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Analysis of the Application of the Rolling Forecast Method for Personal Care Products at PT. Kosmetiku

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Abstract: Demand planning is a significant factor that affects the performance of each stage of supply chain management in fast-moving consumer goods. An unavoidable problem is the inaccuracy of demand planning which has an impact on production planning for the procurement of personal care products. The more products, the more the accuracy of demand forecasting varies, so it is necessary to make efforts to improve the quality of demand planning to have an impact on effective, efficient demand planning and increase customer satisfaction. This research is a mixed method with a concurrent embedded strategy by providing a simulated rolling forecast process (to be) of the current rolling forecast process (as is). The analysis uses the method of rolling forecast, double moving average, double exponential smoothing, and forecast error calculation with Mean Absolute Percentage Error (MAPE). The purposive sampling method is used to calculate demand forecasting for 2022 focusing on product categories with the 80/20 Pareto principle, where 20% of products generate 80% of the company's revenue. This research improves the business process by implementing a planning time horizon that is dissected into 3 months consisting of frozen, slushy, and liquid periods in a rolling forecast and setting safety stock to be obeyed by distributors to get the smallest forecast error rate. The appropriate demand forecasting method for forecasting product demand based on test results shows that each product requires a different forecasting method, depending on the characteristics of each product's historical data.

Keywords: Demand Forecast, Demand Planning, Personal Care, Planning Horizon, Rolling Forecast

INTRODUCTION

Competition in Fast Moving Consumer Goods (FMCG) companies is getting tighter, which requires companies to improve performance and provide the best service for customers. Demand for customer needs always changes over time. This affects the company's performance which requires providing the right and fast service so that customer satisfaction can be met

(Hayes, 2008; Kułyk et al., 2017). Every company strives to meet customer demand to compete with competing companies and maintain their existence in the business world.

PT Kosmetiku is one of the companies engaged in the field of consumer goods with personal care products, such as hair care products, foot care, skin care, and cosmetics. As a company engaged in the production of consumer goods, PT Kosmetiku always tries to improve its strategy to compete and get maximum profit. In the production of personal care, the company uses raw materials (raw materials and packaging materials) from various potential suppliers around the world. The selection of the right supplier is very important to ensure the quality of goods and material services, as well as speed (Christopher, 2011; Jain & Singh, 2020; Schramm et al., 2020). To meet customer demand, FMCG companies often have information distortions on demand generated based on forecasting with actual or realization (Abolghasemi et al., 2020; Bowersox et al., 2020; Seyedan & Mafakheri, 2020).

The mismatch of demand generated based on forecasting with actual orders of goods from customers is called forecasting error (Abolghasemi et al., 2020; Oshri et al., 2015). This is due to distributors and manufacturers conducting forecasting separately based on the data they have and using different forecasting methods. This obstacle can be overcome with good information exchange in this case between distributors, producers, and raw material suppliers. Collaborative planning in the supply chain is important so that inventory management decision-makers have the same information so that they can forecast demand well (Bae, 2017; Christopher, 2011; Li et al., 2020).

According to Bowersox et al. (Bowersox et al., 2020) demand planning is a significant factor in the FMCG industry that affects the performance of each stage of the supply chain. An unavoidable problem is the inaccuracy of demand planning which has an impact on production planning for the procurement of personal care products. The number of products produced has an impact on the accuracy of demand forecasting per unit of product. The greater the number of products, the more the accuracy of demand forecasting varies and the higher the uncertainty of demand. The basis for forecasting is demand data from previous periods in the hope that demand from a certain period can be repeated in the next period (Abolghasemi et al., 2020; Pasaribu & Wahyuni, 2014). For the demand from a certain period to be repeated in the next period, it is necessary to carry out a mathematical model. Forecasting is a tool for planning to predict or project future demand effectively and efficiently (Abolghasemi et al., 2020; Krisma et al., 2019).

The time required to produce a finished product consists of the total preparation time of raw materials and packaging materials, to the production process, waiting time to pass Quality Control, and transportation time. The total time affects inventory levels. The waiting time from suppliers with different geographical locations and modes of transportation is very influential. So that if there is a delay, it can result in an inefficient inventory planning and can lead to shortages or excess inventory levels (Gu et al., 2023; Hutabarat et al., 2023).

Demand Forecasting is an important stage of analysis to gain a better understanding of future demand (Rodrigue, 2020; Uddin, 2022). By minimizing inventory vacancies, accurate demand forecasting will ensure proper supply chain management and increase customer satisfaction. Faced with constantly changing customer demand, so forecasting is very important. Forecasting is helpful in making the right inventory management decisions using Rolling Forecast (Chen et al., 2019). Rolling Forecast is a space to make changes and adjustments to address performance gaps with quick consideration of instabilities that affect targets and performance. Rolling Forecast is also called continuous planning which helps the organization to know the new possibilities among the existing threats (Nodee, 2016). Regular forecasting updates with a longer period of time result in better information management in the hope that forecasting updates will have more accurate results. Rolling Forecast aims to provide an overview for the medium and long term, there are parent data, input information and

assumptions. Historical data of forecasting accuracy in 2022 of PT Kosmetiku can be seen in Table 1.

