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Analysis of Forecasting Ingredients Performance at PT. Jebsen Jessen Ingredients Indonesia

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Abstract: The research conducted by the author aims to analyze which forecasting method's most appropriate to use at PT. Jebsen Jessen Ingredients Indonesia and develop strategies that will be used to increase the effectiveness of forecasting with forecasting accuracy of 60% (KPI). The research method used by the author to develop and find information to achieve goals are quantitative, descriptive and qualitative research methods. The data used by the author consists of the demand variables for raw ingredients, with the data indicators representing the demand requirements for the previous 36 months. The sampling's non-probability purposive sampling. The population utilized comprises historical raw ingredient data from Jebsen Jessen, while the forecast data samples used consist of sales for raw materials derived from ABC Analysis, totaling 18 items from January to December 2022. The results of research conducted using two forecasting methods,exponential smoothing and moving average, indicate thatMAPE value obtained through the exponential smoothing forecasting method for silicon dioxide standard grade (Japan) is 0.045 with an ɑlpha value of 0.897. Meanwhile, MAPE obtained through using moving average forecasting method for silicon dioxide standard grade (Japan) is 0.297. The relevant method for forecasting at PT. Jebsen Jessen Ingredients Indonesia is Exponential Smoothing.

Keywords: Forecasting, Exponential Smoothing, Moving Average

I. INTRODUCTION

Inventory management is a process of planning and controlling goods to ensure the fulfillment of internal (company's business targets) and external (consumer) demands. Inventory management plays a crucial role in securing a company's business and minimizing the required investment costs. Excessive inventory can lead to larger lot sizes in storage locations (warehouses) and can inflate the company's investments. Conversely, if inventory levels are too low, it can disrupt the sales process, leading to reduced company profits.

Inventory management is crucial in companies to maximize business operations and enhance customer satisfaction by maintaining proper stock levels. Inventory management is closely related to forecasting. Forecasting, or inventory prediction, is the process of planning for the procurement of goods. Companies engage in forecasting planning based on qualitative and quantitative methods. In other words, qualitative methods are subjective, while quantitative methods rely on mathematical calculations (Russel & Taylor, 2011). The effectiveness of inventory management largely depends on the accuracy of demand forecasting. Producing accurate demand forecasts requires real-time data, and this data analysis capability can also identify trends that may have been overlooked. With better demand forecasting, companies can manage their inventory more effectively, increase sales, and enhance customer satisfaction.

This research was conducted at PT. Jebsen Jessen Ingredients Indonesia, a multinational company engaged in distributing chemical raw materials for various market segments ranging from raw materials for coating, paint, plastic, rubber, agrochemical, food, veterinary, to personal care and pharmaceutical industries. Ingredients or raw materials serve as basic components or additives used to support the final products in these segments.

Chemical raw materials are fundamental components used in the chemical industry, manufacturing, pharmaceuticals, and various other sectors to produce a wide range of chemical products, medicines, materials, and other chemical substances. Chemical raw materials can consist of pure substances, chemical compounds, or other materials used as the basic ingredients in various production processes. Chemical raw materials can be highly diverse, including organic and inorganic chemicals, solids, liquids, or gases that can originate from natural, synthetic, or recycled sources. Chemical raw materials exhibit a wide range of physical and chemical properties. These properties include concentration, melting point, boiling point, hardness, solubility, and reactivity. Chemical raw materials often undergo various processing steps before being used in production. Chemical raw materials are key components in the chemical and manufacturing industries, and the selection of appropriate raw materials and wise management play a crucial role in the quality of the final products and the environmental impact produced. Here is the sales data for Jebsen Jessen Ingredients Indonesia.

Figure 1. Sales data of Jebsen Jessen from 2021 to mid-2023

Figure 1 shows that there is fluctuation in the sales of raw materials every year. In 2021, the highest sales level was for silica abrasive agent at 9.72 tons/year and the lowest sales was for CPC antibacterial with 0 sales. In 2022, the highest sales level was for silica abrasive agent at 10.5 tons/year and the lowest sales was for CPC antibacterial at 10 kg/year. For the sales in 2023 up to June 2023, the highest sales was for silica thickening at 20.126 tons and the lowest sales was for CPC antibacterial at 15 kg. Fluctuating sales have an impact on forecasting for the future.

