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Design And Development of A Monitoring And Prediction System For Sari Roti Returns In Aceh Utara Using The Single Exponential Smoothing Method

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Abstract

This research focuses on inventory management of Sari Roti branded bread products in North Aceh, Indonesia, which faces financial loss problems due to unexpected product returns. Currently, return calculations are done manually, but this method is still inadequate. This study aims to develop a bread inventory prediction system using the single exponential smoothing method. In this context, Sari Roti is a leading bread manufacturer with various types of bread products. The main problem is the difficulty in estimating the quantity of bread that will be returned by stores in the region. To improve inventory estimation accuracy, this research introduces a prediction and monitoring system that enables stores to track the amount of bread stock to be supplied and the quantity of returns by salespeople each week. The method used is Single Exponential Smoothing, which seeks to improve upon the previous method that had a high error rate. This research is expected to help sales personnel and Sari Roti distributors in North Aceh predict bread return quantities more accurately, with the goal of reducing financial losses due to unexpected returns. The use of the Single Exponential Smoothing method to predict returns and drops for the 10 most common Sari Roti products from each store in North Aceh with an alpha value of 0.3 is quite good, because the prediction results obtained using Mean Absolute Deviation (MAD) error evaluation yielded an average error value below 10%, while the prediction results obtained using Mean Absolute Percentage Error (MAPE) evaluation are not yet satisfactory, because the average error value obtained is below 40%.

Kata kunci: Sari roti, Return, Single Exponential Smoothing, Prediction

1. Introduction

Sari Roti is a brand name from one of the bread manufacturing companies in Indonesia, namely PT. Nippon Indosari Corpindo Tbk. This company was first established in 1995 and began operations in 1996, producing sweet bread and white bread [1]. Sari Roti product variants include white bread, sweet bread, sandwiches, and dorayaki. The Sari Roti distributor in North Aceh receives many reports of returned Sari Roti products. To address this problem, the Sari Roti distributor in North Aceh performs return estimates manually, but estimating the number of returned breads manually is still inadequate. Returns are efforts by buyers to return goods to sellers. This indicates an increase in the quantity of goods, but causes losses [2]. Every trading company is familiar with the terms sales and purchase returns, whether large companies or small traders who only sell a few merchandise items.

Currently, to determine the remaining quantity of bread from each bread supplied, each store records the amount of bread supplied and bread returned. To assist stores in North Aceh, a system is needed that can predict the quantity of bread to be returned so that stores in North Aceh can be helped in knowing the stock quantity of bread that will be returned. Furthermore, monitoring is needed to determine the stock quantity of bread to be supplied and returned by salespeople each week. Monitoring is the collection of necessary information with minimal effort to make timely choices [3]. In this prediction system, the exponential smoothing method is used. Exponential smoothing proves that weights increase exponentially as observation time becomes more recent. One development

of the exponential smoothing method is the Single Exponential Smoothing method. Single Exponential Smoothing is a forecasting method used to predict data in time series based on historical data [4].

As for previous research using the Holt-Winters exponential smoothing method conducted by (Aini, A. N et al., 2022), there were still weaknesses in that research, namely the Mean Absolute Percentage Error (MAPE) and Mean Absolute Deviation (MAD) levels still displayed error values above 40% [5]. There is also other research conducted by Ida Darwati and Lita Sari Marita (2022) using the exponential smoothing method. However, there are still weaknesses in this research, namely, it does not yet have a program that can process calculations so that inventory predictions are better known with low Mean Absolute Percentage Error (MAPE) and Mean Absolute Deviation (MAD) levels [6]. This research is expected to help sales personnel and Sari Roti distributors in North Aceh in estimating the quantity of Sari Roti that will be returned within a certain period using the Single Exponential Smoothing method to predict the quantity of bread returned.

