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Main Menu Sales Forecasting at Bakso Pak Eko MSME Using the Single Exponential Smoothing Method

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Abstract: Sales volume is a critical factor influencing business sustainability, particularly for Micro, Small, and Medium Enterprises (MSMEs) operating in the perishable culinary sector. Bakso Pak Eko MSME faces persistent operational challenges in daily production planning, which currently relies on manual intuition and informal estimation, frequently resulting in inventory surpluses, ingredient spoilage, or unmet consumer demand. To address these operational inefficiencies, this study develops a responsive web-based sales forecasting system for primary menu items using the Single Exponential Smoothing (SES) method to support data-driven production scheduling. The SES method was selected due to its mathematical simplicity, low computational overhead, and proven efficacy in processing short-term historical sales records that exhibit stationary demand patterns without pronounced trend or seasonal fluctuations. The application was engineered using Python and the Streamlit framework, integrating dynamic menu catalog administration, daily transaction logging, customizable smoothing constants, automated forecasting routines, and real-time gross revenue estimation. Functional reliability was verified through Black Box Testing, while predictive performance was benchmarked using the Mean Absolute Percentage Error (MAPE) metric across three core menu items: regular meatballs, egg meatballs, and jumbo meatballs. The evaluation results demonstrate that the application operates reliably across all functional workflows without runtime anomalies. Configured with an optimal smoothing constant of $\alpha = 0.3$, the model achieved a MAPE value of 1.56%, categorizing the forecast as highly accurate with an absolute deviation of only one to two portions per menu item. Furthermore, directly translating unit portion projections into daily revenue calculations provides the enterprise owner with actionable financial transparency alongside physical preparation targets. Consequently, this system effectively bridges computational modeling and shop-floor decision-making, enabling MSME managers to streamline raw material procurement, mitigate food waste, and enhance overall operational cost-efficiency.

Keywords: Sales Forecasting; Single Exponential Smoothing; MSMEs; Streamlit; Web-Based Application.

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1. Introduction

Micro, Small, and Medium Enterprises (MSMEs) play a vital role in sustaining economic stability and driving national growth in Indonesia. This sector contributes substantially to gross domestic product and serves as a major source of employment across local communities. Despite their economic significance, many MSME owners continue to face fundamental operational and managerial constraints. Daily business processes are predominantly conducted conventionally, particularly regarding sales transaction recording and production capacity planning. Operational decision-making relies heavily on the owner's intuition, casual observation, or subjective judgment rather than rigorous quantitative data analysis. Such unscientific planning frequently leads to substantial discrepancies between market demand and actual production volumes, thereby exposing small businesses to serious operational and financial risks. This operational dilemma is evident at Bakso Pak Eko, a culinary micro-enterprise specializing in three main menu items: regular meatballs, egg meatballs, and jumbo meatballs. Direct observations and interviews with the business owner revealed that daily production volumes are determined merely by estimating remaining inventory from the preceding day. Because meatballs are perishable food items with a very short shelf life, overproduction leads directly to material degradation, food waste, and irreversible financial losses. Conversely, underestimating customer demand results in stockouts, causing missed revenue opportunities and diminished customer satisfaction. Managing perishable inventory effectively requires systematic utilization of historical sales records to mitigate daily demand uncertainties in a structured manner (Heizer *et al.*, 2020). Time-series forecasting techniques offer an effective mechanism to address demand variability in retail and culinary environments. Among available quantitative approaches, the Single Exponential Smoothing (SES) method is particularly appropriate for data series exhibiting stationary patterns without significant trends or seasonal fluctuations. The SES technique applies exponentially decreasing weights to past observations, allocating higher priority to the most recent sales data through a predetermined smoothing constant parameter. Empirical evidence from Prayitno (2022) indicates that SES yields reliable forecasting performance for relatively stable demand patterns in small enterprises. Similarly, Anwar (2023) demonstrated that implementing SES enables food vendors to maintain balanced inventory levels and avoid critical supply shortages. Furthermore, Khotimah and Rohman (2023) confirmed that computerizing the SES algorithm into web-based platforms significantly enhances computational speed and eliminates human errors associated with manual calculations.