In conducting its business processes, PT. Jebsen Jessen Ingredients Indonesia performs forecasting to manage inventory shortages or excesses. Forecasting is a crucial performance indicator for the company. The implementation of the forecasting process is carried out by each sales team, and the data is processed in an MRP system based on SAP HANA. However, the overall product forecasting carried out by PT. Jebsen Jessen Ingredients Indonesia still does not meet the established 60% KPI standard and lacks precision in its forecasting analysis.

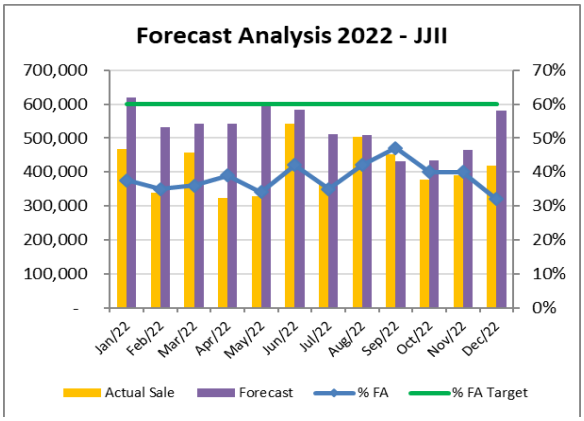

FIgure 2. Sales Forecast Analysis of Jebsen Jessen Ingredients Indonesia in 2022

Figure 2 illustrates the discrepancy between the forecast analysis (FA) and actual sales of materials (Actual Sale), each indicated in kilograms (kg), with the company's %FA set at 60%. Jebsen Jessen Ingredients Indonesia has conducted forecasting based on time-series and average per month, yet inaccuracies in forecasting persist.

Accuracy in forecasting is a critical aspect of planning and decision-making, especially in the context of business and management. Inaccuracy in forecasting can lead to significant consequences, such as financial losses, overstocking or understocking of goods, or poor decision-making. Experts have identified various factors that can contribute to inaccuracies in forecasting.

Changes in consumer behavior can affect demand and purchasing patterns, leading to less accurate forecasting. For example, sudden trends or changes in consumer preferences can impact forecast outcomes. Highly dynamic and unstable markets can also lead to less accurate forecasts. Price volatility, intense competition, or demand fluctuations can make forecasting more challenging. Errors in selecting forecasting models or parameters used in the models can result in inaccurate forecasts. Various forecasting models are suitable for different situations, and models that are not appropriate for the context can yield poor results. Therefore, in this study, the author will identify issues related to forecasting at PT. Jebsen Jessen Ingredients Indonesia.

II. LITERATURE REVIEW

2.1 Forecasting

According to Heizer and Render (2017:113), Forecasting is the science of predicting events in the future. Forecasting is necessary to provide the data's information to manage be used as a basis for decision-making, such as inventory management, production, and sales in company.When an event is about to occur or a need arises, which can be identified through the results, it enables the formulation of policies or important actions that must be taken. In forecasting efforts, it is important to pay attention to reducing the possibility of errors that may occur. The accuracy of the forecasts made plays a crucial role in determining the success of the decisions and plans formulated. Forecasting has several types, such as,

Table 1 Type of Forecasting

Forecasting	Type
Based on Time	Long term forecast
	Short term forecast
Based on Scale	Micro
	Macro
Technique	Qualitative
	Quantitative

According to (Hanke, et al., 2005), there are 5 steps in conducting forecasting:

1. Problem formulation and data's collection
2. Manipulation of data
3. Create the model forecasting and evaluation
4. Implementation (actual estimation)
5. Evaluation

2.2 Moving Average

According to Hanke (2009), moving average is used to calculate a new average by adding the latest value and removing the oldest value.

