Jurnal Teknologi Industri Pertanian 35 (3): 297-303, December 2025
DOI: https://doi.org/10.24961/j.tek.ind.pert.2025.35.3.297
ISSN: 0216-3160 EISSN: 2252-3901

FEASIBILITY STUDY OF GROUPER FISH PROCESSING INDUSTRY IN JAVA ISLAND BASED ON RAW MATERIAL AVAILABILITY ANALYSIS

STUDI KELAYAKAN INDUSTRI PENGOLAHAN IKAN KERAPU DI PULAU JAWA BERDASARKAN ANALISIS KETERSEDIAAN BAHAN BAKU

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Paper: Received August 28, 2025; Revised October 10, 2025; Accepted October 30, 2025

ABSTRAK

Kerapu merupakan komoditas perikanan bernilai tinggi dengan permintaan yang terus meningkat di pasar domestik maupun internasional, sehingga memerlukan ketersediaan bahan baku yang stabil untuk mendukung keberlanjutan industri pengolahan. Namun, kajian kelayakan industri pengolahan kerapu di Indonesia masih jarang menempatkan aspek ketersediaan bahan baku sebagai fokus utama, padahal faktor tersebut sangat menentukan kelancaran proses produksi. Penelitian ini bertujuan mengevaluasi kelayakan pendirian industri pengolahan kerapu di Pulau Jawa melalui integrasi pemetaan pasokan lintas wilayah dan analisis pengendalian persediaan menggunakan pendekatan Safety Stock (SS) dan Reorder Point (ROP). Penelitian dilakukan dengan metode campuran melalui wawancara semi-terstruktur, observasi lapangan pada sepuluh titik pasok utama di pesisir utara Jawa, serta analisis data pasokan dan permintaan selama dua belas bulan terakhir. Hasil penelitian menunjukkan bahwa total pasokan kerapu mencapai sekitar 254 ton per bulan, sedangkan kebutuhan industri hanya sekitar 50 ton per bulan. Variasi harga antarwilayah dipengaruhi oleh kondisi rantai dingin, kapasitas logistik, serta jarak distribusi. Selain itu, fluktuasi musiman dapat dikelola melalui kombinasi pasokan dari perikanan tangkap dan budidaya keramba jaring apung yang mampu menjaga kontinuitas suplai sepanjang tahun. Simulasi menggunakan nilai SS sebesar 602 kilogram dan ROP sebesar 2.402 kilogram menunjukkan bahwa tidak terjadi kekurangan stok selama sepuluh hari pengamatan. Secara keseluruhan, penelitian ini menegaskan bahwa suplai bahan baku kerapu di Jawa stabil, layak, dan mendukung pengembangan industri pengolahan. Hasil ini dapat digunakan sebagai dasar perencanaan rantai pasok yang lebih efektif bagi pemangku kepentingan terkait di wilayah Jawa pada masa mendatang.

Kata kunci : kelayakan bahan baku, pengendalian persediaan, rantai pasok kerapu, safety stock, reorder point

ABSTRACT

Grouper is a high-value fishery commodity with increasing demand in both domestic and international markets, necessitating a stable raw material supply to support sustainable processing activities. However, feasibility assessments for developing grouper processing industries in Indonesia rarely prioritize raw material availability, despite this factor being essential for maintaining consistent production. This study evaluates the feasibility of establishing a grouper processing industry in Java by integrating cross-regional supply mapping with an inventory control analysis based on the Safety Stock (SS) and Reorder Point (ROP) approaches. A mixed-methods design was used, combining semi-structured interviews, field observations at ten major supply points along the northern coast of Java, and analysis of twelve months of supply and demand data. Findings indicate that the total monthly grouper supply reaches approximately 254 tons, while industrial requirements are around 50 tons. Cold chain capacity, logistics conditions, and the distance of distribution influence price differences across regions. Seasonal fluctuations can be managed by relying on both capture fisheries and floating net cage aquaculture, which help maintain a consistent supply throughout the year. A simulation using an SS value of 602 kilograms and an ROP value of 2,402 kilograms demonstrated that no stock outs occurred during a ten-day evaluation. Overall, the study confirms that the supply of grouper raw materials in Java is stable, feasible, and capable of supporting the growth of processing industries, providing a practical basis for future supply chain planning. These findings offer guidance for policymakers and industry stakeholders nationwide.

