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Research Article

Sales Forecasting Analysis Using Fuzzy Time Series and Simple Linear Regression Methods at Toko Ari

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Abstract:
Introduction: Forecasting, often referred to as prediction, can actually help assess conditions or predict future sales. In the business world forecasting is crucial because it can help companies plan their future operations especially when faced with sudden increases and decreases in sales and stockpiles. Especially in retail forecasting is extremely helpful in purchasing merchandise, managing inventory in the warehouse, and reducing losses due to changing customer preferences. Ari's shop, located on Jalan Raya Samu, Singapadu Kaler, Gianyar, Bali, also experiences increases and decreases in monthly sales. Therefore, it is hoped that this sales forecasting can help maintain more stable and smooth operations. Methods: This study used two methods to forecast sales: Fuzzy Time Series (FTS) and Simple Linear Regression (SLR), to predict figures from Ari's shop's monthly sales data. Both methods use the same dataset, which is Ari's Store sales data for 13 months, from January 2024 to January 2025. The forecast results are then compared using the Mean Absolute Percentage Error (MAPE), which measures the model's accuracy in predicting results. Results: Based on the sales forecasts performed, both models produced fairly accurate predictions due to their low MAPE values, below 10%. Of the two methods, Simple Linear Regression provided more accurate results with a MAPE of 3.57%. Meanwhile, the Fuzzy Time Series method produced a MAPE of 5.53%. This difference in values indicates that the linear regression model is more appropriate for Ari's Store sales data, especially since the data pattern tends to follow a linear trend.

Keyword: Sales Forecasting, Fuzzy Time Series, Simple Linear Regression, MAPE, Retail Business.

1. Introduction:

Forecasting also known as forecasting is essentially an attempt to predict future conditions by examining patterns in previously existing data. In business, this is crucial because it can help companies prepare for the future, adapt to changing market conditions, and effectively manage inventory [1], [2]. If the forecast is sufficiently accurate, companies can manage the quantity of inventory they need, which can reduce the risk of sales losses and enable them to make informed decisions [3]. Sales data is often used as a primary benchmark for assessing how well a business is performing [4]. Complete and organized sales records can also facilitate the decision-making process, especially for retail businesses with fast-moving and volatile operations [5]. For small businesses like Toko Ari on Jalan Raya Samu, Singapadu Kaler, Gianyar, Bali, month-to-month changes in sales volume are a key reason for the need for forecasting techniques that can provide sufficiently accurate predictions to prevent overstocking or understocking.

Although Toko Ari has been using a computer-based sales recording system since 2020, its ability to forecast future sales is still lacking. Based on available sales records, monthly sales were recorded in the range of IDR 369 million to IDR 464 million. This situation served as the background for this study, which attempted to compare two forecasting methods: Fuzzy Time Series (FTS) and Simple Linear Regression (SLR). It also used Mean Absolute Percentage Error (MAPE) to determine which method performed better in predicting short-term sales [6], [7].

This study has two main objectives: the first is to predict sales using Fuzzy Time Series (FTS) and Simple Linear Regression (SLR). The second is to compare the accuracy of the two methods with the Mean Absolute Percentage Error (MAPE) based on sales data at Ari's Store. This study is limited to sales data for 13 months, from January 2024 to January 2025. This study only focuses on monthly sales, excluding other sales factors such as inflation, promotions, or price changes.

Method:

Research Design

This quantitative study applies the CRISP-DM framework (Prasetyo, 2022) to ensure a systematic workflow: (1) Business Understanding, (2) Data Understanding, (3) Data Preparation, (4) Modeling, (5) Evaluation, (6) Deployment [8].

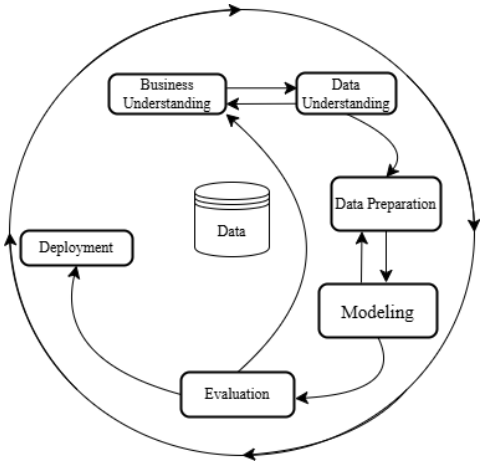


Figure 1. Research Process Framework Based on the CRISP-DM Model

The CRISP-DM approach was selected due to its systematic structure and compatibility with retail data mining applications [9]. It allows researchers to evaluate the forecasting process in a repeatable and scalable manner.

Research Location and Data Source

Research was conducted at Toko Ari, a retail store in Gianyar, Bali. The dataset consists of 13 monthly sales records (Jan 2024 – Jan 2025) collected from the store's sales information system. Data cleaning removed incomplete entries and ensured consistency [10].

