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Implementation of Seasonal ARIMA (SARIMA) for Sales Prediction of Pet Food Products

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A B S T R A C T

The rapid growth of pet ownership in Indonesia has driven a steady increase in demand for pet food products, which typically follows a recurring seasonal pattern across the year. Abadi Petshop, a local pet supply store, has so far relied on manual recording and the owner's intuition to estimate future sales, an approach that does not systematically account for historical sales patterns and frequently leads to inaccurate stock planning, resulting in either overstock or stockouts. This study aims to design and implement a web-based sales prediction system for pet food products using the Seasonal Autoregressive Integrated Moving Average (SARIMA) method, applied to monthly sales data of a Whiskas cat food product collected from January 2023 to December 2024 (24 observations). Non-seasonal differencing (d = 1) and seasonal differencing (D = 1, s = 12) were applied to achieve stationarity, and the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) plots were used to identify the model order, resulting in a SARIMA(1,1,1)(1,1,0)12 model with parameters $\varphi = 0.6$, $\Phi = 0.3$, and $\theta = 0.4$. The system was developed using the Laravel framework with a MySQL database, following the Unified Software Development Process (USDP), and functional black-box testing confirmed that all core features — including login, sales data input, prediction processing, forecast visualization, and result export — operated successfully. The resulting forecast for the twelve months following the training period projected a gradual upward trend, starting at 140.20 kg in the first month and reaching 175.50 kg by the twelfth month, consistent with the increasing trend and annual seasonal pattern observed in the historical data. These findings indicate that the SARIMA method is capable of automatically modeling trend and seasonal components in pet food sales data and can support Abadi Petshop in making more accurate, data-driven decisions regarding inventory planning and sales strategy.

INTRODUCTION

The rapid development of information and communication technology in the digital era has significantly affected economic and trade activities. The use of the internet enables transactions to take place quickly, efficiently, and without geographical boundaries, encouraging the transformation of conventional business models into digital-based businesses such as electronic commerce (e-commerce) [1,2]. E-commerce in Indonesia has grown rapidly along with the increasing number of internet users and the adoption of digital technology; however, large marketplace platforms such as Tokopedia and Shopee dominate the digital market, creating challenges for micro, small, and medium enterprises (MSMEs) in terms of pricing competition, promotion, and data-driven sales management [3,4].

Demand for pet food products is recurring and follows a particular seasonal pattern, which requires proper stock management to avoid both excess and shortage of inventory. Improper stock management can lead to business losses, such as expired products due to overstock or lost sales opportunities when stock runs out while demand increases. One MSME sector that has experienced significant growth is the petshop business, as the rising number of households keeping

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pets has directly increased the demand for pet food products. This recurring and seasonal demand pattern means that proper inventory management is essential to avoid both surplus and shortage of stock [5,6].

A sales prediction system is used to estimate the number of sales in a future period based on available historical data, working by analyzing past sales patterns to find relationships that can serve as the basis for future predictions. In modern business, sales prediction plays an important role in determining marketing strategy, managing inventory, organizing product distribution, and planning operational needs more efficiently. However, most local petshops still rely on manual recording and the intuition of the business owner to estimate sales volume, an approach considered less effective because it does not systematically take historical sales patterns into account, which often results in errors in stock planning and consequent business losses [7,8,9].

Therefore, a sales prediction system capable of analyzing historical data objectively and systematically is required. One widely used approach in sales forecasting research is the Seasonal Autoregressive Integrated Moving Average (SARIMA) method. SARIMA is an extension of the ARIMA method specifically designed for time series data that contain seasonal patterns. This method works by modeling the relationship between current sales data and data from previous periods, while also capturing recurring seasonal patterns within specific time intervals. Demonstrated that the SARIMA method is able to produce accurate forecasting results for sales data with annual or monthly seasonal patterns, and that SARIMA outperforms conventional ARIMA when the data contains a strong seasonal component [10,11].

This research focuses on the development of a web-based sales prediction system using the Laravel framework and a MySQL database. Laravel was chosen for its modular structure, strong security, and ease of feature management and development, while MySQL was selected because it is open source, stable, and widely used in web application development. The system was designed using a structured software development approach, adopting the System Development Life Cycle (SDLC) model so that the analysis, design, implementation, and testing processes could be carried out systematically. Through this research, it is expected that a sales prediction system can be produced that not only automates the forecasting process for pet food sales at Abadi Petshop but also supports more accurate, data-driven decision-making in inventory planning and sales strategy, thereby strengthening the competitiveness of local MSMEs in the era of digital transformation.