Keywords: grouper supply chain, raw-material feasibility, inventory control, safety stock, reorder point

Coressponding Author

INTRODUCTION

The fisheries sector plays an important role in supporting food security and economic development in Indonesia. As an archipelagic country with over 17,000 islands and abundant marine resources, Indonesia relies heavily on fisheries as a major source of protein and animal products for its population (Virgantari *et al.,* 2022; Siswanty and Dewi, 2021). One of the most frequently traded fishery commodities is grouper. Grouper is a high-value fishery commodity with relatively stable demand in both domestic and international markets, with export demand largely driven by live fish markets in Hong Kong, which also serve as a major distribution hub for mainland China (Kam *et al.,* 2024).

Based on official statistics from the Ministry of Marine Affairs and Fisheries, Indonesia's marine aquaculture sector recorded a production volume of approximately 67,201 tons in the first quarter of 2025, while grouper production demonstrated a consistent upward trend over the 2020–2024 period (KKP, 2025; KKP, 2024). The development of the grouper processing industry on Java Island therefore requires support from upstream production regions with adequate cultivation potential to ensure continuous raw material supply. Coastal areas such as Karimunjawa have been shown to support grouper availability at the production level, contributing to upstream supply capacity (Maulina *et al.,* 2021). In addition, several coastal zones in Sumatra have been identified as suitable for grouper mariculture, indicating their potential role in supporting inter-regional supply to processing industries on Java Island (Rijal and Bayuaji, 2021). Similarly, Lampung Bay has been classified as suitable for floating net cage–based grouper cultivation, highlighting its feasibility as a supporting production area (Kamil *et al.,* 2021), while grouper aquaculture in North Bali has demonstrated favourable production performance, suggesting its capacity to contribute to stable raw material supply for the national grouper industry (Utami *et al.,* 2022). Despite the significant potential of grouper production in Indonesia, most feasibility studies have focused on technical and financial aspects, whereas the availability and stability of raw material supply remain underexplored, even though they are critical for production continuity and supply chain efficiency in the fish processing industry.

Effective coordination between suppliers, distributors, and processing units is a key factor determining the sustainability of industrial operations. Therefore, supply chain performance becomes an important element in ensuring the stability of raw material availability (Putri *et al.,* 2020). Based on this, Java Island was chosen as the study location because this region serves as the center for consumption, production, and distribution of fishery commodity logistics in Indonesia. Based on data from the Ministry of Marine Affairs and Fisheries (KKP), national grouper aquaculture production in 2024 reached only 15,353 tons, or about a quarter of the national target of 63,052 tons. On the other hand, the latest marine aquaculture data indicates an increasing role for Java Island as the main region absorbing grouper supply, as evidenced by the increase in inter-regional distribution volume from 18,450 tons in 2022 to 22,870 tons in 2023, or an increase of approximately 23.9 percent (KKP 2024). This trend reflects ongoing expansion and distribution dynamics in major grouper production zones in Indonesia (Mahardika *et al.,* 2024). Based on this data, it shows that Java Island is the main destination for grouper commodity movement and serves as a large consumer market and a strategic logistics gateway for national fishery products. The high concentration of demand indicates that most of the national grouper supply flows to Java to meet the needs of the processing industry. This condition makes evaluating the availability and stability of supply a crucial aspect in determining the feasibility and long-term sustainability of grouper processing operations in the region.

RESEARCH AND METHOD

This research uses a mixed-methods approach, combining qualitative and quantitative methods, to gain the best and most relevant understanding of grouper raw material availability on the island of Java. The qualitative research is designed to conduct interviews with several competent respondents in the field of grouper, focusing on questions related to grouper supply, prices, seasons, and supply chain challenges in grouper distribution. The qualitative data obtained consists of interview results and structured field observations involving several stakeholders and respondents. Quantitative data is used for calculations, including safety stock and reorder point. These two calculations are expected to support the qualitative data, resulting in accurate calculations based on the available field data. This calculation is used to inform decision-making in the supply chain. These two approaches are expected to yield the best recommendations for developing the grouper industry on the island of Java. To clarify the overall methodological sequence and decision-making process applied in this study, the research framework is summarised in Figure 1.

