumer demand in various regions of South Sulawesi. However, the tilapia supply chain system in Pinrang Regency still faces various challenges, including price fluctuations, inconsistent product quality, relatively long distribution distances, and suboptimal coordination between supply chain actors. These issues have the potential to reduce distribution efficiency, increase operational costs, and impact farmer incomes.

Therefore, an analysis of the tilapia supply chain system in Pinrang Regency is necessary to understand how product flow, information flow, and financial flow occur at each link. This analysis is expected to provide a picture of the actual condition of the supply chain and identify various constraints affecting its performance. The results of this study are expected to inform decision-making for business actors and related

parties to improve the efficiency, effectiveness, and sustainability of the tilapia supply chain system in Pinrang Regency.

B. Literature Review

1. Supply Chain

A supply chain is an organizational system for distributing goods to customers. A supply chain is a network of interconnected organizations that aims to regulate the proper distribution of goods (Nurhikmah et al., 2026). Supply chain is a field of study that encompasses the planning and management of all actions related to supplier selection, procurement, and all other logistical activities. This includes collaborating with a network of partners such as agents, suppliers, third parties, and consumers (Atiqoh et al., 2024). The supply chain consists of everyone working to fulfill customer demand and generate profits, including transportation, warehousing, retailers, manufacturers, and the customers themselves (Rahmawati et al., 2025). However, the supply chain consists of three constant flows: information, goods, and money (Anwar, 2011). A supply chain consists of several key elements that are interconnected and work together to produce and distribute products or services to end consumers (Aliahmadi et al., 2022). According to Mentzer et al. (2001), the main elements in a supply chain include:

a. Suppliers: Suppliers are entities or organizations that provide raw materials, components, or products to companies or manufacturers in the supply chain. Suppliers play a crucial role in ensuring the availability of raw materials needed for production.
b. Manufacturers: Manufacturers are entities that source raw materials from suppliers and transform them into finished products. They are responsible for the production process and product quality control.
c. Distributors: Distributors are intermediaries in the supply chain that help distribute products from manufacturers to various points of sale, such as wholesale stores or e-commerce platforms. They play a crucial role in bridging the gap between manufacturers and retailers.
d. Retailers: Retailers are entities that sell products directly to end consumers. They encompass a wide range of businesses, including brick-and-mortar retail stores, e-commerce websites, and others. Retailers are responsible for ensuring products are available to consumers and meet customer demand.
e. Consumers: Consumers are individuals or organizations that use or consume products or services provided by the supply chain. They are the end of the supply chain and the ultimate goal of all efforts within the chain.

The relationships between these elements in a supply chain are often complex, and effective supply chain management requires effective coordination, collaboration, and information management across the entire supply chain. In addition to these primary elements, a supply chain can also include additional elements such as logistics providers, service providers, and other related organizations that can impact the flow of products or services. All of these elements work together to ensure that products or services reach end consumers efficiently and meet their needs (Ihsan & Derosya, 2024).

2. Strategic Supply Chain Objectives

Pujawan and Mahendrawathi (2010:31) state that supply chain management is inseparable from strategic objectives within the supply chain. Strategy cannot be separated from long-term objectives (Kurniawan & Rahmawati, 2022). These objectives are expected to be achieved. Short-term and local decisions should support the organization or supply chain in achieving these strategic objectives (Wisner et al., 2023). These strategic objectives must be achieved to enable the supply chain to win, or at least survive, in market competition. According to Monczka et al. (2021) to win market competition, the supply chain must be able to provide products that are:

a. Affordable

The supply chain must be able to reduce costs without sacrificing quality. Competitive pricing is a crucial factor because consumers tend to be price-sensitive. An efficient supply chain can reduce production, distribution, and storage costs, measured by unit production costs, logistics costs, and feed efficiency (low FCR). In this case, the strategies that must be implemented are production process optimization, efficient

inventory management, and economical supplier selection.

