

Implementation of the Single Exponential Smoothing Forecasting Method for Product Sales Prediction at UD XYZ

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Abstract

In the competitive world of business, demand forecasting is a critical aspect of inventory management. Errors in estimating demand can result in various negative impacts, such as excess inventory that increases storage costs or stock shortages that can lead to lost sales opportunities. UD. Haili often faces challenges in managing inventory due to unpredictable fluctuations in demand. In some cases, demand for certain products experiences sudden spikes, while at other times demand drops sharply. This creates the risk of inventory imbalances, leading to increased operational costs and the potential loss of customers. The objective of this study is to apply the single exponential smoothing (SES) method in forecasting demand for goods so that the forecasting results can provide strategic recommendations for UD. Haili in managing inventory based on the forecasting results. The forecasting results using the developed forecasting application indicate that round shrimp paste has the smallest MAPE, using an alpha of 0.4 with 1.26%, square shrimp paste uses an alpha of 0.1 with 1.98%, and triangular shrimp paste uses an alpha of 0.1 with 4.53%.

Keywords: Forecasting; Exponential Smoothing Method; Shrimp Paste, Product

1. INTRODUCTION

In the competitive world of business, demand forecasting is a very important aspect of inventory management. [1]. Errors in estimating demand can result in various negative impacts, both in the form of excess stock that increases storage costs and stock shortages that can lead to lost sales opportunities [2]. Therefore, choosing the right forecasting method is a necessity for companies, especially those engaged in the trade sector [3].

UD. Haili is a business engaged in the management of shrimp paste and the distribution of daily necessities. As a distributor, UD. Haili must ensure that the goods sold are always available to meet customer needs. However, in managing inventory and demand for goods, particularly unpredictable demand, inventory levels sometimes become excess or insufficient. Since predictions are still made, procurement of goods is often done subjectively without accurate calculations. This creates the risk of losing customers due to delays in fulfilling product needs. To address this issue, a forecasting method needs to be implemented to help UD. Haili make more accurate decisions regarding inventory management and product demand.

UD. Haili often faces challenges in managing inventory due to unpredictable fluctuations in demand. In some cases, demand for certain items suddenly spikes, while at other times demand drops dramatically. This leads to the risk of inventory imbalances, which in turn increases operating costs and the potential for losing customers.

Until now, UD. Haili has relied on experience and intuition to determine the amount of stock to be prepared. This approach has several weaknesses, such as subjectivity in decision making and a lack of quantitative basis for estimating demand. Therefore, a more systematic and data-driven forecasting method is needed to help the company manage its stock more effectively [4]. Due to unpredictable demand, which sometimes leads to excess or insufficient stock, forecasting is needed to make decisions [5]. By applying the SES method, UD. Haili can obtain a clearer picture of future trends in demand for goods [6]. This will assist in decision-making related to stock procurement, thereby reducing the risk of excess or shortage of stock [7]. In addition, this method can also improve the operational efficiency of the company by optimizing resource allocation based on more accurate estimates [8].

The purpose of this study is to apply the single exponential smoothing (SES) method in forecasting demand for goods so that the forecasting results can provide strategic recommendations for UD. Haili in managing stock based on the forecasting results [9].

Within the context of inventory management, demand forecasting has been a widely explored topic. Previous research, such as those conducted by Risqiaty [1] and Widyaningrum [2], has successfully applied various forecasting methods, including Single Exponential Smoothing (SES), to predict sales for diverse products, from yarn to gas refills. However, a significant gap exists between those studies and the present research. Most previous studies have focused on the general application of forecasting methods to provide predictive results without integrating them into a more comprehensive system. This study distinguishes itself by not only applying the SES method to forecast the demand for shrimp paste at UD. Haili but also by developing a functional, web-based forecasting application system. This approach addresses the shortcomings of prior studies that often yielded only theoretical recommendations. With this system, UD. Haili can directly input sales data, perform automatic forecasting calculations, and obtain printable reports that serve as a basis for more strategic and objective decision-making. Therefore, this research not only enriches the literature on the application of the SES method but also provides a practical and integrated solution that was absent in previous studies a system that can actively assist in day-to-day inventory management.