Figure 1 outlines the research framework adopted in this study. The process begins with identifying constraints related to grouper raw material availability on Java Island, followed by the selection of supply areas and interviews with major suppliers. Alternative sourcing locations are considered when supply shortages are encountered. The analysis then focuses on evaluating supply volume, size characteristics, and distribution patterns.

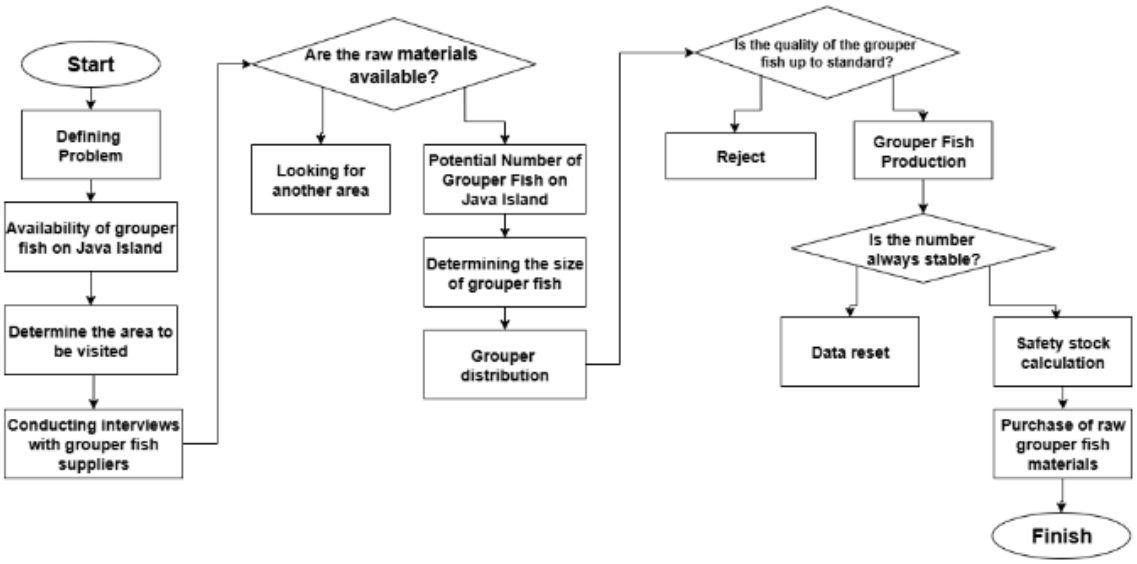

Figure 1. Research flowchart for evaluating raw material availability and inventory control in the grouper processing industry

Quality assessment is performed to ensure compliance with industrial standards, informing acceptance or rejection decisions for processing feasibility. Inventory performance is subsequently analysed using Safety Stock and Reorder Point calculations, with data adjustments applied as necessary to address supply variability and support procurement decisions. In this framework, the term "production" refers solely to the acceptance of raw materials for processing feasibility rather than an evaluation of technical processing operations. This framework integrates qualitative field insights with quantitative inventory analysis to support supply chain decision-making in the grouper processing industry.

Data Collection Methods

This research uses two approaches: quantitative and qualitative methods. Qualitative methods were used to conduct interviews and field analysis regarding grouper processing in Java, including raw material supply, grouper season, fluctuating grouper prices, and challenges in the grouper supply chain and distribution. Qualitative data were collected through interviews with 10 respondents who are competent in grouper processing. There are several requirements to be a respondent for grouper processing: (1) Must have worked or been in the grouper business for at least ten years, (2) Must understand how to buy and sell grouper, (3) Must be fully aware of the competition in the grouper buying and selling business, (4) Must know the source of grouper raw materials, (5) Must know the sales and marketing of grouper. The following requirements are necessary to be a respondent in qualitative data collection, ensuring the validity and reliability of the data obtained.

