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Analysis of Raw Material Inventory Control in The Amplang Production Process (Case Study: UD Taufik Jaya Makmur)

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A B S T R A C T

UD Taufik Jaya Makmur is an SME that produces amplang in various shapes and packaging sizes. Inventory control at this SME faces several issues, such as the lack of production scheduling, high inventory costs, and changes in raw material prices, especially for tapioca flour and fish. These problems impact the quality of service and provide opportunities for competitors to attract consumers. Therefore, a deterministic method is employed to achieve optimal inventory control, which includes methods such as Economic Order Quantity (EOQ), Period Order Quantity (POQ), Least Unit Cost (LUC), Least Total Cost (LTC), Economic Part Period (EPP), Part Period Balancing (PPB), Silver Meal, and Wagner Within. Calculations indicate that the optimal inventory for tapioca flour, after considering the minimum purchase lot from suppliers and warehouse capacity, is achieved using the Economic Part Period (EPP), Part Period Balancing (PPB), and Wagner Within methods. The inventory cost for meeting the demand for the next year is IDR733.802, with savings reaching 72% compared to the business policy. For fish, the optimal inventory is achieved using the Period Order Quantity (POQ), Least Unit Cost (LUC), Least Total Cost (LTC), and Wagner Within methods. The inventory cost is IDR9.159.728, with savings reaching 37% compared to the business policy. Sensitivity analysis shows that inventory control for tapioca flour and fish is sensitive to ordering costs (distribution), necessitating recalculations if there are future changes.

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1. INTRODUCTION

The economy of East Kalimantan Province in 2023 experienced positive growth of 6,22 percent compared to the previous year, with a Gross Regional Domestic Product (GRDP) at current prices amounting to IDR843,57 trillion (Badan Pusat Statistik Provinsi Kalimantan Timur, 2024). From the production side, the processing industry, which includes Micro, Small, and Medium EnteIDRrises (MSMEs), contributed 0,93 percent to this growth with 460.147 business units (Satu Data Indonesia, 2024). This indicates the significant role of MSMEs in East Kalimantan's economy. The government must strive to encourage and support community involvement in processing local resources through capital assistance and policies that facilitate MSMEs. Amplang is a traditional snack from Samarinda that has become a popular souvenir for tourists visiting East Kalimantan (Portal Kaltim, 2018). The substantial opportunity has led to many MSMEs producing and selling amplang, resulting in increasingly fierce competition among these MSMEs. To compete with similar businesses, MSME actors must meet consumer expectations by considering their needs and desires. Additionally, providing better service than competitors will certainly enhance customer satisfaction (Natalya et al., 2018). This can be achieved through effective inventory control.

UD Taufik Jaya Makmur, as one of the MSMEs producing Amplang, has been established since 1992. This MSME has branches in two cities, Samarinda and Balikpapan, with its production center located at Jalan Kapas No. 38, Samarinda City, East Kalimantan Province. UD Taufik Jaya Makmur, operating under the store name "Kampung Amplang," offers several products such as tiger claw amplang, ball amplang, stick amplang, fish floss, and others in various packaging sizes ranging from small to large. Amplang is made from several ingredients including fish, starch flour, eggs, and additional seasonings (garlic, sugar, and shrimp flavoring). The production of amplang occurs once a week with a fixed quantity of 100 kg. However, the production schedule is uncertain as it adjusts according to the stock of amplang products in the store. Several issues currently affect this MSME regarding inventory control.

If fluctuating demand increases, a constant production level cannot meet the demand. Meanwhile, when demand decreases, the surplus production must be stored, which can affect the quality of the products. This MSME orders raw materials before production without having stocks available in the warehouse, resulting in high inventory costs due to repeated ordering and delivery. Furthermore, this MSME also becomes dependent on suppliers for its production, creating supply uncertainty risks especially if problems arise with suppliers. Fluctuating prices of starch flour and fish at certain times also impact overall costs. These issues affect service quality and provide opportunities for competitors to attract consumers. Therefore, research is being conducted on inventory control at UD Taufik Jaya Makmur specifically concerning the raw materials for amplang: starch flour and fish.

Table 1. Amplang demand data

No	Year	Month	Demand (kg)	Production (kg)
1	2022	July	480	500
2		August	363	400
3		September	359	400
4		October	461	500
5		November	395	400
6		December	502	500
7	2023	January	345	400
8		February	357	400
9		March	375	400
10		April	504	500
11		May	358	400
12		June	494	500
13		July	377	400
14		August	355	400
15		September	464	500
16		October	360	400
17		November	402	400
18		December	501	500
19	2024	January	339	400
20		February	360	400
21		March	483	500
22		April	397	400
23		May	357	400
24		June	503	500
Total			**9.891**	**10.500**
Average per Month			412,1	437,5
Average per Week			94,2	100

