

Design and Implementation of a Web-Based Mobile Phone Sales Forecasting Application Using the Single Exponential Smoothing Method

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ARTICLE INFO

Article history:

Initial submission

07-06-2026

Received in revised form

19-07-2026

Accepted 03-08-2026

Available online 30-09-2026

Keywords:

Sales Forecasting, Single Exponential Smoothing, Mean Absolute Percentage Error (MAPE), Web-Based Application

DOI:

<https://doi.org/10.59356/smart-techno.v8i2.227>

ABSTRACT

This study was conducted to address the inventory management issues at iCare Apple Store, where mobile phone stock planning has traditionally relied on estimation, leading to the risk of both stock shortages and overstocking. The objective of this study was to design and implement a web-based mobile phone sales forecasting application using the Single Exponential Smoothing (SES) method. The dataset consisted of monthly sales data for the iPhone XR and iPhone XS from January 2021 to December 2024. The forecasting process was performed by testing alpha values ranging from 0.1 to 0.9, while forecasting accuracy was evaluated using the Mean Absolute Percentage Error (MAPE). The results indicated that the optimal alpha value for the iPhone XR was 0.1, yielding a MAPE of 27.04% and a forecast of 11.45 units, which was rounded to 11 units. For the iPhone XS, the forecasting model produced a MAPE of 52.33% with a forecast of 2.45 units, rounded to 2 units. These findings demonstrate that the Single Exponential Smoothing method can be effectively implemented in a web-based application and can support decision-making in determining appropriate inventory levels for subsequent periods.

1. INTRODUCTION

In today's digital era, the mobile phone industry has experienced rapid growth, accompanied by a continuously increasing market demand. As one of the retail stores specializing in Apple products, iCare Apple Store faces challenges in determining the optimal inventory level due to the absence of an accurate sales forecasting system. Currently, inventory management is carried out using manual records and spreadsheets, which often results in inventory imbalances, including both stock shortages and overstocking. Stock shortages may lead to lost sales opportunities, whereas excess inventory increases storage costs and the risk of financial losses. Furthermore, historical sales data indicate that mobile phone sales fluctuate over time rather than consistently increasing during specific periods. This pattern suggests that sales forecasting should be based on historical data rather than subjective assumptions. Based on observations and interviews conducted with the management of iCare Apple Store, inventory planning is still primarily determined by estimating sales from previous periods.

Such an approach frequently results in discrepancies between the available inventory and actual customer demand. When demand increases unexpectedly, the store may experience stock shortages, leading to missed sales opportunities. Conversely, maintaining excessive inventory increases storage costs and creates the risk of unsold products accumulating in stock. Previous studies have demonstrated that the Single Exponential Smoothing (SES) method is effective for forecasting fluctuating sales data. Alfariasi et al. (2022) reported that the SES method achieved satisfactory forecasting accuracy in fertilizer sales prediction. Similarly, Choirul Anwar et al. (2023) successfully implemented the SES

method in a web-based forecasting system, facilitating the sales prediction process. However, most previous studies have primarily focused on forecasting calculations and have provided limited discussion on implementing a complete web-based system equipped with forecasting visualization and automatic accuracy evaluation using the Mean Absolute Percentage Error (MAPE).

Based on the literature review, most existing studies have concentrated on applying the Single Exponential Smoothing method to generate forecasting results and measure forecasting accuracy. Limited attention has been given to integrating the SES method into a web-based application that can be directly utilized by users as a decision support tool. In addition, the automatic visualization of forecasting results and MAPE calculation has received relatively little attention. Therefore, this study develops a web-based mobile phone sales forecasting application that integrates sales data management, SES-based forecasting, MAPE-based accuracy evaluation, and the presentation of forecasting results through both tables and graphical visualizations.

To address these challenges, this study employs the Single Exponential Smoothing (SES) method, which assigns greater weight to recent observations, making it more responsive to changes in sales patterns. The objective of this study is to develop a web-based forecasting system that can support more effective decision-making in determining optimal inventory levels for future periods.