Qualitative data is data used for determination using several calculations. The calculation is performed by determining the safety stock and reorder point. Safety stock determines how much grouper to store in the warehouse, while the reorder point determines how long it takes to repurchase grouper raw materials. Qualitative and quantitative data are expected to align and support the feasibility of grouper processing agroindustry, ensuring consistency between field observations and quantitative data calculations for grouper processing in Java.

Data Analysis Methods

The data obtained will be processed in two stages. The first stage is to analyze the quantity of raw materials and grouper season based on interviews with grouper business owners. Additionally, an analysis of grouper lead time and supply chain needs to be conducted. The second stage is the calculation of safety stock and reorder point. The aim is to reduce the risk of raw material shortages and the often-fluctuating waiting time for grouper.

Historical Data

The data used are from grouper suppliers over the past year. This data includes monthly grouper quantities, daily grouper demand, uncertain seasons, and grouper transportation. The data used was assessed and evaluated based on: (1) Stable recording period, no data entered was missing or mixed up. (2) Data consistency, the variance used was ±2 standard deviations. (3) Compatibility between interview results and field observations, the aim being to ensure that the data used was consistent with what was happening in the field.

Justification of SS–ROP Parameters

Safety stock plays an important role in mitigating demand or lead-time uncertainty. The goal is to continuously produce raw materials without running out of stock. Calculations using safety stock

and reorder point apply to perishable products such as grouper, given the uncertainty in demand and inventory lead times (Nurcahyawati *et al.,* 2023). Here are some calculations and parameters used in the field observations.:

- Service level (Z) = 95% (Z = 1.65), a commonly used standard in food agroindustry
- Lead time (LT) = 3 days, average transportation time from major supply areasLead-time standard deviation
- (σLT) = 0.5 days, the obstacles encountered were logistics and weather.
- Average daily demand ($\bar{D}$) = 600 kg, daily demand for grouper
- Demand standard deviation (σD) = 120 kg, 20% of the total daily demand requirement

The formulas used:

$$SS = Z \times \sqrt{(\sigma_D^2 \times LT) + (\bar{D}^2 \times \sigma_{LT}^2)}$$

$$ROP = (\bar{D} \times LT) + SS$$

The basic formulas used to assess the parameters are: safety stock is 602 kg, and reorder point is 2,402 kg. In this calculation, observations were made over ten days to assess and monitor the existing grouper stock. The demand for grouper and the reordering time will also be assessed to determine if stockouts occur, necessitating calculations to avoid running out of raw materials and to ensure realistic operational costs.

RESULTS AND DISCUSSION

Raw Material Availability Across Provinces

The availability of raw materials on the island of Java shows differences in the quantity of grouper fish produced by each province. East Java has the highest supply of raw materials, at 110 tons per month, followed by Central Java and Jakarta, at 95 and 70 tons per month, respectively. West Java contributes only around 8 tons per month. The performance of the supply chain may be adversely affected by fluctuations in the availability of raw materials and limitations in storage capacity. Furthermore, challenges related to transportation and cold chain logistics can increase unpredictability in fulfilling raw material deadline requirements (Manggala *et al.,* 2024). Previous research has shown that East Java has the highest availability of grouper raw materials on the island of Java, followed by Central Java, which serves as the center of grouper distribution in the region. Data on the amount of raw material available by province are presented in Table 1.

East Java and Central Java are the two provinces with the highest grouper supply on the island of Java. A study by Muliati *et al.* (2021) found that the east coast of the North Coast (Pantura) has high potential for high-value fisheries due to its proximity to fishing grounds and well-maintained and stable cold chain facilities. Previous research indicates that Surabaya and Lamongan are the areas with the most significant grouper potential in East Java, while Jepara and Tegal are in Central Java.

Table 1. Raw material availability of grouper in Java Island

Province	Supply (tons/month)	Description
DKI Jakarta	70	Major port-based distribution center
West Java	8	Long low-season; limited supply
Central Java	95	Jepara–Tegal as key supply centers
East Java	110	Largest and most stable supply
Total	254	

Several factors, in addition to raw material requirements, must be considered, including maintaining supply chain stability. The goal is to maintain raw material quality by coordinating with suppliers and controlling logistics infrastructure (Septarianes *et al.,* 2020). Proximity to raw material sources aligns with the principle of agglomeration, where concentrating activities in one area helps reduce logistics costs and reduces the risk of raw material quality degradation during transportation.

