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Comparative Analysis of Demand Forecasting Accuracy in Sajiku Seasoned Flour Product with Software POM-QM

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Abstract

Indonesia's growing wheat flour consumption requires precise demand forecasting to optimize supply chain management. This study evaluates the forecasting accuracy of Sajiku seasoned flour demand using three methods: Single Exponential Smoothing, Moving Average, and Linear Regression. Data processing and forecasting error calculations were performed using POM-QM software. The analysis reveals that the Linear Regression method yields the lowest forecasting error, making it the most reliable approach for predicting future demand. This study emphasizes the importance of selecting suitable forecasting techniques to improve the accuracy of demand predictions, which can enhance customer satisfaction and contribute to the long-term sustainability of businesses. The findings underscore the significance of accurate demand planning in maintaining a well-balanced supply chain and addressing market fluctuations effectively.

Keywords: *Demand Forecast, Linear Regression, Moving Average, Sajiku, Single Exponential Smoothing*

1. Introduction

Wheat flour comes from wheat grains washed, peeled, ground, and bleached until white and fine wheat flour is formed [1]. Food made from wheat flour has become a staple food in several countries, one of which is Indonesia. Based on the Ministry of Agriculture data, per capita wheat flour consumption in Indonesia has increased in recent years. In 2023, the average wheat flour consumption will reach 2.94 kilograms per capita per year, up 6.73% from 2.75 kilograms per capita per year in 2022. This increase shows a shift in the consumption patterns of Indonesian society, with wheat flour becoming the main ingredient in various food products. This condition also encourages the growth of the flour-based processed food industry because wheat flour is the leading solution to consumer needs for food ingredients that are easy to process and versatile.

Along with the growth of the wheat flour-based processed food industry in Indonesia, this industry needs help managing demand to keep up with market fluctuations. This is especially important for products such as Sajiku seasoned flour, where various factors, including changes in consumer preferences, can influence demand. Accurate demand forecasting is imperative to ensure production levels match market needs, preventing shortages or excess supplies. With effective forecasting, companies can avoid operational inefficiencies, higher costs, and decreased customer satisfaction, ultimately impacting a company's market position and profitability.

The development of the processed food industry, including instant seasoned flour products such as Sajiku seasoned flour, is directly influenced by the increase in the use of wheat flour in Indonesia. As an innovation that uses wheat flour as an essential ingredient, Sajiku seasoned flour was created to meet the needs of people who want to cook quickly while maintaining the dish's taste. This product responds to the trend of increasing use of wheat flour and plays an important role in building practical solutions for customers' household needs and the culinary industry. This product has succeeded in entering various markets that are increasingly dependent on wheat flour-based foods due to the support of the main ingredient, high-quality wheat flour. For products that use wheat flour as the main ingredient, when demand for wheat flour increases, there is also an increase in demand.

Demand planning is an important part of supply chain management, influencing various aspects of company operations, such as production planning, inventory management, and marketing strategy. A company's success in meeting consumer needs affects customer satisfaction and overall business continuity. The accuracy of demand forecasting methods is essential for strategic decision-making. Demand patterns in the cooking spices industry, such as the Sajiku seasoned flour product, are unique and often cannot be predicted using simple forecasting methods. External factors, such as heavy promotions, certain seasons (such as Ramadan), and fast-paced market preferences, make forecasting demand more difficult. Therefore, a comprehensive analytical approach is taken to assess and compare various demand forecasting methods to increase the reliability of predictions.
So, the ability to accurately predict demand is a technical necessity and a strategic advantage. The choice of forecasting method plays an important role in this process, as it determines how well a company can adjust its operations to meet consumer demand promptly. Although

traditional methods such as Moving Average and Single Exponential Smoothing have been widely used, the increasingly complex demand patterns in the wheat flour-based food industry require more advanced approaches such as Linear Regression. Companies can gain better insight into their demand trends by analyzing and comparing various forecasting methods and improve decision-making processes. This research aims to contribute to the company's understanding of how a forecasting technique can be applied to increase the accuracy of demand planning for the Sajiku seasoned flour product.