The resolution of inventory control issues for starch flour and fish uses deterministic methods such as Economic Order Quantity (EOQ), Period Order Quantity (POQ), Least Unit Cost (LUC), Least Total Cost (LTC), Economic Part Period (EPP) , Part Period Balancing (PPB), Silver Meal, and Wagner Within. Based on interviews conducted with the owner, UD Taufik Jaya Makmur has deterministic demand data for amplang products. This is indicated by data that specifies demand quantities, lead times, and costs accurately. The deterministic methods are compared to one another to obtain optimal inventory with the lowest inventory costs. This is done to address production issues that do not align with demand and to reduce inventory costs. This method is appropriate to use because the inventory calculations are adjusted according to the future demand forecasted using past data (Assauri, 2016). The optimal inventory calculation for starch flour considers the minimum purchase lot from suppliers and warehouse capacity while fish calculations consider freezer capacity. Sensitivity analysis regarding cost changes serves as a reference for adjusting optimal inventory in the future; thus calculations need to be performed. Through this data processing, it is hoped that issues related to inventory control of starch flour and fish can be resolved and optimal inventory can be achieved.

2. LITERATURE REVIEW

Inventory is an asset that is always in a state of rotation because it experiences changes. Inventory must remain for one period and in the next period so that in the production process the company does not run out of raw materials (Fitriyani & Siahaan, 2020). Inventory in determining its optimal solution is viewed from the lowest offered cost (Fitroni & Pulansari, 2024). According to Nasution and Prasetyawan (2008), costs in inventory are all expenses and losses incurred by the existence of inventory. The costs in inventory are as follows.

a. Purchase costs are costs incurred for purchasing goods, the amount of which depends on the number of goods purchased and the unit price of the goods.
b. Procurement costs are divided into two based on the origin of the goods as follows.
    1) Ordering costs are costs incurred due to bringing in goods from outside the company, costs of determining suppliers, typing orders, transportation costs, receiving costs, and others which are assumed to be constant each time an order is placed.
    2) Manufacturing costs are costs incurred to prepare for the production of an item in the form of costs for assembling production equipment, setting up machines, preparing working drawings, etc.
c. Storage costs are costs incurred due to the presence of stored goods, including the cost of having inventory (capital costs) which is measured by the percentage of the inventory value for a certain period of time, warehouse costs which include rental costs and depreciation costs if the warehouse is not rented, damage and depreciation costs which are measured from experience according to the percentage, expiration costs (absolence) which are measured by the decrease in the selling value of the goods, insurance costs, administration costs, and moving costs.
d. If a company is short of goods when there is demand, the company will experience a state of inventory shortage which can be measured from the quantity that cannot be fulfilled, fulfillment time, and emergency procurement costs.

In data processing, there is a forecasting stage whose data will be used in inventory control. Forecasting is the process of estimating a variable (event) in the future based on the variable's data in the previous period (Putrianti et al., 2024). According to Santoso and Heryanto (2017), a time series is a series of observations of a variable and is made in discrete time intervals. In time series, there are several mathematical models that determine the forecasting method as follows: (a) Constant/stationary model where the line has zero slope or is horizontal with data fluctuating around a fixed mean value, (b) The trend model shows an average demand increase of the same magnitude (positive trend) which is indicated by a line that has an upward slope over time, while a negative trend shows a decrease in the line in each period due to decreasing product demand. This model requires 10-15 periods of data for the identification process, (c) The cycle model is a periodic movement in the form of peaks and valleys that occurs in the long term so that it is not involved if the forecast is in the short term. This model occurs in specific industries that are affected by long-term economic fluctuations, such as household appliances, food supplies, etc., and (d) Seasonal model is a demand pattern that rises and falls repeatedly in a certain period, whether day, week, month, quarter, or year. This model is related to products related to weather, vacation, Christmas, Eid, the beginning of school, and others. This model requires data for at least 2 seasons.

Time series methods are used in short-term forecasting with past data as a predictor of the future. For each model there are several methods as follows.

a. Constant Model

1) A simple method uses the last data point as a basis for forecasting for the next period, which is denoted as follows.

$$F_{T+k} = \frac{1}{T}\sum_{t=1}^{T} d_t \quad (1)$$

Information :

F_{T+k} = forecast at time t for k future period,

dt = past query in period t, and

t = period.

2) Moving Average is done by averaging the most recent data and is used for forecasting.

$$F_{T+k} = \frac{1}{N}\sum_{t=T-N+1}^{T} d_t \quad (2)$$

Information :

N = number of periods.

3) Simple exponential smoothing performs forecasting with the most recent data.

$$F_{T+k} = \alpha\,(d_T) + (1-\alpha)\,S_{T-1} \quad (3)$$

Information :

S_T = value of simple exponential smoothing, and

α = value between $0<\alpha<1$.

b. Trend Models

1) Double Moving Average is a moving average with elements of an upward or downward trend periodically.

$$F_{T+k} = a_T + b_T\,(k) \quad (4)$$

Information :

a = constant process,

b = slope or incline of the trend and other notations that have been previously determined, and

k = next period after period T.

