Design and Development of Tempeh Raw Material Control System Based on Periodic Review to Increase Production Efficiencyat CV.XYZ

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Abstract– This research aims to design an efficient inventory control system for tempe raw materials at CV.XYZ by applying the Periodic Review method. The problem faced by the company is the occurrence of excesses and shortages of raw materials due to the absence of an accurate control system. Demand forecasting is carried out using the time series method (Exponential Smoothing, Linear Regression, and Moving Average) to obtain optimal estimates of raw material requirements. Forecasting results are used as a basis for implementing Periodic Review to determine order intervals, maximum inventory and order quantity. The analysis results show that this method can minimize inventory costs and reduce the risk of shortages and excesses of raw materials, thereby increasing production efficiency

Keywords: Raw materials, Inventory control, Time Series, Periodic Review

1. INTRODUCTION

The small to medium-scale food industry in Indonesia plays an important role in providing for the community's consumption needs, one of which is the tempe industry. Tempe is a processed product based on fermented soybeans that has high nutritional value and is widely consumed by the public. However, market demand dynamics and limited management cause many business units to struggle to maintain raw material availability efficiently. The main problem that often occurs is an imbalance between demand and raw material availability, which can lead to shortages (stock out) or excess inventory (over stock), directly impacting production costs and the continuity of the production process.Based on initial observations, the company experiences raw material shortages reaching 9,000 kg per month and excesses up to 2,000 kg per month. This indicates the absence of an accurate and calculation-based inventory control system. The company's policy of relying solely on intuition and experience in ordering raw materials results in inefficiency in inventory management.

To overcome these problems, a systematic and quantitative approach to inventory control is needed. One relevant method is the Periodic Review System, which is an inventory control method that periodically evaluates to determine the order quantity based on the maximum inventory level. This method is very suitable for businesses with limitations in continuous inventory monitoring, but still requires efficiency and accuracy in raw material ordering. As a basis for calculating raw material needs, this method is supported by demand forecasting using time series approaches such as Exponential Smoothing, Linear Regression, and Moving Average.

This research aims to design an optimal and efficient raw material control system at CV.XYZ, through the integration of demand forecasting and the application of the Periodic Review System method. It is hoped that by implementing this system, the risk of raw material shortages and excesses can be reduced, and total inventory costs can be minimized, thereby significantly increasing production efficiency.

2. RESEARCH METHOD

This research uses a quantitative approach with a case study method at CV.XYZ. The object of research is the raw material inventory control system (soybeans, yeast, and tapioca flour) in the tempe production process. This research aims to reduce the risk of raw material shortages and excesses, and to minimize total inventory costs, thereby increasing production efficiency. The research was conducted from June 2024 to May 2025. The data obtained consists of monthly demand data, ordering costs, holding costs, stockout costs, and lead time.

The analysis begins with demand forecasting using three time series methods: Exponential Smoothing, Exponential Smoothing With Trend, Linear Regression, and Weighted Moving Average. Accuracy evaluation is performed using MAD (Mean Absolute Deviation), MSE (Mean Square Error), and MAPE (Mean Absolute Percentage Error) values to select the best method for each raw material.

2.1 Time Series Method
The time series method is a forecasting method that uses historical data as a basis for predicting future values. This method assumes that patterns or trends in the data will continue to repeat over time. The goal is to understand how demand or other variables change over time, so that it can be used as a basis for business decision-making and future planning.In its application, time series considers unavoidable errors, and forecasters try to minimize these errors so that the forecast results are close to actual conditions. By analyzing historical data, this method can identify data movement patterns and assist in planning future activities.
   a.   Exponential Smoothing Method

This method is a forecasting technique that gives greater weight to the most recent data, making it responsive to trend changes.

b. Exponential Smoothing With Trend

The exponential smoothing with trend method is a forecasting method based on a trend line, used as a forecasting model when the historical pattern of actual demand data shows an upward trend over time (Gasversz, 2008).

c. Linear Regression

The linear regression method is a forecasting method based on a trend line, so that the things to be studied in the future can be projected.

d. Linear Trend Line Model

The linear trend line model method is a forecasting method based on a trend line, where the data in this method tends to increase continuously or decrease continuously.

e. Weighted Moving Average

The weighted moving average method is a forecasting method that is more responsive to changes.

f. Mean Absolute Deviation (MAD)

g. Mean Square Error (MSE)

h. Mean Absolute Percentage Error (MAPE)

2.2 Periodic Review System Method

In the periodic review system method, inventory is checked periodically at a certain fixed time interval. Reordering is done with varying order quantities but with a fixed time interval between two consecutive orders. Periodic review controls inventory based on a time interval (T). The steps for solving it are as follows:

a. Calculating the value of T

b. Calculating α

c. Calculating R (Maximum Inventory

d. Calculating the probability of shortage (N)

e. Calculating Ot Periodic Review

3. RESULT AND DISCUSSION

3.1 Results

This research was conducted at CV.XYZ to design a raw material inventory control system for tempe (soybeans, yeast, and tapioca flour) using the Periodic Review method. The data used includes raw material demand, inventory, prices, ordering costs, holding costs, raw material shortage costs, and lead time.