2. Literature Review

2.1. Forecasting

Forecasting is a method of determining attitudes toward future situations in a better and more detailed manner based on a collection of historical data from the previous period to the current period to minimize the error rate [2]. Forecasting is an attempt to predict things that will happen, usually by making a plan first. This plan is based on the company's ability and capacity to meet demand or production [3]. Forecasting focuses on planning and controlling production in the face of uncertainty in the future period. Forecasting also reduces doubts about demand in scheduling and production processes. Its use is to assist in developing methods for analyzing relevant previous data patterns and minimizing the possibility of errors [4]. Forecasting is a prediction, projection, or estimate of the level of uncertain events in the future. Absolute accuracy in predicting future events and levels of activity is impossible to achieve. Therefore, when a company cannot see future events with certainty, it requires a lot of time and energy to have the power to conclude future events [5].

Forecasting is a statement about the value for the next period of a variable, better predictions can be made into decisions using much information [6]. Forecasting is a statement about the future value of a variable. Better predictions can be decisions made using more information. Forecasting involves taking historical data and projecting it into the future using mathematical models. So, it can be concluded that forecasting is the art and science of predicting events that will occur, using historical data, and projecting it into the future with some form of mathematical model [7]. The availability of accurate and sufficient historical data can help determine the appropriate forecasting method. Apart from the accuracy and adequacy of historical data, experience is needed for decision-makers to determine needs. Thus, the intuition of experienced decision-makers becomes an important part of determining the method chosen [8].

2.2. Single Exponential Smoothing

Exponential smoothing shows that the weighting decreases exponentially towards longer observation values. Exponential smoothing is a simple forecasting technique that uses a smoothing constant between 0 and 1. If the value is close to 1, then the forecast results tend to be close to the observed value, whereas if the value is close to 0, then the forecast results lead to the previous forecast value. Forecasting using the exponential smoothing method is generally used to estimate the sales potential of individual products. This method can use past data by assigning weights based on the recency of the data. Current data is given greater weight compared to previous data. The assumption is that more recent data always has a more substantial influence on forecasting results than older data [9]. This forecasting method focuses on decreasing priority exponentially on previous observation objects [10].

2.3. Moving Average

Moving Average, often referred to as a moving average approach, utilizes accurate data from the most recent customers to determine the planning value for demand in the next period [11]. The moving average forecasting method is carried out by taking a group of observation values, finding the average, and then using the average as a forecast for the next period. The term moving average is used because every time new observational data becomes available, a new average figure is calculated and used as a forecast. Moving averages, or moving averages, use several actual past data to produce forecasts. Moving averages are helpful if we assume that market demand will be stable over the period we are forecasting [12].

2.4. Linear Regression

The regression method is a statistical method that uses a mathematical relationship between two variables, the dependent variable (Y) and the independent variable (X). The dependent variable is the variable that results from or is influenced by the independent variable, which is the variable that causes or influences. If the independent variable is known, the value of the dependent variable can be predicted. Demand or sales of a product are usually considered significant dependent variables, or their value is influenced by an independent variable. Linear regression is one of the methods used in production to forecast or predict quality and quantity characteristics [13].

3. Research Method

3.1. Data sources

Data collection is carried out in research to gather information. This data will be input into the data processing stage. The data collection method used is secondary data. The data required is as follows: data history on demand for the Sajiku seasoned flour product during 2024.

