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A Study of the Fishery Logistics System in Fisheries Management Area (WPP) 715, Tomini Bay, Central Sulawesi

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Abstract: The Fish Logistics System (SLI) plays a crucial role in the efficient management of fisheries supply chains, covering all activities from procurement to distribution. This study aims to: estimate local fish consumption needs in Parigi Moutong, Poso, and Tojo Unauna Regencies; and analyze the traceability and logistics system, including production capacity (catch and cultivation) and distribution flows from fishermen to end consumers. Using a descriptive research design with qualitative and quantitative approaches, data were collected through surveys, in-depth interviews, and observations. The results show that Parigi Moutong and Tojo Unauna Regencies have a significant fish production surplus (Approximately 70.9 million kg) in 2024, while Poso Regency faces a deficit (of -7.8 million kg). The distribution flow includes local, regional, and national markets, with significant exports to Malaysia, Singapore, and Colombia. The study highlights the need to strengthen infrastructure and integrate supply chain management to optimize the fisheries potential of WPP 715, ensure food security, and boost regional economies.

Keywords: Central Sulawesi; Fish consumption patterns; Fish logistics; Fisheries balance sheet; Fisheries management; Fisheries supply chain; WPP 715

Introduction

The Fisheries Management Area of the Republic of Indonesia (WPP-RI) 715, especially those areas that include the waters of Tomini Bay, is known as a strategic maritime area with significant fishery resource potential for Indonesia (KKP, 2022; Pramudji, 2018). This area has bright prospects to be developed into a center of fisheries-based economic growth, especially for the Central Sulawesi Province area. Development efforts have focused on strengthening fisheries production centers, increasing added value through processing and preserving products, building an efficient marketing system, and providing other supporting activities in an integrated manner (DKP Sulteng, 2024). This development direction aligns with the national goal of increasing production volume, productivity, and quality of marine and fishery products, which in turn is expected to raise the income of fishery business actors (fishermen, cultivators, processors) in a fair and sustainable manner, as well as optimizing the sector's contribution to the regional economy (Yusrizal et al., 2020).

While the development goals are clear, several challenges exist. Factors such as the optimization of sustainable use of resources, price volatility, access to capital, skilled labor, inadequate infrastructure, and the seasonal nature of fisheries are obstacles that need to be addressed (Purwanto et al., 2019). Therefore, effective resource allocation, which considers both economic and social dimensions, becomes crucial. Modern fisheries management should no longer focus solely on maximizing income, but also on meeting market needs, ensuring equitable access, and creating jobs for coastal communities (Adrianto et al., 2019). Good strategic planning, as outlined in the Strategic Plan (RESTRA) document for marine and fisheries at the provincial and district levels, is essential for ensuring sustainable development (Yusrizal et al., 2020).

Central Sulawesi Province's per capita fish consumption is relatively high, reaching 68.20 kg/capita/year in 2023 (Ditjen PDSPKP, 2023). This high

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consumption can be attributed to increasing public awareness of the importance of fish in the diet, the effectiveness of government programs like the Fish Eating Community Movement (GEMARIKAN), and regulatory support (KKP, 2023). However, challenges remain in ensuring smooth distribution and access to fish, particularly in areas where logistical infrastructure is insufficient. A reliable Fish Logistics System (SLI) is critical to ensuring the efficient distribution of fish from catching or aquaculture to consumers' tables, stabilizing prices, and supporting equitable distribution (Setiawan et al., 2020; Nugroho et al., 2021; Ernan et al., 2022).

The districts of Parigi Moutong, Poso, and Tojo Unauna, as part of WPP 715, have specific fishery resource characteristics and utilization patterns. Market dynamics, including fluctuations in export volumes, suggest that the region's logistics system needs further development (DKP Sulteng, 2024). The market development from traditional to modern, driven by both private initiatives and government policies, requires a fisheries logistics system that is responsive, efficient, and able to guarantee product quality (Wiyono et al., 2023). Therefore, an in-depth study of the current state of the fish logistics system in these three districts is necessary to identify potential improvements and ensure sustainable fisheries development (Abidin et al., 2020).