METHOD

Research Approach

This research adopts a Research and Development (R&D) approach, aimed at producing a functional product in the form of a web-based sales prediction system using the SARIMA method. The R&D approach was chosen because this research does not only focus on theoretical analysis but also produces a real, usable product for a pet supply business. According to Sugiyono (2020), research and development is a research method used to produce a particular product and test the effectiveness of that product. The research also adopts elements of a descriptive quantitative approach, in which historical sales data is processed using the SARIMA method and analyzed to identify trend and seasonal patterns that serve as the basis for forecasting. A qualitative approach was used during the requirements analysis stage, to understand the functional needs of the local petshop business, while a quantitative approach was used during model construction and the evaluation of forecasting results, so that the research outcome is comprehensive, covering both technical and practical aspects.

Data Collection

The data used in this research were collected through three main techniques: literature study, observation, and interviews. The literature study was conducted by reviewing various reference materials, including books, archives, scientific journals, and relevant articles related to machine learning, time series forecasting using the Seasonal Autoregressive Integrated Moving Average (SARIMA) method, and supporting programming technologies. These references served as the theoretical foundation for problem identification and system development.

Observation was carried out through direct visits to Abadi Petshop to obtain primary data and verify the consistency of the available secondary data. This process enabled the researchers to gain a better understanding of the operational conditions and sales activities within the business environment.

In addition, interviews were conducted with relevant personnel at Abadi Petshop to validate the accuracy and reliability of the sales data collected. The interview process also provided additional insights regarding sales patterns and business practices, which supported the analysis and forecasting stages of the research.

SARIMA Process Analysis

The data used in this research consists of monthly sales data for a pet food product at Abadi Petshop, namely Whiskas cat food. Data were collected over the period from January 2023 to December 2024, amounting to 24 observations in total, and were used as training data to build the prediction model with the Seasonal Autoregressive Integrated Moving Average (SARIMA) method. The Whiskas product was selected because it exhibits a relatively stable sales volume with a clear seasonal pattern, particularly an increase in sales toward the end of the year due to promotions and major holiday periods.

RESULTS AND DISCUSSION

System Testing

Testing was conducted to ensure that the designed SARIMA-based system functions properly in accordance with its intended objectives. This process included testing the user interface across the system's various pages using a black-box testing approach, summarized in Table 1.

Table 1. System Testing Results

No	Test Scenario	Test Step	Expected Result	Status
1	System Login	Admin enters username and password	System displays the dashboard	Success
2	Sales Data Input	Admin fills in the month and sales volume form	Data is saved in the database	Success
3	Prediction Process	Admin clicks the “Predict” button	System processes the SARIMA model	Success
4	Chart Display	System displays the forecast chart	Actual vs. forecast chart is shown	Success
5	Result Export	Admin clicks export to PDF/Excel	File is successfully downloaded	Success

The testing results in Table 1 indicate that all of the system's core functions authentication, data input, model processing, forecast visualization, and result export operated successfully according to the expected outcomes.

Sales Data Analysis

The dataset used in this study consisted of monthly sales records of Whiskas cat food products at Abadi Petshop from January 2023 to December 2024, totaling 24 observations. Analysis of the historical sales data showed a gradual upward trend accompanied by an annual seasonal pattern. Sales tended to increase toward the end of each year, particularly during periods associated with promotional activities and increased consumer demand. These characteristics indicate that the dataset contains both trend and seasonal components, making it suitable for forecasting using the Seasonal Autoregressive Integrated Moving Average (SARIMA) method.

Table 2. Monthly Sales Data of Whiskas Cat Food

No	Month	Year	Sales (kg)
1	Jan	2023	120
2	Feb	2023	125
3	Mar	2023	130
4	Apr	2023	128
5	May	2023	135
6	Jun	2023	140
7	Jul	2023	142
8	Aug	2023	145
9	Sep	2023	143

10	Oct	2023	148
11	Nov	2023	150
12	Dec	2023	155
13	Jan	2024	130
14	Feb	2024	135
15	Mar	2024	140
16	Apr	2024	138
17	May	2024	145
18	Jun	2024	150
19	Jul	2024	152
20	Aug	2024	155
21	Sep	2024	153
22	Oct	2024	158
23	Nov	2024	160
24	Dec	2024	165

Based on Table 1, sales increased from 120 kg in January 2023 to 165 kg in December 2024. The recurring increase observed at similar periods each year suggests the existence of a seasonal cycle with a period of 12 months.

