Forecasting demand for frozen whole blocks of swanggi fish at PT. Hatni using a comparison of winter and decomposition methods

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ABSTRACT

PT. HATNI specializes in the export of frozen fish, particularly Swanggi (Priacanthus tayenus) and Kuniran fish. This study focuses on Swanggi fish due to its higher demand in the export market. Swanggi fish, a species of ray-finned marine fish, is characterized by blackish spots, large eyes, and a pink coloration, belonging to the family Priacanthidae. The objective of this research is to identify an effective forecasting method for estimating future export demand for frozen whole Swanggi fish, enabling the company to optimize its production and supply chain planning. Using 2023 data with evident seasonal patterns, trends, and seasonality, the study compares the Winter Multiplicative method and the Decomposition method. Through trial and error, the Winter Multiplicative method was identified as the most accurate, with parameters of α = 0.9, β = 0.1, and γ = 0.9. This method yielded the lowest error values: MAD of 1,602, MSD of 9,161,073, and MAPE of 3%. These results provide PT. HATNI with a reliable forecasting tool to meet future market demand effectively.

1. Introduction

According to Maritime Affairs and Fisheries (2023), Indonesia is a maritime country whose territory is mostly sea with a coastline of 99,083 km, so Indonesia exports a lot of marine products, especially sea fish, because it is rich in marine products, the potential for fisheries and marine resources is very large for support economic development. Therefore, demand forecasting plays an important role in supporting production planning and supply chain management.

PT. HATNI Company exports frozen fish by importing Swanggi and Kuniran fish, China is the main country. In this study, researchers focused more on swanggi fish because swanggi fish is superior to kuniran fish. In the production of Swanggi fish there are various processes, namely:

1. Frozen Head Less Semi Block
2. Frozen Wggs Semi Iqf
3. Frozen Whole Round Block
4. Frozen Fish Fillet Block

Of the four types of swanggi fish processing, researchers chose to focus on Frozen Whole Round Block which is the most widely produced and exported.

Swanggi fish (Priacanthus tayenus) is a type of sea stingray with black spots, large eyes and pink, belonging to the Piacanthidae family, originating from the Indian Ocean and Pacific Ocean, has a lot of energy to meet food needs and fish exports. Swanggi has a strong ability to withstand fishing

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pressure, if its fishing capacity increases it will show signs of "fatigue" and stop fishing (Lailiyah et al., 2024).

PT. HATNI utilizes a fish freezing process to prepare products for export, ensuring the preservation of the fish's natural quality (Kresnasari et al., n.d.). Freezing at low temperatures creates tiny ice crystals that increase the scattering and absorption of light at all wavelengths in the visible light range. Enzymatic and chemical degradation slows at lower temperatures, and this process continues as the food freezes. The taste, appearance and nutritional value of fish are affected by browning and oxidation reactions during storage in ice. Fish and temperatures below -18°C Previously, the storage temperature of frozen fish varied from -18℃ to -30℃. Glaze is used in the fishing industry to protect fish from damage caused by sensitive conditions, and can be said to attach a layer of ice to the surface of white frozen products. Immersion or spraying in a water bath (Elghazali et al., 2023).

Forecasting the number of exports is very important for companies due to the fluctuating demand and availability of swanggi fish as an important raw material for the production process. Forecasting is an important part of the company because it can determine the number of products to be produced using historical data. If the company's output is greater than the customer's demand, the company will be profitable, and conversely, if the company's output is less than the customer's demand, the company will be profitable. satisfaction of the customer to the company. These unsatisfied customers can reduce the company's competitiveness and disrupt the demand cycle (Muhammad et al., n.d.).

