

Sales and production forecasting of fish skin snacks and the availability of pangasius fish skin raw materials at Gatiga Snack

[Peramalan penjualan dan produksi camilan kulit ikan serta ketersediaan bahan baku kulit ikan patin pada Gatiga Snack]

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ABSTRACT

Gatiga Snack is an agro-industrial enterprise that processes pangasius fish skin into value-added fish skin snack. Fluctuations in sales, production levels, and raw material availability pose challenges to production planning. This study aimed to analyze patterns of fish skin chip sales and production, determine suitable forecasting methods for sales, production, and pangasius fish skin availability, and evaluate the balance between raw material availability and production requirements. The study was conducted at Gatiga Snack, Jati Agung, South Lampung Regency, using primary and secondary data. Forecasting was performed using monthly historical data and six time-series methods: Exponential Smoothing with Trend, Exponential Smoothing, Moving Average, Weighted Moving Average, Linear Trend Line, and the Naïve Method. Forecasting accuracy was evaluated using Mean Absolute Deviation (MAD), Mean Absolute Percentage Error (MAPE), and Mean Squared Error (MSE). Sales and production fluctuated, with an increasing tendency toward the end of the year. Exponential Smoothing with Trend was the most suitable method for forecasting sales and production, with MAPE values of 36.761% and 36.044%, respectively. The Linear Trend Line method provided the most accurate forecast of pangasius fish skin availability, with a MAPE of 20.164%. The forecast indicated a production of 21.835 kg of fish skin snack; approximately 43.670 kg of raw material would be required, based on a conversion ratio of 0.5 kg of fish skin snack per kg of pangasius fish skin. Although raw material availability remained in surplus, its declining trend warrants attention. Integrating sales, production, and raw material forecasts can support production planning and raw material procurement to maintain production continuity at Gatiga Snack.

Keywords: fish skin snack, pangasius fish, raw material availability, sales forecasting, production forecasting

ABSTRAK

Gatiga Snack merupakan agroindustri yang mengolah kulit ikan patin menjadi produk camilan kulit ikan bernilai tambah. Dalam kegiatan produksinya, fluktuasi penjualan, perubahan produksi, dan ketidakstabilan ketersediaan bahan baku menjadi kendala dalam perencanaan produksi. Penelitian ini bertujuan untuk menganalisis pola penjualan dan produksi camilan kulit ikan, menentukan metode peramalan yang sesuai untuk penjualan, produksi, dan ketersediaan bahan baku kulit ikan patin, serta mengevaluasi keseimbangan antara ketersediaan bahan baku dan kebutuhan produksi. Penelitian dilaksanakan di Gatiga Snack, Jati Agung, Kabupaten Lampung Selatan, menggunakan data primer dan sekunder. Peramalan dilakukan terhadap data historis bulanan menggunakan enam metode time series, yaitu Exponential Smoothing with Trend, Exponential Smoothing, Moving Average, Weighted Moving Average, Linear Trend Line, dan Naïve Method. Akurasi metode dievaluasi berdasarkan Mean Absolute Deviation (MAD), Mean Absolute Percentage Error (MAPE), dan Mean Squared Error (MSE). Hasil penelitian menunjukkan bahwa penjualan dan produksi camilan kulit ikan berfluktuasi dengan kecenderungan peningkatan pada periode akhir tahun. *Exponential Smoothing with Trend* dipilih sebagai metode terbaik untuk peramalan penjualan dengan MAPE 36,761% dan peramalan produksi dengan MAPE 36,044%. Sementara itu, *Linear Trend Line* merupakan metode terbaik untuk memprediksi ketersediaan kulit ikan patin dengan MAPE sebesar 20,164%. Hasil proyeksi menunjukkan kebutuhan produksi periode sebesar 21.835 kg camilan kulit ikan memerlukan sekitar 43.670 kg kulit ikan patin berdasarkan rasio konversi 0,5. Ketersediaan bahan baku hasil peramalan masih menunjukkan kondisi surplus terhadap kebutuhan produksi pada periode yang dianalisis, tetapi

terdapat kecenderungan penurunan pasokan yang perlu diantisipasi. Hasil penelitian menunjukkan bahwa integrasi peramalan penjualan, produksi, dan ketersediaan bahan baku dapat digunakan sebagai dasar perencanaan kapasitas produksi dan pengadaan bahan baku untuk mendukung kontinuitas produksi camilan kulit ikan pada Gatiga Snack.

Kata kunci: camilan kulit ikan, ikan patin, peramalan penjualan, peramalan produksi, ketersediaan bahan baku

Introduction

One of the agricultural subsectors that plays an important role in the food supply is the fisheries subsector, which provides a significant source of high-quality animal protein with relatively broad accessibility (Sukma et al., 2024). Indonesia has extensive aquatic areas, abundant fisheries resources, and tropical geographical conditions that support the development of the fisheries sector (FAO, 2022). Fisheries management focuses not only on increasing production but also on applying sustainability principles to maintain ecosystem balance and ensure the long-term sustainability of fisheries resources (Pratama & Marwati, 2025). In this context, the development of fisheries agroindustry is an important effort to improve the utilization of fisheries resources by processing them into value-added products.