b. Quality

Products must meet customer standards and expectations. Quality determines customer satisfaction and loyalty. Low-quality products will struggle to compete, even if they are affordable. This can be measured by product defect rates, customer satisfaction, and quality standards (e.g., size, freshness, and product health). Strategies that must be implemented include strict quality control, process standardization, and raw material monitoring.

c. Timeliness

The supply chain's ability to meet demand on time. Delays in delivery can result in lost customers and undermine market confidence. This can be measured by lead time, on-time delivery, and order fulfillment time. Strategies that must be implemented include an efficient distribution system, demand forecasting, and sound transportation management.

d. Varied

To achieve these goals, the supply chain must be able to translate the above objectives into the capabilities of its resources. To support the success of the supply chain, several strategic objectives of the supply chain must be considered.

3. Supply Chain Performance

Supply chain performance is a measure of the extent to which a company's supply chain functions efficiently and effectively in achieving its business objectives (Russell & Taylor, 2023). Supply chain performance evaluation involves various aspects, including operational efficiency, responsiveness to market changes, product quality, delivery reliability, and customer satisfaction (Naja Anwar, 2013).

Supply chain performance is the result of the work achieved by various parties involved in carrying out tasks. To meet demand, improvements in supplier management and supply chain management are necessary to support current market developments (Yolandika et al., 2021). As the market grows, customer needs are increasing, so supply chain management must focus on integrating and managing the flow of goods, services, and information to respond to customer needs while reducing total costs (Wang et al., 2024).

Good performance in terms of responsiveness means the supply chain can respond quickly to market changes or changing customer needs (Snyder et al., 2024). The quality of products or services produced by the supply chain is a critical factor in measuring performance. This includes customer satisfaction levels, product defect or failure rates, and the ability to meet established quality standards (Ivanov, 2024). With an increasing focus on sustainability, supply chain performance is also measured in the context of environmental and social sustainability. This includes practices that support the environment, work ethics, and corporate social responsibility (Bowersox et al., 2022). According to Liputra et al. (2018), some important aspects of supply chain performance are as follows:

a. Operational Efficiency: Operational efficiency encompasses the supply chain's ability to conduct daily operations at minimal cost while maximizing resource utilization. Experts generally measure this efficiency using ratios such as operating costs to revenue or inventory costs to inventory value.
b. Responsiveness: Responsiveness measures the extent to which a supply chain can respond quickly and effectively to market changes, customer demand, or changes in external conditions. Experts often measure responsiveness using indicators such as order fulfillment cycle time or late delivery rates.
c. Quality: The quality of products or services produced by a supply chain is a critical aspect of performance. This encompasses quality control at all stages of the supply chain, including supplier selection, production, and delivery. Experts can use metrics such as defect rates or reclamation rates to measure quality.
d. Delivery Reliability: Delivery reliability encompasses the supply chain's ability to deliver products on time and according to customer orders. Experts can measure reliability by calculating on-time delivery rates or order fulfillment rates.
e. Costs: Cost management in the supply chain is a critical element of performance. Inventory costs, transportation costs, and inventory costs are all important factors. Production

costs are factors that must be managed well to maximize profitability. Experts can measure costs using various financial metrics.

f. Innovation: Innovation in the supply chain is an increasingly important aspect. Innovation can include the use of new technologies, the development of new products, or improvements to more efficient processes. Experts can measure innovation by looking at the rate of adoption of new technologies or the number of innovative ideas implemented.
g. Sustainability: Good supply chain performance also encompasses environmental and social sustainability. This includes efforts to reduce environmental impact, ensure ethical work practices, and support local communities. Experts can measure sustainability by calculating a company's carbon footprint or evaluating its social policies.
h. Customer Satisfaction: Customer satisfaction is one of the most important performance measures. Experts can use customer satisfaction surveys, customer retention rates, or customer complaint rates to measure customer satisfaction.