3.2. Research supporting data

Table 1: Historical Data of STB Product Demand in 2024

2024 Period (t)	Total (unit)
January	2.413
February	2.064
March	1.884
April	1.655

May	2.407
June	2.023
July	2.148
August	1.928
September	2.078
October	2.116
November	1.783
December	1.885

3.3. Data processing methods

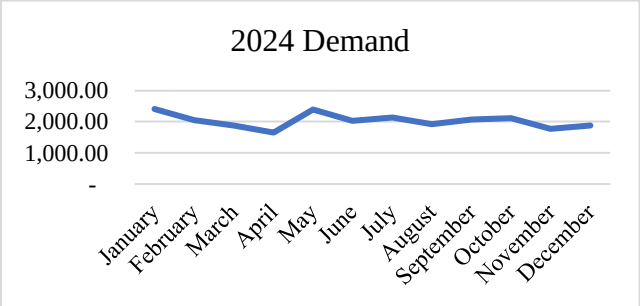


Fig. 1: STB Product Demand Graph in 2024

Data behavior refers to patterns or trends from statistical data or time series. This includes observing fluctuations, trends, seasonality, and other patterns that may be present in the data set. By understanding data behavior, we can identify how data changes over time, allowing us to make more informed and effective predictions or decisions. Behavioral analysis of data often involves using statistical techniques or specific analytical methods to identify, measure, and describe the patterns contained in that data [14]. The demand data shown in the demand graph for Sajiku seasoned flour products in 2024 shows an irregular behavior pattern and tends to fluctuate throughout the year. This pattern shows random or random variations that do not follow a specific seasonal trend or consistent cycle. This random behavior includes probability distributions of data variables collected based on data and theoretical probability distributions. Random numbers describe random and sequential events following changes that occur in the simulation process. The properties of random numbers are the same in every set of random numbers generated, and the previous number does not influence the probability of a random number appearing [15].

Irregularities in this data indicate that product demand is influenced by factors that are dynamic and difficult to predict, such as changes in consumer preferences, changing market conditions, or other external factors such as promotions or certain moments such as holidays. Data characteristics like this require an analytical approach that is flexible and can accommodate random patterns. Therefore, various forecasting methods, including Single Exponential Smoothing, Moving Average, and Linear Regression, can be used effectively to analyze and predict demand. These methods are suitable to assist the analysis of data with random characteristics, providing a different approach to dampen fluctuations and improve forecasting accuracy. The random nature of this data emphasizes the importance of careful selection and comparison of forecasting techniques to identify the most reliable methods for accurately predicting demand.

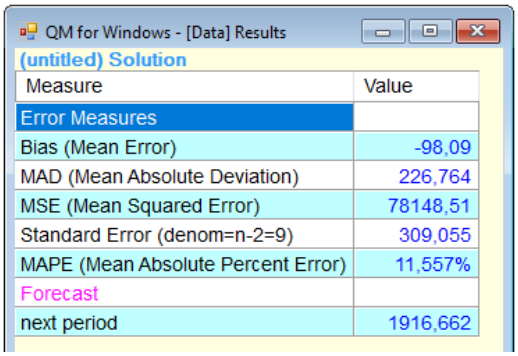
Data processing in this research uses POM-QM software. The methods used in this research are the single exponential smoothing, moving average, and linear regression methods. The difference between the three methods is that a single exponential smoothing method is used for data with little or no seasonal trend, the moving average method is effective for smoothing short-term fluctuations in data, and the linear regression method provides a better picture when the linear relationship between variables can be used to predict demand. These three methods will produce forecasting error values. The accuracy values of the three methods will be compared, and the best will be chosen based on the smallest value. The accuracy of the measurement results in forecasting results from an error regarding the magnitude of the difference between the demand results and the demand in the field. Several approaches have been used to determine the magnitude of errors in a particular forecasting technique. Almost all of these sizes use several functions' existing values with the value resulting from forecasting calculations. This difference in value is usually also called residual [16].