2. LITERATURE REVIEW

Sales forecasting is the process of estimating future values based on historical data. Forecasting methods are widely used to support decision-making, particularly in inventory management. Single Exponential Smoothing (SES) is a simple yet effective forecasting method that assigns greater weight to the most recent observations. The forecasting equation is expressed as follows:

$$F(t+1) = \alpha X_t + (1 - \alpha)F_t \quad (1)$$

Where α is the smoothing constant that determines the sensitivity of the forecast to changes in the data. A higher value of α causes the forecast to respond more quickly to recent observations.

To evaluate forecasting accuracy, the Mean Absolute Percentage Error (MAPE) is employed. MAPE measures the average percentage error between the actual values and the forecasted values, with lower MAPE values indicating higher forecasting accuracy. Mean Absolute Percentage Error (MAPE) is one of the most widely used evaluation metrics for assessing forecasting performance. It calculates the average percentage deviation between actual observations and forecasted values over all observation periods. The MAPE formula is defined as follows:

$$MAPE = (1/n) \sum |(X_t - F_t) / X_t| \times 100\% \quad (2)$$

Where X_t represents the actual value, F_t denotes the forecasted value, and (n) is the total number of observation periods.

A lower MAPE value indicates that the forecasted values are closer to the actual observations, reflecting better forecasting performance. Conversely, a higher MAPE value suggests greater discrepancies between the forecasted and actual values. One of the primary advantages of MAPE is its ease of interpretation, as forecasting errors are expressed as percentages. However, MAPE has a limitation when applied to datasets containing actual values of zero, since the calculation becomes undefined. In this study, MAPE is used as the primary evaluation metric for determining the optimal smoothing constant α in the Single Exponential Smoothing method.

3. METHOD

This study adopted a quantitative research approach consisting of the following stages:

1. Data Collection

The data used in this study consisted of monthly sales records of the iPhone XR and iPhone XS obtained from iCare Apple Store. The dataset comprised 48 observation periods, covering January 2021 to December 2024. Monthly sales data were selected because they serve as the primary basis for sales evaluation and inventory management at the store.

2. Single Exponential Smoothing (SES) Calculation

The forecasting process was carried out by testing smoothing constant α values ranging from 0.1 to 0.9 to determine the optimal forecasting model. The Single Exponential Smoothing (SES) method was employed to generate forecast values based on historical sales data by assigning greater weight to more recent observations. The forecasting equation is expressed as follows:

$$F_{t+1} = \alpha X_t + (1-\alpha)F_t \quad (3)$$

where:

- F_{t+1} = forecast value for the next period
- X_t = actual value at period (t)
- F_t = forecast value at period (t), and
- α = smoothing constant, where ($0 < \alpha < 1$).

In this study, nine smoothing constant values alpha ranging from 0.1 to 0.9 were evaluated to examine the effect of the smoothing level on forecasting performance. The optimal value of (α) was determined based on the lowest Mean Absolute Percentage Error (MAPE).

The forecasting procedure consisted of the following steps:

1. Collect the actual sales data for each observation period.
2. Initialize the first forecast value (F_1) using the actual sales value from the first period.
3. Calculate the forecast value for the subsequent period using the SES equation.
4. Repeat the forecasting process until all observation periods have been calculated.
5. Compute the MAPE value for each tested (α).
6. Select the (α) value that produces the lowest MAPE as the optimal forecasting parameter.

To illustrate the forecasting process, sales data for the iPhone XR during the first two observation periods were used. The actual sales were 15 units in January 2021 and 17 units in February 2021, with a smoothing constant of $\alpha = 0.1$.