4. Supply Chain Operations Reference Model (SCOR)

In supply chain management (SCM) activities, companies potentially face various risks. Examples include raw material shortages, supplier failures, raw material price increases, equipment breakdowns, order uncertainty, changes in demand, transportation failures, and the like (Dutta et al., 2023). These various risks have the potential to occur, and if they do occur, they can impact a company's SCM performance.

SCOR (Supply Chain Operations Reference) is a process reference model developed by the Supply Chain Council as a diagnostic tool for supply chain management. SCOR can be used to measure a company's supply chain performance, improve its performance, and communicate it to all parties involved. SCOR is a management tool that covers everything from suppliers to customers (Setiadi, 2018).

To address these risks, companies need an appropriate approach, such as Supply Chain Risk Management (SCRM). Currently, SCRM has evolved into various different models. One example is the Supply Chain Operations Reference (SCOR) Model developed by the Supply Chain Council (SCC) in 1996.

The SCOR model encompasses at least four domains: interactions between all suppliers and customers, all physical material transactions, all market transactions, and the returns process. To achieve coverage of these four domains, companies need to incorporate the six management processes in the SCOR model: Plan, Source, Make, Deliver, Return, and Enable. Achieving SCOR model coverage also requires an effective approach at every stage of the process, including practices, performance, and human resource (HR) skills.

Throughout the supply chain process, companies face various risks that can impact the operation of the supply chain. These risks can stem from the condition of inventory, products, or equipment used. These risks can have a significant or minor impact depending on their nature. Examples of these risks include loss of contents or weight loss of product in containers, contamination of product packaging, reduced production output due to inventory disruptions, and so on. In fact, these risks can persist until the product reaches the end consumer (Hanugrani et al., 2023).

The SCOR model plays a key role as a foundation for understanding supply chain strategy and operations (Argarini et al., 2019). When risks occur in the supply chain, companies are prepared to operate, identify all parties involved, and analyze their supply chain performance. However, beyond this primary role, the SCOR model also serves as:

a. A tool for gathering necessary information for the company.
b. A supporter of management decision-making.
c. A basis for supply chain management improvement projects.
d. Understandable by all elements and functions within the company.
e. Enabler for linking various activities with appropriate measures or metrics because it uses standard terminology and notation.

The SCOR (Supply Chain Operation Reference) model is used to view supply chain activities. A process-based reference model commonly used to assess supply chain performance is the Supply Chain Operations Reference (SCOR) model. The advantage of the SCOR model lies in its ability to

link business processes, performance metrics, standard practices, and people skills into a unified structure (Liputra et al., 2018).

The SCOR model also serves as a foundation for supply chain management improvement projects by:

a. Identifying processes in a language that is understandable to all elements within the organization and functions.
b. Using standard terminology and notation to facilitate communication.
c. Linking various activities to appropriate measures or metrics (Febriana et al., 2011).

The elements of the SCOR (Supply Chain Operations Reference) Model play a key role in influencing Supply Chain Risk Management (SCRM) performance. Here is a brief overview of these elements:

a. Reliability: Reliability refers to the supply chain's ability to deliver consistent and timely results. It also contributes to reducing variation in order fulfillment. Reliability in the SCOR Model encompasses on-time delivery, quantity delivery, and quality delivery. Reliability enables perfect order fulfillment, that is, delivering the right product, to the right place, at the right time, and in the right condition to the right customer.
b. Responsiveness: Responsiveness relates to how quickly the supply chain can respond to changes and disruptions. The SCOR model measures response speed and evaluates how quickly tasks are executed. This speed must be consistent throughout a company's operations.
c. Agility: Agility refers to the supply chain's ability to adapt to unexpected external changes. This includes changes in demand, supplier operational disruptions, natural disasters, regulatory changes, labor issues, and other uncertainties. Agility enables the supply chain to remain flexible and responsive to market changes.
d. Cost: Cost reflects the value incurred to carry out business processes within the supply chain. This includes various costs such as raw materials, labor, overhead, transportation, and others. The SCOR model enables companies to measure and manage operational costs efficiently. This includes the total cost to serve and helps measure customer-focused performance.
e. Asset Management: Asset management relates to the efficient and effective use of a company's assets. This includes inventory management, production decisions (insourcing vs. outsourcing), and working capital management (Aunyawong et al., 2020).

