The International Journal of Business Management and Technology, Volume 8 Issue 4 July-August 2024
ISSN: 2581-3889

Research Article Open Access

Analysis of Demand Forecasting and Inventory Control Shower Gel Raw Materials at PT XYZ

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Abstract: Demand forecasting and raw material inventory control are things that must be done by companies to increase satisfaction and meet consumer needs. This study aims to determine demand forecasting for shower gel products, determine product classification, calculate maximum inventory, and calculate the smallest total inventory value. The research was conducted with (time series analysis) demand forecasting methods, namely exponential smoothing and trend linear, while for raw material inventory control analysis using ABC analysis, Model Q, and Model P. The best method in exponential smoothing forecasting α = 0.1 with the results of forecasting the inventory of shower gel raw materials in May 2024 of 196.41 kg and the measurement results of the value (error) MAD = 113.36, MSE = 160.87, and MAPE = 0.998%. Results ABC analysis obtained 5 raw materials that are classified in category A, namely glucotain plus, sepimaxzen, solagum ax, oramix ns, and packaging; 3 raw materials that are classified in category B, namely cocamido propyl betaine, aquadest, and glycerine; and 1 raw material that belongs to category C, namely phenoxythanol. The best method for controlling raw material inventory is Model Q with a total maximum overall inventory value of 2,301.65 kg and 401.79 pcs. Total overall inventory cost of raw materials of IDR. 26,665,010.

Keywords: Forecasting, inventory control, model Q, model P, shower gel

I. INTRODUCTION

The development of the cosmetics industry today triggers increasingly fierce competition between companies to produce high-quality products and complete consumer orders according to a predetermined time. The smooth running of a production depends on the optimization of raw material inventory, thus affecting the revenue or profit earned by the company (Lahu&Sumarauw, 2017). Raw material can be interpreted as a basic material that can be processed into another form that has a different form from its original form (Herawati&Mulyani, 2016). Production management always uses forecasting and inventory planning to meet consumer needs (Ngantung&Jan, 2019). Forecasting can be interpreted as an activity that predicts the possibility or events that occur in the future (Seyedan&Mafakheri, 2020). Controlling raw material inventory is a management process that has the aim of managing and regulating the amount of raw materials in the company (Daud&Nuraini, 2017). Control is expected to optimize the costs incurred by the company (Jackson et al., 2020). Prioritization strategy is very important in controlling raw material inventory. Separation of types of raw materials in accordance with the characteristics of raw materials and the correct investment value will minimize the risks that occur for the continuity of the production process (Meishichita et al., 2023).

PT XYZ is a cosmetic industry company engaged in hotel amenities. The type of production at PT XYZ Bali is making to order where the company produces based on the number of orders. The main cause of the company's problems in planning raw material inventory is related to the imbalance between the amount of demand and the amount of inventory, determining the number of orders, and determining the total cost of ordering. Shower gel products have a high level of demand reaching 30 percent of the other 5 categories of amenities. The main raw materials used in the manufacture of shower gel by PT XYZ are aquadest, glycerin, sepimaxzen, solagum ax, glucotain plus, oramix ns, cocamidopropyl betaine, and phenoxyethanol. The company needs to have a suitable raw material demand

and inventory forecasting system such as exponential smoothing and linear trend for demand forecasting, ABC analysis, continuous review system (Q), andperiodic review system (P) methods for inventory control.

The exponential smoothing and linear trend methods are used to perform demand forecasting on frozen pork products. There are 3 types of frozen pork products that have the smallest error value with the exponential smoothing method. There are 2 types of frozen pork products that get the smallest error value with the linear trend model (Luswiantini et al., 2023). Based on research conducted by Pulungan& Fatma (2018) the Q and P methods are used to determine inventory control, determine the total cost, and the smallest amount of inventory on office stationery supplies. In this study, the Q method provides the optimal solution.

II. LITERATURE REVIEW

2.1. Raw Material

Raw materials and auxiliary materials are important elements that support the smooth production process. Raw materials can also be interpreted as the main ingredients that will be processed into finished products, while auxiliary materials are additional materials that support the production process (Nurprihatin et al., 2021).