Purchase and Selling Price Structure Across Regions

Cold chain logistics plays a central role in preserving the quality of perishable products, with implications for logistics efficiency, product losses, and market conditions across regions, as documented in the fresh food literature (Han *et al.,* 2021). The purchase price for grouper generally ranges from Rp 45,000 to Rp 80,000 per kilogram, whereas the selling prices vary from Rp 52,000 to Rp 90,000 per kilogram. These prices exhibit considerable regional variation and are subject to fluctuations based on seasonal changes and the quality of local cold-chain infrastructure. A summary of these price variations is presented in Table 2.

The buying and selling prices of grouper vary widely, reflecting several challenges related to logistics efficiency, supply chain coordination, and seasonal variability. Inefficiencies in supply chain systems may increase operational costs and reduce overall supply chain performance (Zhang *et al.,* 2020). A suboptimal supply chain can be influenced by environmental factors, limited distribution, and minimal risk management, leading to an unstable supply of raw materials for the processing industry (Sugathadasa *et al.,* 2020). This aligns with previous research, which has found that several factors, including seasonal dynamics, distribution distance, and the agro-industry cold chain influence the supply of grouper raw materials. East Java Province is one of

the regions with stable and high grouper potential due to its relatively close and stable cold chain storage and raw material locations.

Seasonal Patterns and Supply Variability

Grouper raw material potential has peak and low seasons. The peak season typically occurs from October to April, while the low season lasts from May to September. Central Java Province, specifically the Batang area, is one of the regions with a relatively stable and consistent grouper supply throughout the year. The use of floating net cages (KJA) in hybrid grouper cultivation is one factor in supply continuity. According to Utami *et al.* (2022), KJA-based production can stabilise raw materials and ensure continuity even under unfavourable conditions. With raw materials fluctuating and constantly changing throughout the season, sustainable supply chain management is necessary throughout the year. Calculations using safety stock (SS) and reorder point (ROP) are one method used to manage grouper quantities each season. They can produce consistent calculations for other supply chains (Nurcahyawati *et al.,* 2023).

Evaluation of Safety Stock (SS) and Reorder Point (ROP)

Inventory control approaches such as Safety Stock and Reorder Point are widely applied in perishable food supply chains due to demand uncertainty and lead-time variability. These models are considered effective in maintaining service levels while minimizing the risk of stockouts, particularly for products with limited shelf life and fluctuating supply conditions (Nahmias and Wang, 2017). Based on the operational parameters used, average daily demand of 600 kg, demand standard deviation of 120 kg, lead time of 3 days, lead-time standard deviation of 0.5 days, and a service level of 95% (Z = 1.65). The Safety Stock (SS) and Reorder Point (ROP) were calculated to be 602 kg and 2,402 kg, respectively. These values are summarized in Table 3.

After calculating the SS and ROP, a buffer is needed to address high demand or delayed supplies. Uncertain delivery times and supply chain disruptions represent significant challenges in agro-industrial systems and may adversely affect overall supply chain performance and sustainability (Khokhar *et al.,* 2020). To prevent this, calculations are needed to control raw materials and reduce operational disruptions (Ulfah *et al.,* 2016). In this context, inventory control models such as Safety Stock and Reorder Point have been shown to be effective for managing perishable products under conditions of uncertain demand and seasonal variability (Nahmias and Wang, 2017).

Ten-Day Stock Simulation

A simulation was conducted over a ten-day operational period using an initial raw-material stock of 4,000 kg. The objective was to evaluate whether the calculated SS and ROP values were adequate for maintaining continuous operations. The results are shown in Table 4.

Table 4 shows that the stock fell below ROP on days 4 and 8. After showing a decrease, it is necessary to reorder. Stock will be returned on days 7 and 10. Since grouper stock is sufficient, it indicates that an SS of 602 kg can be effective in addressing very high demand. This method suggests that SS-ROP can be applied to the grouper industry and is responsive to the industry's needs.