Several previous studies have applied the *Single Exponential Smoothing* (SES) method for demand forecasting in various sectors. Risqiati [1] applied SES to yarn sales, Widyaningrum [2] to gas refill demand, and Ahmar et al. [7] to vehicle registrations. These studies demonstrated the effectiveness of SES in forecasting data with relatively stable patterns. However, most of the existing literature has focused on essential products or large-scale industries, while its application in small and medium enterprises (SMEs), particularly in general trading businesses such as UD. Haili, has not been widely explored.

This research addresses that gap by applying the SES method to forecast product demand in UD. Haili. By analyzing demand patterns in a medium-scale business that sells various daily needs, this study aims to provide practical contributions in supporting inventory planning and more efficient sales strategies. Furthermore, it enriches the literature by presenting a case study in the SME context, which has received relatively less attention compared to large industries.

2. RESEARCH METHOD

This study uses a quantitative approach using sales data from the previous year [10]. This research began with the stages of problem identification, data collection, data analysis, system design, and development of a forecasting system. The stages of this research are shown in Figure 1.

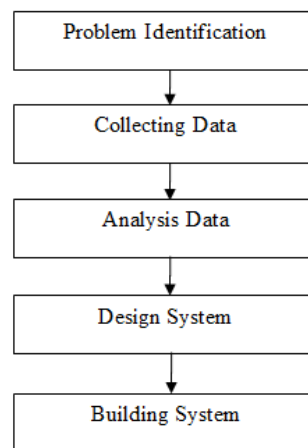


Figure 1. Research Stage

Details of the research stages in Figure 1.

2.1 Problem Identification

Problem identification is the process of determining the core issues of a research study. Here, the author identified several problems, including UD. Haili facing several problems in managing inventory, including unpredictable fluctuations in demand, causing stock to sometimes be excessive or insufficient [11]. The lack of effective forecasting methods means that procurement is often carried out subjectively without accurate calculations. UD. Haili risks losing customers due to delays in fulfilling their needs [12].

2.2 Collecting Data

Data collection was conducted to obtain the necessary information. The author collected data using various methods, including interviews, documentation, observation, and literature review..

2.3 Analysis Data

After collecting the data, the author analyzed it and found a solution to the problem, namely by developing a forecasting system that can assist in the management of shrimp paste at UD. Haili.

2.4 Design System

Based on the results of problem identification and data analysis, the author then designed the system to be built, including designing the information system flow (ASI), UML, database, user interface, input, output, and other process activities.

2.5 Building System

This stage involves the creation of the designed information system. System development can be carried out in whole or in part. System development is the process of creating or modifying a system.

2.6 Single Exponential Smoothing Method

The Single Exponential Smoothing (SES) method is one of the simplest yet effective time series forecasting techniques, particularly suitable for data with relatively stable demand patterns that lack trends or seasonality. Risqati [1] demonstrated that SES provides low forecasting error in yarn sales prediction. Similarly, Widyaningrum [2] showed that SES is effective for forecasting gas refill demand due to its simplicity and ability to accommodate short-term fluctuations. Ahmar et al. [7] compared Single and Double Exponential Smoothing models in predicting passenger car registrations, concluding that SES is more appropriate when data does not exhibit a strong trend component. Single Exponential Smoothing is a continuous smoothing procedure for forecasting the most recent observations. It emphasizes a gradual deprioritization of older observations. In other words, the most recent observations are given higher priority for forecasting than older observations. The formula for Single Exponential Smoothing is as follows:

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

Where:

F_{t+1} : predicted value for period $t+1$.

α : smoothing constant ($0 < \alpha < 1$).

X_t : actual value for period t .

F_t : predicted value for period t .

3. RESULT AND DISCUSSION

3.1 Analysis Data

The data used in this study is the shrimp paste inventory data from May 2024 to April 2025. From this data, we will forecast the inventory for May 2025. The inventory data is shown in Table 1 below.

Table 1. Data on Terasi Stock One Year Ago

No	Period	Square Terasi	Round Terasi	Triangular Terasi
1	Mei 2024	350 Pack	347 Pack	350 Pack
2	Jun 2024	350 Pack	347 Pack	330 Pack
3	Jul 2024	330 Pack	330 Pack	376 Pack
4	Aug 2024	340 Pack	340 Pack	355 Pack
5	Sep 2024	350 Pack	341 Pack	354 Pack
6	Oct 2024	350 Pack	337 Pack	340 Pack
7	Nov 2024	340 Pack	336 Pack	320 Pack
8	Dec 2024	350 Pack	343 Pack	347 Pack
9	Jan 2025	345 Pack	341 Pack	402 Pack
10	Feb 2025	355 Pack	340 Pack	351 Pack
11	Mar 2025	335 Pack	332 Pack	339 Pack
12	Apr 2025	340 Pack	330 Pack	340 Pack

Table 1 presents a one-year overview of UD. Haili's shrimp paste stock data, spanning from May 2024 to April 2025. The table includes data for three types of shrimp paste: square, round, and triangular. Over the course of the year, the stock levels for each type of shrimp paste fluctuated monthly. This data serves as the foundation for forecasting the shrimp paste inventory for May 2025.