The initial forecast value was defined as the actual sales of the first observation period:

$$F_1 = X_1 = 15 \quad (4)$$

The forecast for the second period was calculated as follows:

$$F_2 = \alpha X_1 + (1-\alpha)F_1$$

$$F_2 = (0,1 \times 15) + (0,9 \times 15)$$

$$F_2 = 15 \quad (5)$$

The forecast for the third period was calculated as follows:

$$F3 = \alpha X2 + (1-\alpha)F2$$

$$F3 = (0,1 \times 17) + (0,9 \times 15)$$

$$F3 = 1,7 + 13,5$$

$$F3 = 15,2 \quad (6)$$

These calculations demonstrate that the SES method generates forecast values by combining the most recent actual observation with the previous forecast according to the weighting determined by the smoothing constant alpha.

3. Mean Absolute Percentage Error (MAPE) Calculation

Forecasting errors were evaluated using the Mean Absolute Percentage Error (MAPE) to measure the accuracy of the forecasting results. The MAPE value was calculated for each tested smoothing constant alpha, and the forecasting model with the lowest MAPE was considered the most accurate.

4. System Implementation

The forecasting system was developed as a web-based application using the PHP programming language. The web-based platform enables users to perform sales forecasting efficiently and facilitates inventory planning through an accessible and user-friendly interface.

5. System Testing

System testing was conducted to evaluate the forecasting accuracy achieved by the proposed application. The evaluation used monthly sales data for the iPhone XR and iPhone XS from January 2021 to December 2024. The forecasting process was performed by testing nine smoothing constant values alpha ranging from 0.1 to 0.9. For each value of alpha, the Mean Absolute Percentage Error (MAPE) was calculated to measure the forecasting error. The smoothing constant that produced the lowest MAPE was selected as the optimal parameter and subsequently used to generate the sales forecast for the next period.

4. RESULT AND DISCUSSION

The results demonstrate that the Single Exponential Smoothing (SES) method can be effectively applied to forecast mobile phone sales based on historical data. The proposed forecasting application was successfully implemented as a web-based system. The system provides several key features, including sales data management, Single Exponential Smoothing (SES) forecasting, automatic Mean Absolute Percentage Error (MAPE) calculation, and visualization of forecasting results through tables and graphs. By automating the forecasting process, the system enables users to generate sales forecasts more efficiently than manual calculations, as all forecasting computations are performed automatically. The evaluation of different smoothing constant alpha values and their corresponding forecasting accuracy is presented in Table 1.

Table 1. Forecasting Results for Smoothing Constant alpha Values from 0.1 to 0.9

PARAMETER (ALPHA)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
FORECAST VALUE	11.45	11.18	11.12	11.01	10.83	10.54	10.14	9.6	8.9
TOTAL MAPE (%)	12.98	13.07	13.26	13.43	13.87	14.32	14.87	15.47	16.13
MAPE RESULT	27.04	27.23	27.63	27.98	28.9	29.83	30.98	32.23	33.6
Minimum MAPE result is at ALPHA 0.1 with value: 27.04									
Next Forecast Period:	11.45 UNITS								

The experimental results indicate that the choice of the smoothing constant alpha significantly affects forecasting accuracy. Based on the calculations, an alpha value of 0.1 produced the lowest Mean Absolute Percentage Error (MAPE) of 27.04% for the iPhone XR sales data. As the value of alpha increased, the MAPE generally increased as well. This finding suggests that the sales data used in this study are better represented by a smaller smoothing constant, as sales variations between consecutive periods are relatively moderate. Consequently, alpha = 0.1 was selected as the optimal forecasting parameter.

The results further demonstrate that lower values of alpha provide more accurate forecasts for the iPhone XR dataset. A smaller smoothing constant assigns greater weight to historical observations, resulting in more stable forecasts that are less sensitive to short-term fluctuations in sales. In contrast, when the smoothing constant was increased to 0.9, the forecasting results became more heavily influenced by recent observations. Since the most recent periods in the dataset exhibited relatively high sales fluctuations, using a larger alpha increased the forecasting error. This trend is reflected in the increase of the MAPE value from 27.04% at alpha = 0.1 to 33.60% at alpha = 0.9.

