Seasonal Pattern Analysis In Bolu House Sales Using Seasonal Adjustment Method

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Abstract

Rumah Bolu is a business engaged in the sale of sponge cakes located on Jalan Perumahan Duta Mas 9, Sei Kamah II, Kec. Sei Dadap, Asahan Regency, North Sumatra 21263. The problems faced by Rumah Bolu include if the stock decreases, Rumah Bolu risks losing sales and customer trust, while if the stock is excessive but sales are low it can cause wasteful costs, decreased product quality and financial losses that hinder maximum profits. During certain seasons such as weekends or big celebrations, the demand for sponge cakes can increase drastically which risks causing shortages of raw material stock and delays in marketing. Conversely, on Monday to Friday, sales tend to decrease which can result in stock piling up and increase the risk of loss. With the need for a forecasting system, Rumah Bolu can adjust sales based on seasonal demand patterns so as to avoid the risk of shortages or excess stock, optimize operational costs and increase profits to the maximum. To predict the sale of sponge cake, a forecasting method is applied, namely the Seasonal Adjustment method, which is used when the time series data pattern obtained has a seasonal pattern. The seasonal pattern is a fairly unique sales pattern because it can be seen when there is a certain increase in a certain season. The purpose of this study is to design a sponge cake stock forecasting application with the Seasonal Adjustment method and to apply a forecasting method to predict the stock of sponge cakes at Rumah Bolu using PHP and its MySQL database. The research method used in this study is a quantitative research method. The results of the Seasonal Adjustment calculation prediction on banana sponge cakes for the January 2025 period were 424 with a MAPE of 5.53%. Then the results of the Seasonal Adjustment calculation prediction on pandan sponge cakes for the January 2025 period were 73.67 with a MAPE of 3.84% and the results of the Seasonal Adjustment calculation prediction on birthday sponge cakes for the January 2025 period were 142.67 with a MAPE of 3.03%.

Keywords: Seasonal Adjustmen; Rumah Bolu; Sponge Cake Sale

1. INTRODUCTION

The development of technology continues to progress rapidly changing various aspects of human life, ranging from communication, transportation, to increasingly sophisticated artificial intelligence [1]. Innovations in technology not only increase efficiency and productivity but also open up new opportunities in various sectors such as education, health and industry [2]. In today's business world, information technology plays a very important role in data collection, analysis and management [3]. With rapid advances in technology, companies now have easier access to the information they need to improve their business strategies [4]. One example of the application of information technology in business is in the field of sales data analysis, which allows entrepreneurs to understand the patterns and trends that exist in transactions [5]. As technology continues to evolve, new challenges arise that require adaptation and appropriate policies so that the benefits can be maximized by society [6].

Culinary is everything related to food and drink, both in terms of cooking, serving, and enjoying dishes. Culinary also includes the traditions, culture, and uniqueness of each region in preparing food [7]. In Indonesia, culinary is very diverse ranging from regional specialties such as rendang, satay, gado-gado, to traditional snacks such as klepon and bolu. Culinary can also refer to the food industry and businesses engaged in food and beverages. The development of sponge cake in Indonesia has undergone many changes over time, from traditional sponge cake such as steamed sponge cake, bika ambon, and sponge cake made with hereditary recipes, to modern variations such as rolled sponge cake with various fillings, layered sponge cake that has a soft texture and sponge cake with more diverse flavor creations. Along with the times, contemporary sponge cake trends began to emerge such as artist sponge cake popularized by celebrities, sponge cake with abundant fillings such as chocolate lava and melted cheese, and premium sponge cake using matcha, taro, and red velvet as flavor innovations. In addition, digitalization also encourages the growth of the culinary industry, allowing many MSMEs and home-based cake shops to market sponge with more attractive packaging and more creative marketing strategies. With various innovations in taste, appearance and manufacturing techniques, sponge cake in Indonesia continues to grow and is increasingly favored by various groups, both as an everyday snack and typical souvenirs from various regions.