$$\widehat{\boldsymbol{Y}}_{\boldsymbol{t+1}} = \frac{\boldsymbol{Y_t + Y_{t-1} + \cdots + Y_{t-k+1}}}{\boldsymbol{k}}$$

with,

$\hat{Y}_{t+1}$ = Value of forecasting in next periode
Y_t = Actual value in tperiode
k = Total value

2.3 Exponential Smoothing

Simple exponential smoothing uses data or values from all previous periods. In the other hand, this method provides an exponentially weighted moving average of all previously observed values. The equation for exponential smoothing method is as follows (Wilson and Keating, 2009: 107).

$$\boldsymbol{F_{t+1} = \alpha X_t + (1-\alpha) F_t}$$

with,

F_{t+1} = Value of forecasting in next periode(t+1)
α = Smoothing of Constantawith $0 < \alpha < 1$
X_t = Actual value in tperiode(pada periode*t*)
F_t = Forecasting with exponentialin tperiode

3.1 The Standard Error of Forecasting (MAD, MSE and MAPE)

3.1.1 MAD (Mean Absolute Deviation)

MAD is the type error of forecasting which is used to compute the average absolute error

$$\boldsymbol{MAD} = \frac{\sum|\boldsymbol{At - Ft}|}{\mathbf{n}}$$

with,

A_t = Observational forecasting datas in t periode
F_t = Forecast in tperiode
$\sum$ = Total periode

3.1.2 MSE (Mean Square Deviation)

MSE is the type error of forecasting which which is the average of the squared differences between the forecasted values and the observed values.

$$\boldsymbol{MSE} = \frac{\sum|\boldsymbol{At} - \boldsymbol{Ft}|^2}{\mathbf{n}}$$

with,
A_t = Observational forecasting datas in t periode
F_t = Forecast in tperiode
$\sum$ = Total periode

3.1.3 MAPE (Mean Absolute Percentage Error)

MAPE is calculated as the average absolute difference between the forecasted and actual values, reflected as a percentage of the actual value. The issue with both MAD and MSE is that their values depend on the magnitude of the items being forecasted

$$\boldsymbol{MAPE} = \left(\frac{\mathbf{100}}{\boldsymbol{n}}\right)\sum|\boldsymbol{At} - \frac{\boldsymbol{Ft}}{\boldsymbol{At}}|$$

With,
A_t = Observational forecasting datas in t periode
F_t = Forecast in tperiode
$\sum$ = Total periode

3.2 ABC Methods

The ABC method is used in inventory management to classify raw materials based on the Pareto principle. According to the Pareto principle, raw materials are grouped based on which ones require attention, due to the cost of their annual usage volume. The ABC inventory classification scheme divides inventory items into three groups: high-dollar volume (A), medium-dollar volume (B), and low-dollar volume (C). Dollar volume is an important measure; an item with low cost but high volume may be more critical than an item with high cost and low volume (Jacob and Chase, 2018: 538).

III. RESEARCH METHODS

In this research, the methods employed by the authors to develop and discover information to achieve the objectives are quantitative, qualitative, and descriptive methods. The variables used include the demand raw ingredients for the previous 36 months. Other variables include the type of raw material and the sales period taken from the ABC analysis process within the timeline from January to December 2022.

According to data from PT. Jebsen Jessen Ingredients Indonesia, the company possesses more than 100 raw materials. Considering the researcher's resource constraints, it is not feasible to test the entire population. Therefore, it is necessary to get sampling methods on the target population.

Hence, the type of sampling in this research is non-probability, *purposive sampling* which is the sample selection from the population is done purposively based on specific criteria and set by the researcher (Priadina & Sunarsi, 2021).

Therefore, in this research, the population data used consists of the historical raw ingredient usage data from PT. Jebsen and Jessen, while the sample data for forecasting consists of sales data of raw materials from the ABC Analysis process, comprising 18 items from January 2022 to December 2022.