3.2 Analysis Single Exponential Smoothing Method

In analyzing the system process, the single exponential smoothing method requires weighting, where data is weighted by an exponential function. The single exponential smoothing method is a moving average forecasting method with advanced weighting, yet it is still easy to use. This method requires very little recording of past data. The exponential smoothing formula is as follows [13]:

$$F_{t+1} = \alpha Y_t + (1-\alpha) F_t$$

Where:

F_{t+1} = forecast for the period $t+1$

Y_t = real value of the period t

α = weight indicating the smoothing constant ($0 < \alpha < 1$)

F_{t-1} = forecast for the period $t-1$

After using the equation, the following forecast results are obtained:

Table 2. Inventory Forecasting Results Square Terasi

Period	Data Actual (Yt)	Ft	MAD	MSE	MAPE
May 2024	350	350			
Jun 2024	350	350	0.00	0.00	0.00%
Jul 2024	330	348	20.00	400.00	6.06%
Aug 2024	340	347.2	8.00	64.00	2.35%
Sep 2024	350	347.48	2.80	7.84	0.80%
Oct 2024	350	347.732	2.52	6.35	0.72%
Nov 2024	340	346.9588	7.73	59.78	2.27%
Dec 2024	350	347.26292	3.04	9.25	0.87%
Jan 2025	345	347.036628	2.26	5.12	0.66%
Feb 2025	355	347.8329652	7.96	63.42	2.24%
Mar 2025	335	346.5496687	12.83	164.68	3.83%
Apr 2025	340	350	6.55	42.90	1.93%
Total	-	-	73.702	823.34	21.73%

Table 2 shown the forecast results of the square shrimp paste inventory forecast were calculated using an alpha value of 0.1 because this value has the least error, meaning that the forecasting error is not too large [14].

Next Table 3 displays the forecasting results for round shrimp paste inventory. The calculation for this also utilized the single exponential smoothing method, but with an alpha value of 0.4. Similar to the square shrimp paste, this alpha value was chosen for its minimal error rate. The table details the calculation results for Actual Data (Yt), Ft, MAD, MSE, and MAPE over the full year.

Table 3. Inventory Forecasting Results Round Terasi

Period	Data Actual (Yt)	Ft	MAD	MSE	MAPE
May 2024	347	347			
Jun 2024	347	347	17.00	289.00	5.15%
Jul 2024	330	347	0.20	0.04	0.06%
Aug 2024	340	340.2	0.88	0.77	0.26%
Sep 2024	341	340.12	3.47	12.05	1.03%
Oct 2024	337	340.472	3.08	9.51	0.92%
Nov 2024	336	339.0832	5.15	26.52	1.50%
Dec 2024	343	337.84992	1.09	1.19	0.32%
Jan 2025	341	339.909952	0.35	0.12	0.10%
Feb 2025	340	340.3459712	8.21	67.36	2.47%
Mar 2025	332	340.2075827	6.92	47.95	2.10%
Apr 2025	330	336.9245496	0.00	0.00	0.00%
Total	-	-	46.353	454.52	13.91%

Table 3 shown the results of the round shrimp paste inventory forecast were calculated using an alpha value of 0.4 because this value has the least error, meaning that the forecasting error is not too large.