Fisheries agroindustry contributes to value addition, community income, and employment opportunities, while also supporting regional Gross Domestic Product (GDP) (Andriyanto, 2025). One fisheries agroindustry in Lampung Province is Gatiga Snack, a brand owned by the small and medium enterprise (SME) *Cemilan Anugerah 3*, located in Jati Agung, South Lampung Regency. Gatiga Snack produces various processed foods using locally sourced raw materials, including fish skin snacks made from pangasius fish skin.

Pangasius (*Pangasius* sp.) is a popular freshwater fish with considerable potential for development as a raw material for agroindustrial products. *Pangasius hypophthalmus* has a high protein content, relatively low fat content, and contains minerals and moisture that contribute to its nutritional value as a raw material for processed fish products (Chakma et al., 2022). In addition to its flesh, pangasius fish skin has considerable potential for utilization because it is rich in collagen and protein and can be processed into various value-added products, including gelatin, collagen, and innovative food products such as fish skin snacks (Nurilmala et al., 2021). The use of pangasius fish skin as a raw material for fish skin snacks at Gatiga Snack represents an effort to convert an underutilized fish by-product into a value-added food product. In its business operations, Gatiga Snack faces challenges in production planning, particularly due to fluctuations in sales, production levels, and the availability of pangasius fish skin as the main raw material. Uncertainty in demand may result in a mismatch between production volume and market requirements, while fluctuations in raw material availability may disrupt production continuity. These conditions highlight the need for forecasting to provide information on trends in sales, production, and raw material availability as a basis for production planning.

Several time-series forecasting methods can be applied and compared using Mean Absolute Deviation (MAD), Mean Absolute Percentage Error (MAPE), and Mean Squared Error (MSE) to identify the method most suitable for the characteristics of the data (Reskianto et al., 2023). This is particularly important because sales, production, and raw material availability may exhibit different patterns and trends. Based on these conditions, this study aimed to: (1) analyze the patterns of fish skin snack sales and production; (2) determine the most suitable forecasting methods for sales, production, and the availability of pangasius fish skin as a raw material; and (3) evaluate the balance between production requirements and raw material availability as a basis for production planning at Gatiga Snack.

Materials and methods

Materials

This study used both primary and secondary data. Primary data were collected directly from the Gatiga Snack agroindustry through interviews and observations, particularly regarding sales activities, production, production capacity, raw material requirements, and the processing of fish skin products. Secondary data were obtained from Gatiga Snack, Statistics Indonesia (BPS), South Lampung Regency, previous studies, and other relevant sources. Sales data consisted of monthly sales data for Gatiga Snack's fish skin products from 2022 to 2024. Production and raw material availability data were used to support the forecasting analysis of production and raw material requirements. Data on the composition of pangasius fish body parts were also used to estimate the proportion of fish skin available as raw material. The main respondent was the manager of Gatiga Snack, who provided information on sales activities, production, production capacity, and raw material requirements. Forecasting analysis was conducted using POM-QM for Windows Version 5, while Microsoft Excel was used for data tabulation, calculations, and graphical presentation.

Study location and data collection

The study was conducted at the Gatiga Snack agroindustry, located in Jati Agung, South Lampung Regency, Lampung Province, Indonesia. The location was selected purposively because Gatiga Snack processes fish skin into value-added products and has potential for further development. Primary data were collected through interviews and direct observations. Secondary data were obtained from Gatiga Snack, Statistics Indonesia (BPS), South Lampung Regency, and other relevant sources according to the variables analyzed.

Forecasting procedure

This study employed a quantitative approach to forecast three main variables: (1) fish skin product sales, (2) fish skin chip product production, and (3) the availability of pangasius fish skin as raw material. Monthly historical data were arranged chronologically and visualized to identify fluctuations and trends. Each dataset was then analyzed using six time-series forecasting methods: Exponential Smoothing with Trend, Exponential Smoothing, Moving Average, Weighted Moving Average, Linear Trend Line, and the Naïve Method. Forecasting analysis was conducted separately for each variable because the datasets had different characteristics and might therefore require different forecasting methods. The method with the lowest forecasting error was selected for each dataset and subsequently used to generate projections for the next forecasting period. Forecasting analysis was performed using POM-QM for Windows Version 5, while Microsoft Excel was used to tabulate and graphically present the historical data and forecasting results.

Forecast accuracy evaluation

The accuracy of each forecasting method was evaluated using Mean Absolute Deviation (MAD), Mean Absolute Percentage Error (MAPE), and Mean Squared Error (MSE). MAD was used to measure the average absolute difference between actual and forecast values, MAPE to express the average forecasting error as a percentage of the actual values, and MSE to measure the average squared forecasting error. The forecasting method with the lowest error value was selected as the most suitable method for each dataset and was subsequently used to generate the forecast values. The selected forecasting methods were used to estimate sales, production, and raw material availability for the next forecasting period. The forecast results were then interpreted in relation to production planning and raw material requirements.