1. Raw Material Demand Data

Raw material demand from April 2024 to March 2025 shows fluctuations. Total annual demand recorded:

a. Soybeans: 386,455 kg

b. Yeast: 849 kg

c. Tapioca Flour: 4,244 kg

The results show significant profit fluctuations. Only April approached the target (98%). Most other months were in the poor category, indicating that the company's cost efficiency and income stability are not yet optimal.

2. Raw Material Inventory Data

Raw material inventory data is used for the production process, so the production process provides the raw materials to be produced

3. Raw Material Prices

There are 3 types of raw materials used in tempe production.The prices paid by the company to obtain the products can be seen in Table 1.

Table 1. Types of raw materials

No	Type of Raw Material	Price/Kg (Rp)
1	Soybeans	12.250
2	Yeast	13.000
3	Tapioca Flour	9.200

4. Ordering Costs

a. Ordering Cost Ordering cost is the cost incurred by the company each time it places an order for the three raw materials. These orders are placed by CV.XYZ with the same supplier from Medan. The ordering cost data can be seen in Table 2.

Table 2. Type of cost

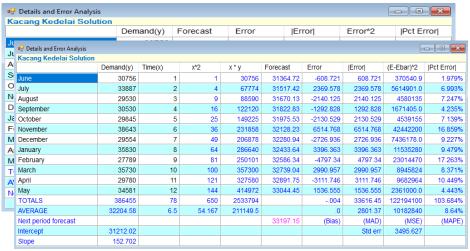| No	Type of Cost	Cost/Order (Rp)
1	Telephone Cost	Rp.2000
2	Administration Cost	Rp.5.000
	Total	Rp.7.000

- Telephone cost per minute is Rp 200. The average telephone duration for each order is 10 minutes, so the company's telephone cost is Rp 2,000/Order.
- Administration cost incurred for each order is Rp 5,000/Order

b. Holding Costs
   Electricity Cost The raw material warehouse requires 47.7 kWh per month with an electricity cost of Rp 1,352 per kWh.

5. Forecasting Soy Beans

a. Exponential Smoothing Method

Details and Error Analysis
Kacang Kedelai Solution

	Demand(y)	Time(x)	x^2	x * y	Forecast	Error	|Error|	(E-Ebar)^2	|Pct Error|
June	30756	1	1	30756	31364.72	-608.721	608.721	370540.9	1.979%
July	33887	2	4	67774	31517.42	2369.578	2369.578	5614901.0	6.993%
August	29530	3	9	88590	31670.13	-2140.125	2140.125	4580135	7.247%
September	30530	4	16	122120	31822.83	-1292.828	1292.828	1671405.0	4.235%
October	29845	5	25	149225	31975.53	-2130.529	2130.529	4539155	7.139%
November	38643	6	36	231858	32128.23	6514.768	6514.768	42442200	16.859%
December	29554	7	49	206878	32280.94	-2726.936	2726.936	7436178.0	9.227%
January	35830	8	64	286640	32433.64	3396.363	3396.363	11535280	9.479%
February	27789	9	81	250101	32586.34	-4797.34	4797.34	23014470	17.263%
March	35730	10	100	357300	32739.04	2990.957	2990.957	8945824	8.371%
April	29780	11	121	327580	32891.75	-3111.746	3111.746	9682964	10.449%
May	34581	12	144	414972	33044.45	1536.555	1536.555	2361000.0	4.443%
TOTALS	386455	78	650	2533794		-.004	33616.45	122194100	103.684%
AVERAGE	32204.58	6.5	54.167	211149.5		.0	2801.37	10182840	8.64%
Next period forecast					33197.15	(Bias)	(MAD)	(MSE)	(MAPE)
Intercept	31212.02							Std err	3495.627
Slope	152.702								