These findings confirm that the selection of an appropriate smoothing constant has a significant impact on the forecasting performance of the Single Exponential Smoothing method. Therefore, evaluating multiple alpha values is essential to identify the parameter that best fits the characteristics of the sales data. The relationship between the smoothing constant and the forecasting error is illustrated in Figure 1.



Figure 1. MAPE Results Graph

As shown in the MAPE graph, the lowest forecasting error was obtained when the smoothing constant was set to alpha = 0.1, resulting in a MAPE value of 27.04%. This result indicates a higher level of forecasting accuracy compared with the other tested alpha values. In contrast, increasing the value of alpha led to higher MAPE values, indicating a decline in forecasting accuracy. These findings suggest that a smaller smoothing constant is more

suitable for the characteristics of the mobile phone sales data used in this study. The forecasting results obtained using each tested alpha value are presented in Figure 2.



Figure 2. Forecasting Results Graph

As illustrated in Figure 2, the forecast values generally decreased as the smoothing constant alpha increased. Using alpha = 0.1, the forecasting model produced a forecast of 11.45 units, which was rounded to 11 units. This result was selected as the optimal forecast because it yielded the lowest forecasting error among all tested alpha values. Therefore, this forecast can serve as a reliable basis for determining the appropriate inventory level for the subsequent period.

The experimental results also reveal that the forecasting performance of the Single Exponential Smoothing (SES) method varies across different products. For the iPhone XR sales data, the model achieved a MAPE of 27.04%, indicating that the SES method was able to capture the sales pattern with reasonably good accuracy. In contrast, the iPhone XS sales data resulted in a MAPE of 52.33%, indicating substantially lower forecasting accuracy. This difference can be attributed to the distinct characteristics of the sales patterns for each product, particularly their levels of fluctuation.

In general, the more stable the historical sales data, the higher the forecasting accuracy achieved by the SES method. These findings suggest that the effectiveness of the Single Exponential Smoothing method strongly depends on the characteristics of the underlying data. While the SES method produced satisfactory forecasting accuracy for the iPhone XR dataset, its performance was considerably lower for the iPhone XS dataset due to the greater variability in sales.

The relatively high MAPE obtained for the iPhone XS is likely attributable to its more unstable sales pattern compared with the iPhone XR. Several observation periods exhibited sharp changes in sales volume, making it difficult for the forecasting model to accurately follow these fluctuations. Since the Single Exponential Smoothing method employs only a single smoothing parameter and assumes that the data do not exhibit strong trend or seasonal components, its forecasting performance tends to decline when applied to data with substantial inter-period variations.

These results further indicate that the Single Exponential Smoothing method has inherent limitations when applied to datasets characterized by pronounced trends or abrupt changes in sales patterns. The SES method is more suitable for relatively stable time-series data because it relies on a single smoothing parameter alpha to update the forecast. For datasets exhibiting upward or downward trends, or significant seasonal patterns, more advanced forecasting methods, such as Double Exponential Smoothing (DES) or the Holt-Winters method, are expected to provide higher forecasting accuracy.

The experimental results indicate that:

- $\alpha = 0.1$ produced the lowest Mean Absolute Percentage Error (MAPE) of 27.04% for the iPhone XR dataset.
- The corresponding sales forecast was 11 units.

For the iPhone XS dataset:

- The forecasting model yielded a MAPE of 52.33%.
- The corresponding sales forecast was 2 units.

The results indicate that forecasting accuracy varies across products depending on the characteristics of the underlying sales data. Compared with simple forecasting techniques such as the Moving Average method, Single Exponential Smoothing (SES) offers the advantage of assigning greater weight to more recent observations, making it more responsive to changes in sales patterns. In contrast, the Moving Average method assigns equal weight to all observations within the selected period, reducing the influence of recent changes on the forecasting results. Furthermore, the SES method is computationally simple and can be readily implemented in a web-based application.