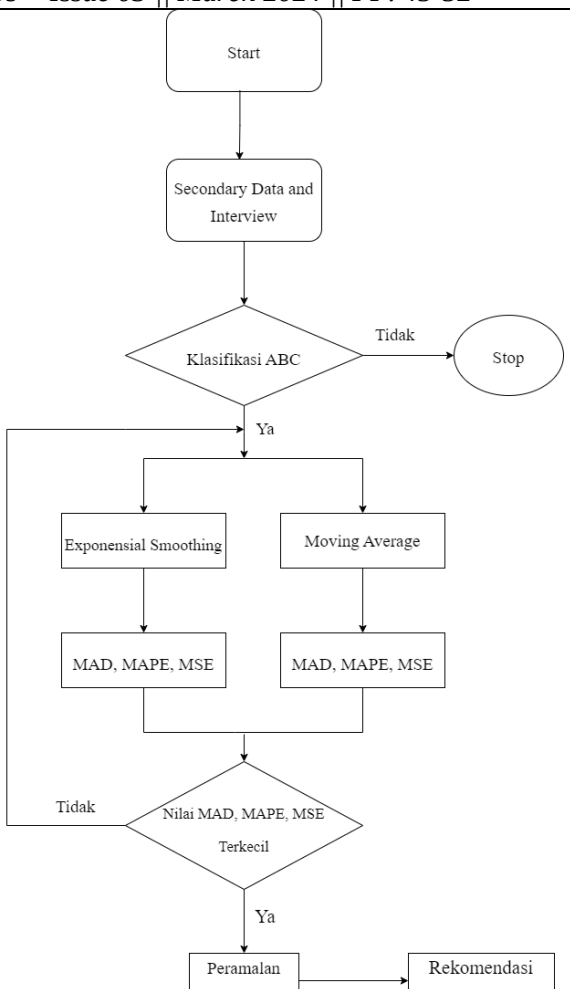

Figure 3 Research Flow

IV. RESULT AND DISCUSSION

4.1 ABC Analysis

Strategic and Non-Strategic product strategies can be determined by ABC analysis of products. This classification is done by obtaining the highest sales within a certain period. In this study, the authors conducted ABC analysis using the Pareto principle with 18 products over the course of a year in 2022. Before conducting the ABC Analysis, the classes were classified first. Products with A class % Cummulative value range between 0-79%, B value ranges between 80-94%, and C value ranges between 95-100%. Here are the analysis results.

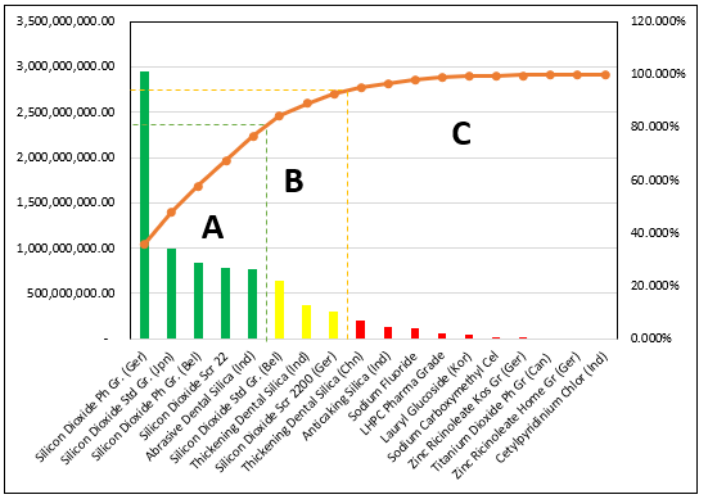

Figure 4 ABC Analysis of Jebsen Jessen Ingredients Indonesia's Product

Based on figure 4, the results of the ABC analysis treatment show that products classified as A include Silicon Dioxide Pharma Grade (Germany), Silicon Dioxide Std. Grade (Japan), Silicon Dioxide Pharma Grade (Belgium), Silicon Dioxide Scrub 22, and Abrasive Dental Silica, with %sales values of 35.67%, 12.149%, 10.154%, 9.488%, and 9.310%, respectively. By identifying and conducting ABC analysis, it is possible to determine strategic and non-strategic products. This is same with Blocher's researchs (2011) that ABC analysis provides accurate information to companies for better strategic decision-making. Strategic and non-strategic products can determine product positioning (priority products), in this case, priority for forecasting. A classification of products represents strategic products that must be maintained and considered in forecasting so that the business can operate smoothly, especially in stock and demand fulfillment for customers.