Sponge cake sales in Indonesia are showing a positive trend along with the increasing public interest in cake and bakery products. Based on reports from various sources, the bread and pastry category has recorded significant total sales in recent years. Of this amount, pastries dominate with a contribution of more than 50%, while sponge or cake also has a promising sales performance. One example of a sponge product that stands out is the brownie variant with various toppings that managed to reach total sales of tens of millions of rupiah in a certain period. This shows that demand for sponge products remains high amidst increasingly fierce market competition. In addition, data from the Central Statistics Agency (BPS) shows that the food and beverage sector continues to experience significant growth, including in the bread and pastry category. Public consumption of processed products such as sponge cake is increasing.

Rumah Bolu is a business engaged in selling sponge cake located on Jalan Perumahan Duta Mas 9, Sei Kamah II, Kec. Sei Dadap, Asahan Regency, North Sumatra 21263. The sponge cake stock forecasting activities at Rumah Bolu have been traditional while many other Bolu Houses have used a web-based system for sponge cake stock forecasting. The problems faced by Rumah Bolu include if the stock is reduced, Rumah Bolu risks losing sales and customer trust, while if the stock is excessive but sales are low it can cause waste of costs, decreased product quality and financial losses that hinder maximum profit. During certain seasons such as weekends or holiday celebrations, the demand for sponge cake can increase dramatically which risks causing shortages of raw materials and delays in marketing. Conversely, on Mondays to Fridays, sales tend to decline which can result in stock piling up and increase the risk of loss. With the need for a forecasting system, Rumah Bolu can adjust sales based on seasonal demand patterns so as to avoid the risk of shortage or excess stock, optimize operational costs and increase profits to the maximum.

Forecasting is a method of quantitatively predicting events that will occur in some future period, based on interrelated and relevant historical data that has occurred in the past [8]. Forecasting is an important technique to predict future business events through previously summarized data sets [9].

Seasonal adjustment is used when the time series data pattern obtained has a seasonal pattern [10]. Seasonal pattern is a unique sales pattern because it can be seen when there is a certain increase in a certain season [11]. By looking at the increase in sales in a particular season, that is the reason for the need to use the seasonal adjustment method [12]. The seasonal adjustment method is carried out to predict if there is a seasonal component in a time series data, which is the reason for the need for the seasonal adjustment method [13].

There are two commonly used forecast error calculations, namely mean absolute deviation (MAD) and mean squared error (MSE) [14]. According to Sanders, demand contains a random component that can cause actual results not to match forecasts. Thus, taking into account the accuracy of forecasting is an important aspect of forecasting [15]. The error rate of the forecast is used to determine whether the forecasting method used is still feasible or not. As long as the error value is still within the historical error estimate, the company can still use the forecasting method.

Based on the problems that occur at Rumah Bolu, this research will design an information system in the form of a web-based application program that can predict sponge cake stock based on previous sales history. By looking at previous sales, it helps the owner in making decisions, whether or not to increase sponge cake stock.

Previous research on sponge cake sales forecasting has generally focused on larger business scales or employed different methods. However, there is a lack of specific studies on forecasting for micro, small, and medium enterprises (MSMEs) like Rumah Bolu, which still relies on manual recording and traditional estimation. The identified research gap is the absence of a computerized forecasting system specifically designed to analyze seasonal sales patterns and address the issues of stock shortages or excess in small-scale cake businesses. Therefore, this study aims to fill that gap by developing a web-based stock forecasting application using the Seasonal Adjustment method, which is proven effective for data with seasonal patterns, thereby providing a practical and accurate solution for Rumah Bolu to optimize its inventory and prevent financial losses.

Several previous studies have applied different forecasting methods in the context of product sales and industrial applications. For instance, Putri & Azizah [3] compared Moving Average and Exponential Smoothing methods for paper production demand, Dzulfikar et al. [4] developed a web-based application for stock prediction in a printing company, and Tamtama & Riantisari [5] analyzed forecasting methods such as Moving Average and Exponential Smoothing in the automotive sector. These studies highlight the effectiveness of forecasting methods in improving prediction accuracy, but they mainly focus on large-scale industries or specific services.

The research gap lies in the limited studies that specifically explore the application of the Seasonal Adjustment method for micro, small, and medium enterprises (MSMEs) in the traditional culinary sector, such as sponge cake sales. Most prior works focus on long-term demand patterns, while in culinary MSMEs, demand patterns are strongly influenced by seasons, weekends, and major holidays. Therefore, this study focuses on developing a web-based forecasting system using the Seasonal Adjustment method at Rumah Bolu. This approach is expected to provide practical contributions for MSMEs by offering more accurate prediction systems, while also enriching the literature on forecasting applications in small-scale culinary businesses.