Production capacity and raw material balance analysis

Production capacity was analyzed by comparing average actual monthly production with the normal production capacity of Gatiga Snack. Capacity utilization was calculated as the ratio of actual production to normal production capacity and expressed as a percentage. This analysis was used to assess the ability of the existing production capacity to meet the projected production requirements for the next forecasting period. The projected availability of pangasius fish skin was then compared with the estimated raw material requirement based on the production forecast. The difference between raw material availability and raw material requirement was calculated to determine the raw material balance. A positive difference indicated a raw material surplus, whereas a negative difference indicated a potential raw material shortage. The results were used to assess the adequacy of pangasius fish skin availability to support future fish skin product production.

Results and discussion

Forecasting of Gatiga Snack fish skin chip sales

Based on Figure 1, sales of pangasius fish skin snack fluctuated throughout the 2022–2024 period, with noticeable increases at the end of each year, particularly in months 12, 24, and 36, corresponding to December 2022, December 2023, and December 2024, respectively. The recurrence of higher sales in December suggests a possible year-end demand pattern. Although the three-year dataset indicates a recurring pattern, the observed increases should be interpreted with caution, as a longer time series would be required to confirm a consistent seasonal effect. Nevertheless, the recurring increase in December is relevant to production and marketing planning, as higher demand during the year-end period may require adjustments to production volume and inventory levels. Seasonal patterns are recurring fluctuations that occur at specific periods and can be important considerations in forecasting and production planning. Saputri et al. (2025) demonstrated that the Holt–Winters Exponential Smoothing method can be used to forecast sales of processed fish products by incorporating trend and seasonal components. Similarly, Isnaini et al. (2024) reported that exponential smoothing methods can incorporate level, trend, and seasonal components in periodic data. These findings support the importance of identifying recurring patterns in historical sales data when developing production and sales forecasts. For Gatiga Snack, the recurring December increase suggests that year-end demand should be factored into production and marketing planning. Anticipating higher sales during this period may help the agroindustry adjust production schedules, prepare sufficient raw materials, and reduce the risk of stock shortages. The observed sales pattern was subsequently used to compare the performance of the forecasting methods applied in this study.

The comparison of forecasting accuracy presented in Table 1 showed that Exponential Smoothing with Trend produced the lowest MAPE value (36.761%) among the six forecasting methods, with a MAD of IDR 1,512,719 and an MSE of IDR 5.347×10^{12} . Although the Linear Trend Line method produced lower MAD and MSE values of IDR 1,356,010 and IDR 3.897×10^{12} , respectively, Exponential Smoothing with Trend was selected because it yielded the lowest MAPE. In this study, MAPE was used as the primary criterion for selecting the forecasting method because it expresses forecast error as a percentage, facilitating comparison of forecasting performance across periods. Exponential Smoothing with Trend also incorporates the underlying trend in the data and gives greater influence to more recent observations, allowing the forecast to respond to changes in the sales pattern over time. The use of multiple accuracy measures, including MAD, MAPE, and MSE, provided a comprehensive basis for evaluating forecasting performance, while the method with the lowest MAPE was selected as the forecasting model for the subsequent period. Lower error values generally indicate better forecasting performance (Alviyanur, 2022).

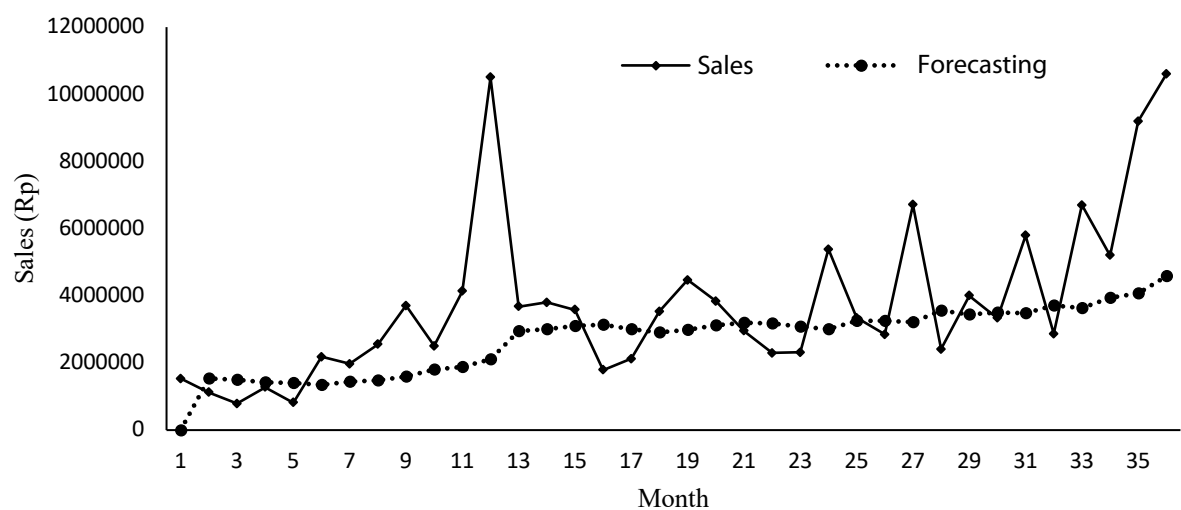


Figure 1. Sales pattern and forecast of Gatiga Snack fish skin products, 2022–2024