This study specifically examines the estimated needs of local fish consumption and the fish logistics system in the three districts. By analyzing the supply-demand balance, distribution flows, and identifying challenges in the current logistics system, this study aims to provide recommendations for developing an integrated and efficient Fish Logistics System (SLI) for the region, which will support both local food security and broader economic goals.

Method

Time and Place of Research

This study employed a descriptive approach with a field survey method to examine the fish logistics system in the Fisheries Management Area (WPP) 715, focusing on three regencies: Parigi Moutong, Poso, and Tojo Unauna in Central Sulawesi Province. The research was conducted from August to October 2024, integrating both qualitative and quantitative methods to provide a comprehensive understanding of the logistics system in these regions.

To determine the specific study locations within each regency, the analysis was conducted at the village or sub-district level. These locations were selected based on the representativeness of significant fishery activities, such as catching, cultivation, processing, and marketing. Additionally, the presence of supporting fisheries infrastructure (e.g., fish landing sites and transportation networks) was considered to ensure a comprehensive analysis. This selection process followed specific criteria to ensure that the locations chosen were representative of the overall fish logistics system in the study area.

Determination of Respondents

The study used a purposive sampling method to select respondents, targeting individuals or groups with direct knowledge and involvement in the fish logistics system. These included fishermen, fish farmers, traders (collectors and retailers), entrepreneurs/exporters, household/small-scale fish product processors, and relevant local government officials. The respondents were selected to represent the key actors in the fish logistics chain across the three regencies.

To track the distribution flow, the tracing sampling method was applied. This method allowed the study to select trader respondents based on referrals from fishermen, ensuring that the entire logistics network, from fish production to final distribution, was adequately represented. A total of 100 respondents participated in the study, with the distribution across the six key stakeholder groups (fishermen, farmers, traders, processors, government officials, and exporters) being proportionally representative of the regions studied.

Data Collection Techniques

Primary data were collected through several techniques: Structured questionnaires were distributed to key stakeholders to gather quantitative information on fish logistics and consumption patterns; In-depth interviews were conducted with representatives from each stakeholder group to gain qualitative insights into the logistics system and the challenges they face; Direct observations were made of fish landing activities, post-harvest handling, buying and selling transactions, and the condition of logistics infrastructure, providing a comprehensive view of the fish supply chain. Additional documentation, including photos and field notes, was used to supplement the observational data, providing visual and contextual support to the study's findings.

Secondary data were collected through literature reviews, including scientific publications, official reports from government agencies (Provincial/Regency Marine and Fisheries Services, BPS), and other relevant documents. These secondary sources were used to complement the primary data, provide a policy context, and offer additional insights into the general conditions of the logistics system and regional challenges. The types of data collected included both cross-sectional and time-series data, whenever available, to ensure a robust analysis.

Data Analysis

The data analysis focused on two main objectives: First, the estimated local fish consumption needs were calculated by multiplying the latest population data (BPS Provinsi Sulawesi Tengah, 2024) with the regional

Fish Consumption Rate (AKI) per capita (Ditjen PDSPKP, 2023). The results of this estimate were compared with total fishery production data (catch and aquaculture) from the local Marine and Fisheries Service to determine the fish surplus or deficit balance in each district. The analysis also examined actual consumption patterns, considering factors such as accessibility and purchasing power, and tested the relationship between variables using correlation analysis.

Second, the fish traceability and logistics systems were analyzed using a qualitative descriptive approach based on a supply chain management framework. This approach included mapping supply chain flows, identifying key actors and their roles, and analyzing production centers, distribution channels, and the challenges within the logistics system. A key aspect of the analysis involved evaluating the traceability parameters such as the tracking system, time delays, and cost efficiency in the logistics network. These were measured based on interviews, observations, and secondary data (Wiyono et al., 2023; Pujawan & Mahendrawathi, 2017).