2. RESEARCH METHOD

The research method used is a quantitative method with a structured waterfall approach. This approach was chosen because it allows each research stage to be carried out systematically and sequentially, the following are the stages of this research:

2.1 Problem Identification

This initial stage focuses on collecting initial data through observation and interviews with the owner of Rumah Bolu. This helped identify the main problem, which is the business's inability to accurately predict stock, often leading to product shortages or surpluses.

2.2 Data Collection

Sales data were obtained from monthly transaction records covering January–December 2023.

2.3 Data Preprocessing

Cleaning missing values and duplicate entries to prepare data for analysis.

2.4 Application of Seasonal Adjustment Method

Conducted by calculating trend, seasonal variation, and random components to generate demand forecasts.

2.5 System Analysis and Literature Review

This stage aims to analyze historical sales data patterns and determine the most suitable method. The sponge cake sales data shows a significant seasonal pattern, with an increase in demand on weekends or during certain celebrations, and a decrease on weekdays. Therefore, the Seasonal Adjustment forecasting method was chosen because it is very effective for data with seasonal patterns. This method works by adjusting time series data to eliminate seasonal fluctuations and then making a forecast. Forecasting accuracy is evaluated using the Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD), and Mean Squared Error (MSE).

2.6 System Design

This stage involves designing a web-based system architecture. The system was designed using a Use Case Diagram to model the interaction between users (admin, owner) and the system. Interface and database design were also carried out using PHP and MySQL.

2.7 System Development

In this stage, the system is built according to the design that has been created. Implementation includes developing program code using PHP and a MySQL database. Within this code, the Seasonal Adjustment algorithm is applied to process historical sales data and generate stock predictions for the upcoming period [16].

2.8 Testing and Evaluation

After the system is built, it is tested using the Black-Box Testing method to ensure all functions are working correctly. The forecasting results are evaluated by comparing the predicted values with actual data and calculating the error rate using MAPE [17].

2.9 Seasonal Adjustment Method

The Seasonal Adjustment method has been widely applied in time series analysis for data influenced by seasonal factors. According to Makridakis et al. (1998), this method is effective in eliminating seasonal components to better reveal long-term trends. Sari et al. (2019) demonstrated that Seasonal Adjustment improves forecasting accuracy for seasonal food products. Similarly, Rahmawati et al. (2020) applied this method to retail sales data and found reduced error rates compared to simple forecasting techniques. Based on these findings, the Seasonal Adjustment method is considered suitable for Rumah Bolu's sales data, which are strongly affected by seasons, weekends, and holidays.

3. RESULT AND DISCUSSION

3.1 Analysis Data

Before designing a system, first analyze the data obtained. The data used is banana sponge sales data from January 2023 to December 2023 which can be seen in table 1.

Table 1. Banana Cake Sales in 2023

No	Period (Month)	Initial Stock	Stock+Remaining	Sales	Remaining
1	Jan-23	430	430	420	10
2	Feb-23	470	480	470	10
3	Mar-23	315	325	325	0
4	Apr-23	690	690	687	3
5	May-23	270	273	266	7
6	Jun-23	250	257	255	2
7	Jul-23	250	252	245	7
8	Aug-23	450	457	450	7
9	Sep-23	455	462	458	4
10	Oct-23	371	375	375	0
11	Nov-23	650	650	646	4
12	Dec-23	790	794	789	5

3.2 Seasonal Adjustment Method

Seasonal Average is the average value of data grouped based on the same seasonal period, for example the same month in several years.

$$Seasonal\ Average_a = \frac{(Y_{a,t1} + Y_{a,t2} + \ldots + Y_{a,tn})}{n} \qquad (1)$$

So:

$$Seasonal\ Average\ \text{January} = \frac{(\text{Jan } 2023\ +\ \text{Jan } 2024\ +\ \text{Jan } 2025\ )}{3}$$

$$\text{January } 2023 = \frac{(420\ +\ 430 + 422)}{3} = 424$$

$$Seasonal\ Average\ \text{February} = \frac{(\text{Feb } 2023\ +\ \text{Feb } 2024\ +\ \text{Feb } 2025\ )}{3}$$

$$\text{February } 2023 = \frac{(470\ +\ 490 + 312)}{3} = 424\ \text{untill period 28.}$$