Based on the findings of this study, the SES method achieved a MAPE of 27.04% for the iPhone XR sales data, indicating that it provides satisfactory forecasting performance and is suitable for supporting sales forecasting at iCare Apple Store. Nevertheless, future research should conduct a comparative evaluation of SES with other forecasting methods, such as Moving Average (MA), Weighted Moving Average (WMA), and Double Exponential Smoothing (DES), to determine the most accurate forecasting approach for mobile phone sales data.

In addition, the findings reveal that mobile phone sales exhibit fluctuating patterns and are not consistently influenced by specific events or seasonal periods. This suggests that a data-driven forecasting approach based on historical sales records is more appropriate than relying on subjective assumptions.

The developed system is capable of:

- Generating sales forecasts;
- Automatically calculating the Mean Absolute Percentage Error (MAPE); and
- Visualizing historical and forecasted sales data through graphical representations.

5. CONCLUSION

Based on the results of this study, the Single Exponential Smoothing (SES) method was successfully implemented in a web-based mobile phone sales forecasting application for iCare Apple Store. The developed system is capable of managing sales data, performing forecasting calculations, automatically computing the Mean Absolute Percentage Error (MAPE), and presenting the forecasting results through both tables and graphical visualizations. The experimental results indicate that the optimal smoothing constant for the iPhone XR sales data was $\alpha = 0.1$, which produced a MAPE of 27.04% and a forecast of 11.45 units, rounded to 11 units. In contrast, the iPhone XS sales data yielded a MAPE of 52.33% with a forecast of 2.45 units, rounded to 2 units. These findings demonstrate that the forecasting accuracy of the Single Exponential Smoothing method is strongly influenced by the characteristics of the underlying sales data.

The proposed web-based application enables the forecasting process to be performed more efficiently and systematically than manual calculations. Consequently, it can support iCare Apple Store in making more informed inventory planning decisions and determining appropriate stock levels for future periods.

6. ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to Universitas Muhammadiyah Jember and iCare Apple Store for providing the data, facilities, and support necessary for the completion of this research.

7. REFERENCES

- Alfarisi, F. I., Rizqi, A. W., & Dahda, S. S. (2022). Peramalan Penjualan Pupuk Organik PT. Petrokindo Cipta Selaras Dengan Mekanisme Single Exponential Smoothing Dan Moving Average. *Jurnal Teknik Industri: Jurnal Hasil Penelitian Dan Karya Ilmiah Dalam Bidang Teknik Industri*, 8(2), 101. <https://doi.org/10.24014/jti.v8i2.19466>.
- Choirul Anwar, E., Asep Muhidin, & Putri Anggun Sari. (2023). Sistem Peramalan Penjualan Menggunakan Metode Single Exponential Smoothing Berbasis Web Di Pt. Sanghiang Perkasa. *Jurnal Informatika Teknologi Dan Sains (Jinteks)*, 5(3), 357–363. <https://doi.org/10.51401/jinteks.v5i3.3206>
- David Mico, A., Arifianto, D., & Maryami, A. (2021). Peramalan Penjualan Batu Gamping Pada “UD Eko Joyo” Menggunakan Single Exponential Smoothing Dan Double Exponential Smoothing Forecasting Of Limestone Sales At “UD Eko Joyo” Using Single Exponential Smoothing And Double Exponential Smoothing. *Jurnal Smart Teknologi*, 1(1), 2774–1702. <http://jurnal.unmuhjember.ac.id/index.php/JST>
- Fadillah, N., & Rahmad, I. F. (2023). *Jurnal InSeDS (Information System and Data Science)* Metode Single Exponential Smoothing untuk Sistem Informasi Peramalan Pengelolaan Stok Vaksin. 2(1), 1–9.
- Farida, Y., Yusi, S., & Yulianti, D. (2021). Forecasting The Number of Aircraft Passengers at Juanda International Airport Using Exponential Smoothing 30 Event-Based Method. *Barekeng*, 15(4), 709–718. <https://doi.org/10.30598/barekengvol15iss4pp709-718>