Table 1. Accuracy Data January 2022 - December 2022

SKU	MaximumPercentage MAPE (Target)	MAPE Percentage2022
XC001	±30%	**27%**
XC002	±30%	**36%**
XC003	±30%	**33%**
XB001	±30%	**16%**
XB002	±30%	**48%**
XB003	±30%	**21%**
ZA001	±30%	**38%**
ZA002	±30%	**66%**
YB001	**±30%**	**19%**

Source: PT Kosmetiku (reprocessed)

There is a distortion of demand forecasting compared to actual orders for hair care products. The variation of demand with actual customer orders is still above the maximum percentage of accuracy of the company's provisions (Maiseli, 2019). The Mean Absolute Percentage Error (MAPE) is ± 30%. Forecasting inaccuracies that occur cause problems in inventory, namely too much inventory (overstock) and too little inventory (stock out). Based on company standards, the MAPE set is + 30%. According to Krisma et al. (2019) the MAPE value is absolute. When the MAPE value is positive, it means that the pessimistic forecast that impacts inventory is too little. This causes the company to be unable to meet customer demand (loss of opportunity). The company suffers losses because it has to carry out continuous production to meet the shortage of customer demand and bring in raw materials quickly by air. When the MAPE value is negative, it causes too much inventory (overstock). Overstock results in product stockpiles (obsolete), slow sales, and the possibility of expired products (Bowersox et al., 2020). Companies must incur costs to carry out promo activities so that products can be sold immediately and do not become waste products. Often companies find it difficult to determine the number of goods to be produced, how much production capacity is needed, whether it is in accordance with the available capacity, and what level of inventory is needed. The Demand Planning Division of PT Kosmetiku is responsible for forecasting customer demand and product availability to be distributed to all distributors nationwide. Researchers analyzed demand forecasting and measured the accuracy of the company's demand forecasting in 2022. The forecast error calculation, MAPE, is calculated based on 2021 sales data. The focus of the hair care product catego[ries studied are fast moving, such as shampoo, tonic and conditioner.

METHOD

The research method contains the type of research, sample and population or research subjects, time and place of research, instruments, procedures, and research techniques, as well as other matters relating to the method of research. This section can be divided into several sub-chapters, but no numbering is necessary.

The research method is mixed method with concurrent embedded strategy, starting from defining the current rolling forecast process (as is) and continuing with the simulation of the simulated rolling forecast process (to be). Analysis is carried out using rolling forecast, double moving average, and double exponential smoothing methods. Calculation of safety stock and forecast error with MAPE. Safety stock is needed to defend the logistics system against the

uncertainty of the demand cycle (Bowersox et al., 2020). The research location is at the head office of PT Kosmetiku, Jakarta, Indonesia.

The sampling method is non-probability sampling by means of purposive sampling, namely sampling based on predetermined goals, objectives and uses (Etikan, 2016)(Yusuf, 2016). To do demand forecasting in 2022, focus on product categories from the results of the 80/20 Pareto principle (Cooper & Schindler, 2014). The data source needed in this research is secondary data that is already available. The data are forecasting data and actual product demand from January 2022 - December 2022, Personal Care sales January 2021 - December 2021, and product distribution Lead Time Data. The variable used is the personal care product demand forecasting method. Qualitative data used is data from observations and interviews with parties related to the object of research.

Data Analysis Techniques

1. Manage Data

The data obtained and collected are processed using Microsoft Excel. The object of research is the Pareto (fast moving) product category, specifically shampoo, tonic and conditioner products for the period January 2022 - December 2022.

2. Calculation of Double Moving Average Forecasting Method

Mathematically, the double moving average is expressed as follows:

a. The first moving average

$$S'_t = \frac{Xt + Xt-1 + Xt-2 + Xt-n-1}{n}$$

b. The second moving average

$$S''_t = \frac{S't + S't-1 + S't-2 + S't-n-1}{n}$$

c. Determination of the size of the constant

$$a_t = S'_t + (S'_t - S''_t) = 2\,S'_t - S''_t$$

d. Determination of trend size

$$b_t = \frac{2}{n-1}\,(S'_t - S''_t)$$

e. Determination of forecasting magnitude

$$F_{t+p} = a_t + btm$$

Where:
X_t = observation data of period t
n = number of time series
S't = single moving average value
S''_t = double moving average value
a_t = constant value
Bt = trend coefficient
Ft+p = Forecasting period $t+_1$

3. Calculation of Brown's Double Exponential Smoothing (DES) Forecasting Method

Brown DES is a forecasting method to solve the problem of differences in results that arise between actual data and forecasting when there is a long-term upward or downward trend Double exponential smoothing brown method towards sales forecasting system with a linear and non-stationary data trend (Dharmawan & Indradewi, 2021). (The method developed by Brown can overcome the differences that arise between actual data and forecast values due to trends in the plot. This method uses a smoothing parameter, namely alpha with $0 < \alpha < 1$ (Febrian et al., 2020). Mathematically, Brown's DES is expressed as follows:

a. Determination of the first smoothing value

$$S'_t = \alpha X_t + (1-\alpha)\,S'_{t-1}$$

b. Determination of the second smoothing value

$$S''_t = \alpha S'_t + (1-\alpha)\,S''_{t-1}$$

c. Determination of the magnitude of the constant

$$\alpha_t = 2S'_t - S''_t$$

d. Determining the magnitude of the trend

Where:
S'_t = First smoothing value
S"t = Second smoothing value
a = Exponential smoothing parameter
X_t = Real value of period t
S''_{t-1} = Previous Exponential smoothing value
αt = The magnitude of the period constant t
b_t = The slope/trend value of the corresponding data
F_{t+m} = The forecasting value

$$b_t = \frac{\alpha}{1-\alpha}(S'_t - S''_t)$$

e. Determination of forecasting magnitude

$$F_{t+m} = \alpha t + b\, m_t$$

Trial and error is necessary for the appropriate smoothing value between $0 < \alpha < 1$ in order to determine the lowest error value. The values of S'_{t-1} and S''_{t-1} must be available at the beginning of the period, so S'_t and S''_t are set equal to the actual values of X_1 .