2. Method

2.1. System Overview

The stages of the Single Exponential Smoothing method include determining the alpha value and testing the alpha value [17]. The Single Exponential Smoothing calculation can be written in the formula:

$$Ft + 1 = \alpha Xt + (1 - \alpha) Ft \quad (2.1)$$

Description:
Ft+1 = Prediction for periode t+1
Xt = Real value for periode t
α = Weight for constant smoothing
(0 < α <1)
Ft = Prediction for periode t

To evaluate prediction performance, evaluation metrics such as Mean Absolute Deviation (MAD) and Mean Absolute Percentage Error (MAPE) can be used [18]. The following explains the stages of this method:

1. Determination of Alpha Value (α)
   The alpha value determines how quickly the model reacts to changes in the data. The alpha value is freely determined according to actual data to find the lowest error value.
2. Testing of Alpha Value
   To test the optimal alpha value, a series of experiments are conducted using historical data and trying various alpha values. This process involves generating predictions using the Single Exponential Smoothing method with each alpha value being tested. The prediction results are then compared with actual data to evaluate prediction accuracy.
3. Implementation Stage of Single Exponential Smoothing Method
   After the optimal alpha value is determined, the Single Exponential Smoothing method can be implemented to predict Sari Roti returns in North Aceh. This process involves using available historical data and systematic calculations using the Single Exponential Smoothing formula.

2.2. Evaluation of Prediction Results

Evaluation of prediction results is used as a benchmark for the accuracy of the prediction system that has been created against actual data. There are several methods for calculating the error rate of forecasting, including:

1. Mean Absolute Deviation (MAD)
   This method is used to evaluate forecasting methods using the sum of simple errors. Mean Absolute Deviation (MAD) measures forecasting accuracy by averaging the estimated errors (absolute values of each error). MAD is useful when measuring forecasting errors in the same units as the original [19]. The equation used is as follows:

   $$MAD = \sum(|x - y|)/n \quad (2.2)$$

   Description:
   MAD : Mean Absolute Deviation
   x : Actual Result Value
   y : Predicted Result Value
   n : Amount of Data

2. Mean Absolute Percentage Error (MAPE)
   Mean Absolute Percentage Error (MAPE) is the average value of the absolute difference that exists between

the forecast value and the actual value expressed as a percentage of the actual value [20]. Mean Absolute Percentage Error (MAPE) can be calculated with the following equation:

$$MAPE = (1/n) * \Sigma(|xt - yt| / |xt|) * 100 \quad (2.3)$$

Keterangan:
MAPE : Mean Absolute Percentage Error
Xt : Actual Result Value
Yt : Predicted Result Value
n : Amount of Data

2.3. DFD Level 1

In this system, the admin's role is to log in, manage user accounts, add store data, add product data, input Sari Roti return and drop data, and view prediction data for the quantity of Sari Roti drops and returns. The owner can log in, input, edit, and delete bread return and drop data from their own store and can use predictions. Sales personnel have the role of logging in, inputting drop and return data, and viewing prediction data for the quantity of Sari Roti returns. The Level 1 Data Flow Diagram can be seen in Figure 1.

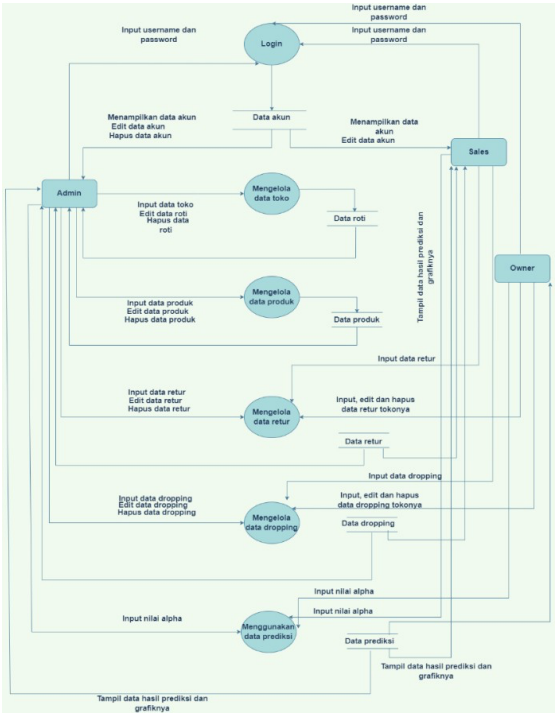


Figure 1. Data Flow Diagram Level 1

3. Result and Discussion

3.1. User Interface Implementation

User interface implementation is the implementation of the interface between users and the application that has been designed in the user interface subsection with the aim of making it easier for users to use the application that has been built. This implementation starts from the interface when logging in or registering and the functions of other buttons, including also the selection of appropriate colors in the system to make it more attractive and comfortable to use.

1. Login Page
   The login implementation is used as the most primary step before users enter this system. In the built system, users must log in first. Users in this system have two roles, namely admin and sales; these two roles have different access rights in this system. After users log into the system, the system will direct users to their respective pages according to their user role. The following Figure 2 is the page for logging in.