Table 1. Comparison of sales forecasting methods

Forecasting method	MAPE (%)	MAD (Rp)	MSE (RP ²)	Category	Forecast for period 37 (Rp)
Exponential smoothing with trend	36.761	1,512,719	5,347,137,000,000	Acceptable	5,354,904
Exponential smoothing	36.841	1,531,710	5,475,477,000,000	Acceptable	5,182,119
Moving average	39.565	1,619,268	4,651,042,000,000	Acceptable	8,333,334
Weighted moving average	40.707	1,588,966	4,694,720,000,000	Acceptable	9,900,000
Linear trend line	41.868	1,356,010	3,897,400,000,000	Acceptable	6,222,923
Naïve method	46.135	1,719,718	5,800,830,000,000	Acceptable	10,600,000

A MAPE value of 36.761% indicates that the forecasting model has a relatively high forecasting error. Therefore, the forecast should be interpreted with caution and used as a planning aid rather than as an exact estimate of future sales. The forecast values provide supporting information for managerial decision-making, particularly when combined with historical sales patterns and other relevant business information. The use of Exponential Smoothing with Trend remains appropriate because the method incorporates the trend component of time-series data and gives greater weight to more recent observations, allowing the forecast to respond to changes in sales patterns over time. This method has also been applied in sales and production forecasting (Wiyanti, 2023).

Table 2. Sales forecasting results for 2025

Period	Month	Sales forecast (Rp)	95% Confidence interval (±)
37	January-25	5,354,904	4,662,842
38–48	February–December 2025	Trend exponential smoothing model	4,662,842

The sales forecasting results for 2025 are presented in Table 2. For period 37, corresponding to January 2025, the forecasted sales value was IDR 5,354,904, with a 95% confidence interval width of ± IDR 4,662,842. The forecast value was lower than the sales recorded during the peak period in December 2024, indicating a possible decline in demand following the year-end period. This result is consistent with the recurring December sales increase and suggests that sales may decline after the year-end peak. However, fluctuations in sales may also be influenced by other factors, including changes in consumer preferences, promotional activities, and market conditions. Therefore, the forecasting results can be used as supporting

information for determining production volumes, raw material requirements, inventory levels, and marketing strategies for subsequent periods (Kazeem et al., 2023).

Overall, the annual sales data presented in Table 3 showed a fluctuating pattern, with sales decreasing by 2.87% in 2023 and subsequently increasing by 36.80% in 2024. Total annual sales decreased from IDR 41,175,827 in 2022 to IDR 39,995,735 in 2023, before increasing to IDR 54,709,238 in 2024. The substantial increase in 2024 indicates a notable increase in sales compared with the previous year; however, the factors underlying this change cannot be determined solely from the sales data. The increase may be associated with changes in market demand, consumer preferences, marketing activities, or other business factors. In food SMEs, sales performance can be influenced by the ability to innovate products and adapt marketing strategies to changing consumer needs. Product innovation and market orientation are important factors in strengthening SME competitiveness by supporting customer retention and market expansion (Putri & Warganegara, 2024). These historical sales patterns provide an important basis for evaluating forecasting performance and developing production and marketing plans for subsequent periods.

Table 3. Analysis of historical sales patterns

Period	Year	Total sales (Rp)	Monthly average (Rp)	Growth (%)
01–12	2022	41,175,827	3,431,319	–
13–24	2023	39,995,735	3,332,978	–2.87%
25–36	2024	54,709,238	4,559,103	36.80%
Total	2022–2024	135,880,800	3,774,467	–

Source: Gatiga Snack (2025)

Forecasting of fish skin chip production

The production data for Gatiga Snack's fish skin products showed a fluctuating pattern, with a pattern broadly similar to the fluctuations observed in sales. The production pattern and forecasting results presented in Figure 2 illustrate changes in actual production over the 2022–2024 period and their relationship with the observed sales pattern. These conditions indicate the importance of considering historical demand patterns in production planning so that production volumes can be appropriately aligned with market requirements. Production forecasting can help reduce the risk of mismatches between production volume and market demand while supporting operational planning and inventory control (Liu et al., 2023).