Calculation of forecasting accuracy by looking at the MAD, MSE, and MAPE values. The accuracy of calculating an error predicted for a forecasting model explains the comparison of predicted values with actual values and observed values. MAD (Mean Absolute Deviation) is the average of absolute errors in a certain period without paying attention to the results of predictions that are larger or smaller than reality. MSE (Mean Squared Error) measures the average squared difference between observed and predicted values. MSE calculation aims to determine the forecasting results with the lowest error value, which will be taken as accurate forecasting results. MAPE (Mean Absolute Percent Error) is calculated as the average absolute differentiation between predicted and actual values.

4. Result and discussion

1. Single Exponential Smoothing

Based on historical data on demand for the Sajiku seasoned flour product in the 2024 period, the next researcher tried to focus on predicting the calculation of the Sajiku seasoned flour product using the Single Exponential Smoothing approach with the help of the POM-QM software and showed the following results:


QM for Windows - [Data] Results

(untitled) Solution

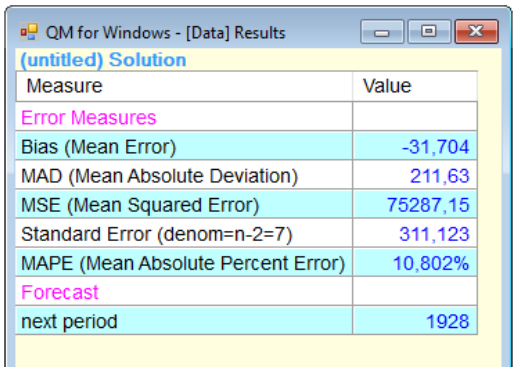
Measure	Value
Error Measures	
Bias (Mean Error)	-98,09
MAD (Mean Absolute Deviation)	226,764
MSE (Mean Squared Error)	78148,51
Standard Error (denom=n-2=9)	309,055
MAPE (Mean Absolute Percent Error)	11,557%
Forecast	
next period	1916,662

Fig. 2: Forecasting Results Using Single Exponential Smoothing

The accuracy values obtained from the forecasting results using Single Exponential Smoothing were obtained from the forecasting results. In Figure 2, it can be seen that there is a Mean Error value of -98,09; the MAD (Mean Absolute Deviation) value is 226,76; the MSE (Mean Squared Error) value is 78148,51; the Standard Error value is 309,06; and the MAPE (Mean Absolute Percent Error) value is 11,557%.

2. Moving Average

Based on historical data on demand for the Sajiku seasoned flour product in the 2024 period, the next researcher tried to focus on predicting the calculation of the Sajiku seasoned flour product using the Moving Average approach with the help of the POM-QM software and showed the following results:


QM for Windows - [Data] Results

(untitled) Solution

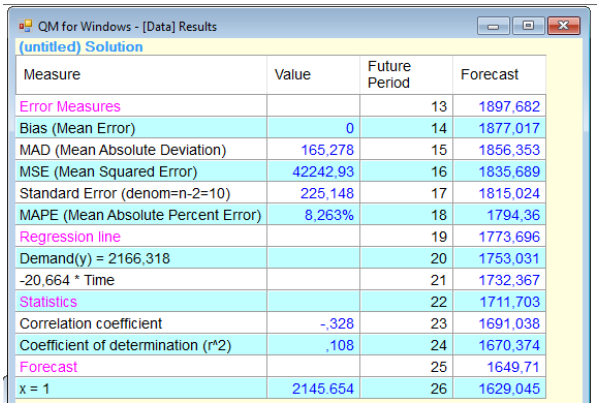
Measure	Value
Error Measures	
Bias (Mean Error)	-31,704
MAD (Mean Absolute Deviation)	211,63
MSE (Mean Squared Error)	75287,15
Standard Error (denom=n-2=7)	311,123
MAPE (Mean Absolute Percent Error)	10,802%
Forecast	
next period	1928

Fig. 3: Forecasting Results Using Moving Average

The accuracy values obtained from the forecasting results using Moving Avarage were obtained from the forecasting results. In Figure 3, it can be seen that there is a Mean Error value of -31,70; the MAD (Mean Absolute Deviation) value is 211,63; the MSE (Mean Squared Error) value is 75287,15; the Standard Error value is 311,12; and the MAPE (Mean Absolute Percent Error) value is 10,80%.