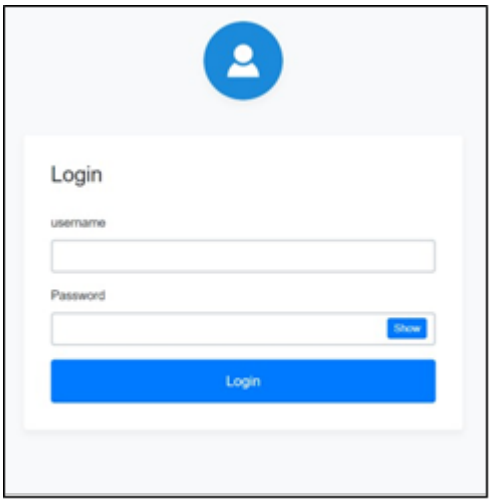


Figure 2. Login Page

2. Admin Page
   The admin and sales main page are the first page displayed by the system after the admin logs in. The menus available on this page are the home menu, store data, product data, drop data, return data, drop prediction, return prediction, and user data. On the home menu, sales personnel can choose to view return data or bread drop data at various stores in Aceh Utara.

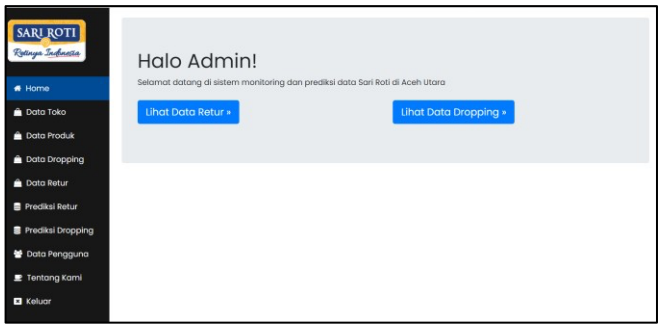


Figure 3. Admin Page

3. Stores Page
   On the stores page, the admin can view a list of store names and store codes that are already registered in this system. The admin can add store names to the list and can edit and delete each store's data. The store data page can be seen in Figure 4.

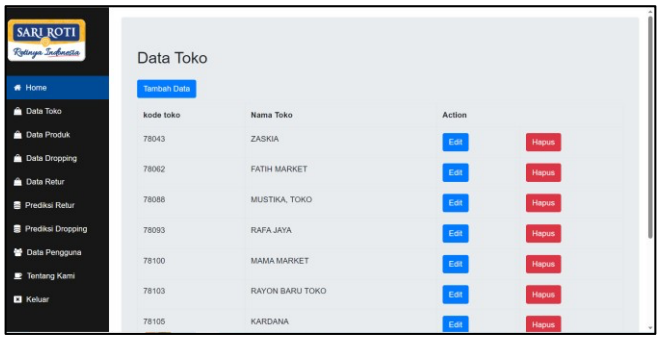


Figure 4. Store Page

4. Products Page
   On the product data page, the admin can view a list of product names and product codes that are already registered in this system. The admin can add product names to the list and can edit and delete each Sari Roti product's data. The number of Sari Roti products already registered here is 64 types of bread. The product data page can be seen in Figure 5.

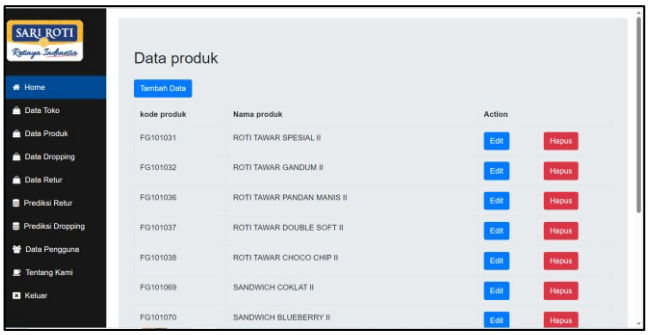
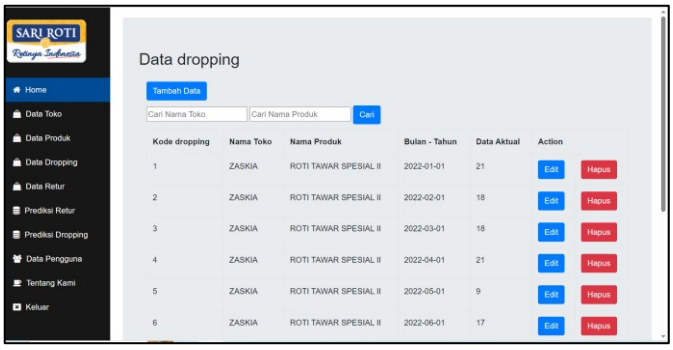