Centered Mean Calculation

$$Centered\ Mean = \frac{Seasonal\ Average}{n} \qquad (2)$$

$$Centered\ Mean = \frac{(\text{Jan } 2023\ + \cdots +\ \text{Des } 2023 +\ \text{Jan } 2024 + \cdots + \text{Apr } 2025)}{28} = 435,71$$

Seasonal Index Calculation

$$Seasonal\ Index_i = \frac{Seasonal\ Average_i}{Centered\ Mean} \qquad (3)$$

So

$$Seasonal\ Index\ \text{January} = \frac{420}{435,71} = 0,97\ until\ period\ 28$$

Forecasting Seasonal Adjustment Forecast

$$Forecast_i = Seasonal\ Index_i \text{ x } Centered\ Mean \qquad (4)$$

So:
January 2023 = 0,97 x 435,71 = 424
February 2023 = 0,97 x 435,71 = 424 and until to period 28.

The calculation of forecasting error using Mean Absolute Deviation (MAD) and Mean Absolute Percentage Error (MAPE) is as follows:

$$MAD = \frac{\sum |Yt - Ft|}{n} = \frac{646}{28} = 23,071$$

$$MAPE = \frac{\sum |Yt - Ft|(100)}{Yt} = \frac{154,83\%}{28} = 5,53$$

3.3 Forecasting Result

The results of the forecast using the Seasonal Adjustment method were compared with actual data to evaluate accuracy. Accuracy testing was carried out using the Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD), and Mean Squared Error (MSE) indicators. The results are as MAPE Value: 5,53%, MAD Value: 23,071 units and MSE Value: 1431,90 units. A MAPE value of 5,53% indicates that the forecasting error rate is relatively low and acceptable. This proves that the Seasonal Adjustment method is effective for predicting sponge cake sales at Rumah Bolu, which has a seasonal sales pattern. The web application developed is able to automatically process historical data and display prediction results in the form of graphs and tables, allowing the owner to make more precise decisions regarding stock quantities. Forecasting results can be seen in table 1 below.

Table 2. Forecast Result

Period	Calculation Seasonal Adjusment With Bolu Pisang								
	Sales	Seasonal Average	Seasonal Index	Forecast	Error	Abs Erorr	Erorr^2	E/P	APE (%)
Jan-23	420	424,00	0,973	424,00	4,00	4,00	16,00	0,0095	0,95
Feb-23	470	424,00	0,973	424,00	-46,00	46,00	2116,00	0,0979	9,79
Mar-23	325	347,67	0,798	347,67	22,67	22,67	513,78	0,0697	6,97
Apr-23	687	599,67	1,376	599,67	-87,33	87,33	7627,11	0,1271	12,71
May-23	266	263,00	0,604	263,00	-3,00	3,00	9,00	0,0113	1,13

Jun-23	255	252,50	0,580	252,50	-2,50	2,50	6,25	0,0098	0,98
Jul-23	245	242,50	0,557	242,50	-2,50	2,50	6,25	0,0102	1,02
Aug-23	450	420,00	0,964	420,00	-30,00	30,00	900,00	0,0667	6,67
Sep-23	458	451,00	1,035	451,00	-7,00	7,00	49,00	0,0153	1,53
Oct-23	375	350,00	0,803	350,00	-25,00	25,00	625,00	0,0667	6,67
Nov-23	646	640,50	1,470	640,50	-5,50	5,50	30,25	0,0085	0,85
Dec-23	789	787,50	1,807	787,50	-1,50	1,50	2,25	0,0019	0,19
Jan-24	430	424,00	0,973	424,00	-6,00	6,00	36,00	0,0140	1,40
Feb-24	490	424,00	0,973	424,00	-66,00	66,00	4356,00	0,1347	13,47
Mar-24	330	347,67	0,798	347,67	17,67	17,67	312,11	0,0535	5,35
Apr-24	600	599,67	1,376	599,67	-0,33	0,33	0,11	0,0006	0,056
May-24	260	263,00	0,604	263,00	3,00	3,00	9,00	0,0115	1,15
Jun-24	250	252,50	0,580	252,50	2,50	2,50	6,25	0,0100	1,00
Jul-24	240	242,50	0,557	242,50	2,50	2,50	6,25	0,0104	1,04
Aug-24	390	420,00	0,964	420,00	30,00	30,00	900,00	0,0769	7,69
Sep-24	444	451,00	1,035	451,00	7,00	7,00	49,00	0,0158	1,58
Oct-24	325	350,00	0,803	350,00	25,00	25,00	625,00	0,0769	7,69
Nov-24	635	640,50	1,470	640,50	5,50	5,50	30,25	0,0087	0,87
Dec-24	786	787,50	1,807	787,50	1,50	1,50	2,25	0,0019	0,19
Jan-25	422	424,00	0,973	424,00	2,00	2,00	4,00	0,0047	0,47
Feb-25	312	424,00	0,973	424,00	112,00	112,00	12544,00	0,3590	35,90
Mar-25	388	347,67	0,798	347,67	-40,33	40,33	1626,78	0,1040	10,40
Apr-25	512	599,67	1,376	599,67	87,67	87,67	7685,44	0,1712	17,12
Centered Mean	435,71								
Count		12200,00	28,00			646,00	40093,33		154,83
MAD						23,071			
MSE							1431,90		
MAPE									5,53