Although previous studies have established the reliability of the Single Exponential Smoothing method, most existing implementations remain confined to theoretical algorithmic evaluations or deliver only raw numerical output of forecasted units. These systems rarely integrate production quantities with financial projections. For food micro-enterprises such as Bakso Pak Eko, obtaining unit forecasts alone provides incomplete managerial guidance unless translated into projected gross revenue. Therefore, an integrated computational platform is required to process transaction histories, calculate future menu requirements, and automatically generate corresponding financial estimations. To address this need, this study aims to design and develop a web-based sales forecasting system using the Single Exponential Smoothing (SES) method tailored to Bakso Pak Eko MSME. The application is built using Python and the Streamlit framework, providing an intuitive, responsive, and lightweight user interface suitable for non-technical users. The system integrates menu catalog administration, historical sales logging, smoothing constant parameter configuration, automated forecasting routines, and menu-based revenue calculations. Forecasting precision is evaluated using the Mean Absolute Percentage Error (MAPE) metric to verify model validity. Ultimately, this application serves as a practical decision-support tool enabling the business owner to schedule daily production volumes accurately, minimize inventory waste, and enhance overall operational efficiency.

2. Related Work

Various empirical studies have evaluated the Single Exponential Smoothing (SES) method for demand forecasting across distinct commercial domains. Rahmawati and Nugroho (2023) demonstrated that SES assists micro and small enterprises in projecting future sales volumes using historical transaction records, thereby substantially mitigating the risks of inventory surpluses and product shortages. In a related study, Saputra (2022) developed a web-based sales forecasting architecture employing the SES algorithm, which streamlined data processing workflows and automated the generation of periodic projection reports. Furthermore, Kurniawan and Hidayat (2022) validated that the SES algorithm delivers satisfactory forecasting accuracy for short-term sales series characterized by stationary patterns without significant structural shifts. In addition to single-parameter exponential smoothing, subsequent literature has investigated more sophisticated time-series and machine learning methodologies, including Holt-Winters exponential smoothing, Seasonal Autoregressive Integrated Moving Average (SARIMA), Artificial Neural Networks (ANN), and Support Vector Regression (SVR). Although these advanced computational techniques often achieve high predictive

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accuracy on volatile data, they demand substantial computational resources, extensive parameter fine-tuning, and large-scale training datasets. For small culinary enterprises such as Bakso Pak Eko, daily sales figures do not exhibit prominent seasonal cycles or long-term growth trends. Consequently, the SES algorithm was selected due to its mathematical simplicity, low processing overhead, straightforward implementation in web frameworks, and proven capability in handling stationary short-term demand series. Synthesizing findings from existing literature indicates that prior research has predominantly concentrated on algorithmic predictive accuracy and standalone forecasting computations. In contrast, the system developed in this study bridges algorithmic modeling and operational decision support. By integrating the SES forecasting engine into an interactive Python-based Streamlit web platform, this research provides an end-to-end operational solution featuring dynamic menu catalog administration, parameter adjustment, automated unit sales prediction, and direct daily revenue estimation to assist enterprise owners in production scheduling.

3. Methodology

This study employed a quantitative case study methodology conducted at Bakso Pak Eko MSME in East Jakarta, Indonesia. Empirical data were collected through direct observation, semi-structured interviews with the business owner, and internal documentation of daily sales records across the enterprise's three primary menu items: regular meatballs (*bakso biasa*), egg meatballs (*bakso telur*), and jumbo meatballs (*bakso jumbo*). Baseline operational records indicated an average daily sales volume of approximately 150 portions for regular meatballs, 50 portions for egg meatballs, and 120 portions for jumbo meatballs, generating a combined baseline of 320 portions per day. The research execution followed an engineering workflow comprising problem identification, historical sales data logging, system requirement analysis, software architectural modeling, implementation of the forecasting algorithm, system verification, and error evaluation using percentage-based predictive metrics. The forecasting engine utilizes the Single Exponential Smoothing (SES) method to project future menu requirements from historical transactions. SES was selected because daily demand at Bakso Pak Eko demonstrates a stationary pattern without pronounced seasonal cycles or steep long-term trends, making it an efficient model for short-term operational forecasting. In this implementation, the smoothing constant parameter (α) was set to 0.3 to maintain forecast stability while remaining sensitive to recent demand shifts. The standard mathematical formulation for Single Exponential Smoothing is defined as:

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

Where F_{t+1} denotes the forecasted sales volume for the subsequent operational period, α represents the smoothing parameter (α =0.3), X_t is the actual sales volume recorded at period t, and F_t represents the smoothed forecast calculated for period t. The resulting value of F_{t+1} serves as the quantitative foundation for determining raw material requirements and scheduled daily cooking volumes. System requirement engineering identified core functional specifications tailored to non-technical users, requiring the platform to manage menu catalogs, archive historical sales volumes, execute automated SES calculations, display projection summaries, and compute expected daily revenue. To facilitate intuitive user interaction, the application was engineered using the Python programming language and deployed via the Streamlit web framework, ensuring responsive data rendering and minimal computational latency. Architectural modeling was documented through Use Case Diagrams, system Flowcharts, and Class Diagrams to detail component interactions, data persistence schemes, and the step-by-step transition from historical transaction inputs to tabular visual summaries. System validation was conducted through a two-stage evaluation protocol encompassing functional verification and forecasting error assessment. Functional robustness was examined using Black Box Testing across user workflows, covering menu database management, transaction logging, smoothing parameter configuration, and automated revenue calculations. Forecasting accuracy was evaluated using the Mean Absolute Percentage Error (MAPE) metric by comparing daily projected quantities against actual sales records, expressed as:

$$MAPE = \frac{1}{n} \sum \left| \frac{X_t - F_t}{X_t} \right| \times 100\% \quad (2)$$

Where Xt represents the actual sales observation, Ft is the corresponding forecast value, and n denotes the total number of evaluation periods. The resulting MAPE percentage indicates the magnitude of forecasting deviation, where lower percentages signify higher predictive accuracy. The empirical interpretation of MAPE values follows established time-series forecasting benchmarks, as detailed in Table 1.

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Table1. MAPE Value Categories and Forecasting Accuracy Interpretation

MAPE Range	Accuracy Classification
< 10%	Highly Accurate
10% – 20%	Good Forecast
20% – 50%	Reasonable Forecast
> 50%	Inaccurate Forecast

4. Results and Discussion

4.1 Results

The sales forecasting application was implemented using the Python programming language and deployed via the Streamlit web framework. The system architecture is designed to manage historical sales transactions, execute real-time projections using the Single Exponential Smoothing (SES) algorithm with a default smoothing parameter of α =0.3, and compute projected revenue based on predefined menu pricing. The user interface provides administrative modules for updating the menu catalog and inputting daily sales figures. The operational dashboard summarizes transactional records, smoothing parameters, and projected production quantities, as illustrated in Figure 1.



Figure 1. Main Dashboard Interface of the Sales Forecasting System

Menu catalog administration allows the business owner to register item identifiers, set portion pricing, and update ingredient requirements. The operational workflow of this module enables dynamic synchronization with the forecasting engine, as displayed in Figure 2.



Figure 2. Menu Management Interface for Catalog Configuration

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Forecasting computations were executed on the three primary menu items of Bakso Pak Eko MSME: regular meatballs (*bakso biasa*), egg meatballs (*bakso telur*), and jumbo meatballs (*bakso jumbo*). Table 2 summarizes the comparative figures between actual daily sales and the forecasted portion demand generated by the system using α =0.3.

Table 2. Daily Sales Forecasting Results by Menu Item

Menu Item	Actual Sales (Portions/Day)	Forecasted Demand (Portions/Day)	Absolute Variance (Portions)
Regular Meatballs (*Bakso Biasa*)	150	148	2
Egg Meatballs (*Bakso Telur*)	50	49	1
Jumbo Meatballs (*Bakso Jumbo*)	120	118	2

The empirical results in Table 2. demonstrate that the absolute deviation between actual daily sales and predicted portion demand remains minimal, with discrepancies ranging between 1 and 2 portions per menu item. For regular meatballs, the model forecasted 148 portions against an actual volume of 150 portions. Similarly, forecasts for egg meatballs and jumbo meatballs differed from actual daily demand by only 1 portion and 2 portions, respectively. To evaluate overall forecasting precision, the Mean Absolute Percentage Error (MAPE) was computed across the aggregated daily sales volume of 320 portions (yielding an aggregate forecast of 315 portions). The quantitative evaluation is detailed in Table 3.