2) Double Exponential Smoothing is a development of simple exponential smoothing with the addition of a trend element.

$$F_{T+k} = S_T + k(B_T) \quad (5)$$

c. Cyclical and Seasonal Models

1) According to Aryati et al. (2020), winter is a forecasting method used to estimate model parameters and produce forecasts consisting of three parameters, namely α (for level), β (for trend smoothing), and γ (for seasonal components). In the winter method there are two methods, namely additive (addition) and multiplicative (multiplication). The difference between the two is that multiplicative is used when the original data plot shows varying seasonal fluctuations, while additive tends to be stable. Parameters are trial and error using values ranging from 0.1 to 0.3. The smallest error value is the benchmark for a parameter to be used in forecasting (Fani et al., 2017). The formula for the multiplicative winter method is as follows.

$$F_{t+m} = (L_t + b_t .m)\,(S_{t-s+m}) \quad (6)$$

Meanwhile, the winter additive method is as follows.

$$F_{t+m} = L_t + b_t .m + S_{t-s+m} \quad (7)$$

Information :

F_{t+m} = forecast result to-t+m,

L_t = level of year t,

b_t = trend in year t,

m = forecast period,

S_t = seasonal in year t, and

s = length of the seasonal period.

2) Decomposition method that breaks down data into trend, seasonal, cyclical, and random change patterns that help forecast accuracy. This method consists of multiplicative (multiplication) and additive (addition). Multiplicative is used by assuming that if the data value increases, the seasonal pattern also increases, while additive assumes that the data value is at a constant width centered on the trend (Kristiyanti & Sumarno, 2020). Forecasting with the decomposition method, both multiplicative and additive, has two types of methods based on the basis for smoothing, namely centered moving average and average of all data (Syaifulloh, 2018).

In determining the data model for forecasting, an autocorrelation test is carried out. The autocorrelation test is carried out to determine the magnitude of the correlation between the time data (t) and the previous time (t-1) where if the magnitude is high enough and gradually decreases approaching zero, then there is a possibility of having a trend element and the data is not random. Data plots that show alternating waves between positive and negative can be said to have seasonal elements. If the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) data plots fall close to zero quickly after the second or third lag and are within significant limits indicating no correlation between lags, then the data plot can be said to be constant/stationary to the average (Nugraha & Suletra, 2017). Testing is also carried out by creating a Box-Cox plot to determine whether the data is constant/stationary to the variance indicated by the R-Value or λ as much as 1 (Yuliyanti & Arliani, 2022).

After obtaining a model that is likely to be owned by the data, forecasting is carried out using a method according to the model. The forecasting results are compared with each other by looking at the method with the smallest error value. Errors are calculated using several methods as follows.

a. Mean Square Error (MSE) is the average of each sum of the squares of all errors in the data. The smaller the MSE value, the closer the forecasting method is to the actual conditions (Utami et al., 2020). According to Kumila et al. (2019), MSE is calculated using the following formula.

$$\mathrm{MSE} = \frac{\sum_{t=1}^{N} (X_t\text{-}S_t)^2}{N} \tag{8}$$

Information :
N = number of forecasting periods involved.

b. Mean Absolute Deviation (MAD) is the average absolute error over a certain period. If the MAD value is close to zero, the forecasting method is close to the actual conditions (Utami et al., 2020). According to Kumila et al. (2019), MAD is calculated using the following formula.

$$\mathrm{MAD} = \frac{\sum_{t=1}^{N} |X_t\text{-}S_t|}{N} \tag{9}$$

c. Mean Absolute Percentage Error (MAPE) is a measure of relative error. MAPE states the percentage error of the forecast results to actual demand during a certain period which will provide information on the percentage of errors that are too high or too low (Utami et al., 2020). According to Kumila et al. (2019), MAPE is solved with the following formula.

$$\mathrm{MAPE} = \frac{1}{n} \sum_{t=1}^{n} \left| \frac{X_t\text{-}S_t}{X_t} \right| \tag{10}$$

d. According to Rabbani et al. (2022), tracking signal is a validation method that shows the feasibility of forecasting. Forecasting data is accepted if the tracking signal value is within the control limit, namely a maximum of +4 and a minimum of -4.

$$\text{Tracking signal} = \frac{\sum_{t=1}^{n} e_t}{\mathrm{MAD}} \tag{11}$$

Forecasting data is then used in inventory control which needs to be grouped into static and dynamic which is done by looking at the demand variability coefficient which is said to be static if it is less than 0,25 and is said to be dynamic if it is equal to or greater than 0,25 (Aritantia et al., 2018). The data variability measurement formula is as follows.

$$V = \frac{n \sum_{t}^{n} D_t^{\,2}}{(\sum_{t}^{n} D_t)^2} - 1 \tag{12}$$

According to Santoso and Heryanto (2017), lot sizing is a process to determine the order quantity . Lot sizing techniques include the following.

a. Economic Order Quantity (EOQ)
EOQ is used to determine the order quantity by minimizing holding costs with several assumptions, such as product demand is constant, uniform, and known, the price per unit of product, holding costs, ordering costs, and lead time are constant, and there is no shortage of materials or back orders. The formula used in this lot sizing technique is as follows.