b. Linear Regression Method

c. Moving Average Method

d. MAD, MSE, and MAPE Calculation Results for Soybeans

Details and Error Analysis
Kacang Kedelai Solution

	Demand(y)	Forecast	Error	|Error|	Error^2	|Pct Error|
June	30756					
July	33887					
August	29530	32321.5	-2791.5	2791.5	7792472	9.453%
September	30530	31708.5	-1178.5	1178.5	1388862.0	3.86%
October	29845	30030	-185	185	34225	.62%
November	38643	30187.5	8455.5	8455.5	71495480	21.881%
December	29554	34244	-4690	4690	21996100	15.869%
January	35830	34098.5	1731.5	1731.5	2998092.0	4.833%
February	27789	32692	-4903	4903	24039410	17.644%
March	35730	31809.5	3920.5	3920.5	15370320	10.973%
April	29780	31759.5	-1979.5	1979.5	3918420.0	6.647%
May	34581	32755	1826	1826	3334276	5.28%
TOTALS	386455		206	31661	152367600	97.06%
AVERAGE	32204.58		20.6	3166.1	15236770	9.706%
Next period forecast		32180.5	(Bias)	(MAD)	(MSE)	(MAPE)
				Std err	4364.167	

Based on the results of measuring fore casting accuracy using POM QM For Windows V5, it shows that for ecasting methods for soybeanshave different accuracies.

No	Metode	MAD	MSE	MAPE
1	Exponential smoothing	3804,77	19094590	11,651%
2	Linear regression	2801,37	10182840	8,64%
3	Moving average	3166,1	15236770	9,706%

From the results of demand estimates using the three estimation methods above, it is known that the for ecasting results with the lowest MAPE valueare8.64%.

e. Yeast MAD, MSE, and MAPE Calculation Results
Based on the results of fore casting accuracy testing using POM QM For Windows V5, it shows that the forecastingmethod for yeast has different accuracies.

No	Metode	MAD	MSE	MAPE
1	Exponential smoothing	6,854	63,474	9,984%
2	Linear regression	4,957	34,854	7,25%
3	Moving average	5,75	50,525	8,454%

From the results of demand for ecasting calculations using the three for ecasting method sabove, it is knownthat the for ecasting results with the lowest MAPE valueare 7.25%.

f. MAD, MSE and MAPE calculation results for starch
Based on the results of for ecasting accuracy testing using POM QM For Windows V5, it shows that the forecasting method for starch has different accuracies.

No	Metode	MAD	MSE	MAPE
1	Exponential smoothing	76,611	7217,087	22,242%
2	Linear regression	55,254	403,328	16,177%
3	Moving average	69,25	6935,725	21,112%

From the results of demand for ecasting calculations using the three for ecasting methods above, it is knownthat the forecastingresultswith the lowest MAPE valueare16.177%

3.2 Discussion

1. Analysis of Total Inventory Costs According to Company Policy
Ordering cost is the multiplication of monthly holding cost by the average inventory in the warehouse.

Raw Material	Purchase Cost (Rp)	Inventory Cost (Rp	TCn (Rp)
Kacang Kedelai	4.410.000.000	2.075.880.000	6.485.800.000
Ragi	9.360.000	971.880	10.331.880
Tepung Kanji	32.400.000	20.756.700	53.156.700

2. Analysis of Total Inventory Costs Using the Periodic Review System Method
Based on the calculation results using the periodic review system method, which refers to a fixed time period between orders and when orders can be placed. In this method, the total inventory cost for soybeans is Rp 5,180,639,276, for yeast is Rp 9,428,685, and for tapioca flour is Rp 35,638,638. Based on these calculations, savings were obtained for soybeans (20%), yeast (8.7%), and tapioca flour (31%). The following table shows the periodic calculation between orders, maximum inventory, and total inventory costs:

No	Raw Material	Purchase Cost (Rp)	InventoryCost (Rp	TCn (Rp)
1	Kacang Kedelai	0,028	14786	5.180.639.276
2	Ragi	0,770	660	9.428.685
3	Tepung Kanji	0,045	235	35.638.638

Based on the analysis results above, comparing total inventory costs, the periodic review system method has a lower total inventory cost compared to the company's policy.

4. CONCLUSION

Based on the raw material inventory calculation results using the time series method, the results for the period June 2024 – May 2025 are 408,444 kg for soybeans, 808 kg for yeast, and 4,401 kg for tapioca flour. Based on the calculation results using the Periodic Review System method, the results for soybeans are (T) 0.028, (R) 14,786 kg, and a total inventory cost of Rp 5,180,639,276. For yeast, (T) 0.770 years, (R) 660 kg, and a total cost of Rp 9,428,685. For tapioca flour, (T) 0.045 years, (R) 235 kg, and a total inventory cost of Rp 35,638,638.

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