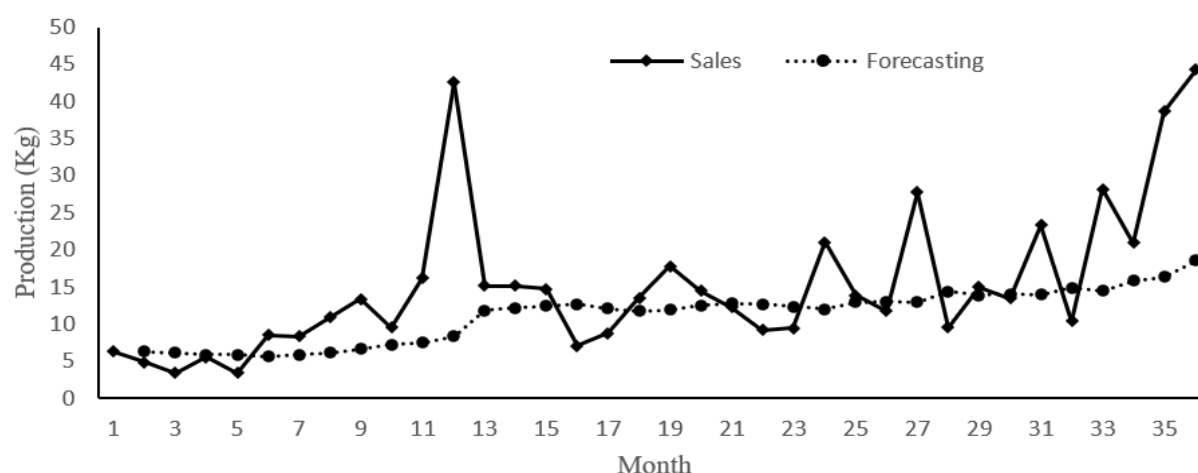


Figure 2. Production pattern and forecasting of fish skin chip products, 2022–2024

The comparison of production forecasting methods presented in Table 4 showed that Exponential Smoothing with Trend produced a MAPE value of 36.044% and a MAD value of 6.114 kg. Based on the forecasting accuracy measures presented in Table 4, Exponential Smoothing with Trend was selected as the most suitable method for forecasting production. The method incorporates the trend component of the time series and gives greater influence to more recent observations, allowing the forecast to respond to changes in production patterns over time (Svetunkov et al., 2022). The integration of sales forecasting with production planning can support more efficient production scheduling, reduce uncertainty in resource requirements, and improve operational decision-making (Alviyanur, 2022).

Table 4. Comparison of production forecasting methods

Forecasting method	MAPE (%)	MAD (kg)	MSE (kg ²)	Category	Forecast for period 37 (kg)
1. Exponential smoothing with trend	36.044	6.114	92.088	Feasible	21.835
2. Exponential smoothing	36.109	6.189	94.203	Feasible	21.108
3. Moving average	41.827	6.568	80.56	Feasible	41.45
4. Weighted moving average	41.827	6.568	80.56	Feasible	41.45
5. Linear trend line	41.934	5.625	67.582	Feasible	25.278
6. Naïve method	46.228	6.941	99.624	Feasible	44.300

A MAPE value of 36.044% indicates that the forecasting model has a relatively high forecasting error. Therefore, the forecast should be interpreted as an estimate that supports production planning rather than a definitive production value. Nevertheless, using the forecasting method with the lowest MAPE can assist Gatiga Snack in estimating production requirements for the subsequent period and preparing the necessary resources. The production capacity analysis presented in Table 5 showed an increase in total production from 112.70 kg in 2022 to 170.35 kg in 2023 and 264.70 kg in 2024. The average monthly production also increased from 9.392 kg in 2022 to 14.196 kg in 2023 and 22.058 kg in 2024. This increase indicates an expansion of production activity during the observation period. Based on the assumed normal production capacity of 15 kg per month, capacity utilization increased from 62.80% in 2022 to 94.60% in 2023 and 147.10% in 2024. Capacity utilization exceeding 100% in 2024 indicates that average actual monthly production exceeded the assumed normal capacity, suggesting that production activity had surpassed the established normal operating level and may have placed increasing pressure on the existing production.

Table 5. Production capacity analysis

Period	Year	Total production (kg)	Monthly average (kg)	Growth (%)	Capacity utilization*
1–12	2022	112.70	9.392	–	62.80%
13–24	2023	170.35	14.196	51.17%	94.60%
25–36	2024	264.70	22.058	55.40%	147.10%
Total	2022–2024	547.75	15.215	–	–

*Assumed normal capacity of 15 kg/month based on the overall average

The projection results indicate that the forecasted production for January 2025 exceeds the assumed normal monthly capacity of 15 kg, which was used as the basis for calculating capacity utilization. This finding suggests that production capacity may need adjustment if sales and production continue to increase. However, production capacity is not the only factor that may constrain future production. The availability of pangasius fish skin is also critical because an increase in production will directly increase raw material requirements. Therefore, the production forecast should be compared with the projected

availability of pangasius fish skin to determine whether the available raw material will be sufficient to support the forecasted production volume in the subsequent period. In fish processing industries, uncertainty in raw material supply and fluctuations in demand are important factors that should be considered in production planning (Suhadak et al., 2022).

Table 6. Projected production requirements for 2025

Indicator	Value	Description
Production forecast for period 37	21.835 kg	January 2025
Standard error	9.883 kg	Level of uncertainty
95% confidence interval	2.06–41.61 kg	Prediction range
Raw material requirement*	43.670 kg	Pangasius fish skin
Bias (mean error)	4.028 kg	Tendency toward overestimation

*Based on a conversion ratio of 0.5 (1 kg of fish skin produces 0.5 kg of fish skin chip product)

Forecasting the availability of pangasius fish skin raw materials

The raw material requirement derived from the production forecast needs to be compared with the availability of pangasius fish skin to assess whether the available raw material will be sufficient to support the continuity of Gatiga Snack's fish skin production. Based on Table 7, pangasius fish skin accounts for approximately 4.1% of the whole fish weight. This relatively low proportion indicates that a substantial quantity of whole fish must be processed to obtain sufficient fish skin as raw material. Therefore, the availability of pangasius fish skin is closely related to the volume of pangasius fish processed and the continuity of fish processing activities. This condition highlights the importance of raw material supply planning to ensure a consistent supply of fish skin for pangasius fish skin-based agroindustries (Nurilmala et al., 2021).