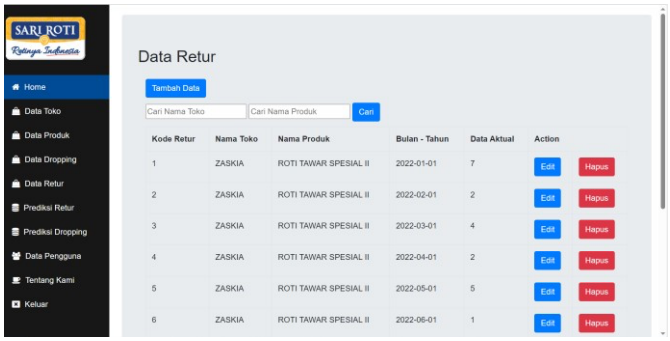
Figure 5. Products Page

5. Drop Data Page
   On the drop data page, bread drop data is displayed for each store, product, bread drop date, and the quantity of bread drops in North Aceh. The admin can add store names, product names, and drop dates, edit bread data, and delete bread data. The drop data page can be seen in Figure 6.



Gambar 6. Drop Data Page

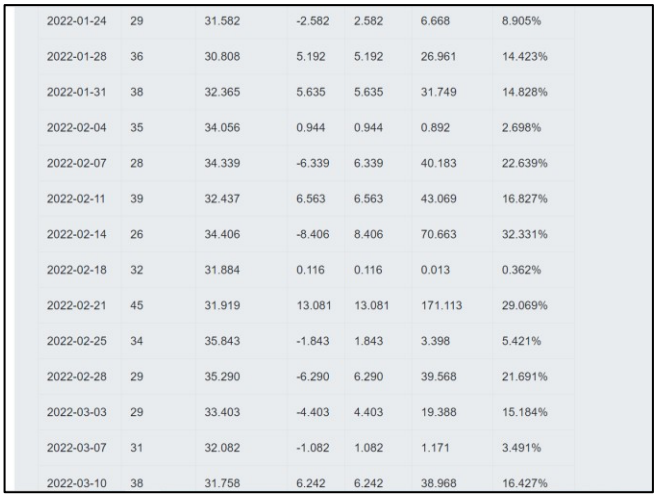
6. Return Data Page
   On the return data page, bread return data is displayed for each store, product, bread return date, and the quantity of bread returns in North Aceh. The admin can add store names, product names, and return dates, edit bread data, and delete bread data. The return data page can be seen in Figure 7.



Gambar 7. Return Data Page

7. Return Prediction Page
   On the return prediction page, there is a table containing dates in the actual data, estimated data, and error values for each date, and sales personnel can input the alpha value to determine the average error rate and prediction results and display a comparison graph between actual data and prediction data. Before starting to display prediction results, users can select a store and select a product for which they want to display prediction results. The drop data displayed is data over a one-year period. The following Figures 8 shown sample pages of return predictions for all bread products and bread return graphs from Kardana store.

a. Return Prediction Page (1)



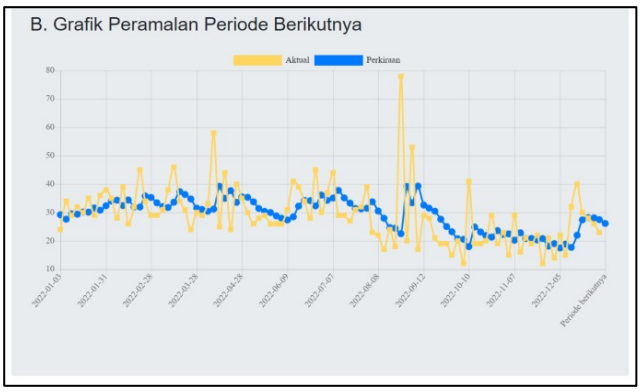
2022-01-24	29	31.582	-2.582	2.582	6.668	8.905%
2022-01-28	36	30.808	5.192	5.192	26.961	14.423%
2022-01-31	38	32.365	5.635	5.635	31.749	14.828%
2022-02-04	35	34.056	0.944	0.944	0.892	2.698%
2022-02-07	28	34.339	-6.339	6.339	40.183	22.639%
2022-02-11	39	32.437	6.563	6.563	43.069	16.827%
2022-02-14	26	34.406	-8.406	8.406	70.663	32.331%
2022-02-18	32	31.884	0.116	0.116	0.013	0.362%
2022-02-21	45	31.919	13.081	13.081	171.113	29.069%
2022-02-25	34	35.843	-1.843	1.843	3.398	5.421%
2022-02-28	29	35.290	-6.290	6.290	39.568	21.691%
2022-03-03	29	33.403	-4.403	4.403	19.388	15.184%
2022-03-07	31	32.082	-1.082	1.082	1.171	3.491%
2022-03-10	38	31.758	6.242	6.242	38.968	16.427%