The following data is obtained from PT. HATNI regarding data on requests to China as its export destination in January – December 2023:

Table 1 Number of requests for frozen whole blocks of swanggi fish

Month	Year	Number of Requests	Month	Year	Number of Requests
Jan	2023	47.500,00	Jul	2023	19.712,50
Feb	2023	16.235,50	Aug	2023	47.842,00
Mar	2023	43.025,50	Sept	2023	44.650,00
Apr	2023	23.750,00	Oct	2023	45.590,50
May	2023	60.097,00	Nov	2023	68.875,00
Jun	2023	48.545,00	Dec	2023	68.276,50

Source: PT. HATNI (2024)

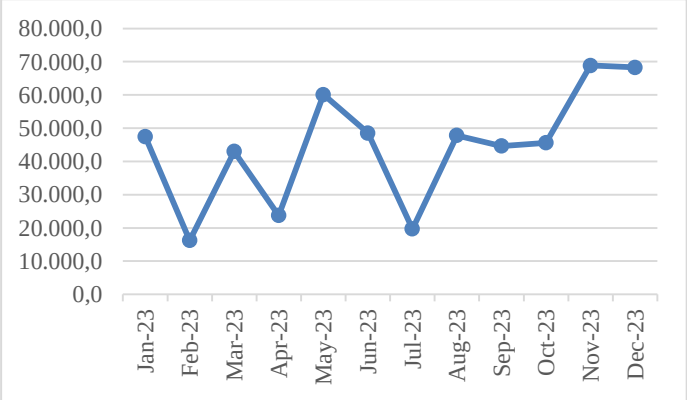

Fig. 1 Graph of export demand data for all blocks of frozen swanggi fish (in kg).

According to previous research by (Rizqi Az Zahran & Prayudha Hidayat, 2024) the Multiplicative Decomposition method was designed to increase production efficiency and reduce the impact of branch shortages in the electronics industry in PT. Omron Indonesia. Furthermore, Siagian (Siagian & Supriana, n.d. 2024) conducted research to predict Indonesian cocoa production and imports in 2022–2026 using the Triplr Holt Winters and ARIMA methods. Furthermore, Hadiyan's research (Hadiyan Amaly et al., 2022) used summary and winter methods to estimate the average number of PKM PKH during the 2021 period in NTB province.

In forecasting calculations, the main thing to do is to understand the characteristics of the methodology used in forecasting so that it is in accordance with the decisions to be taken based on existing data and is appropriate for the implementation of the topic being studied. Based on the

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background and data patterns above, the researcher will use the winter method which has a seasonal pattern data model whether there is a trend element or not and the decomposition method as a comparison because it has cyclical, trend, seasonal and random components in the data. From the results of the experiments carried out on the calculations of this method, a more effective method can be selected to be used by the company as a reference for forecasting the demand for frozen whole swanggi fish exports in the future by looking at the results of the error level, namely the mean absolute deviation, mean square deviation, and mean absolute percentage error.

The objective of this research is to identify an effective forecasting method for estimating future export demand for frozen whole Swanggi fish, enabling the company to optimize its production and supply chain planning.

2. Methods

The researchers conducted several data collection methods, including observation, interviews, literature research, and taking data from the company's manual, and processed the data using quantitative forecasting methods according to the data model. Observations were made to directly examine the production process in the PT. HATNI, and conducting interviews with employees to obtain information about problems that occur in the company. In this case, the forecast aims to reduce the uncertainty that occurs in the company and achieve a useful forecast that can be seen from the results of the minimum error measured by MAD, MSD and MAPE (Mamun et al., 2020). There are three stages of prediction related to the time period (Nugraheni et al., 2022), namely:

1. A long-term forecasting
   Usually more than 18 months, and many times are needed for site planning, capital issues and research and development.
2. Medium-term forecasting
   Cover 3 to 18 months, usually required for construction and procurement planning and contracting activities.
3. Short-term forecasting
   are used ≤ 3 months, and are used to plan work schedules, asset purchases, and employee performance.

To manage the data processing process, the first step is to determine the prediction objective to determine the data period obtained, select a method according to the data model, and then collect and analyze the data. Predictions are made and the data graph is determined from the data obtained, prediction calculations are performed in a predictable and accurate manner, and the prediction results are checked.

There are quantitative and qualitative methods in prediction (Ihwah et al., 2021). Qualitative methods rely on a person's judgment and experience (subjectivity), changing conditions, and direct relationships between the company's environment and internal information. On the other hand, quantitative methods use past data and statistics to predict the future, and assume that past data patterns will persist.