$$\mathrm{EOQ} = \sqrt{\frac{2DS}{h}} \tag{13}$$

$$\text{Order frequency} = \frac{D}{\mathrm{EOQ}^*} \tag{14}$$

Information :
EOQ = economic order quantity,
S = order cost,
D = annual demand data, and
h = storage cost.

b. Period Order Quantity (POQ)
Period Order Quantity (POQ) is also called Economic Time Cycle because it is used to determine the ordering time interval

(Economic Order Interval). The advantage of using this technique is that it produces different lot sizes in meeting Demand but the results will be better if the annual setup cost is always the same and the carrying cost is lower. The formula used in this lot sizing technique is as follows.

$$P* = N\left(\frac{EOQ}{D}\right) \quad (15)$$

Information :

P* = amount to meet P* period demand, and

N = number of periods in one year.

c. Least Unit Cost (LUC)

This technique minimizes the total cost per unit. The formula used in this technique is as follows.

$$\text{Cost/unit} = \frac{\text{order cost+holding cost}}{\text{cumulative of demand}} \quad (16)$$

d. Least Total Cost (LTC)

This technique balances between ordering cost and holding cost. The lot size starts in the first period and then adds to the next period. If the cumulative cost is lower then that lot will be used. Work is stopped if the lot cost is higher than the previous period's cumulative and a new lot needs to be created.

e. Minimum Cost per Period or Silver Meal

This technique takes into account lot sizing by considering warehouse capacity. Silver Meal uses demand as a basis for repeating a variable in the next period. This method minimizes the total of holding and ordering costs per period. The formula used in this technique is as follows.

$$K(m) = \frac{1}{m}(S + hD_2 + 2hD_3 + ... + (m - 1)hD_m) \quad (17)$$

Information :

K(m) = average inventory cost per unit time,

m = period, and

D_m = demand in the mth period (D1, D2, ..., Dm). Calculations are Performed repeats and stops when K(m+1) > K(m).

f. Economic Part Period (EPP)

This technique is a variation of Least Total Cost (LTC) that tries to balance ordering costs and holding costs using Economic Part Period (EPP). The formula for EPP is as follows.

$$EPP = \frac{\text{order cost}}{\text{holding cost}} \quad (18)$$

g. Part Period Balancing (PPB)

According to Ardila et al. (2022), this technique examines the optimality of EPP results with look ahead and look back. The requirements for combining periods for ordering lots in the inspection process are as follows.

1) If N' (D_{n+1}) ≤ D_{n+2} on a lot , then look ahead is successful so D_{n+1} is combined into the lot being checked and look back is not carried out. If N' (D_{n+1}) > D_{n+2} , then a look back is done, and
2) If N' (D_n) > $\sum_{i=1}^{M} D_{n+i}$on a lot, then the look back is successful and the lot checked is reduced by D_n. If N' (D_n) ≤ $\sum_{i=1}^{M} D_{n+i}$, then the lot is optimal.

Information :

N' = number of storage periods for one period demand that added or subtracted,

D_n = last period demand in lot,

D_{n+1} = first period demand after lot,

D_{n+2} = second period demand after lot, and

M = period covered by the lot furthermore.

h. Wagner-Within

This technique uses a matrix to calculate the possibilities of combining periods for order lots. According to Rahmawi et al. (2023), the total cost matrix formula is as follows.

$$O_{en} = S + h\sum_{t=1}^{n}\left(q_{en} - q_{et}\right) \quad (19)$$

$$f_n = \text{Min}[(O_{en} + f_{e-1})] \quad (20)$$

Information :

$q_{et} = \sum_{t=1}^{n} D_t$,

e = initial limit of the period covered in q_{et} booking , and

n = maximum period covered in q_{et} order .

Sensitivity analysis is an analysis of problem solving based on previous research due to changes caused by a dynamic environment, such as raw material prices, fluctuating demand, machine changes, increased production costs, changes in government policies, and others. This is done to provide an overview if there is a price change without the need to recalculate from the beginning (Solahuddin & Andari, 2018).

3. RESEARCH METHOD

The research was conducted at UD Taufik Jaya Makmur located at Jalan Kapas, No. 38, Samarinda, East Kalimantan. The research will use primary and secondary data. Primary data is data that has been collected directly from the source by conducting measurements and interviews. The primary data required in this study are warehouse size data, data in the form of raw material measurements and lead time. Meanwhile, secondary data is previously available data collected from indirect or second-hand sources, for example from written sources owned by MSMEs. The secondary data required in this study are amplang demand data, raw material prices, storage costs, and raw material ordering costs. The stages in this study are described in the following flow diagram.