Table 7. Percentage composition of pangasius fish components

Pangasius Fish Part	Percentage (%)
Flesh	31.0
Head	24.3
Belly	3.5
Trimming (remaining flesh)	7.4
Viscera	29.7
Skin	4.1
Total	100.0

The availability of pangasius fish skin raw materials presented in Figure 3 showed considerable fluctuations, with an overall declining trend during 2023. The largest decrease occurred in period 7 (July 2023), when raw material availability declined from 9.782 kg to 4.398 kg, representing a decrease of approximately 55.0%. This substantial decline indicates variability in the supply of pangasius fish skin, which may create challenges in maintaining production continuity. Fluctuations in raw material availability may be associated with variations in fish production, aquaculture environmental conditions, harvesting patterns, and production management practices (Santoso et al., 2024). Such variability highlights the importance of raw material availability forecasting and supply planning to anticipate potential shortages and support the continuity of fish skin production at Gatiga Snack.

Based on the characteristics of the data, several forecasting methods were compared to determine the most appropriate method for projecting the availability of pangasius fish skin raw materials. The comparison results presented in Table 8 showed that the Linear Trend Line method produced the lowest

forecasting errors among the six methods evaluated, with a MAPE of 20.164%, MAD of 1,545.16 kg, and MSE of 5,641,146 kg². These error values were lower than those obtained using Exponential Smoothing with Trend, Exponential Smoothing, Naïve Method, Weighted Moving Average, and Moving Average. Therefore, the Linear Trend Line method was selected to forecast the availability of pangasius fish skin raw materials. The results suggest that, among the forecasting methods evaluated, the observed changes in raw material availability were better captured by a linear trend than by methods that place greater emphasis on recent observations. The selected model generated a forecast of 9,475.48 kg for period 13.

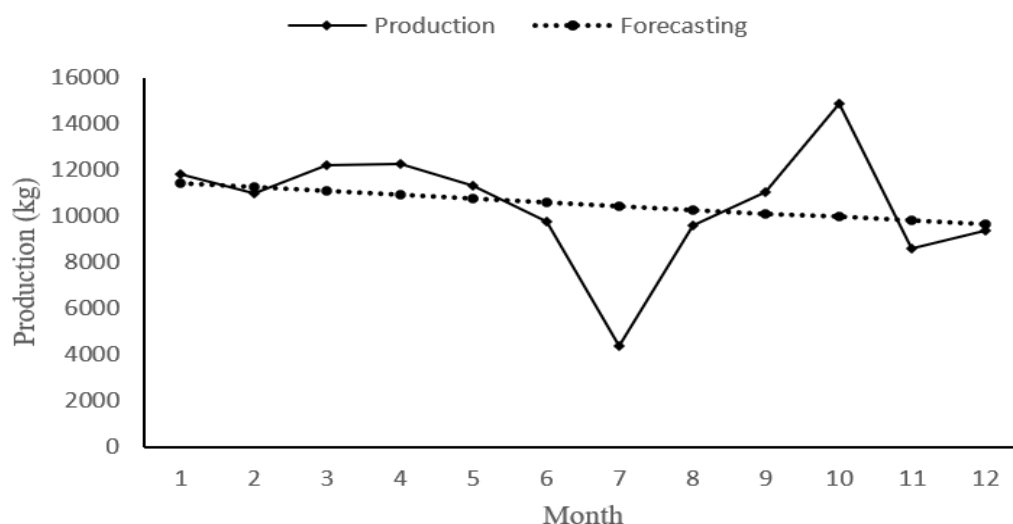


Figure 3. Availability pattern of pangasius fish skin raw materials in 2023

Table 8. Comparison of raw material forecasting methods

Forecasting Method	MAPE (%)	MAD (kg)	MSE (kg ²)	Category	Forecast for Period 13 (kg)
Linear Trend Line	20.164	1,545.16	5,641,146	Good	9,475.48
Exponential Smoothing with Trend	26.618	1,934.68	7,665,495	Feasible	10,700.51
Exponential Smoothing	29.137	2,315.00	8,786,190	Feasible	9,928.64
Naïve Method	30.812	2,502.43	10,729,930	Feasible	9,384.90
Weighted Moving Average	32.483	2,607.38	11,146,300	Feasible	9,306.79
Moving Average	34.976	2,838.70	11,162,060	Feasible	8,994.33