2.2. Demand Forecasting

Forecasting is an important managerial activity as it is the first stage of any planning procedure. Many organizations fail due to lack of forecasting or forecasting errors on which planning is based (Hasan &Dhali, 2017). Sales forecasting is an important aspect in planning strategies and managing inventory. By forecasting, companies can be better prepared for market challenges, optimize production, and can plan effective marketing strategies to meet consumer demand (Tratar et al., 2016).

2.3. Inventory Control

Inventory management is an activity carried out by a company that is needed in decision making, so that material needs for company activities both production and sales can be met optimally, with the least possible risk (Gunawan&Setiawan, 2022).Inventory management is the activity of developing and managing inventory levels of raw materials, work in progress and finished goods in such a way as to ensure that sufficient inventory is available and costs are minimized. Inventory management is necessary to make an organization efficient and effective (Pandya & Thakkar, 2016).

2.4. Exponential Smoothing

The exponential smoothing method is a method that demonstrates a continuous weight reduction based on the most recent data. The exponential smoothing method assumes that the data fluctuate around a fixed mean value or have a horizontal structure (Anggrainingsih, 2015). Formula of exponential smoothing forecasting:

$F_1 = F_{t-1} + \alpha (A_{t-1} - F_{t-1})$

Description:

F_t = Forecast value for time period t

F_{t-1} = Forecast value for one time period ago

A_{t-1} = Actual value for one period of time ago

a = Smoothing constant

2.5. Trend Linear

Forecasting can also be called trend forecasting, where this forecasting method adjusts a trend line on a series of past data and then projects the line into the future (Ihsan et al., 2018). Formula of trend linear:

$Ft = \alpha + bt$

Description:

Ft = Forecast for period t

α = F value at time t=0

b = Slope of the line, where slope is the level of importance

t = The specified number of time periods, starting from t=0

2.6. ABC Analysis

ABC analysis is a strategic approach used in inventory management that aims to classify goods based on the level of capital used. The ABC method categorizes the types of materials into three groups, namely category A raw materials, which are categories with high investment, category B, which are categories with medium investment, and category C, which are categories with low investment (Nallusamy et al., 2017).

2.7. Continuous Review System (Model Q)

The continuous review system method is a method that consistently monitors and regulates the amount of stock in a system to ensure product availability. If the stock reaches or falls below the specified reorder point, a product order will be placed, for finding the best answer, there is a Model Q operating criteria function, which is to minimize the total inventory cost. (Syamil et al., 2018).

2.8. Periodic Review System (Model P)

The periodic review system method manages inventory by regulating when orders are placed based on specified time intervals. The amount of inventory ordered can vary according to need, but the period of each order remains consistent (Rahman &Abidin, 2024).

III. RESEARCH METHDOLOGY

The research was conducted at PT XYZ Bali located in South Kuta District, Badung Regency, Bali. The data collection method was carried out by interviewing the manager of PT XYZ using an interview guide, related to company profile data, product demand, raw material names, raw material needs, and raw material prices. The data was summarized and analyzed to obtain the results of measuring the Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE) values on the exponential smoothing and trend linear demand forecasting methods. The demand forecast calculation used POM for Windows 3 software. Inventory control was analyzed using the continuous review system (Q) and periodic review system (P) methods to obtain the maximum amount of inventory and determine the smallest total inventory value.

IV. RESULT AND DISCUSSION

4.1. Product Sales Data

Sales of shower gel products at PT XYZ fluctuate every month, this is based on the size of consumer demand. Sales data of shower gel products for 12 months in XYZ Bali is presented in Figure 1.

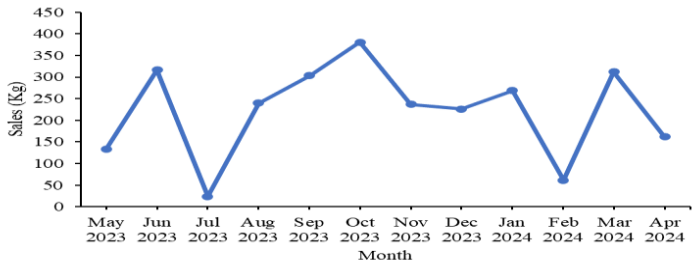

Figure 1. Chart of Sales Shower Gel Product

Based on the graph above (Fig. 1), there are fluctuations in movement from left to right data that tend to decrease or increase in certain months, so that the sales data for shower gel products is obtained, namely seasonal data patterns. Seasonal elements can occur due to the influence of the season (weather) and national holidays, so that they can affect the sales level of shower gel products (Setiawan et al., 2020).