4.2 Exponential Smoothing, Moving Averageand Identification The Standard Error of Forecasting (MAD, MSE, MAPE)

Based on the samples obtained from the classification of raw materials in class A from the ABC Analysis results, the forecasting value, actual sales, and forecasting errors (MAD, MSE, MAPE) were obtained using the exponential smoothing method with a value of α equal to 0.897.

Table 2 The Result of Forecasting Calculationusing Exponential Smoothing

Material description	Forecast 2023	Actual Sales 2023	ABS dev	MAD	MSE	MAPE
Silicon Dioxide Std Grade (Japan)	3388.356727	4100	711.643273	119.92	23704.40	0.045
Silicon Dioxide Pharma Grade (Belgium)	1504.619614	3520	2015.38039	95.13	17302.55	0.133
Silicon Dioxide Pharma Grade (Germany)	1868.871496	2548.75	679.878504	96.51	14960.21	0.064
Silicon Dioxide Scrub 22 (Taiwan)	5912.905248	5500	412.905248	738.96	715137.06	#DIV/0!
Abrasive Dental Silica (India)	14503.84997	19795	5291.15003	651.99	636612.28	0.059

Based on the calculation and result,that's found the five products/raw materials in class A obtained the values of MAD, MSE, and MAPE as attached in Table 2. The smallest MAPE value is found in the standard grade silicon dioxide (Japan) raw material with a value of 0.045. The reason is getting smaller the MAPE's value in forecasting, get the smallererror of forecasting. This is also same with the research conducted by Rosalendro (2021), where the lowest MAPE value obtained was 6.23. In his research, he used an alpha value of 0.9. This also confirms the assumption that the best smoothing for forecasting is obtained with an alpha of 0.9, as conducted by Jacobs and Meindl (2016). On the other hand, there are calculations that cannot show their results due to the highly fluctuating demand, and there are even products with zero sales (due to no sales in that month).

Exponential smoothing with trend forecasting has been used by Katarina in 2017 at PT. TIS, where she compared four forecasting methods, resulting in the smallest error value in the exponential smoothing with trend method at only about 43%. Similarly, Rizal Rachman in the Informatics Journal entitled "Application of Moving Average and Exponential Smoothing Methods in Forecasting Garment Industry Production", compared two forecasting methods in the garment sector. The research concluded that consumer demand forecasting using exponential smoothing method with α= 0.9 yielded smaller results compared to other methods. In time series models, as the data increases, the forecast values tend to improve, but the researcher only considered the previous 12 months and projected for the next 12 months. The values of alpha and beta were obtained through trial and error by seeking the smallest error value forα (alpha).

Therefore, based on moving average methods,

Table 3 The Result of Forecasting Calculation using Moving Average

Material description	Forecast 2023	al Sales	ABS Dev	MAD	MSE	MAPE
Silicon Dioxide Std Grade (Japan)	3628	4100	472.00	1039944.44	-0.090	0.297
Silicon Dioxide Pharma Grade (Belgium)	1654.00	3520	1866.00	920754.32	-0.434	0.805
Silicon Dioxide Pharma Grade (Germany	1796.00	2549	752.75	688211.11	-0.198	0.447
Silicon Dioxide Scrub 22 (Taiwan)	6453.00	5500	953.00	21010438.89	#DIV/0!	#DIV/0!
Abrasive Dental Silica (India)	14528	19795	5267.00	17983780.25	-0.212	0.358

Based on the analysis, thas's found the five products/raw materials in class A obtained the values of MAD, MSE, and MAPE as attached in Table 3. The smallest MAPE value is found in the standard grade silicon dioxide (Japan) raw material with a value of 0.297. According to Zainun (2003), a forecasting is considered to be accurate if it has a MAPE value below 10%. The smaller the MAPE value, the more accurate the forecasting. According to Heizer (2011), the longer the time period of the moving average, the smoothing effect (forecasting error) will be smaller, resulting in better forecasting accuracy.