Quantitative Forecasting Methods

Quantitative methods require historical data, information, or numerical data. The search for information using the numerical method is systematic, structured, and planned from the beginning of the research, starting from data collection, interpretation, and application of results that include many numbers. (Zellner et al., 2021). To ensure that there are no significant differences between the predicted results and reality, each method used must spread the level of accuracy of the predicted results to ensure that the predicted results truly depend on the method used. Some of the characteristics of this method are:

1. Using statistical data
2. Using historical data to predict the future
3. Assuming past data patterns will persist in the future

Two types of quantitative forecasting are the periodic series method (Time Series), which uses historical data to make predictions (Khemavuk & Leenatham, 2020). On the other hand, causal methods use relationships between variables that influence each other to make predictions.

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Time series method

According to Heizer and Render (2009), the time series analysis method is based on a sequence of data points that have the same time interval (weekly, monthly, quarterly, etc.) to predict the future using historical data (Bimantoro et al., 2021). Forecasting time series data is a part of statistical modelling that is widely used in various fields because it is convenient to make decisions.

Time series analysis has many purposes, including forecasting, modelling and management. The purpose of time-series forecasting is to predict the future value of a time-varying variable using past values. The use of time series data for forecasting based on the behavior of past events. In time series data, the behavior of past events can be used for forecasting, as the effects of past behavior are expected to continue in the future (Hendikawati et al., 2020).

Winter

One method used for seasonal data series is the winter method. Winter trend statistics are based on three elements, i.e. constant, trend and seasonal elements for each season, and use three weights, i.e., α (predicted value), β (slope) and γ (variation of seasonal effects) (Pertiwi, 2020).

1. Additive model

   If there is initial data showing seasonal changes with stable data

$$L_t = \alpha(X_t - S_{t-s}) + (1-\alpha)(L_{t-1} + T_{t-1}) \quad (1)$$

$$T_t = \beta(L_t - L_{t-1}) + (1-\beta)T_{t-1} \quad (2)$$

$$S_t = \gamma(X_t - L_t) + (1-\gamma)S_{t-s} \quad (3)$$

$$F_{t+m} = L_t + T_t m + S_{t-s+m} \quad (4)$$

2. Multiplicative Model

   If there are seasonal changes, use the multiplication model with the following formula. (Andriani et al., 2022):

$$L_t = \alpha\frac{X_t}{S_{t-s}} + (1-\alpha)(L_{t-1} + T_{t-1}) \quad (5)$$

$$T_t = \beta(L_t - L_{t-1}) + (1-\beta)T_{t-1} \quad (6)$$

$$S_t = \gamma\frac{X_t}{L_t} + (1-\gamma)S_{t-s} \quad (7)$$

$$F_{t+m} = (L_t + T_t m)S_{t-s+m} \quad (8)$$

Description of the winter method formula

α : Level smoothing parameters
β : Trend smoothing parameters
γ : Seasonal smoothing parameters
X_t : Actual data at time-t
L_t : Level smoothing at time-t
T_t : Trend smoothing at time-t
S_t : Seasonal smoothing at time-t
S : Seasonal length
L_s : Level smoothing at time-s
T_s : Trend smoothing at time-s
S_i : Seasonal smoothing at time-i
F_{t+m} : Forecasting at time-(t+m)

Decomposition

It is a method of analyzing time series data to identify the component characteristics associated with each value in the data, and each component is identified separately. The purpose of this division is to help increase the accuracy of forecast results. In addition to that, separating the sub-samples helps the model to understand the behavior of the data series. This method is used when the data shows a pattern of trend, seasonality or two with four parameters for prediction, namely error, change, trend and seasonality (Supriatna et al., 2019). With the following two models:

1. Additive model

   To produce predictable results, combine all parameters to create a data cycle with trend, seasonality, cycle, and error.

$$X_t = T_t + C_t + S_t + I_t \quad (9)$$

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2. Multiplicative Model

Create time-series data with trend, seasonality, cycle, and error components to multiply forecast results for all components.

$$X_t = T_t \times C_t \times S_t \times I_t \quad (10)$$

Description of the model for the analysis method

X_t : Actual data at time-t
T_t : Trend component
C_t : Cycle components
S_t : Seasonal components
I_t : Irregular components

Measurement of forecasting accuracy

Although forecasting is never perfect, errors do occur when forecasting. This error is what makes predictive planning ineffective, as this error can create risk, so errors should be kept to a minimum or close to zero. In order to make a correct prediction, the correct test should be done with the minimum error (Hariguna, 2023).