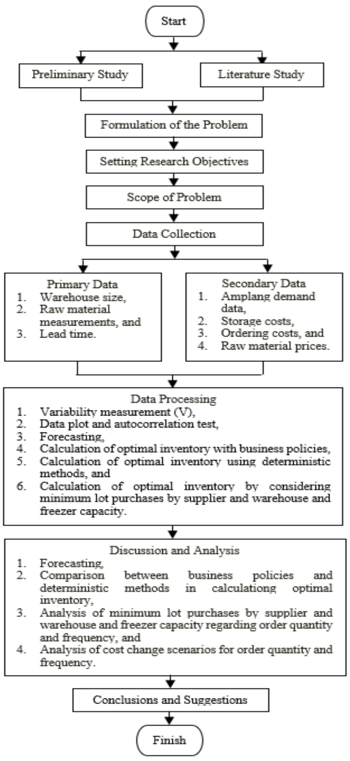

Figure 1. Research flow chart

Data to be used are described as follows.

Table 2. Cost data

No	Cost Components	Cost (IDR)	Information
	Starch Flour		
1	Order fee	50.001	per order
2	Storage costs	4.245	per kg per year
	Fish		
1	Order fee	250.067	per order
2	Storage costs	112.599	per kg per year

Table 3. Data on changes in electricity prices

	Period	Price (IDR)	Information
Electricity	January 2017-September 2020	1.467	per KWh
	October 2020-June 2022	1.445	
	July 2022-to date	1.700	

Source: https://web.pln.co.id/pelanggan/tarif-tenaga-listrik/tariff-adjustment

Table 4. Data on changes in raw material prices

Raw material	Period	Price (IDR)	Information
Starch Flour	February-December 2022	305.000	per sack (25 kg)
	December 2023-February 2024	320.000	
	March 2024-Present	310.000	
Fish	November 2023	50.000	per kg
	February 2024	55.000	
	July 2024	45.000	
	August 2024-Present	40.000	

Table 5. Distribution cost change data

	Period	Cost (IDR)	Information
Fish	2022	200.000	per delivery
	2023-2024	250.000	

4. RESULT AND DISCUSSION

From the flow chart that has been created, the research results are discussed in several points as follows:

4.1 Forecasting

Forecasting is done using demand data. The data is processed by plotting data, autocorrelation tests, partial autocorrelation tests, and Box-Cox plots.

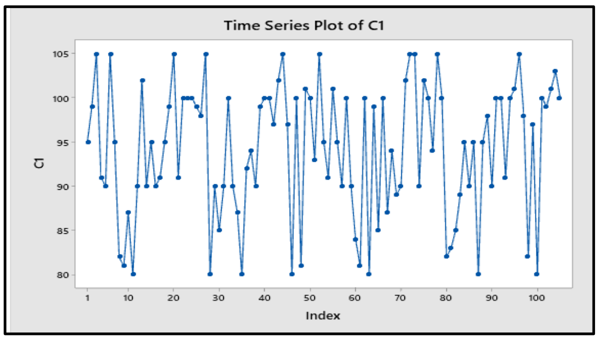

Figure 2. Plot data

The pattern was identified after eliminating other potential patterns. From the data plot not showing a gradual upward or downward trend.

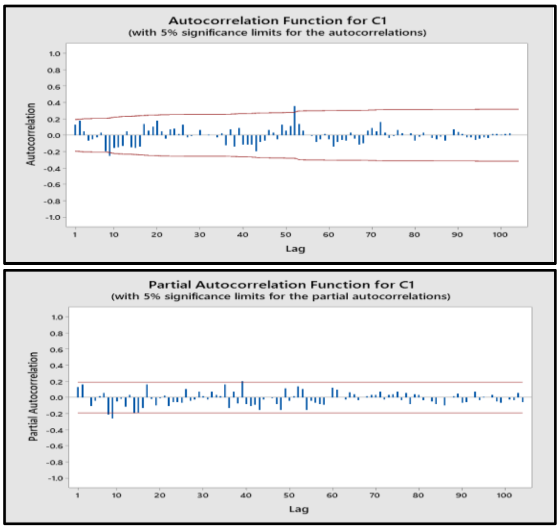

Figure 3. Autocorrelation test and partial autocorrelation test

The autocorrelation test and partial autocorrelation test validate that the data passes the upper significance limit and the lower significance limit. This shows that the data is not constant/stationary to the mean. From the tests carried out, it is known that the data has a seasonal pattern marked by positive and negative movements.

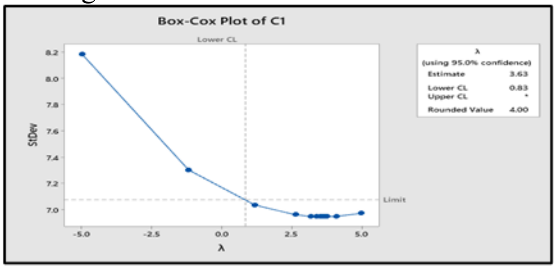

Figure 4. Box cox plot

The Box-Cox plot performed shows an R-value of 4. This shows that the data is not constant/stationary to the variance. Therefore, the forecasting method used is a method for seasonal data patterns, such as the Multiplicative Decomposition-Centered Moving Average method, Multiplicative Decomposition-Average of All Data, Additive Decomposition-Centered Moving Average, Additive Decomposition-Average of All Data, Winter Multiplicative, and Winter Additive.