Results and Discussion

Condition of Fish Landing Infrastructure (TPI/PPI)

The availability and functionality of fish landing infrastructure, such as PPI (Pelabuhan Perikanan Induk) and TPI (Tempat Pelelangan Ikan), are crucial for supporting post-harvest activities and the efficiency of the fisheries supply chain. In Parigi Moutong Regency, one PPI (Paranggi) is reported to function well, but out of the 18 TPI facilities, only 4 are still actively operating, while the others are either damaged or non-functional. Poso Regency has one TPI (Gebang Rejo), which is not functioning optimally due to sedimentation and damaged infrastructure. On the other hand, Tojo Unauna Regency has three active TPIs (Malenge, Bahari, Labuan), which are operating relatively well. The limited number of operational TPIs in several locations is a significant obstacle for improving the efficiency of fish handling and marketing, which directly affects the overall logistics efficiency (Setiawan et al., 2020; Siregar et al., 2021).

Table 1. List of distribution and conditions of TPI/PPI in Parigi Moutong, Poso, and Tojo Unauna Regencies

TPI	Location		Information
	District	Village/Sub-District	
Parigi Moutong Regency			
Tambu	Sauce	Tambu	Inactive (no fish loading activity).
Trout	Trout	Trout	Missing (Affected by Natural Disasters
Boyanton	Paris Selatan	Boyanton	Missing (Affected by Natural Disasters
Maesa	Paris	Maesa	Inactive (no fish loading activity).
Kampal	Paris	Kampal	Active
Petapa	Paris Tengah	Petapa	Inactive (no fish loading activity).
Sienjo	Toribulu	Sienjo	Inactive (Severely damaged condition & no fish unloading activity
Kasimbar	Kasimbar	Kasimbar	Inactive (severely damaged)
Sigenti	Tinombo Selatan	Sigenti	Inactive (Severely damaged condition & no fish unloading activity
Silabia	Tinombo	Silabia	Inactive (no fish loading activity).
Tinombo	Tinombo	Siavu	Inactive (severely damaged)
Dusunan	Tinombo	Dusunan	Inactive (no fish loading activity).
Dongkalan	Brass	Dongkalan	Inactive (severely damaged)
Ambesia	Tomini	Ambesia	Inactive (far from the beach, converted by the local community into a kindergarten building)
Ogotion	Mepanga	Ogotion	Active (operating outboard motors and boats without motors as well as seaweed buying and selling activities)
Low	Bolano	Low	Active
Moutong Tengah	Moutong	Moutong Tengah	Inactive (severely damaged)
Labuan	Moutong	Labuan	Inactive (moderately damaged & no fish unloading activity.
Poso Regency			
Gebang Rejo	Poso Kota	Gebang Rejo	The pier is not functioning due to sedimentation, the gas station is broken, the ice factory & the administration room is still functioning.
Labuan	Malei Location	Labuan	Inactive (severely damaged)
Tojo Unauna Regency			
Labuan	Ampana City	Labuan	Active
Malenge	Walea	Malenge	Active
Bahari	Kepulauan Tojo	Bahari	Active

Source: Data processed, 2024

Estimation of Community Fish Needs and Consumption Patterns

Efforts to balance the availability of supply (production) with the demand (consumption) of fish require careful planning. The estimated fish consumption needs at the district level are calculated based on the projected population in 2024 (BPS Provinsi Sulawesi Tengah, 2024) and the Fish Consumption Rate (AKI) of Central Sulawesi Province in 2023 (68.2 kg/capita/year) (Ditjen PDSPKP, 2023). The comparison between total fishery production and estimated consumption needs produces an overview of the regional fisheries balance (Table 2).

Table 2. Estimated fish needs vs fisheries production in WPP 715 (3 districts), 2024

Regency	Population	Chicken	Production (tons)		Sum of Production (tons)	Estimated Fish Needs
			Catch	Cultivation		
Paris Moutong	457,031	68.2	39,797.8	49,746.92	89,544.72	31,169,514
Dregs	251,654	68.2	4,831.5	4,496.38	9,327.88	17,162,803
Tajo Unauna	169,000	68.2	15,854.2	8,226.39	24,080.59	11,525,800
Sum	877,685				122,953	59,858,117

Source: Data processed, 2024

The results of the analysis in Table 2 show a significant disparity. Parigi Moutong Regency and Tojo Unauna Regency were recorded to have a large fish production surplus, while Poso Regency experienced a deficit. This deficit condition logically requires Poso Regency to rely on fish supplies from other regions to meet the consumption needs of its people. The results of field observations confirm this, where the supply of fish for Poso comes from Tojo Unauna Regency and possibly also from Parigi Moutong. The large surpluses in Parigi Moutong and Tojo Unauna also explain the region's ability to supply regional markets as well as national and export markets.