4.2. Exponential Smoothing

Forecasting product demand using exponential smoothing uses a value of α = 0.1 representing the beginning of the data, α = 0.5 representing the average, and α = 0.9 representing the end of the data (Alfarisi&Sunarmintyastuti, 2018). The results of demand forecasting using the exponential smoothing method can be seen in Table 1.

Table 1. Forecasting shower gel demand in May 2024 with exponential smoothing method

Product	α	Forecasting Result (Kg)	Error Value		
			MAD	MSE	MAPE
Shower Gel	**0.1**	**196.41**	**113.36**	**160.87**	**0.998%**
	0.5	199.75	120.45	179.18	1.362%
	0.9	174.69	143.21	263.25	1.724%

Source: Data processed (2024)

In this study, the results of forecasting calculations using the exponential smoothing method obtained results for shower gel products have the smallest errorvalue at a value of α = 0.1.

4.3. Trend Linear

The results of demand forecasting using trend linear method can be seen in Table 2.Based on the results of forecasting with the trend linear method, the results of the y equation are obtained, with the value of the equation being able to calculate more than one period ahead by replacing the x value in the equation, where the x value is the period for which the forecasting value will be calculated (Ihsan et al., 2018).

Table 2. Forecasting shower gel demand in May 2024 with the trend linear method

Product	Forecasting Result (Kg)	Error Value			Equation
		MAD	MSE	MAPE	
Shower Gel	229.91	84.67	106.69	1.119%	y=268.4849-4.32x

Source: Data processed (2024)

4.4. The Best Forecasting Method

In this study, the best forecasting method is characterized by the smallest error rate (Wiharja&Ningrum, 2020). The exponential smoothing method α = 0.1 has a Mean Absolute Deviation (MAD) value of 113.36, a Mean Squared Error (MSE) value of 16.087 and a Mean Absolute Percentage Error (MAPE) value of 0.998% with a forecast result of 196.41 kg. Therefore, the best forecasting method is using the exponential smoothing method compared to other methods (Setyowati, 2022).Acomparison of the error rates of each forecasting method can be seen in Table 3.

Table 3. Error value of each forecasting method

No	Forecasting Method	Demand Forecasting (Kg)	Error Value		
			MAD	MSE	MAPE
1	***Exponential Smoothing*α = 0.1**	**196.41**	**113.36**	**160.87**	**0.998%**
2	*Exponential Smoothing*α = 0.5	199.75	120.45	179.18	1.362%
3	*Exponential Smoothing*α = 0.9	174.69	143.21	263.25	1.724%
4	*Trend linear*	229.91	84.67	106.69	1.119%

Source: Data processed (2024)

4.5. Raw Material Requirements

The data used in this study is inventory data from May 2023 to April 2024 which can be seen in Table 4.

Table 4. Raw material requirements and inventory data

No	Raw Materials	Unit Price(IDR)	Purchase	Usage	Total Usage Cost(IDR)
1	Aquadest	4,000	1,892 kg	1,837.63 kg	7,350,520
2	Cocamido Propyl Betaine	20,000	396 kg	370.83 kg	7,416,600
3	Glucotain Plus	161,000	240 kg	238.43 kg	38,387,230
4	Glycerin	137,000	68 kg	52.75 kg	7,226,750
5	Oramix NS	100,000	86 kg	78.05 kg	7,805,000
6	Phenoxythanol	281,000	33 kg	25.59 kg	7,190,790
7	Sepimax Zen	1,177,000	36 kg	21.05 kg	24,775,850
8	Solagum AX	616,000	45 kg	39.7 kg	24,455,200
9	Packaging	14,000	572 pcs	534 pcs	7,476,000
		Total Cost			132,083,940

Source: PT XYZ

4.6. Always Better Control (ABC) Analysis

The results of the recapitulation of raw materials, investment value and investment percentage value based on ABC analysis can be seen in Tables 5 and 6.