4. Safety Stock Calculation

Based on diverse demand conditions and lead time, the safety stock calculation formula is as follows:

Varied demand conditions and fixed lead times

$$SS = z_\alpha \sigma_d \sqrt{L}$$

Description:

SS = Safety stock.
z_α = inverse value of normal distributio on values α
α = Service Level
d = average demand
σ_d = demand standard deviation
L = average lead time

5. MAPE Calculation of Moving Average and Double Exponential Smoothing Methods

The MAPE calculation is a measurement of the absolute average value of errors in a period of time in the form of a percentage value. The purpose of MAPE is to determine the difference between demand data and actual orders, using the following calculation:

$$MAPE_n = \frac{\sum_{i=1}^{n} \left|\frac{Xt - Ft}{Xt}\right|}{n} \; x \; 100$$

Where:

Ft = demand forecasting period t
Xt = actual demand of period t
n = number of periods

RESULTS AND DISCUSSION

Company Business Process Identification

Some activities related to the demand planning environment business process at PT. Kosmetiku, as follows:

Rolling Forecast Process (As Is)

1. Rolling forecast is forecasting for products categorized as finished goods, which is independent demand. Demand forecast comes from the sales and marketing department. Sales and Marketing provide the sales plan in 1 year (forecasting basis) and changes in sales plan (rolling forecast basis) to the Demand Planner.
2. Demand Planner receives sales plan data from sales and marketing and processes it into forecast and rolling forecast/adjustable forecast.
3. Demand Planner converts sales plans to outlets (selling out) into customer/distributor purchase plans (forecast selling in). Forecast selling in is made at the beginning of each month or the first week for the next three months with the mechanism that one month ahead is a freeze forecast and the next two months is an adjustable forecast (70% accuracy).

4. Sales & Operation Planning (S&OP) Meeting is attended by Sales, Marketing, Demand Planner, Logistics, PPIC, Procurement, Finance, and Business Development departments to determine the forecast for each product. The information obtained during the S&OP meeting is in the form of forecast figures per product.
5. The Demand Planner informs the Production Planning Inventory Control (PPIC) Factory of the selling in forecast in the first week of every month.
6. Demand Planner converts the forecast selling in into suggest purchase orders that are sent to distributors in the first week of every month. The distributor then sends fix purchase orders and additional orders without any time limit during the current month.
7. PPIC Factory provides information to the demand planner regarding the plan to fulfill the delivery of goods on the forecast received.
8. PPIC Factory makes production plan every week
9. PPIC Factory creates an explosion Bill of Materials (BoM) and forms the procurement of raw materials (Raw Material) and packaging materials (Packaging Material).
10. RM and PM procurement is made in a purchase requisition (PR).
11. Procurement converts purchase requisition (PR) into purchase order (PO) to the supplier and informs the supplier's delivery and fulfillment schedule to PPIC for production planning preparation.
12. Distributors send fixed purchase orders and additional orders without a certain time limit during the current month to the demand planner then the demand planner converts the purchase order (PO) into a sales order (SO) in the ERP system.
13. The Logistics team converts the sales order (SO) into a delivery order (DO) in the ERP (Enterprise Resource Planning) system and then issues a road letter.
14. The Logistics team sends the order to the distributor.
15. Distributors receive orders and make payments according to the terms of payment

Company Business Process Simulation Model

An alternative simulation model of the demand planning process at PT Kosmetiku, as follows:

Rolling Forecast Process Simulation (To Be)

1. Distributors as a source of finish goods volume, to demand forecasts from distributors. Distributors provide forecast figures and changes in demand for finish goods on a rolling forecast basis. Planning time horizon is applied for three periods (quarterly) to the principal Demand Planner, with the following conditions:
   a. The delivery of the distributor's rolling forecast figures to the Demand Planner principal is mutually decided by the 5th of each month. The calculation of the forecast number is based on the following formulation: = Demand Forecast + Safety Stock - (Stock On Hand + Outstanding Order)
      For the Last Bite program (last pickup before price increase), volume pickup is determined based on a minimum increase of 75% to 100% of the maximum sales in the last 6 months.
   b. The distributor's rolling forecast delivered for three months was decided as follows:
      - Month I is called the frozen period, which is a fixed number and cannot change, or 0% change, which translates as a frozen order/purchase order to the principal.
      - Month II is called the slushy period. Figures can change but with a percentage of ± 20% and can be revised at each meeting at the beginning of the month week 2.
      - Month III is called the liquid period. Changes can be made but are set at a percentage of 25% - 35%.

The three-monthly forecast is dissected and scrolled continuously according to the period in the three-month planning time horizon.

c. Purchase order submission period to Demand Planner is every Monday & Wednesday. Demand planners must respond to Purchase Orders submitted within 1 x 24 hours (working days). Distributors can submit an Additional Order (AO) if the branch selling needs exceed the submitted plan. AO is submitted to the demand planner maximum on Tuesday of the second week. Demand planner must respond to the submitted AO within 1 x 24 hours. The demand planner can fulfill the entire amount of AO requested, partially fulfill the amount of AO requested, or reject the AO requested. The basis for fulfillment of AO from distributors is as follows:
   - Availability of finish goods stock
   - Distributor stock availability and forecast numbers delivered
   - Average sales 6 months, maximum sales 6 months, and sales 1 month earlier
   - AO's reason
   - Other special reasons, such as allocations from the marketing team, allocation restrictions, etc.