Based on Table 2, the results of the banana sponge cake sales forecast using the Seasonal Adjustment method are detailed. The forecast covers the period from January 2023 to April 2025. The accuracy of this method is considered good, with a very low Mean Absolute Percentage Error (MAPE) of 5.53%. In addition, other error metrics calculated include a Mean Absolute Deviation (MAD) of 23.071 units and a Mean Squared Error (MSE) of 1431.90 units. The forecasting data indicates that this method is capable of predicting future sales, which will help the owner of Rumah Bolu manage their inventory more efficiently.

3.5 Design System

The system design uses a use case diagram so that the system depiction is easier [18]. The following is a design of a forecasting system using the seasonal adjustment method. The system design is presented in Figure 1
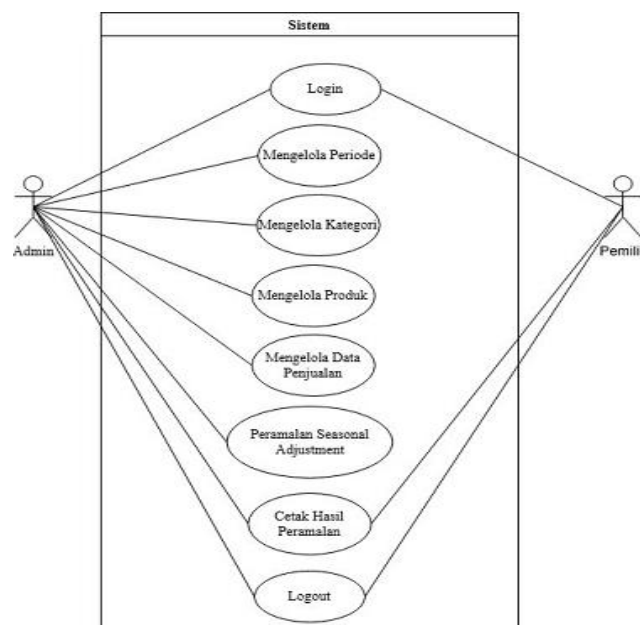

Figure 1. Design System

Figure 1 explained the proposed system design is a web application that allows two types of users, namely Admin and Owner, to interact with various system functions. Both have access to login and logout [19]. Admin has a broader role, where he can manage periods, categories, and products. In addition, Admin can also manage sales data, perform forecasting using the Seasonal Adjustment method, and print forecasting results. On the other hand, Owner has access to the same functions, but perhaps with different limitations, namely to view forecasting results and print them. This design shows a clear workflow between users and the system to support the stock forecasting process [20].

Based on the analysis and system implementation, the application of the Seasonal Adjustment method proved effective for forecasting sponge cake stock at Rumah Bolu. Through a series of integrated steps within the web-based application, we successfully identified seasonal sales patterns, such as increased demand on weekends or holidays and decreased demand on weekdays. Using historical data, the system automatically calculates seasonal averages, seasonal indices, and forecast values, which are then evaluated using error metrics such as MAPE. The high level of accuracy, as shown by the low MAPE value, confirms that this method is highly suitable for MSMEs like Rumah Bolu, which face seasonal sales fluctuations. Consequently, the owner can make more informed decisions regarding production quantities, avoid the risks of excess or insufficient stock, and ultimately optimize profits.