3. Linear Regression

Based on historical data on demand for the Sajiku seasoned flour product in the 2024 period, the next researcher tried to focus on predicting the calculation of the Sajiku seasoned flour product using the Linear Regression approach with the help of the POM-QM software and showed the following results:


QM for Windows - [Data] Results

(untitled) Solution

Measure	Value	Future Period	Forecast
Error Measures		13	1897,682
Bias (Mean Error)	0	14	1877,017
MAD (Mean Absolute Deviation)	165,278	15	1856,353
MSE (Mean Squared Error)	42242,93	16	1835,689
Standard Error (denom=n-2=10)	225,148	17	1815,024
MAPE (Mean Absolute Percent Error)	8,263%	18	1794,36
Regression line		19	1773,696
Demand(y) = 2166,318		20	1753,031
-20,664 * Time		21	1732,367
Statistics		22	1711,703
Correlation coefficient	-,328	23	1691,038
Coefficient of determination (r^2)	,108	24	1670,374
Forecast		25	1649,71
x = 1	2145,654	26	1629,045

Fig. 4: Forecasting Results Using Linear Regression

The accuracy values obtained from the forecasting results using Linear Regression were obtained from the forecasting results. In Figure 4, it can be seen that there is a Mean Error value of 0; the MAD (Mean Absolute Deviation) value is 165,28 the MSE (Mean Squared Error) value is 42242,93; the Standard Error value is 225,15, and the MAPE (Mean Absolute Percent Error) value is 8,263%.

Table 2: Forecasting Error Test Results

Method	Accuracy Value		
	MAD	MSE	MAPE
Single Exponential Smoothing	226,76	78148,51	11,557%

Moving Average	211,63	75287,15	10,802%
Linear Regression	165,28	42242,93	8,263%

The forecast error test results show the MAD (Mean Absolute Deviation), MSE (Mean Squared Error), and MAPE (Mean Absolute Percentage Error) values for each forecasting method used in this research. Based on Table 2, which presents the results of forecasting error tests on historical demand data for the 2024 period, it can be seen that the Linear Regression method has the lowest error percentage with a MAPE value of 8.263%. This percentage is below the 10% threshold, so the forecasting accuracy of the Linear Regression method is classified as very good. For comparison, the Moving Average method produces a slightly higher MAPE value, namely 10.802%, while the Single Exponential Smoothing method has the highest MAPE value of 11.557%. These results show that the Linear Regression method is the most reliable and accurate among the three tested methods for predicting demand. The superior performance of this method can be attributed to its ability to establish transparent relationships between variables, making it more effective in dealing with random and fluctuating demand patterns seen in the data. Therefore, the Linear Regression method is recommended as the most suitable approach for forecasting demand in the future period because this method minimizes forecasting errors and provides a solid basis for operational and strategic decision-making in supply chain management.

5. Conclusion

This research succeeded in showing novelty in selecting a demand forecasting method using comparative analysis between Single Exponential Smoothing, Moving Average, and Linear Regression. The research results confirm that the Linear Regression method has the highest level of accuracy with a MAPE value of 8.263%, below the 10% threshold. This advantage shows that the Linear Regression method is more effective in capturing the pattern of relationships between variables, even when the data has a random pattern that is difficult to predict. This finding significantly contributes to supply chain management, especially wheat flour-based products like Sajiku seasoned flour. With the ability to minimize the level of forecasting error, the Linear Regression method can be relied on to support better strategic decision-making in production planning, inventory management, and optimally meeting market demand. This research provides new insights for the wheat flour-based processed food industry in improving operational efficiency and customer satisfaction. Thus, this research opens up opportunities for broader implementation in the context of other products with similar demand characteristics, as well as becoming a reference for developing more innovative forecasting methods in the future.

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