d. Sales and Marketing team provides Sales Promotion Program and Marketing Activity to Demand Planner.
e. Demand Planner receives forecast figures from distributors, Sales Promotion Programs and Marketing Activity Programs, Demand Planner then performs forecasting calculations, analyzes sales trends, calculates and includes the need for principal programs, converts the plan into a distributor purchase plan (Rolling Forecast Selling In). The analysis is set every quarter per SKU based on the longest supplier lead time, which is 3 months. Things to look out for when determining the Forecast:
   - Demand Forecast Principal
   - Distributor Forecast
   - Sales History
   - Program Principal
   - Market Trends
   - Safety Stock (the service level used is 95%)
   - Distributor Stock (Stock On Hand + Outstanding Order)
   - Last Bite (price increase) with the provision of taking based on an increase of at least 75% to 100% of the maximum sales in the last 6 months.

f. The Sales & Operation Planning (S&OP) Meeting is attended by the Sales, Marketing, Demand Planner, Logistics, PPIC, Procurement, Finance, and Business Development departments. The monthly meeting is held to determine the forecast for each product. Schedule The information obtained during the S&OP meeting is in the form of forecast figures per product.
g. Demand planners provide forecast figures per product to the PPIC team by the 20th of each month.
h. PPIC calculates the number of finish goods requirements in the coming months and converts them into batch units.
i. PPIC Factory provides information to the Demand Planner regarding the plan to fulfill the delivery of goods on the forecast received.
j. PPIC Factory creates a production plan every week and informs the Demand Planner of the finished goods.
   - Market Trends

- Safety Stock (the service level used is 95%)
- Distributor Stock (Stock On Hand + Outstanding Order)
- Last Bite (price increase) with the provision of taking based on an increase of at least 75% to 100% of the maximum sales in the last 6 months.

k. PPIC Factory creates explosion Bill of Materials (BoM) as well as RM and PM in purchase requisition (PR).
l. Procurement converts the PR into a purchase order (PO) to the supplier and informs the delivery schedule in preparation for production planning.
m. Rolling forecasts from distributors in the first period are called frozen periods, which are fixed numbers and cannot change. This rolling forecast is used as a purchase order to the principal. The Demand Planner then converts the purchase order (PO) into a sales order (SO) in the ERP system.
n. The Finish Goods Logistics team converts sales orders (SO) into delivery orders (DO) in the ERP system to issue road letters.
o. The Logistics team sends the order to the distributor.
p. The distributor receives the order and makes payment according to the terms of payment.
q. Improve the business process from Pull System, which is inventory based on the size of the purchase order from each distributor branch to Push System, which is inventory allocation to distributor branches based on rolling forecast figures sent by distributors to the principal.

Forecasting Demand for Hair Care Products with the Double Moving Average Method.

Double Moving Average is forecasting using the results of a single moving average to be forwarded to a double moving average. Mathematically, the double moving average is expressed as follows:

a. First moving average
$$S'_t = \frac{Xt + Xt-1 + Xt-2 + Xt-n-1}{n}$$
b. Second moving average
$$S''_t = \frac{S't + S't-1 + S't-2 + S't-n-1}{n}$$
c. Determination of the size of the constant
$$a_t = S'_t + (S'_t - S'_t) = 2\,S'_t - S'_t$$
d. Determination of trend size
$$bt = \frac{2}{n-1}\,(S'_t - S''_t)$$
e. Determination of forecasting magnitude
$$F_{t+p} = a_t + btm$$

Where:

X_t	=	observation data of period t
N	=	number of time series used
S'_t	=	single moving average value
S''_t	=	double moving average value
A_t	=	constant value
bt	=	trend coefficient
F_{t+p}	=	forecasting period t+1

Data processing for forecasting 2022 hair care products using the three-month *double moving average* method based on2021 sales is as follows:

a. Shampoo (XC001, XC002,XC003, XB001, XB002, XB003)

The data processing obtained for forecastingthe total demand for XC001 in 2022 is as follows:

S'_1	=	20.056
S''_1	=	20.691
a_1	=	21.232
b_1	=	270
F_{t+p}	=	21.502

To calculate the 13th period forecasting,the values of *a* and *b are* obtained: a_{12} = 23492; b_{12} = 1887. Based on the *a* and *b* values of period 12, up to forecasting for period 13, F_{13} = 25379 and so on up to period 24. Forecasting XC001, XC002, XC003, XB001, XB002, and XB003 in 2022, where from period to period, has an assumed increasing demand trend.

b. Tonic (ZA001 & ZA002)

The data processing obtained for forecasting the total demand for ZA001 in2022 is as follows:

Double Moving Average:

S'_1 = 29.388
S''_1 = 30.613
a_1 = 32.951
b_1 = 1.169
F_{t+p} = 34.120

To calculate the 13th period forecasting,the values of *a* and b are obtained: a_{12} = 22910; b_{12} = -1067. Based on the *a* and *b* values of period 12,so the forecasting for period 13 isobtained F_{13} = 21843 and so on untilperiod 24. Forecasting ZA001 in 2022 from period to next period has an assumed decreasing demand trend. WhileZA002 has an assumed increasing demand trend.

c. Conditioner (YB001)

The data processing obtained for forecasting the total demand for YB001 in 2022 is as follows:

S'_1 = 27.539
S''_1 = 27.577
a_1 = 25.318
b_1 = -1.129
F_{t+p} = 24.189

To calculate the 13th period forecasting,the values of *a* and *b are* obtained: a_{12} = 28056, b_{12} = 11. Based on the *a* and *b* values of period 12,the forecasting for period 13 is obtained as F_{13} = 28067 and so on until the 24th period. It is obtained that forecasting YB001 in 2022 from period to period has an assumed increasing demand trend.