A survey of households in the coastal area of Parigi Moutong Regency provides an overview of actual consumption patterns (Table 3). The majority of respondents (56.8%) consume fish in the range of 2-5 kg/capita/month. This level of consumption seems to be influenced by the accessibility of fish and the profession of the head of the family. The most consumed type of fish is marine fish (70.5%), especially small pelagic fish groups. The main source of fish acquisition is from own catch or cultivation (44.33%), followed by purchases from fishermen (22.26%) and traders/retailers (33.41%). The most common fish processing techniques were fried (46%) and smoked/grilled (28.33%).

Table 3. Characteristics of fish consumption of coastal communities (sample) in WPP 715 - Parigi Moutong

Characteristics of Fish Consumption	Percentage
Actual amount of fish consumption	
≤ 2 kg (capita/month)	-
2 - 5 kg (capita/month)	56.8
≥ 5 kg (capita/month)	43.2
Types of Fish for Consumption	
Freshwater fish	21.67
Seawater fish	70.5
Brackish Water Fish	7.83
Source of Fish Procurement	
Own catch/fish farmer	44.33
Fisherman	22.26
Traders/Retailers	33.41
Processed Fish Techniques	
Frying pan	46
Smoking/Baking	28.33
Drying	15
Fermentation	10.67

Source: Data processed, 2024

The correlation analysis (Table 4) between the number of family members and the average actual per capita fish consumption in the sample households in Parigi Moutong showed a very weak and statistically insignificant relationship ($p > 0.05$). These findings indicate that the actual quantity of fish consumption at the coastal household level is determined more by fish availability factors as well as preferences and

purchasing power capabilities, rather than simply by the number of family members.

Table 4. The relationship of family classification to the average fish consumption of coastal communities in Parigi Moutong Regency

Yes	Family Classification	Average Fish Consumption (kg/capita/month)	Correlation Test
1	Small family (≤ 4 family members)	5.7	Correlation coefficient[2] : ≤ 0.25 (very weak)
2	Small family (≤ 5 - 7 family members)	4.5	Significant influence[3] : 0.74 ≥ 0.05 (no effect)
3	Small family (≥ 8 family members)	4.8	

Information:
1) Central Bureau of Statistics (2023)
2) Correlation coefficient 0.043
3) Sig (2-tailed) 0.74

Source: Primary Data Processed, 2024

Fish Logistics and Supply Chain Systems at WPP 715

The fisheries supply chain in Fisheries Management Area (WPP) 715, especially in Parigi Moutong Regency, is supported by infrastructure such as PPI Paranggi and ice factories. Fishing boat fleets, especially using ring trawlers, can produce a catch of 5–10 tons per trip during peak season. Fish caught, especially pelagic types such as selar, mackerel, single, baby tuna skipjack, and cob, are mostly landed in PPI Paranggi and several other coastal areas.

Fishermen generally partner irregularly basis with local traders, who then distribute their catch to markets within the sub-district. For marketing out of Parigi Moutong, it is usually done by traders from Palu who have established subscriptions with ring trawl fishermen (Figure 1). In addition, fishery commodities from this region, both caught and aquaculture such as milkfish, are widely sent to Jakarta and Surabaya.

UD Frozen, a company based in Jakarta, receives almost 200 tons per month directly from Parigi Moutong. Meanwhile, PT Mahkota Samudera Jaya from Surabaya comes directly to Parigi to collect large pelagic fish and milkfish, which are then exported to Malaysia, Singapore, and Colombia. Shipments are carried out routinely every month by sea using refrigerated containers, with a total of 10–12 containers per month (Figure 2).

The flow of fisheries supply chains in this region, including from Poso and Tojo Unauna Regencies, is influenced by the type and quantity of fish landed or farmed, the business actors involved, the modes of transportation used, and marketing objectives. This supply chain is a network that involves cooperation between actors to distribute products to end consumers. The role of fishing companies, commodity types, transportation systems, and distribution directions are the dominant factors in the sustainability of the supply chain (Figure 3).