Table 4. Inventory Forecasting Results Triangular Terasi

Period	Data Aktual (Yt)	Ft	MAD	MSE	MAPE
May 2024	350	350			
Jun 2024	330	350	20.00	400.00	6.06%
Jul 2024	376	348	28.00	784.00	7.45%
Aug 2024	355	350.8	4.20	17.64	1.18%
Sep 2024	354	351.22	2.78	7.73	0.79%
Oct 2024	340	351.498	11.50	132.20	3.38%
Nov 2024	320	350.3482	30.35	921.01	9.48%
Dec 2024	347	347.31338	0.31	0.10	0.09%
Jan 2025	402	347.282042	54.72	2994.05	13.61%
Feb 2025	351	352.7538378	1.75	3.08	0.50%
Mar 2025	339	352.578454	13.58	184.37	4.01%
Apr 2025	340	351.2206086	11.22	125.90	3.30%
Total	-	-	178.410	5570.09	49.85%

The results of the round shrimp paste inventory forecast shown in Table 4 were calculated using an alpha value of 0.1, as this value has the lowest error rate, meaning that the forecasting error is not too large [15].

3.3 Design System

This forecasting application was designed using a model based on a use case diagram. The purpose of using a use case diagram is to explain the definition of system users in detail [16]. The design of the forecasting system using a use case diagram can be seen in Figure 2.

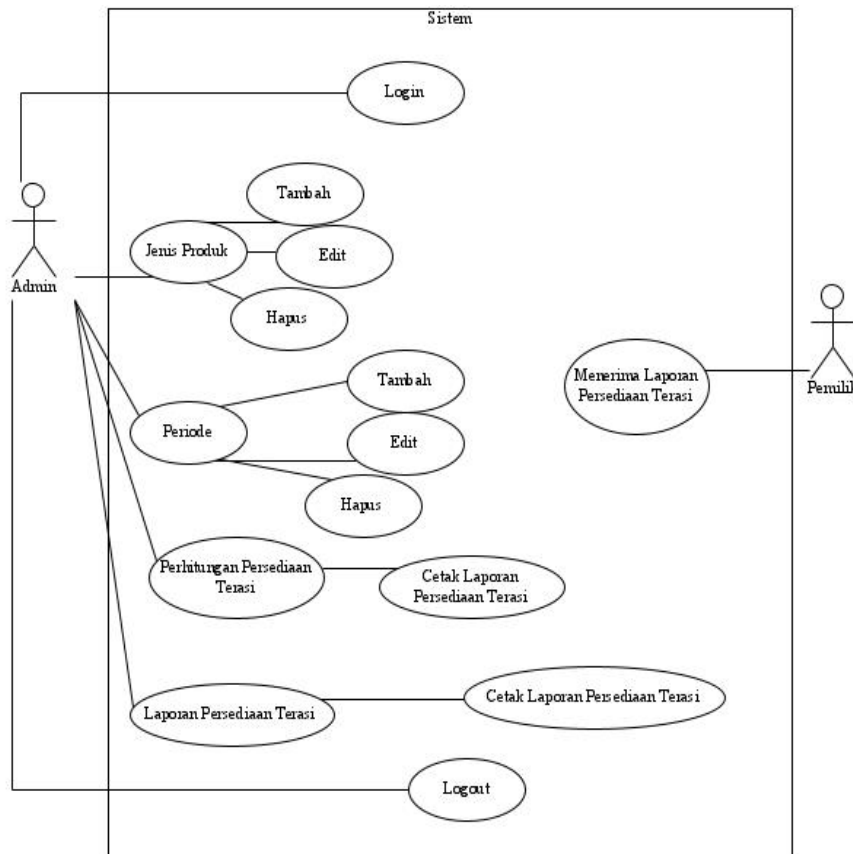


Figure 2. Use Case Diagram

3.3 Building System

3.3.1 Data Period

To access the forecasting menu, users are required to log in first [17]. Only users who have been registered previously can access the forecasting system. After logging in to the forecasting system, users are directed to the main menu, from which they can access the Period Data menu. This menu is used by administrators to enter sales data, as shown in Figure 3 below.

Data Periode					
Cari tanggal...		Refresh			
No	Tanggal	Terasi Segi Empat	Terasi Bulat	Terasi Segi Tiga	Aksi
1	2024-05-31	350	347	350	 
2	2024-06-30	350	347	330	 
3	2024-07-31	330	330	376	 
4	2024-08-31	340	340	355	 
5	2024-09-30	350	341	354	 
6	2024-10-31	350	337	340	 
7	2024-11-30	340	336	320	 
8	2024-12-31	350	343	347	 
9	2025-01-31	345	341	402	 
10	2025-02-28	355	340	351	 
11	2025-03-31	335	332	339	 
12	2025-04-30	340	330	340	 

Figure 3. Period Data Display

3.3.2 Forecasting Calculation

After entering the period data, proceed to the forecasting calculation menu. In this menu, you can select the alpha value, the number of periods to be forecasted, and the type of product to be forecasted, as shown in Figure 4 below.