C. Methods

This study used a qualitative approach to describe and analyze the tilapia (Oreochromis niloticus) supply chain system in Pinrang Regency. The study was conducted in Alitta Village, Mattiro Bulu District, Pinrang Regency, South Sulawesi Province. The research informants consisted of tilapia farmers, distributors, and retailers directly involved in supply chain activities. Informants were selected using a snowball sampling technique, with subsequent informants being recruited based on recommendations from previous informants.

The data used in this study consisted of primary data obtained through in-depth interviews, field observations, and documentation. Interviews were conducted semi-structured using an interview guide to obtain information on product flow, information flow, financial flow, and supply chain activities carried out by each actor. Observations were used to directly observe the tilapia cultivation, distribution, and marketing processes, while documentation served as supporting data in the form of photographs, field notes, and documents related to the research.

Data analysis was conducted descriptively, referring to the Supply Chain Operations Reference (SCOR) model. The analysis focused on mapping product flows, information flows, and financial flows, as well as evaluating supply chain performance based on indicators of operational efficiency, responsiveness, quality, cost, and innovation. The analysis phase included data reduction, data presentation, and conclusion drawing to obtain a picture of the condition of the tilapia supply chain in Pinrang Regency and the issues affecting its performance.

D. Result and Discussion

Results Interview

This study focuses on analyzing the tilapia (Oreochromis niloticus) supply chain in Pinrang Province, with particular attention to the products, information, and financial transactions that occur between participants. Tilapia is a leading freshwater commodity with high economic value and a crucial role in meeting the needs of the general public. As a tilapia-producing region, Pinrang Regency has significant potential for business development, but still faces numerous challenges in its supply chain.

The tilapia supply chain in Pinrang Regency faces numerous challenges, including uncertain harvest times, price fluctuations, inconsistent product quality, long distribution distances, and technical issues during the harvest and post-harvest processes. These conditions indicate that the tilapia supply chain system is not well managed, impacting business efficiency and farmer income.

1. Research Results On The Supply Chain Analysis Of Tilapia Fish In Pinrang Regency

In this study, the researcher will describe the results of a study on tilapia fish farmers in Pinrang Regency. These results will be divided into several sections according to the focus and method described in the Supply Chain Operational Reference Standard (SCOR): operational efficiency, responsiveness, quality, cost, and innovation.

a. Operational Efficiency

Operational efficiency is the ability of an organization, company, or work unit to optimally utilize resources (time, labor, costs, materials, and technology) to produce maximum output with minimal waste.

Tilapia production in Pinrang Regency is carried out using two systems: nursery cultivation and grow-out cultivation. Nursery cultivation involves raising tilapia larvae purchased from farmers in various regions in Indonesia. Grow-out cultivation involves raising fish until they reach a weight that meets market demand, or more specifically, is suitable for consumption. The size of tilapia typically sold for consumption from farms in Pinrang Regency varies from 0.25 kg to 0.50 kg (2-4 fish/kg).

Figure 1. Tilapia Fishing Results

The production process for tilapia fish farmers, starting with the nursery stage, involves several stages. First, a dedicated nursery pond must be prepared to raise the tilapia fry to one month of age, before they are then stocked in several larger grow-out ponds to optimize growth without compromising the stocking capacity per pond. This is corroborated by an interview with Mr. Aswar, a pond owner in Pinrang Regency, who stated, "In this cultivation process, we implement two maintenance phases: the nursery phase, where we raise the fish from 6 days old to 30 days old, or until they reach the specified size. The second phase, the grow-out phase, where the fish are stocked in several grow-out ponds and then cared for until they meet market demand," said Mr. Aswar on April 26, 2026.

b. Responsiveness

Responsiveness in tilapia fish farming is the farmer's ability to detect changes in pond conditions and take immediate and appropriate action to ensure optimal fish health, growth, and survival.