Table 6. Recapitulation of error values of forecasting methods for seasonal patterns

No	Method	Parameter			Error		
		Alpha	Beta	Gamma	MAPE	MAD	MSD/MSE
1	Multiplicative Decomposition-Average of All Data				0,020	2,020	8,020
2	Multiplicative Decomposition-Centered Moving Average				0,020	2,090	15,840
3	Additive Decomposition-Average of All Data				0,020	2,020	8,020
4	Additive Decomposition-Centered Moving Average				0,020	2,050	15,800
5	Winter Multiplicative	0,1	0,1	0,1	0,024	2,277	9,972
6	Winter Additive	0,1	0,1	0,1	0,024	2,275	9,972

These methods are compared and the method with the smallest error value is selected. The recapitulation of the error values of the six methods can be seen in Table 6. From the table, it can be seen that the method with the smallest error value is the Multiplicative Decomposition-Average of All Data method and Additive Decomposition-Average of All Data. Then, signal tracking is carried out on both methods.

Tracking signal shows that there is no data that passes the upper control limit and the lower control limit so that both methods will be used in the forecast by being rounded. This happens because the seasonal pattern in the data does not have too much influence or is regular. The results of the amplang product demand forecast are used to determine the need for starch flour and fish in the future.

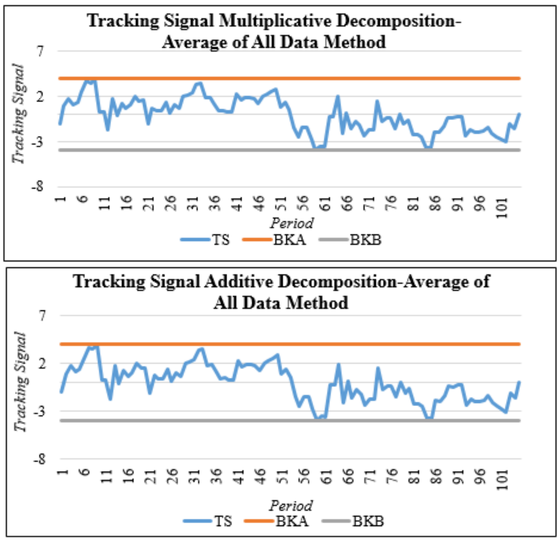

Figure 5. Tracking signal

4.2 Optimal Inventory Analysis

Variability measurements are carried out to determine the method to be used.

$$V = \frac{105\,(937.599)^2}{(9891)^2} - 1$$

$$= 0{,}006$$

From the results of measuring data variability, the inventory control of starch flour and fish has a value of 0,006, which means that the data is static so that the method used is Economic Order Quantity (EOQ). However, the dynamic deterministic method will still be used as a comparison. The method consists of several methods, namely Period Order Quantity (POQ), Least Unit Cost (LUC), Least Total Cost (LTC), Economic Part Period (EPP), Part Period Balancing (PPB), Silver Meal, and Wagner Within.

After calculating the optimal inventory using these methods, adjustments were made to the minimum purchase lot by the supplier, especially for starch flour because the purchase was in the form of 25 kg sacks. In addition, the storage quantity was also considered. The calculation results show that the warehouse has a maximum capacity of 4.216,15 kg or 168,65 sacks and the freezer with the Modena MD130W brand can accommodate up to 1.300 kg of fish. If you look at the storage quantity in one period, there is no lot size that stores raw materials exceeding the existing capacity. The optimal inventory for starch flour and fish can be seen in Table 7 and Table 8 below.

Table 7. Recapitulation of the results of calculating the optimal inventory of starch flour with business policies and deterministic methods

Method	Order Frequency	Storage Quantity (kg)	Order Cost (IDR)	Holding Cost (IDR)	Inventory Cost (IDR)
Business Policy	52	0	2.600.027	0	2.600.027
Economic Order Quantity (EOQ)	8	4626,75	400.004	377.676	777.680
Period Order Quantity (POQ)	8	4176,75	400.004	340.943	740.947
Least Unit Cost (LUC)	8	4176,75	400.004	340.943	740.947
Least Total Cost (LTC)	8	4176,75	400.004	340.943	740.947
Economic Part Period (EPP)	7	4701,75	350.004	383.798	733.802
Part Period Balancing (PPB)	7	4701,75	350.004	383.798	733.802
Silver Meal	8	4351,8	400.004	355.228	755.232
Wagner Within	7	4701,75	350.004	383.798	733.802

From the table, it can be seen that the Economic Part Period (EPP), Part Period Balancing (PPB), and Wagner Within methods are the methods with the smallest inventory costs with the same value, which is IDR 733.802. This can happen because the frequency and size of the order lot are the same and affect the storage quantity with the same amount. The three methods have different considerations in determining the size of the order lot so that it can be concluded that the resulting value is optimal. The table also shows that lot adjustments do not affect order costs, but storage costs increase. With these methods, MSMEs can save inventory costs of up to 72% from implementing inventory control using business policies. This happens because in the Economic Part Period (EPP), Part Period Balancing (PPB), and Wagner Within methods, orders are made only 7 times a year to reduce order costs to IDR 350.004. These methods also utilize warehouses to store raw materials with a quantity of 4.701,75 kg in a year and a storage cost of IDR 383.798.