Table 2. Purchase and selling prices of grouper across regions

Region	Purchase Price (Rp/kg)	Selling Price (Rp/kg)	Notes
DKI Jakarta	45,000–49,000	52,000–53,000	Stable; strong distribution network
West Java	47,000–80,000	52,000–90,000	High fluctuation; weak cold-chain infrastructure
Central Java	48,000–52,000	55,000–63,000	Reasonable and stable margin
East Java	45,000–65,000	50,000–70,000	Largest supply; low variability

Table 3. Parameters for SS and ROP Calculation

Parameter	Value	Justification / Source
Average daily demand ($\bar{D}$)	600 kg	Industry survey
Std. dev. of demand (σ^d)	120 kg	12 months of historical data
Average lead time (LT)	3 days	Supplier interview
Std. dev. of lead time (σLT)	0.5 days	Observed delivery variability
Service level (Z)	1.65	Standard for food industry
Safety Stock (SS)	602 kg	Calculated
Reorder Point (ROP)	2,402 kg	Calculated

Table 4. Ten-Day stock simulation for grouper raw material

Day	Demand (kg)	Remaining Stock (kg)	Triggered ROP	Reorder	Notes
1	550	3,450	No	No	Stable
2	593	2,857	No	No	–
3	344	2,513	No	No	–
4	797	1,716	Yes	Ordered	Below ROP
5	385	1,331	No	In transit	–
6	703	628	No	In transit	Near SS
7	–	2,982	No	Restock	Safe
8	645	2,337	Yes	Ordered	ROP triggered
9	543	1,794	No	In transit	–
10	596	1,198	No	In transit	–

Feasibility Assessment of Raw Material Supply

The total potential for grouper available on the island of Java is 254 tons per month. This figure far exceeds the industry's demand of 50 tons per month, reaching 508 per cent of the required capacity. This indicates that the raw material potential is highly suitable for supporting the grouper processing industry on the island of Java. Models of integrated production and distribution in fish food systems demonstrate the importance of traceability and logistics optimization for efficient raw material flow and cost reduction (Handayani *et al.,* 2021). Adequate and continuous raw material availability plays a crucial role in improving operational efficiency and reducing supply-related costs in agro-industrial systems. In the context of high-value fish commodities, stable supply conditions also contribute to maintaining product quality and supporting sustainable processing activities (Han *et al.,* 2021). Despite the challenge of price fluctuations during the lean season in West Java, a relatively stable supply of raw materials is available in East and Central Java, thereby encouraging the development of the grouper processing industry on the island of Java.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Grouper supply in Java is recorded at approximately 254 tons per month, while industrial demand is only around 50 tons. This condition indicates that raw materials are available in sufficient quantities and still far exceed actual needs. Price margins in various regions remain profitable, although stability is significantly influenced by the quality of the cold chain and the distance of distribution. Seasonal factors significantly influence supply volume, but availability can be maintained through a combination of capture fisheries and aquaculture using floating net cages. The inventory control model using a Safety Stock of 602 kg and a Reorder Point of 2,402 kg proved effective in a ten-day simulation. No stockouts were observed, and the reordering mechanism responded promptly to daily demand fluctuations. These findings confirm that the availability of raw materials for the grouper processing industry in Java is in a reasonable and relatively stable condition, and the SS–ROP model can be used as a basis for developing supply chain strategies, supplier partnerships, and more efficient logistics policies.

Recommendations

Future research could involve a larger and more diverse sample of respondents, as well as utilise multi-year historical data to gain a more comprehensive understanding of supply dynamics. Operational simulations should also consider extreme conditions, such as prolonged severe weather or distribution disruptions, to assess the robustness of the SS–ROP model under high uncertainty. Furthermore, the feasibility assessment could be expanded to include financial aspects, process technical efficiency, and cold chain capacity. More adaptive inventory control methods, such as probabilistic approaches or demand simulation models, could also be considered to improve the accuracy of raw material planning in the grouper processing industry.

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