More accurate measurements can increase the number and average of errors because MAD is the absolute value of the number of errors.

$$MAD = \frac{\sum_{t=1}^{n} |A_t - F_t|}{n} \quad (11)$$

Mean Square Deviation is the squared difference between the predicted value and what occurred.

$$MSE = \frac{\sum_{t-1}^{n} (A_t - F_t)^2}{n} \quad (12)$$

Mean Absolute Percentage Error is the absolute average between the actual and predicted values.

$$MAPE = \left(\frac{100}{n}\right) \sum_{t-1}^{n} \left|\frac{A_t - F_t}{A_t}\right| \quad (13)$$

Error formula description

A_t : Actual Demand period-t
F_t : T-period forecasting
n : Number of forecasting periods
t : Period

The Mean Absolute Percentage Error (MAPE) is categorized as follows: a value below 10% indicates very high accuracy, 10% to 20% is considered good, 20% to 50% is average, and values exceeding 50% reflect low accuracy.

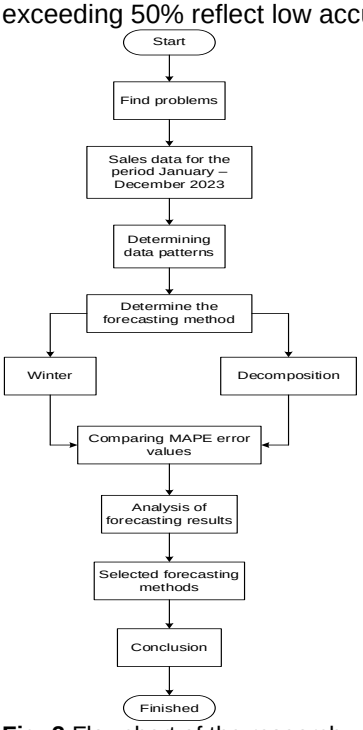

Fig. 2 Flowchart of the research.

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3. Results and Discussion

For now, researchers use data collected from PT investors. HATNI from January to December 2023, which is suitable for forecasting using the time series method, where data is presented in monthly intervals. To simplify the process of obtaining forecasting results with the smallest error, researchers used Minitab 21 software.

Multiplicative Winter Method

To calculate alpha, beta, and gamma values in the winter method, three weightings alpha (estimated value), beta (slope), and gamma (change in seasonal effects) are used. The trial was carried out three times to get the smallest error value, and the results of the winter multiplication method showed that alpha 0.9, beta 0.1, and gamma 0.9 had the smallest error value (see in Fig. 3).

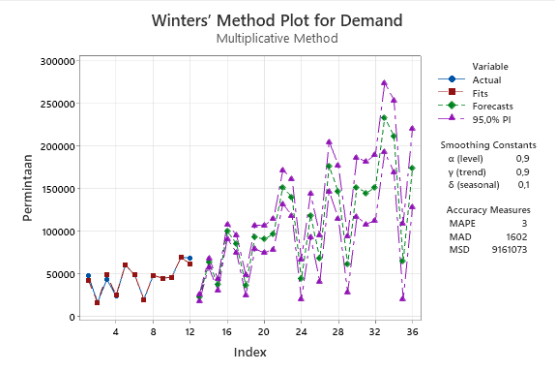

Fig. 3 Graphic multiplicative winter method.

As shown in Fig. 3, the error values calculated are MAD = 1,602, MSD = 9,161,073, and MAPE = 3. The forecast results for the next 12-month period, generated using Minitab 21 software, are presented in Fig. 4.

	C1	C2	C3	C4
	Demand	FORE1	UPPE1	LOWE1
1	47500,0	21997	25921	18074
2	16235,5	62592	67832	57351
3	43025,5	36941	43780	30101
4	23750,0	99351	107914	90787
5	60097,0	84867	95217	74517
6	48545,0	36292	48464	24120
7	19712,5	92427	106442	78411
8	47842,0	90230	106103	74357
9	44650,0	96097	113837	78357
10	45590,5	151043	170656	131429
11	68875,0	139122	160615	117629
12	68276,5	43214	66590	19839
13		118096	143357	92834
14		67255	94405	40105
15		175219	204259	146179
16		145468	176400	114537
17		60627	93452	27803
18		150842	185561	116123
19		144158	180772	107544
20		150572	189082	112063
21		232469	272874	192063
22		210618	252921	168315
23		64431	108632	20231
24		173600	219698	127501

Fig. 4 Result forecast multiplicative winter method.