Based on the results of both analyses, it is found that the exponential smoothing method with α equal to 0.897 yields lower MAD, MSE, and MAPE values compared to using the moving average method. This is consistent with the research conducted by Rahmat (2023) in a banana processing factory, which resulted in the lowest MAPE value of 0.1665 with α equal to 0.6. According to Wilson (2009), the moving average method is more accurate for long time periods, provided that the trend obtained does not fluctuate or has a linear and constant trend. However, in this research, the data trend fluctuates, resulting in undefined MAPE values and thus less accuracy in identifying these values. The limitation of the researcher in using manual calculations makes it prone to errors. However, overall, the best method that can be used as a reference for the company's managerial leadership in forecasting is the exponential smoothing method.

4.3 The Comparition of Actual Sales in 2023 with Forecasting Conducted

Table 4The Resultof Comparation Forecasting vs Aktual Sales 2023 Forecasting using Exponential Smoothing

Material description	Actual Sales 2023 (kg)					%FA					Forecasting 2023 (kg)				
	Aug.23	Sep.23	Oct.23	Nov.23	Dec.23	Aug.23	Sep.23	Oct.23	Nov.23	Dec.23	Aug.23	Sep.23	Oct.23	Nov.23	Dec.23
Silicon Dioxide Std Grade (Japan)	6790	4180	5550	4690	6260	86%	85%	70%	99%	31%	5840.78	4817.50	3877.89	4713.99	1938.68
Silicon Dioxide Pharma Grade (Belgium)	1700	2340	3270	2470	1450	63%	60%	70%	77%	26%	1076.01	1402.51	2288.29	1895.14	2518.43
Silicon Dioxide Pharma Grade (Germany)	1490	1480	1300	1550	3600	83%	82%	83%	71%	82%	1233.03	1212.37	1084.66	2004.39	2960.24
Silicon Dioxide Scrub 22 (Taiwan)	7775	7110	975	90	825	65%	55%	91%	0%	60%	10529.35	10287.74	1059.64	9420.00	1158.63
Abrasive Dental Silica (India)	13620	17200	25100	12000	11000	84%	64%	71%	97%	97%	15764.45	10952.54	17776.43	12415.57	10697.30

Based on table 4, the comparison results of actual sales from August 2023 to December 2023 with the forecasting conducted using the exponential smoothing method with α equal to 0.897 are as follow refer to the KPI forecast accuracy from Jebsen Jessen Ingredients Indonesia of 60%, it is found that 3 products are still below the forecasting accuracy threshold. These are silicon dioxide standard grade (Japan) in December 2023 at 31%, silicon dioxide pharma grade (Belgium) in December 2023 at 26%, and silicon dioxide scrub 22 (Taiwan) in September and November 2023 at 55% and 0%, respectively. The actual sales of silicon dioxide scrub experienced drastic fluctuations, causing the forecast percentage to fall below the standard. These fluctuations may be due to consumer preferences, economic conditions, and market trends (Kotler, 2016).

Table 5 The Result of Comparation Forecasting vs Aktual Sales 2023 Forecasting using Moving Average

Material description	Actual Sales 2023 (kg)					Forecasting 2023 (kg)					%FA				
	Aug.23	Sep.23	Oct.23	Nov.23	Dec.23	Aug.23	Sep.23	Oct.23	Nov.23	Dec.23	Aug.23	Sep.23	Oct.23	Nov.23	Dec.23
Silicon Dioxide Std Grade (Japan)	6790	4180	5550	4690	6260	4586.667	4873.333	4846.667	4426.667	3400.000	68%	83%	87%	94%	54%
Silicon Dioxide Pharma Grade (Belgium)	1700	2340	3270	2470	1450	1633.333	1016.667	1646.667	1893.333	2276.667	96%	43%	50%	77%	43%
Silicon Dioxide Pharma Grade (Germany	1490	1480	1300	1550	3600	1990.000	1210.000	1163.333	1463.333	2083.333	66%	82%	89%	94%	58%
Silicon Dioxide Scrub 22 (Taiwan)	7775	7110	975	90	825	6960.000	7390.000	7290.000	6880.000	3530.000	90%	96%	0%	0%	0%
Abrasive Dental Silica (India)	13620	17200	25100	12000	11000	15547	12580	15053	13587	13620	86%	73%	60%	87%	76%