Figure 2. Water Conditions At The Cultivator's Location

The water at the farm comes from drilled wells drilled by the farmers to distribute water to each pond. This is because the nearest river is located in a rice field, and there's a high risk of pesticide

contamination, which can kill fish. During the dry season, the water becomes oxygen-deficient due to the high temperature, making it difficult for fish to adapt and ultimately lead to fish death. The rainy season also presents a challenge, as rainwater mixing with the water can lead to high acidity, which can inhibit tilapia growth and even lead to fish mortality. This argument was supported by Mr. Aswar, a tilapia fish farmer, who wrote on April 26, 2026, "Usually, during the rainy season, many fish die due to declining water quality, especially acidity. However, in actual fish farming, there are many common obstacles due to declining water quality caused by fish waste and leftover feed, which pollute the water, or what we call ammonia. This can lead to sudden fish deaths, but this can be prevented by regular water changes."

c. Quality

Quality measurement in tilapia fish farming is the process of assessing how well farming practices are carried out to produce fish that are healthy, uniform in size, safe to consume, and have a high market value. In this case, the quality measurement of tilapia fish farmers is carried out using four main indicators:

1) Water Quality

The results of an interview conducted with a pond owner, where Mr. Aswar stated on April 26, 2026, "water quality greatly affects tilapia cultivation because water quality problems can cause fish deaths and also affect the growth rate of fish." Similarly, another pond owner, Mr. Saung, stated on April 26, 2026, "water is often toxic to fish, and fish often die due to poor water quality."

2) Measuring Fish Growth

To determine the success of tilapia cultivation, the average weight of the fish, which is 10-20% of the population, is measured, along with the length of the fish, and the growth rate. The faster the tilapia grows, the better the quality of the culture.

3) Survival Rate (SR)

$$SR = \frac{N_t}{N_0} \times 100$$

$$SR = \frac{1200}{1500} \times 100$$

$$SR = 80\%$$

Description:

Nt = final number of live fish

N0 = initial number of fish

Good standard: 80–90%

In this case, field interviews indicate that the Survival Rate (SR) calculation is often used by farmers to assess the survival rate of tilapia after the stocking period and to determine the number of surviving fish. Based on the calculations, it can be concluded that the survival rate in tilapia farming is very high. This was validated in the field by interviewing Mr. Saung, a farmer in Pinrang Regency, on April 26, 2026. "This SR is very important because it allows us to monitor the survival rate of the fish and also allows us to adjust the feed portion for the fish. It also allows us to assess the success rate of this business, whether it is a profit or loss."

4) Feed Efficiency (Feed Conversion Ratio/FCR)

$$FCR = \frac{F}{(W - X)}$$

$$FCR = \frac{2.250kg}{(2.700\text{kg} - 2.250\text{kg})}$$

$$FCR = 0{,}7854 = 0{,}8\%$$

Description:

F = amount of feed

W = final biomass

X = initial biomass

Interpretation:

FCR (>1.5 indicates efficient feed use), while (<1.5 indicates inefficient feed use), can be concluded that feed use is efficient. A high FCR indicates inefficient feed use and can result in feed waste.

Figure 3. Interview with a Tilapia Fish Feed Supplier

An interview with Mr. Aswar on April 26, 2026, stated that "At the beginning of stocking, we stocked around 5,600 fish (180 kg), and the amount of feed given from the beginning until harvest was around 75 sacks. Each sack is 30 kg, so the total feed was around 2,250 kg. The harvest was around 2,900 kg, so the remainder was simply included in the formula." From the calculation above, it can be concluded that the FCR level was low.