Additive Winter Method

Following are the results of trial and error using the winter additive method that alpha 0.8 beta 0.3 and gamma 0.4 have the smallest error values after testing 5 times, as shown in the Fig. 5.

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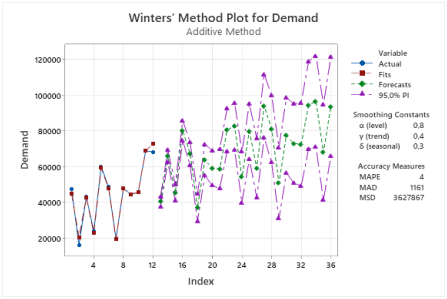

Fig. 5 Graphic additive winter method.

From the image above, information is obtained that the MAD error value is 1,161, MSD is 3,627,867, MAPE is 4 and the forecast results obtained from Minitab 21 software for the next 12 month period are:

As shown in Fig. 5, the error values calculated are MAD = 1,161, MSD = 3,627,876, and MAPE = 4. The forecast results for the next 12-month period, generated using Minitab 21 software for the next 12 month period, are presented in Fig. 6.

	C1	C2	C3	C4
	Demand	FORE1	UPPE1	LOWE1
1	47500,0	40302,3	43148	37456,8
2	16235,5	65945,1	69544	62345,9
3	43025,5	45318,5	49835	40801,5
4	23750,0	80258,4	85776	74741,0
5	60097,0	67291,1	73854	60728,1
6	48545,0	37047,1	44682	29412,0
7	19712,5	63770,1	72494	55046,2
8	47842,0	59175,3	68999	49351,4
9	44650,0	58715,2	69647	47783,5
10	45590,5	80600,3	92646	68555,1
11	68875,0	82704,8	95868	69541,8
12	68276,5	54120,8	68405	39836,9
13		79763,6	95171	64356,3
14		59137,0	75670	42604,1
15		94076,9	111737	76417,0
16		81109,6	99898	62321,2
17		50865,6	70783	30947,6
18		77588,6	98637	56540,2
19		72993,8	95173	50814,1
20		72533,7	95845	49222,1
21		94418,8	118863	69974,7
22		96523,3	122100	70946,2
23		67939,2	94650	41228,7
24		93582,1	121427	65737,7

Fig. 6 Result forecast additive winter method.

Multiplicative Decomposition Method

The decomposition method test uses the help of Minitab 21 software and the results obtained can be seen in Fig. 7.

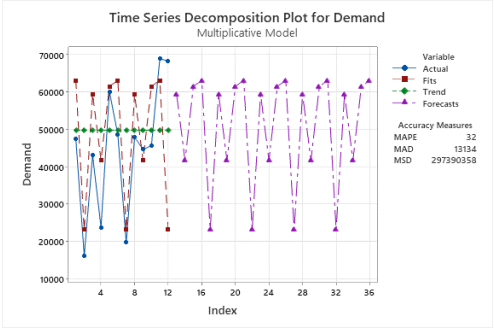

Fig. 7 Graphic multiplicative decomposition method.

As shown in Fig. 75, the error values calculated are MAD = 13,134, MSD = 297,390,358, and MAPE = 32. The forecast results for the next 12-month period, generated using Minitab 21 software for the next 12 month period, are presented in Fig. 8.

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	C1	C2
	Demand	FORE1
1	47500,0	59423,1
2	16235,5	41673,2
3	43025,5	61506,0
4	23750,0	63058,2
5	60097,0	23182,6
6	48545,0	59423,1
7	19712,5	41673,2
8	47842,0	61506,0
9	44650,0	63058,2
10	45590,5	23182,6
11	68875,0	59423,1
12	68276,5	41673,2
13		61506,0
14		63058,2
15		23182,6
16		59423,1
17		41673,2
18		61506,0
19		63058,2
20		23182,6
21		59423,1
22		41673,2
23		61506,0
24		63058,2

Fig. 8 Result forecast multiplicative decomposition method.

Additive Decomposition Method

The decomposition method test uses the help of Minitab 21 software and the results obtained can be seen in the Fig. 9.