Stationarity Analysis

Before developing the forecasting model, the historical sales data were examined to ensure stationarity. The original dataset exhibited an increasing trend and a recurring annual seasonal pattern, indicating that the data were not stationary and therefore unsuitable for direct SARIMA modeling. To address this issue, a first-order differencing process was applied to remove the trend component from the series. The differenced values showed fluctuations around a relatively stable mean, although seasonal effects were still visible in several periods.

To further eliminate the seasonal component, seasonal differencing with a 12-month period was performed. The results of the seasonal differencing process indicated that most values were concentrated around zero, suggesting that both trend and seasonal effects had been successfully reduced. Consequently, the transformed series was considered sufficiently stationary and appropriate for subsequent SARIMA modeling. These results confirm that the sales data contain both trend and seasonal characteristics, which justify the use of a seasonal forecasting approach.

SARIMA Model Determination dan Parameter Estimation

After the stationarity requirement was satisfied, model identification was performed using Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) analyses. Based on the observed correlation patterns, the most appropriate model was identified as SARIMA$(1,1,1)(1,1,0)_{12}$. This model consists of one non-seasonal autoregressive component, one non-seasonal differencing component, one non-seasonal moving average component, one seasonal autoregressive component, one seasonal differencing component, and a seasonal period of twelve months.

The parameter estimation process produced coefficient values of $\varphi = 0.6$, $\Phi = 0.3$, and $\theta = 0.4$. These coefficients indicate that both previous observations and seasonal observations contribute to the prediction of future sales values. Using the established model, forecasting was conducted for the period January–December 2025. The forecasting results showed a gradual increase in sales volume, beginning at 140.20 kg in January 2025 and reaching 175.50 kg in December 2025. The predicted pattern follows the historical sales behavior, reflecting both the upward trend and recurring seasonal fluctuations observed in the dataset. These findings suggest that the SARIMA model is capable of capturing the underlying characteristics of pet food sales and can provide useful information for inventory planning and decision-making at Abadi Petshop.

The selection of SARIMA$(1,1,1)(1,1,0)_{12}$ demonstrates that the sales data contain both short-term dependencies and recurring annual seasonal effects. This finding is consistent with the characteristics of retail sales data, where purchasing patterns tend to repeat during certain periods of the year. By incorporating seasonal parameters into the forecasting process, the model is capable of capturing periodic fluctuations more effectively than non-seasonal forecasting models, thereby improving its ability to represent the underlying behavior of pet food sales at Abadi Petshop.

Forecasting Results

The forecasting process using the SARIMA$(1,1,1)(1,1,0)_{12}$ model generated sales predictions for the period January to December 2025. The forecast results indicate a gradual increase in sales throughout the prediction period, starting from 140.20 kg in January 2025 and reaching 175.50 kg in December 2025. This upward trend suggests that demand for Whiskas cat food at Abadi Petshop is expected to continue growing in the upcoming year. The predicted values also exhibit a seasonal pattern similar to that observed in the historical sales data, where sales tend to increase during certain periods of the year. The consistency between the forecast pattern and historical observations indicates that the SARIMA model is capable of capturing both trend and seasonal components within the dataset. Therefore, the forecasting results can serve as a useful reference for inventory planning, stock management, and sales strategy development at Abadi Petshop.

The projected increase in sales reflects the positive growth trend observed during the training period, where product demand consistently increased from year to year. Furthermore, the forecast maintains the recurring seasonal behavior identified in the historical data, indicating that the model successfully incorporates seasonal effects into the prediction process. By providing an estimate of future demand, the forecasting system enables business owners to prepare inventory more effectively, minimize the risk of stock shortages, and reduce the possibility of overstocking. These findings demonstrate the practical value of integrating SARIMA-based forecasting into a web-based decision support system for small and medium-sized businesses.

CONCLUSION

Based on the results of the research and the implementation of the pet food sales prediction system at Abadi Petshop using the SARIMA (Seasonal ARIMA) method, several conclusions can be drawn. The SARIMA method is able to properly model pet food sales data that contains both trend and seasonal components, producing a reasonably accurate sales forecast based on the resulting model evaluation. The implementation of the SARIMA method within the sales prediction system has also improved the efficiency of sales data processing, as the forecasting process can be performed automatically without manual calculation, making it easier for Abadi Petshop to analyze its sales. In addition, the developed prediction system is able to provide sales forecast information along with stock recommendations, thereby supporting decision-making in inventory planning and sales strategy for pet food at Abadi Petshop.

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