The forecasting results using the Linear Trend Line method indicated that the availability of pangasius fish skin was projected to reach 9,475.48 kg in period 13 (January 2024). The MAPE value of 20.164% was lower than those obtained using the other forecasting methods evaluated in this study. Therefore, the selected forecast can be used as a basis for estimating raw material availability for the subsequent period. However, as with the sales and production forecasts, the forecast value remains an estimate and should be interpreted in conjunction with actual supply conditions and external factors that may affect raw material availability. The declining trend in raw material availability should be considered in future business development planning because increasing production will result in higher requirements for pangasius fish skin. One strategy is to strengthen relationships with suppliers through long-term partnerships while developing alternative sources of raw materials. Diversification of supply sources can improve supply chain resilience and reduce the risk of supply disruptions (John and Mishra, 2024). Furthermore, utilizing fish skin that has previously been underutilized as a raw material can support the implementation of circular economy principles by increasing the value derived from fish-processing by-products (Ramesh et al., 2022). The projected raw material availability and the balance between raw material supply and production

requirements are presented in Table 9. The projection results indicate that the availability of pangasius fish skin remained substantially higher than the estimated raw material requirement during January–March 2024. In January 2024, for example, the projected raw material availability was 9,475.48 kg, whereas the estimated raw material requirement was 43.67 kg, resulting in a surplus of 9,431.81 kg. Similar conditions were observed in February and March 2024. Quantitatively, these results indicate that the projected raw material availability was sufficient to meet the estimated requirements for fish skin production during the analyzed periods.

Table 9. Projected raw material availability and supply–demand balance analysis

Period	Forecast supply (kg)	Production requirement (kg)*	Gap (kg)	Status
Jan-24	9,475.48	43.67	9,448.19	Surplus
Feb-24	9,314.41	43.67	9,287.12	Surplus
Mar-24	9,153.33	43.67	9,126.04	Surplus

Note: Based on the fish skin production forecast for period 37 and a conversion ratio of 0.5.

Nevertheless, a raw material surplus during the initial forecast periods does not necessarily mean that raw material availability poses no risk to business sustainability. The declining trend in availability should be anticipated because an imbalance between increasing production requirements and future raw material availability could eventually disrupt production continuity. Therefore, forecasting results should be integrated with production capacity planning and raw material procurement strategies so that production decisions can be adjusted to actual supply conditions.

Synthesis of forecasting results

Overall, the forecasting results showed that Exponential Smoothing with Trend was selected as the most appropriate method for forecasting both *fish skin* sales and production, whereas Linear Trend Line was selected for forecasting the availability of pangasius fish skin raw materials. The use of different forecasting methods indicates that the three datasets exhibited different characteristics. Sales and production data were better represented by a method that accounts for trend changes over time, whereas raw material availability was better represented by a linear trend among the methods evaluated. The analysis highlights the need to integrate three key aspects of the agroindustry: market demand, production capacity, and raw material availability. Sales and production exhibited fluctuating patterns with an overall increasing trend, while raw material availability showed a declining trend. This condition represents a strategic issue for the development of the *fish skin* agroindustry because production sustainability depends not only on the ability to respond to market demand but also on adequate production capacity and a continuous supply of raw materials. Therefore, the forecasting results can provide a quantitative basis for business planning, particularly for determining production capacity requirements and developing raw material procurement strategies (Liu et al., 2023).

Conclusion

The study showed that Gatiga Snack's *fish skin* sales and production exhibited fluctuating patterns with an overall increasing trend, including recurring increases toward the end of the year. In contrast, the availability of pangasius fish skin as a raw material showed an overall declining trend during the 2023 observation period. Among the forecasting methods evaluated, Exponential Smoothing with Trend provided the best results for forecasting both sales and production, while Linear Trend Line provided the best results for forecasting raw material availability. The forecasting results provide quantitative information that can support production planning, capacity evaluation, and raw material procurement decisions. The supply–demand balance analysis indicated that the projected raw material availability remained sufficient to meet the estimated production requirements during the analyzed period. However,

the declining trend in raw material availability should be anticipated through appropriate supply planning and diversification strategies to maintain the continuity of *fish skin* production at Gatiga Snack.