Table 5. Raw material recapitulation results based on ABC analysis

No	Raw Materials	Total Cost(IDR)	Cost(%)	Cumulative Cost(%)	Category
1	Glucotain Plus	38,387,230	29.1	29.1	A
2	Sepimax Zen	24,775,850	18.8	47.8	A
3	Solagum AX	24,455,200	18.5	66.3	A
4	Oramix NS	7,805,000	5.9	72.2	A
5	Packaging	7,476,000	5.7	77.9	A
6	Cocamido Propyl Betaine	7,416,600	5.6	83.5	B
7	Aquadest	7,350,520	5.6	89.1	B
8	Glycerin	7,226,750	5.5	94.6	B
9	Phenoxythanol	7,190790	5.4	100.0	C

Source: Data processed (2024)

Table 6. Investment value results and percentage value based on ABC analysis

Raw Material Group	Investment Value (IDR)	Investment (%)	Number of Raw Material Types	Number of Raw Material Types (%)
Group A	102,899,280	78	5	55.55
Group B	21,993,870	17	3	33.33
Group C	7,190,790	5	1	11.11
Total	132,083,940	100	9	100

Source: Data processed (2024)

The classification diagram of raw material types with ABC analysis can be seen in Figure 2.

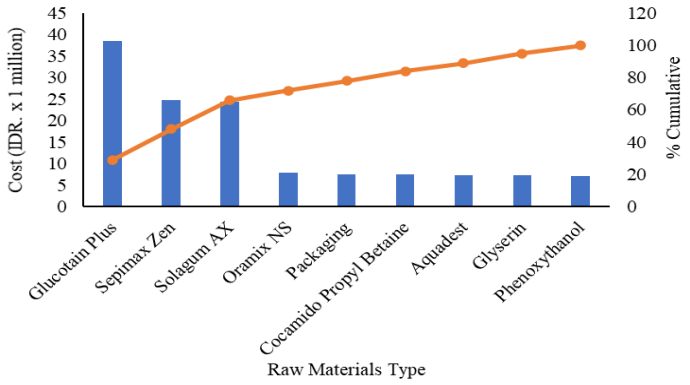

Figure 2. The Classification Diagram of Raw Materials Type with ABC Analysis

The results of the calculation using the ABC analysis method obtained five types of raw materials that fall into class A with a cost percentage of 78 percent with a total investment value of IDR. 102,899,280, namely glucotain plus, sepimaxzen, solagum ax, oramix ns, and packaging. There are three types of raw materials that fall into class B with a cost percentage of 17 percent with a total investment value of IDR. 21,993,870, namely cocamido propyl betaine, aquadest, and glycerin. There is one type of raw material that falls into class C with a cost percentage of 5 percent with a total investment value of IDR. 7,190,790, namely phenoxythanol.

4.7. Order Cost

Ordering costs can include telephone costs, administrative costs, and expedition costs (Iqbal et al., 2017). The total cost of ordering at PT XYZ company is IDR. 404,327.

4.8. Storage Cost

Storage costs are the costs that must be incurred by the company to store raw materials in the warehouse (Lestari et al., 2019). Based on an interview with the manager of PT XYZ, the cost of storing raw materials is assumed to be 20% of the price of raw materials. The storage costs of shower gel raw materials at XYZ can be seen in Table 7.

Table 7. Storage cost of shower gel raw materials at PT XYZ

No	Raw Materials	Unit Price (IDR)	Storage	Total Storage Cost (IDR)
1	Aquadest	4000	20%	800
2	Cocamido Propyl Betaine	20,000	20%	4,000
3	Glucotain Plus	161,000	20%	32,200
4	Glycerin	137,000	20%	27,400
5	Oramix NS	100,000	20%	20,000
6	Phenoxy thanol	281,000	20%	56,200
7	Sepimax Zen	1,177,000	20%	235,400
8	Solagum AX	616,000	20%	123,200
9	Packaging	14,000	20%	2,800

Source: PT XYZ

4.9. Stockout Cost

Stockout costs are costs that arise when inventory cannot meet demand (Sulaiman& Nanda, 2015). If the company experiences a shortage of raw materials, the company must issue a sudden order which results in a 15% increase in the price of raw materials. Then the cost of raw material inventory shortages can be seen in Table 8.