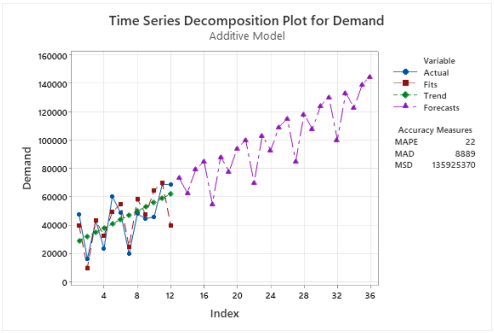

Fig. 9 Graphic additive decomposition method.

As shown in Fig. 9, the error values calculated are MAD = 8,889, MSD = 135,925,370, and MAPE = 22. The forecast results for the next 12-month period, generated using Minitab 21 software for the next 12 month period, are presented in Fig. 10.

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	C1	C2
	Demand	FORE1
2	16235,5	62697
3	43025,5	79136
4	23750,0	84884
5	60097,0	54871
6	48545,0	88067
7	19712,5	77695
8	47842,0	94135
9	44650,0	99883
10	45590,5	69870
11	68875,0	103065
12	68276,5	92694
13		109133
14		114881
15		84869
16		118064
17		107693
18		124132
19		129880
20		99867
21		133063
22		122691
23		139130
24		144879

Fig. 10 Result forecast additive decomposition method.

After processing the data to predict demand for sales of whole blocks of frozen Swanggi fish in the next period and getting results with the smallest error rate from all methods, then determine the most appropriate method by looking at the error results in the MAPE value of each experiment that has been carried out. Because a smaller MAPE value means a smaller forecasting error, and vice versa, a larger MAPE value means a bigger forecasting error. A comparison of these values shows that the most appropriate method is the method that has the smallest error rate (Table 2).

Table 2 Error rate (MAPE) in frozen whole block Swanggi fish forecasts

Method	MAPE
Multiplicative Winter	3
Additive Winter	4
Multiplicative Decomposition	32
Additive Decomposition	22

Based on the results of the error rate (MAPE) in the table above with several forecasting methods that have been carried out, it can be concluded that the effective method to use because it has the smallest error rate is forecasting using the Winter Multiplicative method with α = 0.9, β = 0 .1, γ = 0.9 and the forecast for the next period is 118,096, 67,255, 175,219, 145,468, 60,627, 150,842, 232,469, 210,618, 64,431, 173,600 with an error value of MAD of 1,602, MSD of 9 ,161,073, and a MAPE of 3 Thus, for forecasting demand for the next period, the most accurate method is to use the Winter Multiplicative method. Based on previous research contained in the introduction above, the results of this study found values for MAPE = 15, MAD = 2761, and MSD = 1692444, whereas previous research found values for MAD = 1602, MSD = 916,073, and MAPE = 3. MAPE results This shows that this research is much better than previous research.

To implement this prediction, there are several obstacles. These include the limited amount of data, the process of determining a prediction model, and external factors such as weather and the economy that can alter accurate predictions. The way to overcome this problem is to improve the quality of data requests and use predictive analytics to improve prediction accuracy. Therefore, more research can be conducted to study contextual aspects that may influence forecasting performance, such as user perceptions and organizational culture. They can also learn how new technologies used by practitioners through a combination of AR and AI can impact them.

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4. Conclusion

From the results of the analysis and forecasting calculations above:

1. To predict the demand for Swanggi fish in 2024 at PT. HATNI uses the time series method (winter and decomposition method), the first steps are analysis using the time series method and it can be concluded that forecasting demand for Swanggi fish in 2024 at PT. HATNI can be carried out using the time series method (winter method and decomposition method). This is because the data used in the analysis is based on a time series from January 2023 to December 2023. The choice of this forecasting method is also based on the type of data pattern seen in the previous period's demand data. This data pattern has seasonal and trend data components which can be carried out using winter and decomposition methods, after which forecasting accuracy or error levels are tested using MAD, MSD and MAPE. With this error rate value, the one with the smallest value is selected which can be used to forecast demand for frozen whole blocks of swanggi fish in the next period.
2. Based on the results of these calculations, the method that can be used with the smallest error rate is the multiplicative winter method with a MAD value of 1,602, MSD of 9,161,073, and MAPE of 3.

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