3.6 Implementation System

3.6.1 Main Page

Figure 2 illustrates the Main Page of the developed forecasting system. This page provides access to the main menus, including sales data management, forecasting processes using the Seasonal Adjustment method, and features to display forecasting results in both tabular and graphical formats. The user interface is designed to be simple and intuitive, enabling both the owner and admin to efficiently manage data and interpret forecasting results.

Figure 2. Main Page

3.6.2 Forecast Result Page

Figure 3 presents the Forecast Result Page, which displays the output generated from the Seasonal Adjustment forecasting process. The results are shown in tabular form, including actual values, predicted values, and the corresponding error or deviation. This view allows users to easily compare historical data with forecasting results, providing a solid foundation for decision-making in inventory planning and sales strategies.

Figure 3. Forecast Result Page

3.6.3 Forecast Graph

Figure 4 illustrates the Forecast Graph generated using the Seasonal Adjustment method. The graph presents a visual comparison between actual data and predicted results, making it easier to observe overall trends and seasonal effects. Through this graphical representation, users can better interpret the differences between historical and forecasted data, as well as monitor the accuracy of the applied model.
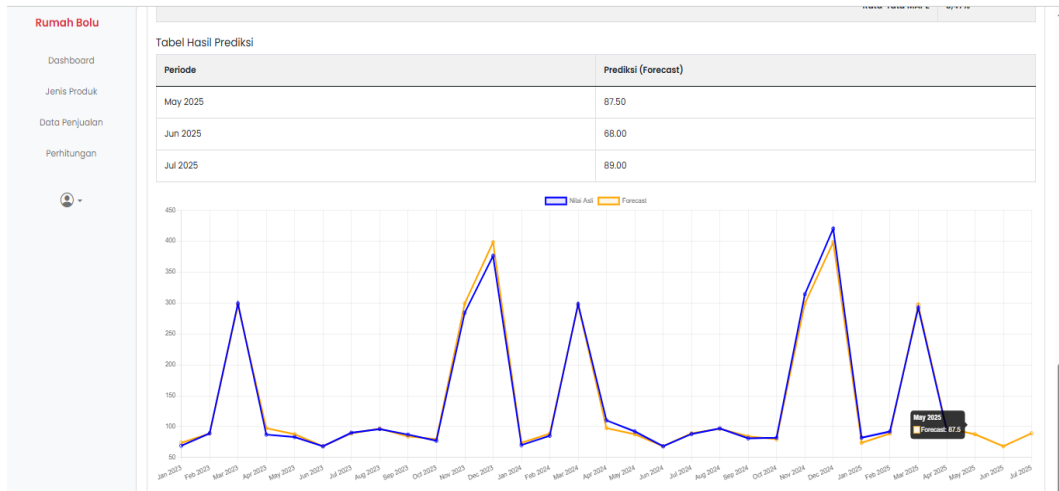

Figure 4. Forecast Graph

4. CONCLUSION

Based on the research results and implementation system, it can be concluded that the design of a cake stock forecasting application using a real-time method. Increased sales efficiency can be achieved by utilizing the prediction results from the Seasonal Adjustment method, which is effective in identifying seasonal patterns in cake sales data. By understanding this seasonality, the system is able to produce more accurate stock predictions. The implementation of this forecasting method in a PHP and MySQL-based application has proven efficient in processing historical sales data and providing future stock estimates. This technology accelerates data management and displays prediction results in real-time. Increased sales efficiency can be achieved by utilizing the prediction results from the Seasonal Adjustment method. By knowing the optimal production quantity for the next period, Rumah Bolu can avoid excess or shortage of stock, which ultimately makes operations more efficient and minimizes potential losses. The Seasonal Adjustment prediction calculation for banana cake in January 2025 is 424 with a MAPE of 5.53%. The Seasonal Adjustment prediction results for pandan cake for January 2025 are 73.67 with a MAPE of 3.84%, and the Seasonal Adjustment prediction results for birthday cake for January 2025 are 142.67 with a MAPE of 3.03%.

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