Table 3. Forecasting Accuracy Evaluation Using MAPE

Smoothing Parameter (α)	Average Actual Sales (Portions/Day)	Average Forecasted Sales (Portions/Day)	MAPE Value	Accuracy Category
0.30	320	315	1.56%	Highly Accurate

As presented in Table 3, applying an α value of 0.30 yielded an average daily forecast of 315 portions against an average actual volume of 320 portions, resulting in a MAPE metric of 1.56%. Based on the benchmark criteria defined in Table 1, this error rate falls well below the 10% threshold, placing the model within the "Highly Accurate" category. In parallel, comprehensive Black Box Testing was executed across all user interaction paths, including menu catalog updates, transaction data logging, smoothing constant parameter inputs, automated forecasting, and revenue projections. All tested test cases executed successfully without functional discrepancies or interface runtime errors, confirming that the system meets user functional specifications.

4.2 Discussion

The empirical findings confirm that the Single Exponential Smoothing (SES) method is highly effective for forecasting daily menu demand in micro-scale culinary enterprises. Setting the smoothing constant to α =0.3 provides an appropriate balance, assigning substantial weight to historical demand baselines while moderating short-term transactional volatility. Achieving a MAPE score of 1.56% demonstrates that the model maintains a very low error margin, verifying its suitability for time-series datasets that exhibit stationary characteristics without pronounced trend or seasonal patterns. These results corroborate earlier findings by Rahmawati and Nugroho (2023), who established that SES provides an effective, low-overhead mechanism for micro-enterprises to estimate sales requirements from historical records. Furthermore, the high predictive accuracy aligns with the conclusions of Kurniawan and Hidayat (2022), confirming that single-parameter exponential smoothing provides robust performance for short-term retail demand forecasting when underlying transactional patterns remain relatively stable. The primary operational contribution of this study lies in the functional synthesis achieved through the Streamlit web architecture. While prior literature predominantly focused on isolated algorithmic modeling or static spreadsheet calculations, the platform developed in this research couples the SES forecasting routine directly with menu pricing configurations to generate instant financial projections. This integration bridges a critical operational gap for micro-enterprises: the owner is provided not only with physical portion targets to schedule daily culinary preparation but also with estimated daily gross revenues. Consequently, the reliance on subjective daily guesswork is replaced by data-driven scheduling, effectively mitigating the dual risks of ingredient spoilage caused by overproduction and revenue loss caused by stockouts.

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5. Conclusion and Recommendations

This study successfully designed and implemented a web-based sales forecasting system using the Single Exponential Smoothing (SES) method tailored for Bakso Pak Eko MSME. Developed using Python and the Streamlit framework, the platform integrates menu catalog management, historical transaction logging, automated algorithmic forecasting, and daily revenue estimations into a unified operational workflow. Implementing the SES algorithm with a smoothing constant parameter of $\alpha=0.3$ generated demand projections closely aligned with actual sales figures across all primary menu items. Quantitative evaluation using the Mean Absolute Percentage Error (MAPE) confirmed high predictive accuracy with an error rate of 1.56%, placing the system within the "Highly Accurate" category. By converting historical transaction logs into definitive daily portion targets and projected gross revenues, the application effectively eliminates intuitive guesswork, mitigating the operational risks of food waste from overproduction and missed sales opportunities from stockouts. To enhance the generalizability and functional capabilities of the system, several directions for future research are recommended. Subsequent studies should examine broader historical datasets spanning longer operational horizons to evaluate forecasting stability across diverse operational conditions. Methodological comparisons evaluating SES against multi-parameter techniques, such as Double Exponential Smoothing, Holt-Winters, or Autoregressive Integrated Moving Average (ARIMA), are also warranted to identify optimal predictive algorithms under fluctuating demand patterns. Furthermore, future technical development should incorporate dynamic analytical dashboards for visual trend tracking and extend deployment to mobile platforms, thereby improving real-time accessibility for micro-enterprise operators.

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