Currently, several fish collectors in Parigi Moutong work together with fishing companies from Jakarta, Surabaya, and Makassar. A company from Jakarta (UD Frozen) accepts shipments of sea fish such as skipjack, baby tuna, single, selar, cob, and milkfish from brackish water, both for consumption and bait.

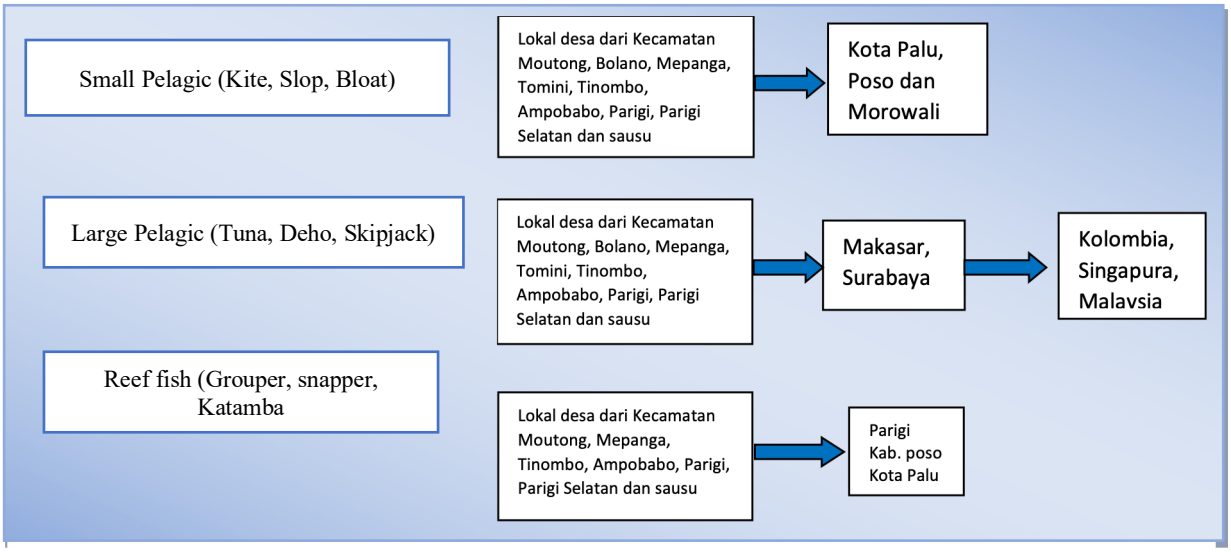

Figure 1. Targets and structure of fishery commodity supply chain by fish type in Parigi Moutong Regency Area

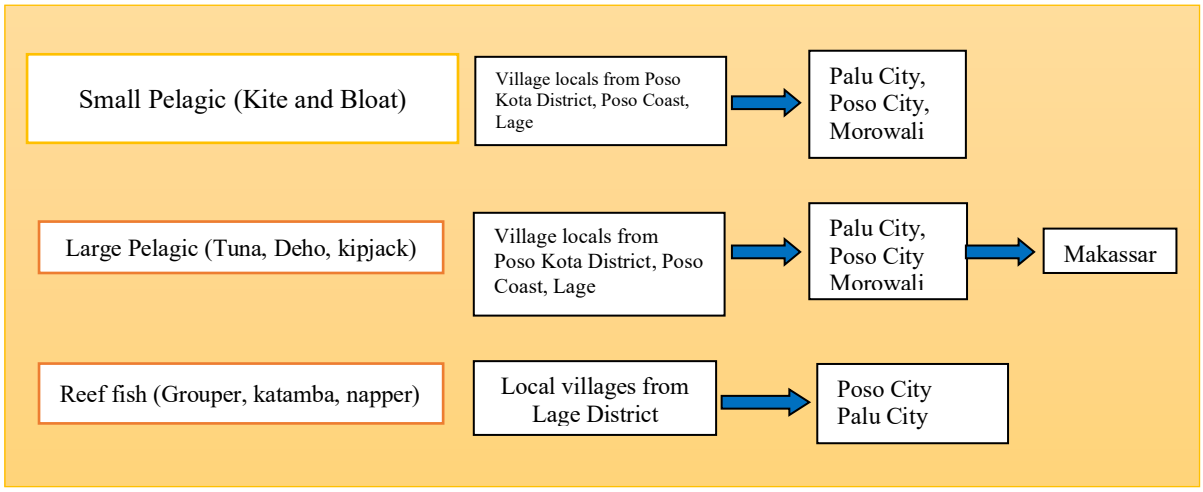

Figure 2. Targets and structure of fishery commodity supply chain by fish type in Poso Regency Area