Table 8. Stockout cost of shower gel raw materials at PT XYZ

No	Raw Materials	Unit Price (IDR)	Increment	Total Stockout Cost (IDR)
1	Aquadest	4000	15%	600
2	Cocamido Propyl Betaine	20,000	15%	3,000
3	Glucotain Plus	161,000	15%	24,150
4	Glycerin	137,000	15%	20,550
5	Oramix NS	100,000	15%	15,000
6	Phenoxythanol	281,000	15%	42,150
7	Sepimax Zen	1,177,000	15%	176,550
8	Solagum AX	616,000	15%	92,400
9	Packaging	14,000	15%	2,100

Source: PT XYZ

4.10.Continuous Review System (Model Q)

Here is an example of a calculation using the Q Model formula for ordering aquadest raw materials:

Iteration 1

a. Optimal order size

$$q_{01} = \sqrt{\frac{2AD}{h}}$$

$$q_{01} = \sqrt{\frac{2(404.327)(1.837,63)}{800}}$$

q_{01} = 1,362.90 kg

b. Possible inventory shortages

$$\alpha = \frac{hq\,01}{CuD + hq\,01}$$

$$\alpha = \frac{800 \text{ x } 1,362.90}{(600 \text{ x } 1,837.63) + (800 \text{ x } 1,362.90)}$$

α = 0.497

Using the Z table, it was found that for α = 0.497, the $Z\alpha$ value is 0.01

c. Reorder point

$r_1 = DL + Z\alpha\, s\sqrt{L}$

$r_1 = 1,837.63(0.015) + (0.01)\ 74.47\sqrt{0.015}$

r_1 = 27.66 kg

d. Possible number of inventory shortages

$N = s\sqrt{L}\,[f(Z\alpha) - Z\alpha\,\psi(Z\alpha)]$

N = 9.12068 [0.3989 – 0.01 (0.3744)]

N = 3.6 kg

Iteration 2

a. Optimal order size

$$q_{02} = \sqrt{\frac{2D[A+CuN]}{h}}$$

$$q_{02} = \sqrt{\frac{2(1{,}837.63)\,[404{,}327 + 600(3.6)]}{800}}$$

$q_{02} = 1{,}366.54$ kg

b. Possible inventory shortages

$$\alpha = \frac{hq\,02}{CuD + hq\,02}$$

$$\alpha = \frac{800 \text{ x } 1{,}366.54}{(600 \text{ x } 1{,}837.63) + (800 \text{ x } 1{,}366.54)}$$

$\alpha = 0.498$

Using the Z table, it was found that for $\alpha = 0.498$, the $Z\alpha$ value is 0.01

c. Reorder point

$r_2 = DL + Z\alpha\, s\sqrt{L}$

$r_2 = 1{,}837.63\ (0.015) + (0.01)\ 74.47\sqrt{0.015}$

$r_2 = 27.66$ kg

d. Possible number of inventory shortages

$N = s\sqrt{L}\,[f(Z\alpha) - Z\alpha\,\psi(Z\alpha)]$

$N = 9.12068\ [0.3989 - 0.01\ (0.3744)]$

$N = 3.6$ kg

e. Safety stock value

$ss = Za \text{ x } s\sqrt{L}$

$ss = 0.01 \text{ x } 9.12068$

$ss = 0.09$ kg

f. Maximum inventory

$S = q0 + r$

$S = 1{,}365.54 + 27.66$

$S = 1{,}394.20$ kg

g. Purchasing cost

$Ob = D \text{ x } P$

$Ob = 1{,}837.63 \text{ x } 4{,}000$

Ob = IDR. 7,350,520

h. Order cost

$$Op = \frac{AD}{q0}$$

$$Op = \frac{404{,}327 \text{ x } 1{,}837.63}{1{,}365.54}$$

Op = IDR. 543,710

i. Storage cost

$Os = (\frac{1}{2}\, q0 + S) \text{ x } h$

$Os = (\frac{1}{2}\, 1{,}365.54 + 1{,}394.20) \text{ x } 800$

Os = IDR. 1,661,978

j. Inventory shortage cost

$$Ok = \frac{CuD}{q0} \text{ x } N$$

$$Ok = \frac{600 \text{ x } 1{,}837.63}{1{,}366.54} \text{ x } 3{,}60$$

Ok = IDR. 1,454.49

k. Total inventory cost

$TC = Op + Os + Ok$

$TC = 543{,}710 + 1{,}661{,}978 + 1{,}454.49$

TC = IDR. 2,208,595

The results of the inventory of each raw material with the Q model can be seen in Table 9.