d. Costs

The costs of tilapia cultivation are dominated by feed, followed by seed, and energy. Good cost management is crucial for profitability, so farmers must control feed, water quality, and stocking density to keep the cost per kilogram of fish low. On Monday, April 26, 2026, Mr. Aswar stated that, "Our costs are very limited here, so we focus on stocking, feed stocks, and operational issues. For example, we limit daily fish feeding and limit the population in each pond, taking into account available capital." Similarly, Saung, a fish farmer, stated, "When it comes to costs, we simply adjust them based on the number of fish and feed."

e. Innovation

Mr. Aswar explained this on April 27, 2026, saying, "Innovation here is not much different from other fish farmers. We focus on accelerating fish growth and speeding up the harvest period. To do this, we add water wheels to meet the fish's oxygen needs, ensuring their health, and ensuring effective feeding." This contrasted with La Suang's statement on April 27, 2026, who stated, "My innovation differs from Mr. Aswar's because, to accelerate fish growth, we don't add water wheels, but rather reduce the stocking density so the fish can move freely and experience rapid growth."

2. Identification Of Actors In The Tilapia Supply Chain In Pinrang Regency

The actors involved in the tilapia supply chain in Pinrang Regency include:

a. Fish Farmers

Fish farmers sell their tilapia by visiting collectors who buy large quantities from Pinrang Regency and outside the Pinrang area, including restaurant owners and local residents.

Based on an interview with Mr. Aswar, he stated that "The collectors come directly to our ponds to harvest the tilapia, and then they catch the fish themselves using fishing gear such as fishing nets."

In this case, there is no standard quantity to purchase. The selling price from farmers is based on the weight (kilograms) of tilapia purchased. Market demand during holidays also significantly influences the selling price. "From an interview with Mr. Rusman, they stated that "collectors take an irregular amount of fish, usually 200 kg per day, sometimes up to 1 ton." Fish farmers typically sell at varying prices, ranging from Rp. 25,000 to Rp. 30,000 per kilogram, but around holidays, they can sell for up to Rp. 30,000 to Rp. 35,000 per kilogram. Based on the interview, Mr. Aswar stated that "the price of tilapia here varies and is relatively common.

Figure 4. Interview with Fish Farmers

Collectors adjust the price based on the size of the fish. For example, a price of 7-9 kg is bought for Rp. 15,000, a price of 5-6 kg is bought for Rp. 25,000, and a price of 2-4 kg is bought for Rp. 30,000. However, some collectors also buy fish of size 2-9 kg for Rp. 30,000. Payment is usually made by the distributors, who usually pay cash and wait for the fish to be sold at the market before paying."

b. Distributor

The volume of tilapia purchased by Distributors charge between 200 and 1,000 kilograms per transaction. Purchases are made at fish farmers' premises. The purchased fish are then resold in smaller quantities to retailers in traditional markets in Pinrang Regency and other regencies such as Sidrap, Pare-Pare, Enrekang, and the surrounding areas. The distributors cover transportation costs. An interview with H. Kadong on April 27, 2026, stated, "We go directly to the fish farmers' ponds to buy fish, complete with fishing gear, fish boxes, and ice."

The fish are purchased dead. The fish purchased by distributors from farmers are packed in 50-kilogram boxes, then iced to maintain quality, before being sold to retailers. Payment is made from wholesalers to fish farmers in cash upon receipt of the fish, which are wholesalers on weekdays generally ranges from IDR 27,000 to IDR 32,000 per kilogram. A common risk faced by wholesalers is when selling Retailers in traditional markets must wait until the fish are sold, after which the wholesaler receives

payment. According to an interview with H. Kadong, "I usually distribute fish directly to market sellers according to their selling capacity. One box has a capacity of around 50 kg. Some market sellers usually take two boxes, some take one box, and some take three to five boxes. We also sell to areas like Palu, Majene, and Toraja. Market traders usually pay cash, while others wait until the fish are sold before paying."

c. Retailer

In the tilapia supply chain, a retailer is a trader who purchases fish from collectors or distributors and then sells it directly to consumers in traditional markets, modern markets, or fish stalls. Retailers function to shorten the distance between products and consumers and ensure the availability of fish at the market level. In this regard, an interview with Mr. Ulla, a retailer in Pinrang Regency, on April 27, 2026, stated, "Our daily consumption at the market is around 4-5 boxes, each with a 50 kg capacity scale. I order the fish directly from the collector the day before selling.