Data Collection

Sales data were exported to Microsoft Excel for pre-processing and imported into RStudio and Google Colab for analysis. Outliers and non-numeric values were excluded [11].

Data Preparation

Before modeling, data underwent a series of preparation stages to ensure consistency and analytical suitability:

1. Data Cleaning – removal of duplicate or missing entries to maintain dataset integrity.
2. Data Transformation – normalization and conversion of numeric values into comparable scales.

3. Data Structuring – reformatting monthly transaction data into time-series sequences.

The cleaned dataset contained 13 valid monthly sales observations. A sample of the processed dataset is summarized below.

Table 1. Summary of Monthly Sales Data (January 2024 – January 2025)

Month	Year	Sales Value (IDR)
January	2024	399.615.400
February	2024	400.467.400
March	2024	424.191.600
April	2024	369.274.450
May	2024	407.683.000
June	2024	390.872.500
July	2024	425.719.600
August	2024	421.822.000
September	2024	426.460.500
October	2024	453.727.300
November	2024	416.004.400
December	2024	464.167.200
January	2025	464.800.496
Total		5.464.805.846

The total sales for the 13-month period amounted to IDR 5,464,805,846, with the lowest sales in April 2024 and the highest in January 2025.

Forecasting Methods

Fuzzy Time Series (FTS)

Steps: define the universe of discourse, divide intervals (Sturges formula), construct fuzzy sets, fuzzify data, establish Fuzzy Logical Relationships (FLR and FLRG), and defuzzify for forecasting [12], [13].

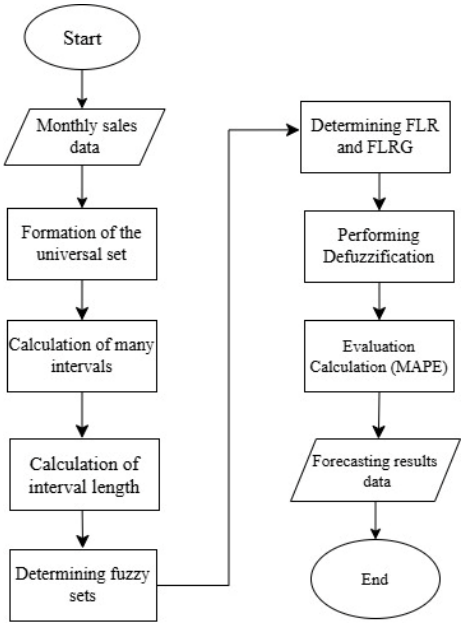


Figure 2. Flowchart of Fuzzy Time Series Forecasting Process

Simple Linear Regression (SLR)

The SLR model uses the equation

$$[\, Y = a + bX \,] \quad (1)$$

where Y is the forecasted sales and X the time period. Regression coefficients were computed using Google Colab [14], [15].

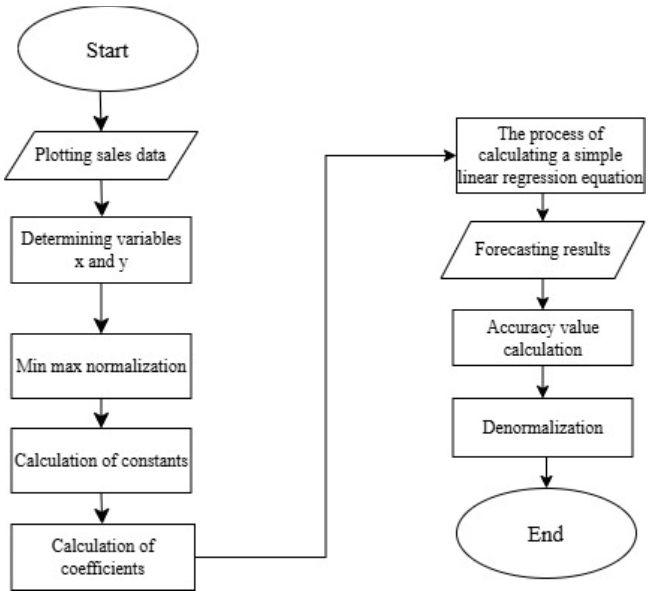


Figure 3. Flowchart of Simple Linear Regression Forecasting Process

Model Evaluation

Model accuracy was measured by Mean Absolute Percentage Error (MAPE):

$$\text{MAPE} = \sum \frac{[At - Ft]}{\frac{At}{n}} x\ 100 \quad (2)$$

where A_t is the actual value, F_t is the forecasted value, and n is the number of observations. According to industry standards, forecasting accuracy is classified as follows [16].