Forecasting Demand for Hair Care Products with the Brown Double Exponential Smoothing Method

Brown's double exponential smoothing method is used to overcome the difference in results between actual and forecast data, when there is a trend in the data pattern. Mathematically, Brown's Double Exponential Smoothing is expressed as follows:

a. Determination of the first smoothing value

$$S'_t = \alpha X_t + (1- \alpha)\ S'_{t-1}$$

b. Determination of the second smoothing value

$$S''_t = \alpha S''_t + (1- \alpha)\ S''_{t-1}$$

c. Determination of the size of the constant

$$\alpha_t = 2S'_t - S''_t$$

d. Determination of trend magnitude

$$b_t = \frac{\alpha}{1-\alpha}(S'_t - S''_t)$$

e. Determination of forecasting magnitude

$$F_{t+m} = \alpha t + b_t m$$

Where:

S't	=	The first smoothing value
S"t	=	The second smoothing value
A	=	Exponential smoothing paramaters
Xt	=	Real value of period t
S" t-1	=	Previous exponential smoothing value
At	=	The magnitude of the constant period t
Bt	=	Slope / trend value of the corresponding data
Ft+m	=	Forecasting data
M	=	Forecasting time frame

Data processing for forecasting 2022 haircare products using the *double exponential* smoothing method based on 2021 sales is as follows:

1. Shampoo (XC001, XC002, XC003, XB001, XB002, XB003)

The data processing obtained for forecasting the total demand for XC001 in 2022 with α = 0.07, α = 0.17 and α = 0.2 is as follows:

a. Determine S't (first smoothing)

$S't = \alpha Xt + (1- \alpha)\ S'\ t-1$

t=1	$X_1 = 21.381$	$S'_1 = 21,381$
t=2	$X_2 = 16.333$	$S'_2 = 21,028$
t=3	$X_3 = 22,454$	$S'_3 = 21,127$
t=12	$X_{12} = 23,336$	$S'_{12} = 20.391$

b. Determine S''_t (second smoothing)

$S''_t = \alpha S''_t + (1- \alpha)\ S''_{t-1}$

t=1	$X_1 = 21.381$	$S'_1 = 21,381$
t=2	$X_2 = 16.333$	$S'_2 = 21,356$
t=3	$X_3 = 22,454$	$S'_3 = 21,340$
t=12	$X_{12} = 23,336$	$S'_{12} = 20,924$

c. Determine the size of the constant

$\alpha_t = 2S'_t - S''_t$

t=1	$\alpha_1 = 21.381$
t=2	$\alpha_2 = 20.699$
t=3	$\alpha_3 = 20.915$
t=12	$\alpha_{12} = 19.858$

d. Determine the trend size

$bt = = \frac{\alpha}{1-\alpha}(S'_t - S''_t)$

t=1	$b_1 = 0$
t=2	$b_2 = -25$
t=3	$b_3 = -16$
t=12	$b_{12} = -40$

e. Determine next period forecasting

$F_{t+m} = \alpha t + b\, m_t$

t=1	m=1	$F_2 = 21.381$
t=2	m=1	$F_3 = 20.674$
t=11	m=1	$F_{12} = 19.315$
t=12	m=1	$F_{13} = 19.819$
t=13	m=t-12	$F_{14} = 19.778$
t=23	m=t-12	$F_{24} = 19.376$

The same was done with α = 0.17 and α = 0.2 for shampoo categories XC002, XC003, XB001, XB002, and XB003. Product XC001 forecasting in 2022 with α = 0.07 from period to period has an assumed decreasing demand trend. With α = 0.17 and 0.2 has an assumed increasing demand trend. Product XC002 forecasting in 2022 with α = 0.07 from period to period has an assumed increasing demand trend. With α = 0.17 and 0.2 has an assumed increasing demand trend. Product XC003 forecasting in 2022 with α = 0.07; 0.17; 0.2 from period to period has an assumed decreasing demand trend. Product XB001 forecasting in 2022 with α = 0.07; 0.17; 0.2 from period to period has an assumed increasing demand trend. Product XB002 forecasting in 2022 with α = 0.07; 0.17; 0.2 from period to period has an assumed increasing demand trend. XB003 forecasting in 2022 with α = 0.07 from period to period has an assumed decreasing demand trend. With α = 0.17 and 0.2, the demand trend is assumed to increase.

2. Tonic (ZA001 and ZA002)

The data processing obtained for forecasting the total demand for ZA001 in2022 with α = 0.07, α = 0.17 and α = 0.2 is as follows:

a. Determine S'_t (first *smoothing*)

$S'_t = \alpha X_t + (1- \alpha)\, S'_{t-1}$

t=1	$X_1 = 28640$	$S'_1 = 28640$
t=2	$X_2 = 26170$	$S'_2 = 28467$
t=3	$X_3 = 33354$	$S'_3 = 28809$
t=12	$X_{12} = 24337$	$S'_{12} = 27442$

b. Determine S''_t (second *smoothing*)