Table 8. Recapitulation of the results of calculating optimal fish stock with business policies and deterministic methods

Method	Order Frequency	Storage Quantity (kg)	Order Cost (IDR)	Holding Cost (IDR)	Inventory Cost (IDR)
Business Policy	52	5.200	13.003.501	1.608.552	14.612.053
Economic Order Quantity (EOQ)	24	2541,6	6.001.616	5.503.577	11.505.193
Period Order Quantity (POQ)	26	1227,5	6.501.750	2.657.978	9.159.728
Least Unit Cost (LUC)	26	1227,5	6.501.750	2.657.978	9.159.728
Least Total Cost (LTC)	26	1227,5	6.501.750	2.657.978	9.159.728
Economic Part Period (EPP)	18	2410,5	4.501.212	5.219.597	9.720.809
Part Period Balancing (PPB)	18	2410,5	4.501.212	5.219.597	9.720.809
Silver Meal	25	1378,5	6.251.683	2.984.947	9.236.630
Wagner Within	26	1227,5	6.501.750	2.657.978	9.159.728

From the table, it can be seen that the Period Order Quantity (POQ), Least Unit Cost (LUC), Least Total Cost (LTC), and Wagner Within methods are the methods with the smallest inventory costs with the same value, which is IDR 91.59.728. This can happen because the frequency and size of the order lot are the same and affect the storage quantity with the same amount. The four methods have different considerations in determining the size of the order lot so that it can be concluded that the resulting value is optimal. With these methods, MSMEs can save inventory costs of up to 37% from implementing inventory control using business policies. This happens because in the Period Order Quantity (POQ), Least Unit Cost (LUC), Least Total Cost (LTC), and Wagner Within methods, orders are made only 26 times a year to reduce ordering costs to IDR 6.501.750. These methods also utilize freezers to store raw materials with a quantity of 1.227,5 kg in a year and a storage cost of IDR 2.657.978.

4.3 Analysis of Cost Change Scenarios against Order Quantity and Frequency

Sensitivity analysis is conducted due to changes in market prices that are influenced by inflation. To see the ability of the selected method to price changes, a sensitivity analysis is conducted. The cost change scenario that will be carried out will be based on past data owned by UD Taufik Jaya Makmur .

a. Electricity Price Changes
   Electricity prices have experienced several decreases and increases, information about which is known from the official PLN website. From 2017 to the present, there have been 2 price changes, in which in October 2020 there was a decrease of 2% and in July 2022 the price increased by 18%. Inflation affects electricity prices in certain groups so that inflation is considered in this sensitivity analysis. Inflation in 2023 reached 2,61% (Badan Pusat Statistik Indonesia, 2024). To anticipate possible changes in electricity prices in the next 1 year, a sensitivity analysis was carried out on the selected method.

Table 9. Recapitulation of sensitivity analysis of starch flour and fish inventory to changes in electricity prices

	Order Frequency	Storage Quantity (kg)	Order Cost (IDR)	Holding Cost (IDR)	Inventory Cost (IDR)	Purchase Cost (IDR)
			Starch Flour			
Price Drop 2%	7	4701,75	350.004	383.784	733.788	15.500.000
Price Increase 2,6%	7	4701,75	350.004	383.816	733.820	15.500.000
Price Increase 18%	7	4701,75	350.004	383.922	733.925	15.500.000
			Fish			
Price Drop 2%	26	1227,5	6.501.750	2.604.098	9.105.848	98.180.000
Price Increase 2,6%	26	1227,5	6.501.750	2.726.331	9.228.082	98.180.000
Price Increase 18%	26	1227,5	6.501.750	3.135.547	9.637.297	98.180.000

Based on the data processing carried out, it can be seen that changes in electricity prices affect storage costs. The results of the data processing also show that the method of controlling the inventory of starch flour and fish is not sensitive to changes in electricity prices because there are no changes in the period or quantity of orders that occur.

b. Changes in Raw Material Prices
The price of raw materials for amplang products, namely starch flour and fish, often decreases and increases. This happens because the demand for starch increases in certain seasons, such as religious holidays and others or there are obstacles that result in small fish catches. The raw material price scenario shows that starch flour has experienced a price decrease of 2% and an increase of 3%. Meanwhile, the price of fish has increased by 13%, 25%, and 38%. To anticipate this, a sensitivity analysis was carried out.