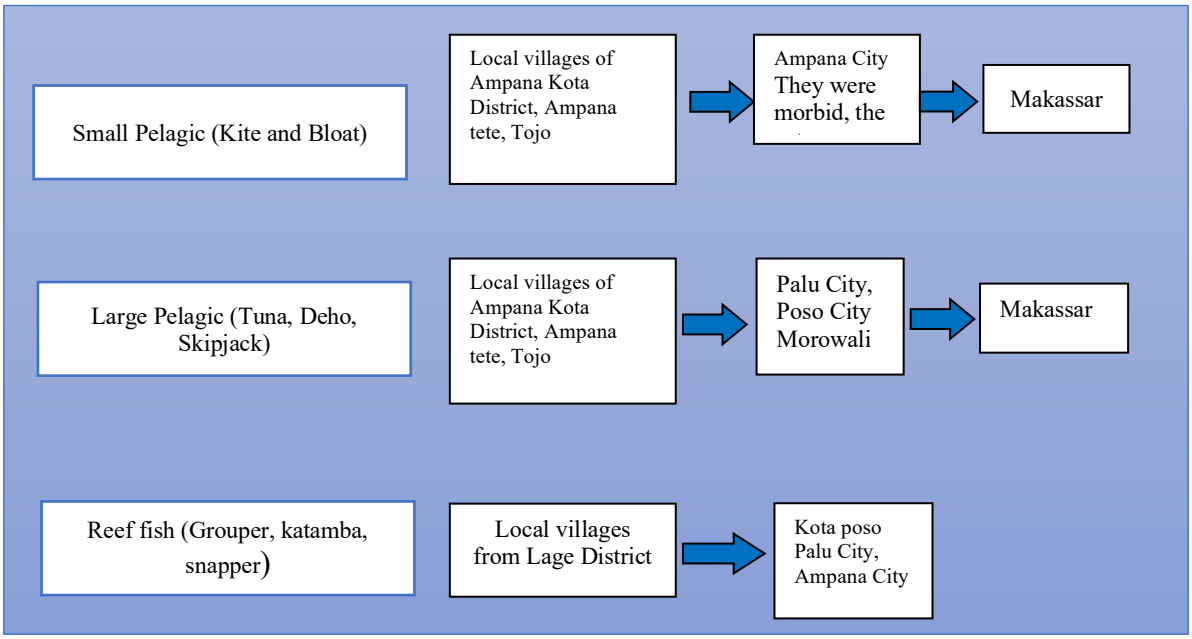

Figure 3. Targets and structure of fishery commodity supply chain by fish type in Tojo Unauna Regency Area

A company from Surabaya (PT. Mahkota Samudera Jaya) exports baby tuna skipjacks and milkfish to Malaysia, Singapore, and Colombia. These export products are sent regularly every month, and before being sent abroad, the fish are first sent to Surabaya. The total shipment from Parigi Moutong to Surabaya reaches 90 tons per month, using 1 TEU refrigerated container. Transportation in this cold chain uses refrigerated trucks and container ships. Trucks are used to transport fish to Pantoloan Port, while sea shipments are carried out by container ships owned by the shipping company SAMAS.

Fish Distribution and Logistics Mapping

Geographical mapping (Figure 4) shows that the centers of fishery production are spread across coastal districts. The distribution flow shows the pattern of fish movement from production centers to consumption centers andregional (Palu, Poso), national (Surabaya, Makassar), and international logistics hubs. The main routes for exports identified from the study area (specifically Parigi Moutong) are: Production Center → Pantoloan Port (Palu) → Surabaya Hub → Destination Countries (Singapore, Colombia).