$S''_t = \alpha S'_t + (1- \alpha)\, S''_{t-1}$

t=1	$X_1 = 28640$	$S'_1 = 28640$
t=2	$X_2 = 26170$	$S'_2 = 28628$
t=3	$X_3 = 33354$	$S'_3 = 28641$
t=12	$X_{12} = 24337$	$S'_{12} = 28446$

c. Determine the size of the constant

$\alpha t = 2S'_t - S''_t$

t=1	$\alpha_1 = 28640$
t=2	$\alpha_2 = 28306$
t=3	$\alpha_3 = 28978$
t=12	$\alpha_{12} = 26437$

d. Determine the trend size

$$bt = \frac{\alpha}{1-\alpha}(S'_t - S''_t)$$

t=1 $b\,1$ = 0
t=2 $b\,2$ = -25
t=3 $b\,3$ = -12
t=12 $b\,12$ = -76

e. Determine next period forecasting

$F_{t+m} = \alpha t + b\ m_t$

t=1 *m=1* F_2 = 28640
t=2 *m=1* F_3 = 28294
t=11 *m=1* F_{12} = 26765
t=12 *m=1* F_{13} = 26362
t=13 *m=(t-12)* F_{14} = 26286
t=23 *m=(t-12)* F_{24} = 25530

Forecasting ZA001 products in 2022 withα = 0.07; 0.17; and 0.2 from period to period has an assumed decreasing demand trend. Forecasting ZA002 products in 2022 with α = 0.07; 0.17; and 0.2 from period to period has an increasing demand trend.

3. Conditioner (YB001)

Forecasting the demand for product YB001 in 2022 with α = 0.07, α = 0.17 and α = 0.2 is as follows:

a. Determine S'_t (first smoothing)

$S'_t = \alpha X_t + (1- \alpha)\ S'_{t-1}$

t=1 X_1 = 25171 S'_1 = 25171
t=2 X_2 = 30087 S'_2 = 25515
t=3 X_3 = 27359 S'_3 = 25644
t=12 X_{12} = 27366 S'_{12} = 25897

b. Determine S''_t (second smoothing)

$S''_t = \alpha S'_t + (1- \alpha)\ S''_{t-1}$

t=1 X_1 = 25171 S'_1 = 0 S''_1 = 25171
t=2 X_2 = 30087 S'_2 = 25515 S''_2 = 25195
t=3 X_3 = 27359 S'_3 = 25644 S''_3 = 25227
t=12 X_{12} = 27366 S'_{12} = 25897 S''_{12} = 25419

c. Determine the size of the constant

$\alpha t = 2S'_t - S''_t$

t=1 α_1 = 25171
t=2 α_2 = 25835
t=3 α_3 = 26026
t=12 α_{12} = 26374

d. Determining the trend size

$bt = = \frac{\alpha}{1-\alpha} (S'_t - S''_t)$

t=1 b_1 = 0
t=2 b_2 = 24
t=3 b 3 = 31
t=12 b 12 = 36

e. Determine next period forecasting

$F_{t+m} = \alpha t + b\ m_t$

t=1 m=1 F_2 = 25171
t=2 m=1 F_3 = 25859

t=11 m=1 F_{12} = 26224
t=12 m=1 F_{13} = 26410
t=13 m=(t-12) F_{14} = 26446
t=23 m=(t-12) F_{24} = 26805

Forecasting product YB001 in 2022 with α =0.07; 0.17; and 0.2 from period to period has an assumed increasing demand trend.

Safety Stock Calculation

Based on the condition of unfixed demand and fixed leadtime to distribute products nationwide, with a service level of 95%, Safety Stock is obtained as follows:

$SS = z_\alpha \sigma_d \sqrt{L}$
z_α=1.64
α = 5%

d = average demand per product perdistribution point in 2021
σd = standard deviation of *demand for* each product

L = lead time of each branch (in months).

Calculation of safety stock of XC001products for Branch 1 samples with 95% service level as follows:

d= 260
dd= 105

L = 0.32

SS =97

obtained safety stock XC001 Branch 1 is 97. The same calculation is done for all hair care products.

Table 2. Recapitulation of Safety Stock Calculation Results Hair Care Products

Produk	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	d	σd	SS
XC001	21381	16333	22454	24388	16050	19320	16728	16711	17042	20375	21104	23336	19601	8219	8311
XC002	55537	48553	66828	90878	29555	33716	80516	30443	40905	56901	76581	73486	57000	27553	24415
XC003	16112	6944	12610	8921	9058	7516	8507	7288	10072	7930	11038	10234	9686	5528	4948
XB001	30835	25384	33458	37764	25819	34513	25198	23078	25877	44665	36667	38234	31791	14090	13914
XB002	92767	98725	128822	150944	70909	88108	123515	96793	108846	138414	140005	140731	114973	37921	33766
XB003	17373	16238	14515	15808	17520	15025	12075	18377	16179	21536	15544	19320	16626	7887	7030
ZA001	28640	26170	33354	32486	29507	27151	22419	23659	29749	22720	24876	24337	27089	9967	9240
ZA002	38502	38973	46170	98102	68323	59764	66634	47388	42600	44554	52999	51899	54659	31866	28158
YB001	25171	30087	27359	28784	23199	22562	21844	27441	25917	32092	24705	27336	26375	8958	8334

Source: Data Processing Results

Table 2 is the safety stock calculation value of shampoo, tonic and conditioner products with a service level of 95% for 64 distribution points.