Based on Table 5, the comparison results of actual sales from August 2023 to December 2023 with the forecasting conducted using the Moving Average method show that almost all materials have forecasting accuracy percentages below the company's KPI, with the highest discrepancies observed in December 2023. This indicates that demand fluctuations affect the accuracy of the method used, as measured by the FA percentage.

Based on both methods, it can be concluded that the exponential smoothing method with α equal to 0.897 yields better accuracy compared to using the Moving Average method in terms of forecasting accuracy percentage. Forecasting or predictions made for the future should provide an overview of the expected conditions, allowing managerial leadership to control and anticipate potential occurrences such as market competition, market trends, and economic changes.

Additionally, managerial leadership can evaluate product quality and sales techniques. According to Swastha (2014), several sales techniques can be employed, including trade selling (B2B technique to distributors/competitors), technical selling (analyzing consumer needs and problem-solving), and missionary selling (utilizing specific distributors to reach target consumers).

Moreover, companies can control forecasting using exponential smoothing methods based on order. According to Wilson (2009), there are three orders in exponential smoothing methods. Each order can be used according to sales trends; for example, using order 2 or order 3, which are suitable for non-linear or non-constant time series data (sales).

V. CONCLUSION AND SUGGESTION

5.1 Conclusion

Based on the research conducted, it can be concluded that the MAPE value obtained through the exponential smoothing forecasting method for silicon dioxide standard grade (Japan) is 0.045 with an alpha (α) value of 0.897. Meanwhile, the MAPE value obtained through the moving average forecasting method for silicon dioxide standard grade (Japan) is 0.297. The smaller the MAPE value, the better the forecasting accuracy. This is consistent with previous research and references. However, demand fluctuations can cause data to change (undefined). In this study, the autho concludes that the exponential smoothing method is better and can be used in forecasting for PT. Jebsen Jessen Ingredients Indonesia.

The forecasting accuracy Key Performance Indicator (KPI) for PT. Jebsen Jessen Ingredients Indonesia is set at 60%. Based on the researcher's calculations using the exponential smoothing and moving average methods on actual sales data from August 2023 to December 2023, the author concluded that the use of the exponential smoothing method with an alpha (α) value of 0.897 resulted in better data compared to the moving average method. The results show that there are only 3 products that are still below the forecasting accuracy: silicon dioxide standard grade (Japan) in December 2023 at 31%, silicon dioxide pharma grade (Belgium) in December 2023 at 26%, and silicon dioxide scrub 22 (Taiwan) in September and November 2023 at 55% and 0%, respectively. This research provides an opportunity for the company's managerial leadership to control and anticipate potential occurrences such as market competition, market trends, and economic changes. Additionally, managerial leadership can maintain product quality and conduct sales evaluations to avoid excessive fluctuations in demand through techniques such as trade selling (B2B technique to distributors/competitors), technical selling (analyzing consumer needs and assisting in problem-solving), and missionary selling (using specialized distributors to reach target consumers).

5.2 Implication and Suggestion

The output of this research (implication) is crucial in running businesses effectively. In this research, the company can choose the most suitable forecasting method based on data characteristics, aiming to use exponential smoothing with α of 0.897, which will result in more accurate forecasting compared to moving average while still achieving a KPI of %FA exceeding 60%. Management should consider evaluating and improving forecasting performance continuously and ensuring the relevance of the data used, including factors such as market trends and others. Management also needs to provide training and development to employees involved in the forecasting process and ensure effective communication. By considering these managerial implications, the company can improve the quality and effectiveness of their forecasting process, which in turn will help them make better decisions and achieve long-term business success. Therefore, further research/future directions of this study could investigate a forecasting stage where actual demand sales fluctuate.

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