In Poso Regency, annual fishery production reached 9,327.88 tons, consisting of capture fisheries of 4,831.50 tons and aquaculture of 4,496.38 tons. This amount is not enough for local consumption and processing, so the supply of fish is partly imported from Tojo Unauna and Parigi Moutong Regencies. In contrast, Tojo Unauna produces 24,080.59 tons per year (15,854.20 tons of catch and 8,226.39 tons of cultivation), enough to meet the needs of its region of 11,525.80 tons, even surplus to be marketed to other regions.

The distribution of fish in WPP 715 has been going on for a long time, from fishermen to collectors, then to

local and foreign markets such as Palu, Makassar, Surabaya, Jakarta, to exports to Malaysia, Singapore, and Colombia. In Parigi Moutong, fishery products are sold to the local market (Parigi Kota), to Palu, and then sent further to major cities and abroad through the distribution channels shown in Figure 5.

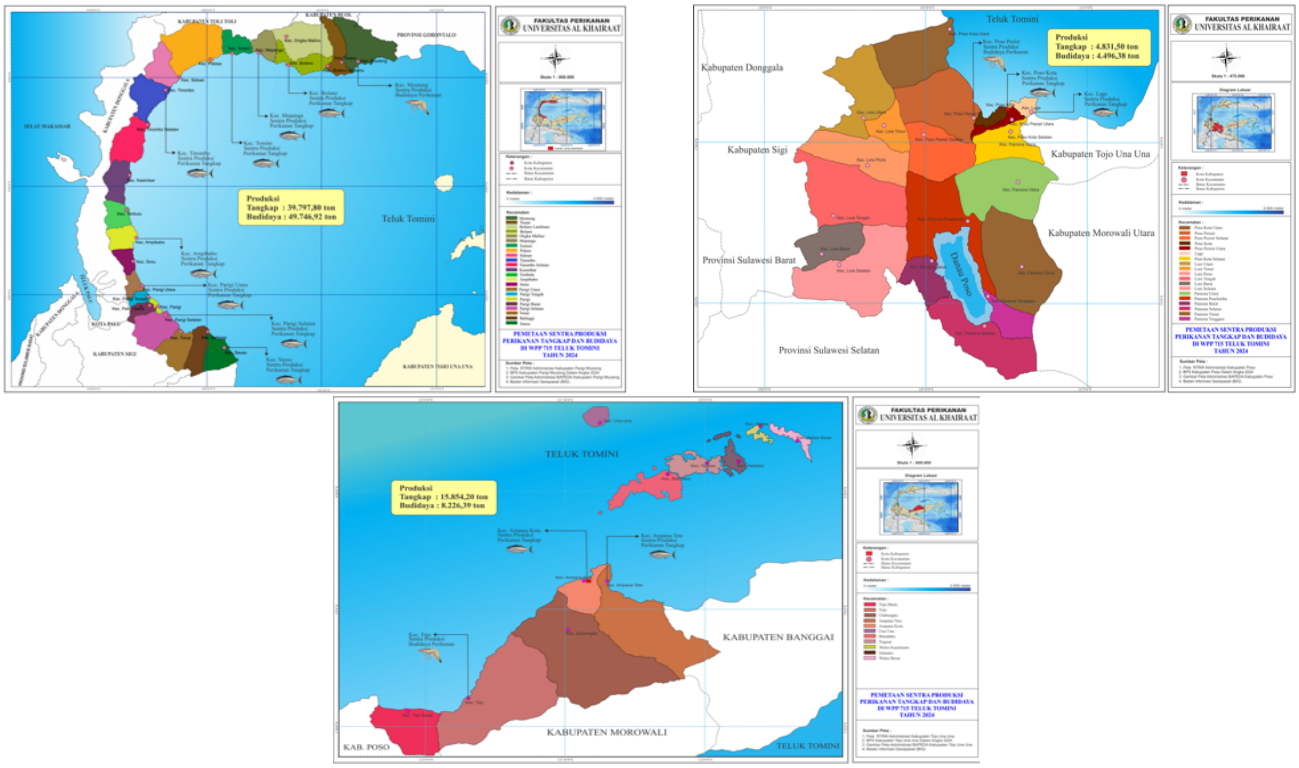

Figure 4. Mapping of fisheries production centers (catch and aquaculture) in WPP 715