Calculation of MAPE Value of Double Moving Average and Double Exponential Smoothing Methods

MAPE calculation is a measurement of the absolute average value of errors in a period of time. MAPE aims to determine the difference between demand data and actual orders. The MAPE calculation formula is as follows:

$$MAPE_n = \frac{\sum_{i=1}^{n} |\frac{Xt - Ft}{Xt}|}{n} \; x \; 100$$

Where:

Ft = demand forecasting period t
Xt = actual demand of period t
n = number of periods

Data processing to calculate MAPE in 2022 using the double moving average method is as follows:

1. **Shampoo** (XC001, XC002, XC003, XB001, XB002, XB003)

The calculation of the total MAPE value of XC001 in 2022 is as follows:

Table 3. Recapitulation of MAPE Calculation Results of Product XC001

	Bulan	Xt	Ft	IErrorI IXt - FtI	MAPE (IXt - FtI)/Xt*100
XC001	Jan-22	29568	25379	4189	14.17%
XC001	Feb-22	29376	27265	2111	7.19%
XC001	Mar-22	20688	29152	8464	40.91%
XC001	Apr-22	19392	31039	11647	60.06%
XC001	May-22	14928	32926	17998	120.56%
XC001	Jun-22	19920	34812	14892	74.76%
XC001	Jul-22	16224	36699	20475	126.20%
XC001	Aug-22	21984	38586	16602	75.52%
XC001	Sep-22	15216	40473	25257	165.99%
XC001	Oct-22	14976	42360	27384	182.85%
XC001	Nov-22	12960	44246	31286	241.41%
XC001	Dec-22	14832	46133	31301	211.04%
MAPE					110%

Source: Data Processing Results

The same calculation steps were performed for all shampoo products.

2. **Tonic** (ZA001 and ZA002)

The calculation of the total MAPE value of ZA001 in 2022 is as follows:

Table 4. Recapitulation of MAPE Calculation Results for Product ZA001

Produk	Bulan	Xt	Ft	IErrorI IXt - FtI	MAPE (IXt - FtI)/Xt*100
ZA001	Jan-22	15696	21843	6147	39.16%
ZA001	Feb-22	15072	20775	5703	37.84%
ZA001	Mar-22	15312	19708	4396	28.71%
ZA001	Apr-22	23040	18640	4400	19.10%
ZA001	May-22	19680	17573	2107	10.71%
ZA001	Jun-22	28896	16506	12390	42.88%
ZA001	Jul-22	22704	15438	7266	32.00%
ZA001	Aug-22	14976	14371	605	4.04%
ZA001	Sep-22	25008	13303	11705	46.80%
ZA001	Oct-22	17328	12236	5092	29.39%
ZA001	Nov-22	8352	11168	2816	33.72%
ZA001	Dec-22	8688	10101	1413	16.26%
MAPE					28%

Source: Data Processing Results

The same calculation steps were performedfor all *tonic* products.

3. Conditioner (YB001)

The calculation of the total MAPE value of YB001 in 2022 is as follows:

Table 5. Recapitulation of MAPE Calculation Results for Product YB001

Produk	Bulan	Xt	Ft	IErrorI IXt - FtI	MAPE (IXt - FtI)/Xt*100
YB001	Jan-22	23688	28067	4379	18.49%
YB001	Feb-22	21960	28078	6118	27.86%
YB001	Mar-22	21888	28090	6202	28.33%
YB001	Apr-22	19080	28101	9021	47.28%
YB001	May-22	14136	28112	13976	98.87%
YB001	Jun-22	28584	28124	460	1.61%
YB001	Jul-22	15360	28135	12775	83.17%
YB001	Aug-22	30312	28146	2166	7.14%
YB001	Sep-22	20448	28158	7710	37.70%
YB001	Oct-22	12216	28169	15953	130.59%
YB001	Nov-22	8784	28180	19396	220.81%
YB001	Dec-22	15744	28192	12448	79.06%
MAPE					65%

Source: Data Processing Results

Data processing to calculate MAPE in 2022with the *double exponential* smoothing method is as follows:

1. Shampoo (XC001, XC002, XC003,XB001, XB002, XB003)

The calculation of the total MAPE value ofXC001 in 2022 is as follows:

Table 6. Recapitulation of MAPE Calculation Results Product XC001 $\alpha = 0.07$

Produk	Bulan	Xt	Ft	IErrorI IXt - FtI	MAPE (IXt - FtI)/Xt*100
XC001	Jan-22	29568	19818	9750	32.98%
XC001	Feb-22	29376	19778	9598	32.67%
XC001	Mar-22	20688	19738	950	4.59%
XC001	Apr-22	19392	19697	305	1.58%
XC001	May-22	14928	19657	4729	31.68%
XC001	Jun-22	19920	19617	303	1.52%
XC001	Jul-22	16224	19577	3353	20.67%
XC001	Aug-22	21984	19537	2447	11.13%
XC001	Sep-22	15216	19497	4281	28.13%
XC001	Oct-22	14976	19457	4481	29.92%
XC001	Nov-22	12960	19417	6457	49.82%
XC001	Dec-22	14832	19376	4544	30.64%
MAPE					22.94%

Source: Data Processing Results

The same calculation steps were performed for all *shampoo* products with $\alpha = 0.17$ and $\alpha = 0.2$.

2. Tonic (ZA001 and ZA002)

The calculation of the total MAPE value of ZA001 in 2022 is as follows:

Table 7. Recapitulation of MAPE Calculation Results for Product ZA001 α = 0.07

Produk	Bulan	Xt	Ft	IErrorI IXt - FtI	MAPE (IXt - FtI)/Xt*100
ZA001	Jan-22	15696	26362	10666	67.95%
ZA001	Feb-22	15072	26286	11214	74.40%
ZA001	Mar-22	15312	26210	10898	71.18%
ZA001	Apr-22	23040	26135	3095	13.43%
ZA001	May-22	19680	26059	6379	32.41%
ZA001	Jun-22	28896	25983	2913	10.08%
ZA001	Jul-22	22704	25908	3204	14.11%
ZA001	Aug-22	14976	25832	10856	72.49%
ZA001	Sep-22	25008	25757	749	2.99%
ZA001	Oct-22	17328	25681	8353	48.21%
ZA001	Nov-22	8352	25605	17253	206.58%
ZA001	Dec-22	8688	25530	16842	193.85%
MAPE					67.31%

Source: Data Processing Results

The same calculations steps for all tonic products with α = 0.17 dan α = 0.2.