Table 10. Recapitulation of sensitivity analysis of starch flour and fish inventory to changes in raw material prices

	Order Frequency	Storage Quantity (kg)	Order Cost (IDR)	Holding Cost (IDR)	Inventory Cost (IDR)	Purchase Cost (IDR)
Starch Flour						
Price Drop 3%	7	4701,75	350.004	383.798	733.802	15.035.000
Price Drop 2%	7	4701,75	350.004	383.798	733.802	15.190.000
Price Increase 2%	7	4701,75	350.004	383.798	733.802	15.810.000
Price Increase 3%	7	4701,75	350.004	383.798	733.802	15.965.000
Fish						
Price Drop 38%	26	1227,5	6.501.750	2.657.978	9.159.728	60.871.600
Price Drop 25%	26	1227,5	6.501.750	2.657.978	9.159.728	73.635.000
Price Drop 13%	26	1227,5	6.501.750	2.657.978	9.159.728	85.416.600
Price Increase 13%	26	1227,5	6.501.750	2.657.978	9.159.728	110.943.400
Price Increase 25%	26	1227,5	6.501.750	2.657.978	9.159.728	122.725.000
Price Increase 38%	26	1227,5	6.501.750	2.657.978	9.159.728	135.488.400

Based on the data processing carried out, it is known that changes in the price of starch flour and fish only affect purchasing costs. The results of data processing also show that the inventory control method for starch flour and fish is not sensitive to changes in raw material prices because there are no changes in the period or quantity of orders that occur.

c. Changes in Distribution Costs
The distribution of both raw materials has a difference where starch flour is distributed from the supplier to the production location with the help of UD Taufik Jaya Makmur workers who are paid IDR 50.000 and there has never been a change in costs. However, it is possible that there will be an increase in distribution costs due to the larger order quantity than the business policy. While fish are distributed directly by suppliers whose costs can be influenced by several aspects, such as increases in fuel prices, changes in employee wages, and others. The raw material price scenario uses Table 4 which shows a decrease in ordering or distribution costs experienced by fish by 20%. To anticipate this, a sensitivity analysis is carried out with a recapitulation in Table 11 below.

Table 11. Recapitulation of sensitivity analysis of starch flour and fish inventory to changes in distribution costs

	Order Frequency	Storage Quantity (kg)	Order Cost (IDR)	Holding Cost (IDR)	Inventory Cost (IDR)	Purchase Cost (IDR)
Starch Flour						
Price Drop 25%	9	3676,75	337.505	300.129	637.633	15.500.000
Price Increase 25%	7	4701,75	437.504	383.798	821.302	15.500.000
Price Increase 50%	6	5551,75	450.003	453.183	903.186	15.500.000
Fish						

Price Drop 20%	26	1227,5	5.201.750	2.657.978	7.859.728	98.180.000
Price Increase 20%	22	1739,5	6.601.481	3.766.642	10.368.123	98.180.000
Price Increase 40%	19	2178,5	6.651.279	4.717.234	11.368.513	98.180.000

Based on the recapitulation, it can be seen that changes in the distribution costs of starch flour affect the ordering costs and storage costs. In addition, the table also shows that the higher the distribution costs, the lower the frequency of orders will be to reduce ordering costs. The results of the data processing also show that the starch flour inventory control method is sensitive to changes in distribution costs. This is because in a 25% price decrease and a 50% price increase there is a change in the period or quantity of orders that occur. Therefore, if UD Taufik Jaya Makmur wants to make changes to distribution costs with that percentage, it is necessary to recalculate its inventory control method. Furthermore, a sensitivity analysis of the fish inventory control method is carried out to changes in distribution costs. Based on the recapitulation, it can be seen that changes in fish distribution costs affect ordering costs and storage costs. In addition, the table also shows that the higher the distribution costs, the lower the frequency of orders will be to reduce ordering costs. The results of data processing also show that the fish inventory control method is sensitive to changes in distribution costs. This occurs at an increase of 20% and 40% due to changes in the period or quantity of orders that occur. Therefore, if UD Taufik Jaya Makmur wants to change distribution costs by that percentage, it is necessary to recalculate the inventory control method.

5. CONCLUSION

Data processing of raw material inventory control uses deterministic methods. The most optimal fish inventory control uses the Period Order Quantity (POQ), Least Unit Cost (LUC), Least Total Cost (LTC), and Wagner Within methods. These methods were chosen because they have the lowest inventory costs with the same value, which is IDR 9.159.728. This can happen because the frequency and lot size of the four methods are the same and affect the storage quantity with the same amount. Orders are made 26 times a year with a storage quantity of 1.227,5 kg, and can save 37% of business policy. After adjusting the lot, it is known that the optimal inventory of starch flour is in the Economic Part Period (EPP), Part Period Balancing (PPB), and Wagner Within methods. These methods have the lowest inventory costs with the same value, which is IDR 733.802. This can happen because the frequency and lot size of the four methods are the same and affect the storage quantity with the same amount. Orders are made 7 times a year, storage quantity is 4.701,75 kg, and can save up to 72% of business policy. The price change scenario carried out shows that inventory control of starch flour and fish is sensitive to changes in distribution costs so that if it occurs in the future, inventory control needs to be recalculated. From this conclusion, there are several suggestions that can be given to research and further research, such as UD Taufik Jaya Makmur needs to implement inventory control with the frequency and order quantity according to the selected deterministic method and the results of the inventory control that have been carried out need adjustments if there are changes in distribution costs or a gap between forecasted and actual data with a significant error. For future researchers can use inventory control methods that consider the quality of stored goods or employ inventory control methods for perishable products.

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