References

- Alviyanur, A. 2022. Analisis perencanaan produksi menggunakan metode forecasting. *Jurnal Indonesia Sosial Teknologi*, 3(3), 426–437. <https://doi.org/10.59141/jist.v3i03.387>
- Andriyanto, A., 2025. Analisis potensi peningkatan nilai tambah produk sektor perikanan di indonesia. *Jurnal Logistik Bisnis*, 15(2). <https://doi.org/10.46369/logistik.v15i2.4665>
- Chakma, S., Rahman, M. A., Siddik, M. A. B., Hoque, M. S., Islam, S. M., & Vatsos, I. N. (2022). Nutritional profiling of wild (*Pangasius pangasius*) and farmed (*Pangasius hypophthalmus*) pangasius catfish with implications to human health. *Fishes*, 7(6), 309. <https://doi.org/10.3390/fishes7060309>
- Food and Agriculture Organization of the United Nations. (2022). The state of world fisheries and aquaculture 2022: Towards blue transformation. *FAO*. <https://doi.org/10.4060/cc0461en>
- Gamtesa, S. 2022. Capacity utilization, factor substitution, and productivity growth in Canadian food processing sector. *Agricultural and Food Economics*, 10, Article 21. <https://doi.org/10.1186/s40100-022-00229-4>
- Isnaini, F. D., Via, Y. V., & Mandyartha, E. P. 2024. Penerapan Holt-Winters untuk peramalan harga beras di Provinsi Jawa Timur dengan pendekatan time series. *Jurnal Informatika dan Teknik Elektro Terapan*, 12(3), 2706–2716. <https://doi.org/10.23960/jitet.v12i3.4890>
- John, E. P., & Mishra, U. 2024. Integrated multitrophic aquaculture supply chain fish traceability with blockchain technology, valorisation of fish waste and plastic pollution reduction by seaweed bioplastic: A study in tuna fish aquaculture industry. *Journal of Cleaner Production*, 434, Article 140056. <https://doi.org/10.1016/j.jclepro.2023.140056>
- Kazeem, R. A., Petinrin, M. O., Akhigbe, P. O., Jen, T. C., Akinlabi, E. T., Akinlabi, S. A., & Ikumapayi, O. M. 2023. Forecast of the trend in sales data of a confectionery baking industry using exponential smoothing and moving average models. *Mathematical Modelling of Engineering Problems*, 10(1), 1–13. <https://doi.org/10.18280/mmep.100101>
- Liu, S., Chang, L., & Wang, L. 2023. Demand forecasting of cold-chain logistics of aquatic products in China under the background of the Covid-19 post-epidemic era. *Plos One*, 18(11). <https://doi.org/10.1371/journal.pone.0287030>
- Nurilmala, M., Darmawan, N., Putri, E. A. W., Jacoeb, A. M., and Irawadi, T. T. 2021. Pangasius fish skin and swim bladder as gelatin sources for hard capsule material. *International Journal of Biomaterials*. 3, 1–6. <https://doi.org/10.1155/2021/6658002>
- Pangawikan, A. D., Mukti, R. C., Sari, D. I., & Ridhowati, S. 2022. Prediksi masa simpan kerupuk ikan Palembang melalui pendekatan angka total oksidasi (Totox) dengan metode Accelerated Shelf-Life Test (ASLT). *Jurnal Teknologi & Industri Hasil Pertanian*, 27(2), 81–89. <https://doi.org/10.23960/jtihp.v27i2.81-89>
- Pratama, A. R. and Marwati, W. 2025. Implementation of sustainable fisheries principles in marine fishery resource management. *Journal of Marine Fisheries* Vol. 1 (2) 43–48. <https://doi.org/10.70716/marfish.v1i2.18543>
- Putri, T. N., & Warganegara, T. L. P. 2026. Pengaruh orientasi pasar, inovasi produk, digital marketing terhadap kinerja pemasaran UMKM di Bandar Lampung. *Jambura: Jurnal Ilmiah Manajemen dan Bisnis*, 9(1), 549–559. <https://doi.org/10.37479/jimb.v9i1.38692>
- Ramesh, T., Vijay, A. P. K. A., Krishnamoorthy, S., & Ramakrishnan, P. 2022. Resource recovery from fish waste: Prospects and the usage of intensified extraction technologies. *Chemosphere*, 299, Article 134361. <https://doi.org/10.1016/j.chemosphere.2022.134361>

- Reskianto, D., Barata, M. A., & Sahri. 2023. Forecasting metode single exponential smoothing dalam meramalkan penjualan barang. *Jurnal Informatika Polinema*, 9(4), 435–444. <https://doi.org/10.33795/jip.v9i4.1405>
- Saputri, A. D. D., Achmadi, S., & Auliasari, K. 2025. Penerapan metode Holt Winter exponential smoothing dalam memprediksi penjualan pada produk Sipetek. *Jurnal Informatika Teknologi dan Sains (JINTEKS)*, 7(1), 289–297. <https://doi.org/10.51401/jinteks.v7i1.5227>
- Santoso, A. A., Syaukat, Y., & Fariyanti, A. 2024. Risiko produksi usaha budidaya patin di kawasan minapolitan Kabupaten Banjar Provinsi Kalimantan Selatan. *Institut Pertanian Bogor*.
- Savsar, M., & Çiçek, H. 2021. Analysis and improvement of production planning processes in a food factory. *Avrupa Bilim ve Teknoloji Dergisi*, (29), 377–386. <https://doi.org/10.31590/ejosat.1035233>
- Svetunkov, I., Kourentzes, N., & Ord, J. K. 2022. Complex exponential smoothing. *Naval Research Logistics*, 69(8), 1108–1123. <https://doi.org/10.1002/nav.22074>
- Suhadak, D., Darmawan, & Zulkarnain. 2022. Dampak fluktuasi pasar ikan Uni Eropa terhadap utilitas industri perikanan di pelabuhan perikanan Samudera Nizam Zachman Jakarta. *Jurnal Sosial Ekonomi Kelautan dan Perikanan*, 17(1), 75–89. <https://doi.org/10.15578/jsekp.v17i1.9633>
- Sukma, R. N., Pratiwi, dan Sa'adah, N. 2025. Pola mahasiswa mengonsumsi ikan laut sebagai sumber pangan bergizi. *Arborescent Journal* Vol. 2 (3). 74-80 hlm. <https://doi.org/10.56630/arj.v2i3.1369>
- Wiyanti, W. 2023. Efektivitas metode exponential smoothing untuk prediksi data runtun waktu pola tren dan non-musiman (Studi kasus cakupan vaksinasi covid-19). *Jurnal Matematika, Statistika dan Komputasi*, 20(1), 52–64. <https://doi.org/10.20956/j.v20i1.27193>