3. **Conditioner** (YB001)

The calculation of the total MAPE value ofYB001 in 2022 is as follows:

Table 8. Recapitulation of MAPE Calculation Results Product YB001 α = 0.07

Produk	Bulan	Xt	Ft	IErrorI IXt - FtI	MAPE (IXt - FtI)/Xt*100
YB001	Jan-22	23688	26410	2722	11.49%
YB001	Feb-22	21960	26446	4486	20.43%
YB001	Mar-22	21888	26482	4594	20.99%
YB001	Apr-22	19080	26517	7437	38.98%
YB001	May-22	14136	26553	12417	87.84%
YB001	Jun-22	28584	26589	1995	6.98%
YB001	Jul-22	15360	26625	11265	73.34%
YB001	Aug-22	30312	26661	3651	12.04%
YB001	Sep-22	20448	26697	6249	30.56%
YB001	Oct-22	12216	26733	14517	118.84%
YB001	Nov-22	8784	26769	17985	204.75%
YB001	Dec-22	15744	26805	11061	70.25%
MAPE					58.04%

Source: Data Processing Results

The same calculation steps were performed for all *conditioner* products with α = 0.17 dan α = 0.2.

Recapitulation of the calculation of the MAPE value of the double moving average method and the double exponential smoothing method, year 2022as follows:

Table 9. Recapitulation of MAPEValue Data Double Moving Average andDouble Exponential Smoothing Methods

Produk	Double Moving Average	Double Exponential Smoothing		
		$\alpha = 0.07$	$\alpha = 0.17$	$\alpha = 0.2$
XC001	110%	22.94%	25.93%	29.08%
XC002	330%	55.27%	74.43%	84.36%
XC003	149%	35.54%	27.33%	27.92%
XB001	149%	24.73%	37.59%	43.02%
XB002	180%	56.18%	83.24%	89.78%
XB003	54%	30.71%	37.23%	40.04%
ZA001	28%	67.31%	50.02%	47.15%
ZA002	194%	123.81%	123.65%	114.73%
YB001	65%	58.04%	63.32%	64.61%

Source: Data Processing Results

The error values in Table 9 are obtained based on the results of testing the double moving average and double exponential smoothing forecasting methods with $\alpha = 0.07$. $\alpha = 0.17$ dan $\alpha = 0.2$. The yellow color is the smallest MAPE value from the test results of each forecasting method.

Forecasting Method Selection

The best forecasting method is selected from the smallest MAPE results. The number in yellow is the smallest MAPEvalue. It can be seen that each product requires a different forecasting method, depending on the characteristics of eachproduct's historical data.

1. Shampoo XC001, XC002, XB001, XB002, and XB003, and **conditioner** YB001 with double exponential smoothing method and $\alpha = 0.07$ have the smallest MAPE value, compared to the double moving average and double exponential smoothing methodwith $\alpha = 0.07$ dan $\alpha = 0.17$.

2. Shampoo XC003 with double exponential smoothing method and $\alpha = 0.17$ has the smallest MAPE value compared to the double moving average and double exponential smoothing methodwith $\alpha = 0.07$ dan $\alpha = 0.2$.

3. Tonic ZA001 with double moving average method has the smallest MAPEvalue compared to the double exponential smoothing method with $\alpha = 0.07$, $\alpha = 0.17$ dan $\alpha = 0.2$

4. **Tonic** ZA002 with double exponential smoothing method and $\alpha = 0.2$ has the smallest MAPE value compared to the double moving average anddouble exponential smoothing method with $\alpha = 0.07$ dan $\alpha = 0.17$

The MAPE standard set is ± 30%. Because the MAPE value is absolute, so if the MAPE value is positive, the forecast is pessimistic,resulting in stock outs. If the MAPE value is negative, the forecast is optimistic, resultingin over stock. MAPE values that meet the forecast error standard are for products XC001, XB001, XB003 (double exponential smoothing method with α=0.07), product XC003 with double exponential smoothing method with α=0.17 and product ZA001 double moving average). For MAPE values that are still over forecast, the forecast is revised in the slushy period and liquid period.

CONCLUSION

Based on the results of the previous discussion, the following conclusions are drawn:

1. In order to get the smallest forecast error rate, distributors must improve business processes by implementing a three- month planning time horizon and setting safety stock.

2. The appropriate demand forecasting method of hair care products is different for each product, depending on the historical data characteristics of each product:
   - Shampoo XC001, XC002, XB001, XB002, and XB003, and conditioner YB001 using double exponential smoothing method with. conditioner YB001 using the double exponential smoothing method with $\alpha = 0.07$.
   - Shampoo XC003 using the double exponential smoothing method with $\alpha = 0.17$.
   - Tonic ZA001 using the double moving average method
   - Tonic ZA002 using the double exponential smoothing method with $\alpha = 0.2$
3. Rolling forecasts are applied regularly and disciplined with cross- departmental consensus (sales, marketing, demand planner, logistics, PPIC, procurement, finance, and business development).
4. To get a better forecast error than ± 30%, we can do predictive management collaboratively, and not only use forecasting formulas.

   The application of several forecasting methods aims to obtain forecasting results with better accuracy (Christopher, 2011)

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