Tabel 9. Recapitulation of Q Model calculation results

No	Raw Materials	Maximum Inventory (S)	Total Inventory Cost (IDR)
1	Aquadest	1,394.20 kg	2,208,595
2	Cocamido Propyl Betaine	280.12 kg	2,218,654
3	Glucotain Plus	82.24 kg	5,161,788
4	Glycerin	40.35 kg	2,189,642
5	Oramix NS	57.51 kg	2,276,887
6	Phenoxythanol	19.62 kg	2,184,115
7	Sepimax Zen	8.91 kg	4,112,613
8	Solagum AX	16.91 kg	4,085,194
9	Packaging	401.79 pcs	2,227,536
	Total	1,899.86 kg & 401.79 pcs	26,665,024

Source: Data processed (2024)

4.11. Periodic Review System

Here is an example of a calculation using the Model P formula for ordering aquadest raw materials:

a. Calculating the time period between order

$T = \sqrt{\frac{2A}{Dh}}$

$T = \sqrt{\frac{2 \times 404{,}327}{1{,}837.63 \times 800}}$

$T = 0.742$

b. Possible inventory shortages

$\alpha = \frac{Th}{Cu}$

$\alpha = \frac{0.742 \times 800}{600}$

$\alpha = 0.989$ kg

Using the Z table, it was found that for $\alpha = 0.989$, the $Z\alpha$ value is 2.29

c. Calculating the maximum inventory value

$R = D\,(T+L) + Z\alpha\sqrt{T + L}$

$R = 1{,}837.63\,(0.742+0.015) + 2.29\sqrt{0.742 + 0.015}$

$R = 1{,}392.46$ kg

d. Calculate the possible number of inventory shortages

$N = SD\sqrt{T + L}\,(f(Z\alpha) - (Z\alpha \times \psi\, Z\alpha))$

$N = 74.47 \times 1{,}837.63\sqrt{0.742 + 0.015}\,(0.0283 - (2.29 \times 0.0037))$

$N = 2{,}360.20$ kg

e. Calculating the total cost of inventory

$TC = \frac{A}{T} + (r - DL - \frac{DT}{2}) \times h + (\frac{CuN}{T})$

$TC = \frac{404{,}327}{0.742} + (1{,}392.46 - (1{,}837.63 \times 0.015) - \frac{1{,}837.63 \times 0.742}{2}) \times 800 + (\frac{600 \times 2{,}360.20}{0.742})$

TC = IDR. 3,001,29

The results of the inventory of each raw material with the P model can be seen in Table 10.

Table 10. Recapitulation of Model P calculation results

No	Raw Materials	Maximum Inventory (R)	Total Inventory Cost(IDR)
1	Aquadest	1,392.46 kg	3,001,295
2	Cocamido Propyl Bet0ol.aine	281.24 kg	1,643,325
3	Glucotain Plus	81.95 kg	8,786,225
4	Glycerin	42.68 kg	1,163,017
5	Oramix NS	58.85 kg	1,408,852
6	Phenoxythanol	22.62 kg	1,251,106
7	Sepimax Zen	8.88 kg	3,848,293
8	Solagum AX	16.81 kg	5,376,746
9	Packaging	402.51 pcs	2,043,115
	Total	1,905.49 kg & 402.51 pcs	28,521,974

Source: data processed (2024)

V. CONCLUSIONS AND SUGGESTIONS

5.1. Conclusions

The best demand forecasting method for shower gel products is the exponential smoothing method α = 0.1. The results of the ABC analysis show that there are 5 category A raw materials, 3 category B raw materials, and there is 1 category C raw material. The best method for controlling raw material inventory is Model Q (continuous review system) with a total maximum number overall inventory of2,301.65 kg and 401.79 pcs. Total overall inventory cost of raw materials of IDR. 26,665,010.

5.2. Suggestions

Companies can pay attention to the components of inventory costs, namely the cost of raw material shortages and storage costs, because these cost components are the company's main reference in controlling inventory.

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