Table 2. MAPE Classification Criteria

MAPE Value	Interpretation
<10%	Very Accurate
10-20%	Good
20-50%	Fair
>50%	Poor

Result and Discussion:

Results

Description of Data Processing Results

The sales dataset from Toko Ari underwent cleaning and validation to ensure accuracy before modeling. Out of 13 months of transaction data, all entries were valid and contained no missing values. Data consistency was verified using Microsoft Excel, while descriptive analysis was performed in RStudio to examine sales variation patterns [17]. The total sales over the period of January 2024 to January 2025 amounted to IDR 5,464,805,846, with the lowest sales

recorded in April 2024 (IDR 369,274,450) and the highest in January 2025 (IDR 464,800,496). These fluctuations reflect typical variations in retail purchasing behavior influenced by seasonal and economic factors.

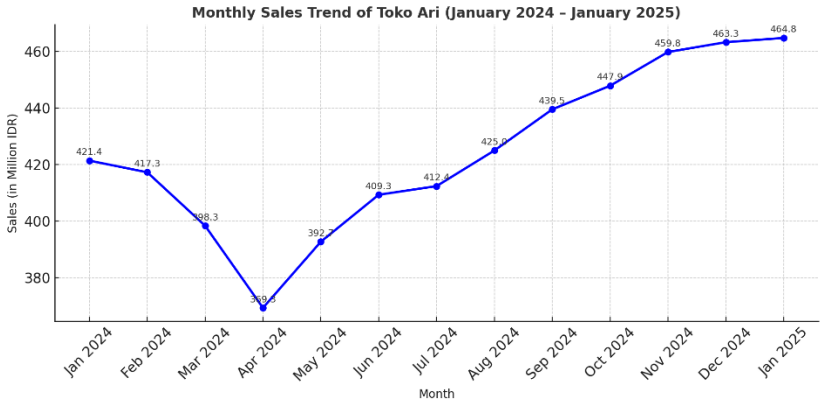


Figure 4. Monthly Sales Trend of Toko Ari (January 2024 – January 2025)

As illustrated in **Figure 4**, the sales trend shows a moderate upward trajectory, with slight dips in the second quarter of 2024 and significant increases toward the end of the year. This pattern aligns with consumer behavior in Indonesia, where retail sales often peak during holiday seasons [18].

Visualization of Forecasting Results

Both forecasting methods—Fuzzy Time Series (FTS) and Simple Linear Regression (SLR)—were applied to the same dataset for comparative analysis. The outputs were generated using RStudio for FTS and Google Colab for SLR, ensuring computational consistency.

Table 3. Forecasting Accuracy Comparison Based on MAPE

Method MAPE (%)	Accuracy	Classification
Fuzzy Time Series	5.53	Very Accurate
Simple Linear Regression	3.57	Very Accurate

The results in **Table 3** demonstrate that both models achieved MAPE values below 10%, indicating very high accuracy in forecasting sales performance. Among them, SLR provided better precision with a MAPE of 3.57%, compared to FTS at 5.53%.

Interpretation of the Results

The smaller MAPE obtained from the SLR model indicates that Toko Ari's sales data exhibit a strong linear pattern with gradual month-to-month increases [19]. In contrast, the FTS method's slightly higher error rate may be attributed to sensitivity in interval determination during the fuzzification process [20]. The performance difference between the two models can be explained by their methodological nature. SLR relies on deterministic relationships between time and sales, making it ideal for datasets showing stable growth. FTS, however, interprets variations through fuzzy logic, which is advantageous when dealing with uncertainty but may yield minor deviations in stable datasets [21].

Significant Findings

The analysis yields several key findings:

1) Both FTS and SLR are suitable for short-term forecasting.
2) SLR showed better precision with MAPE = 3.57%.
3) Sales rise toward year-end due to holiday demand.
4) Forecasting helps reduce stock imbalances and supports strategic planning [22].

Discussion

Interpretation and Evaluation

The SLR method outperformed FTS because Toko Ari's sales follow a linear trend. FTS is slightly less accurate due to its dependence on interval grouping.

Relation to Previous Studies

Results align with studies showing SLR accuracy for linear data and FTS flexibility for non-linear data. This supports that model choice depends on data structure.

Practical Implications

Using SLR forecasts helps Toko Ari manage inventory efficiently, reduce loss from overstock, and enhance customer satisfaction.

Limitations

The dataset spans only 13 months and excludes external factors like promotion or competitors. Only two methods were tested [23].

Recommendations

Future research should analyze multi-year data and add methods such as ARIMA or hybrid models. Incorporating external variables could improve forecast robustness.

4. Conclusion:

Both Fuzzy Time Series and Simple Linear Regression achieved high accuracy for sales forecasting at Toko Ari. The SLR model performed better (MAPE 3.57%) than FTS (5.53%), proving effective for linear data. Implementing this approach supports data-driven decisions and reduces inventory risks [24]. Further research should extend time series and evaluate additional methods to enhance forecasting accuracy [25].

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