The fish are purchased dead. The fish purchased by the retailer from the distributor are packaged in 50-kilogram boxes, then iced to maintain quality, and then sold to the retailer. The payment system from the retailer to the distributor is a loan after all the fish are sold at the market, followed by payment to the distributor. This was validated by Mr. Ulla on April 27, 2026, "I usually borrow the fish for a day before paying the collector. I also pay cash immediately after the fish arrive." Retailers' selling prices on weekdays generally range from Rp. 35,000 to Rp. 40,000 per kilogram, in this case across all supply chains. The supply chain involved retailers represents the chain with the highest sales to the end consumer.

d. Consumers

Consumers are the final actors in the supply chain. Consumers in this supply chain channel are the general public who purchase tilapia for consumption. Based on observations of the tilapia supply chain, consumers purchase this product from local communities and the general public. In this case, consumers purchase fish at prices determined by all actors in the supply chain.

Discussion of Research Results

The distribution channels in the tilapia supply chain in Pinrang Regency illustrate the flow of product, finance, and information between members of the chain. The three channels in this tilapia supply chain are as follows:

1. Channel I: Fish Farmers – Consumers

The first supply chain channel in the marketing of tilapia commodities in Pinrang Regency consists of fish farmers as producers and end consumers. The channel design used in this first supply chain channel is a zero-level channel, where producers, in this case fish farmers, directly sell tilapia commodities to end consumers. There are product flows, information flows, and financial flows that occur in the following figure:

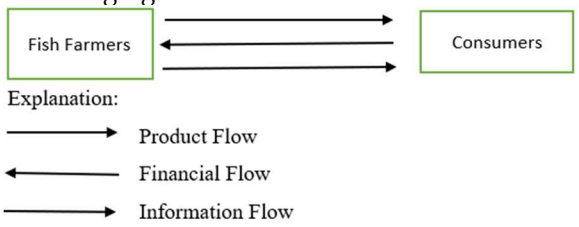

Figure 5. Product flow, financial flow, and information flow in channel 1

Channel I of the tilapia supply chain begins with farmers selling their produce directly to end consumers. Product flow occurs without a set purchase quantity, as it depends on consumer demand and harvest availability, which is influenced by the 4–5 month cultivation cycle and various production risks. Financial flows occur from consumers to farmers through a cash payment system with prices ranging from IDR 30,000–IDR35,000 per kilogram. Meanwhile, information flows in both directions, including information on demand quantities, product availability, prices, and purchase times, communicated through telecommunications media so that farmers can meet consumer demand while maintaining fish quality.

2. Channel II: Fish Farmers – Distributors – End Consumers

The second supply chain channel for tilapia marketing in Pinrang Regency consists of fish farmers, distributors, and consumers. The channel design used in this supply chain channel is a second-level channel, where distributors sell

to end consumers. In this second-level channel, distributors sell to end consumers through traditional markets in Pinrang, Sidrap, and surrounding regencies. There are product flows, financial flows, and information flows that occur in this second-level supply chain channel. The form of flow that occurs in the second-level supply chain channel can be clearly seen in the following figure:

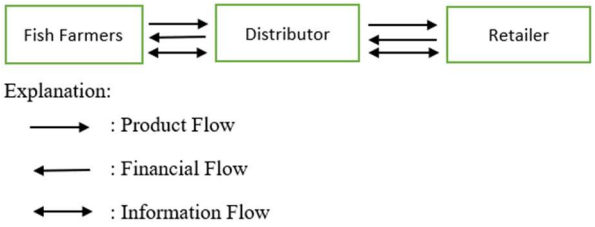

Figure 6. Product Flow, Financial Flow, And Information Flow In Channel II

In channel II, the product flow begins with tilapia farmers in Pinrang Regency who sell their products to distributors who also act as retailers in traditional markets. Distributors purchase a minimum of 100 kg of fish, or approximately 300–400 fish, then distribute them to retailers for sale to end consumers. Financial flows occur from distributors to farmers and from end consumers to retailers through a cash payment system. The selling price of tilapia from farmers to distributors ranges from IDR 25,000–IDR 30,000 per kilogram, while the price from distributors to retailers ranges from IDR 32,000–IDR 35,000 per kilogram. Meanwhile, information flows in both directions through telecommunications media, including information on stock availability, demand, prices, and fish collection times. This information serves as the basis for coordination between farmers and distributors to ensure product availability and maintain the quality of fish distributed to consumers.

3. Channel III: Fish Farmers – Retailers

The third supply chain channel in the marketing of tilapia in Pinrang Regency consists of fish farmers and retailers. The channel design used in this supply chain is a three-level channel, where farmers sell to retailers. In this third-level channel, farmers sell to retailers directly at the farmers' premises. The flow patterns in the third supply chain channel can be clearly seen in the following figure:

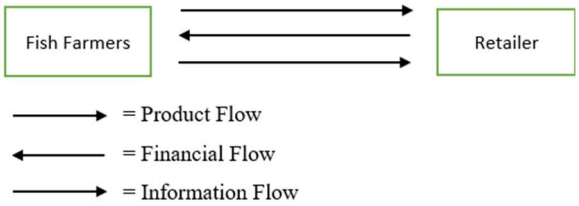

Figure 7. Product Flow, Financial Flow, And Information Flow In Channel III

In channel III, product flow occurs from tilapia farmers in Pinrang Regency to retailers who buy fish directly without minimum quantity requirements, so that purchase volumes are adjusted to market demand. Financial flow occurs from retailers to farmers through a cash payment system when the fish are ready to be picked. The selling price from farmers to retailers ranges from IDR 30,000-IDR 33,000 per kilogram, while retailers resell to end consumers at IDR 35,000–IDR 40,000 per kilogram. Meanwhile, information flows between farmers and retailers through direct communication and telecommunications media, including information on demand volume, product availability, and price agreements based on market conditions and consumer demand.

E. Conclusion and Recommedation

Based on the research results and discussion outlined above, the following conclusions can be drawn regarding the tilapia supply chain in Pinrang Regency:

1. Fish Farmers: the product flow process is limited by the volume that can be produced each period. Therefore, farmers often experience losses from selling prices to distributors because the selling price to distributors is lower than selling directly to retailers or end consumers.
2. Distributors: distributors' purchasing decisions are adjusted to their daily sales capacity in traditional markets.
3. Retailers: retailers receive products from distributors and then resell them in traditional markets to end consumers. Although the product quantity is not large, the prices offered are higher than those offered directly by farmers.

4. The tilapia supply chain in Pinrang Regency consists of three distribution channels: channel I (farmers–end consumers), channel II (farmers–distributors–retailers–end consumers), and channel III (farmers–retailers–end consumers). These three channels include product flow from upstream to downstream, financial flow from downstream to upstream, and information flow that supports coordination between supply chain actors. The differences between each channel lie in the distribution mechanism, payment system, and number of actors involved. Channel II has a wider distribution reach and greater cash flow because it involves distributors as the main intermediaries, while channels I and III have shorter distribution chains, resulting in simpler transaction processes.

To improve the performance of the tilapia supply chain in Pinrang Regency, it is recommended that business actors begin utilizing digital technologies, such as the Internet of Things (IoT) and data analytics, to monitor production and predict market demand more accurately. Furthermore, farmers need to expand their marketing networks beyond existing markets to avoid relying on a few distributors or specific marketing areas. This step is expected to increase sales volume, expand market share, and boost revenue and the sustainability of tilapia farming businesses.

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