Parameter Peramalan

Awal *

05/31/2024

Akhir *

04/30/2025

Alpha (α) *

0.1

Nilai antara 0 dan 1. Contoh: 0.2

Next Periode *

2

Jenis Produk *

Terasi Segi Empat

Hitung

Figure 4. Forecasting Calculation

3.3.3 Forecasting Result

After calculating the forecast, the results can be viewed and printed for archiving, as shown in Figure 5 below.

Periode (t)	Y_t	α	$1-\alpha$	αY_t	F_t	e_t	e_t^2	$ e_t $	$ e_t/Y_t $
May 2024	350	0.1	0.9	0.00	0.00	0.00	0.00	0.00	0.00
June 2024	350	0.1	0.9	35.00	350.00	0.00	0.00	0.00	0.00
July 2024	330	0.1	0.9	33.00	350.00	20.00	400.00	20.00	0.06
August 2024	340	0.1	0.9	34.00	348.00	8.00	64.00	8.00	0.02
September 2024	350	0.1	0.9	35.00	347.20	-2.80	7.84	2.80	0.01
October 2024	350	0.1	0.9	35.00	347.48	-2.52	6.35	2.52	0.01
November 2024	340	0.1	0.9	34.00	347.73	7.73	59.78	7.73	0.02
December 2024	350	0.1	0.9	35.00	346.96	-3.04	9.25	3.04	0.01
January 2025	345	0.1	0.9	34.50	347.26	2.26	5.12	2.26	0.01
February 2025	355	0.1	0.9	35.50	347.04	-7.96	63.42	7.96	0.02
March 2025	335	0.1	0.9	33.50	347.83	12.83	164.68	12.83	0.04
April 2025	340	0.1	0.9	34.00	346.55	6.55	42.90	6.55	0.02
Total	4,135.00				3,826.05	41.05	823.34	73.70	0.22

MSE	: 74.85
MAE	: 6.70
MAPE	: 1.98%

Hasil Prediksi Periode Selanjutnya:

Periode (n)	F_t
May 2025	345.89
June 2025	345.31

Asahan, 25 / 06 / 2025

Pemilik,

Kelvin

Figure 5. Forecast Result

Based on Figure 5, it can be seen that the system calculation displays the same results as the manual calculation, and the forecasting results presented are also identical. This report can be printed for archiving.

The forecasting system developed using the Single Exponential Smoothing (SES) method was successfully implemented to assist UD. Haili in managing its shrimp paste inventory. The application was designed using the PHP programming language and a MySQL database [18], which ensures ease in processing inventory data. System testing demonstrated that the application has full functionality, starting with a login menu for user authentication, a period data input menu for entering one year of previous sales data (May 2024 - April 2025), and a forecasting calculation menu. In the calculation menu, users can specify the alpha value, the number of periods to be forecasted, and the type of shrimp paste product [19]. Following the calculation process, the system displays detailed forecasting results that can be printed as a report. The forecasting results indicate that the system can measure the forecasting accuracy for each type of shrimp paste. For round shrimp paste, the smallest error rate (MAPE) was 1.26% with an alpha value of 0.4. Square shrimp paste had the smallest MAPE of 1.98% with an alpha of 0.1. Triangular shrimp paste achieved the smallest MAPE of 4.53% with an alpha of 0.1. Therefore, the developed system not only helps UD. Haili to predict the stock needs for the following month but also provides an objective, quantitative basis for procurement decisions. This reduces the risk of excess or insufficient stock that previously often occurred due to relying solely on intuition [20].

4. CONCLUSION

After conducting research on UD. Haili, several conclusions can be drawn, namely that this system is designed using the PHP programming language and MySQL database, which will facilitate the processing of shrimp paste inventory at UD. Haili. This system can determine and measure the accuracy of terasi inventory forecasting, which can serve as a reference for stocking terasi over the next few periods. The system, developed using the Single Exponential Smoothing (SES) method, can assist UD. Haili in forecasting terasi inventory for the following month. The results of terasi forecasting with the smallest error are as follows: using alpha 0.4 with 1.26% for round terasi, using alpha 0.1 with 1.98% for square terasi, and using alpha 0.1 with 4.53% for triangular terasi.

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