Figure 5. Fish marketing and distribution pathways in fisheries management areas (WPP) 715

Poso production is generally distributed to the cities of Poso, Morowali, and Palu. Meanwhile, production from Tojo Unauna is marketed to the cities of Ampana, Morowali, Palu, and partly to Makassar. The export routes from Parigi Moutong are: Production center – Pantoloan Port – Surabaya – Malaysia/Singapore/Colombia. Transportation uses container trucks to ports, then container ships for shipment abroad through several transit points.

Discussion

The results of this study confirm the existence of significant potential fishery resources in WPP 715 Tomini Bay, but their utilization is constrained by logistical system challenges. The disparity in fisheries balance between surplus districts (Parigi Moutong, Tojo Unauna) and the deficit district (Poso) highlights the importance of connectivity and distribution efficiency between regions to ensure food availability and local price stability (Nugroho et al., 2021). Poso's dependence on external supply confirms SLI's vital role in equitable access to fish protein sources. The varied condition of TPI/PPI infrastructure, most of which is not functioning optimally, is a significant bottleneck in the supply chain, potentially reducing fish quality and marketing efficiency, in line with findings in other regions of Indonesia (Setiawan et al., 2020; Siregar et al., 2021).

Fish consumption patterns in coastal communities that are not strongly correlated with the number of family members but are influenced by profession and accessibility show the complexity of consumption determinants at the household level. These findings differ from some general studies, but are relevant in the context of coastal communities where catches are often preferred for sale (Yusrizal et al., 2020). The average actual consumption that is close to the provincial AKI (Ditjen PDSPKP, 2023) indicates high demand potential, but this needs to be supported by the availability of a stable and affordable supply.

The identified supply chain structures, ranging from small-scale fishers to exporters, show a clear market segmentation (Abidin et al., 2020). Local and regional markets absorb most of the catch, while high-value commodities are directed to national markets and exports. The involvement of large companies from outside the region (Jakarta, Surabaya) signals the integration of this region into national and global supply chain networks, but it also raises questions about the sharing of added value for local actors (Ernan et al., 2022). The length of distribution routes, especially for exports via Surabaya, highlights the potential for logistics inefficiencies and high transportation costs that can reduce product competitiveness (Wiyono et al., 2023).

The development of the SLI in WPP 715 must overcome infrastructure challenges, improve coordination between actors, and strengthen connectivity (Pujawan & Mahendrawathi, 2017). Revitalizing TPI/PPI, investing in cold chain facilities, and improving transportation access are key priorities (DKP Sulteng, 2024). In addition, strengthening fishermen/cultivator institutions and facilitating partnerships can improve bargaining positions and market access (Adrianto et al., 2019; Purwanto et al., 2019). Improving the quality of logistics data is also crucial for more effective planning and monitoring (KKP, 2024). The optimization of logistics networks, including perhaps by considering alternative hubs or direct shipping, needs to be further studied to improve efficiency (Campbell et al., 2020; BPS Provinsi Sulawesi Tengah, 2020).

Conclusion

This study found a significant disparity in the fish supply between Parigi Moutong and Tojo Unauna, which have a production surplus, and Poso, which has a deficit in WPP 715. These imbalances affect regional food security and the sustainability of local fisheries. The fish logistics system faces major challenges in infrastructure and efficiency, particularly for long-distance distribution. The lack of an effective traceability system further limits the logistics flow. Strengthening cold chain facilities, improving transportation networks, and enhancing data management are key to improving efficiency and ensuring equitable fish distribution. Ultimately, an integrated logistics system is essential to support sustainable fisheries management in WPP 715 and to improve regional food security.

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Author Contributions

Conceptualization, F and U; methodology, F, U, and M; formal analysis, F and U; investigation, F, U, and M; resources, F, U, and M; writing preparation of original draft, F; writing reviewing and editing, U and M; visualization, M; supervision, M; project administration, F; obtaining funding, F and M. All authors have read and approved the final manuscript.

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Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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