b. Return Prediction Page (2)

2022-12-05	22	17.512	4.488	4.488	20.139	20.398%
2022-12-08	15	18.859	-3.859	3.859	14.889	25.724%
2022-12-12	32	17.701	14.299	14.299	204.460	44.684%
2022-12-15	40	21.991	18.009	18.009	324.334	45.023%
2022-12-19	30	27.394	2.606	2.606	6.794	8.688%
2022-12-22	28	28.175	-0.175	0.175	0.031	0.627%
2022-12-26	26	28.123	-2.123	2.123	4.506	8.165%
2022-12-29	23	27.486	-4.486	4.486	20.124	19.504%

Perkiraan untuk Periode berikutnya adalah 26.140

c. Return Prediction for Next Period

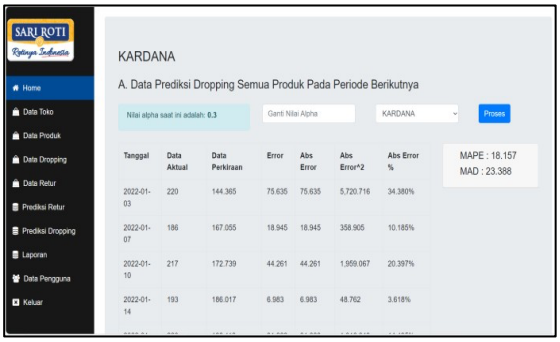


d. Return Prediction Chart

Figures 8. Sample pages of return predictions for all bread products and bread return graphs from Kardana store

8. Drop Prediction Page

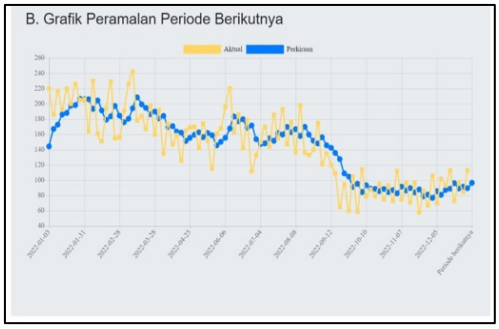
On the drop prediction page, there is a table containing dates in the actual data, estimated data, and error values for each date, and sales personnel can input the alpha value to determine the average error rate and prediction results and display a comparison graph between actual data and prediction data. Before starting to display prediction results, users can select a store and select a product for which they want to display prediction results. The return data displayed is data over a one-year period. The following Figures 9 shown sample pages of return predictions for all bread products and bread return graphs from Kardana store.



a. Dropping Prediction Data (1)

b. Dropping Prediction Data (2)

c. Dropping Prediction Data for Next Periode

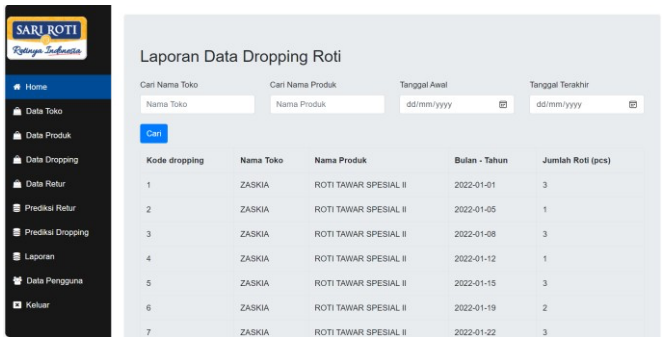


d. Dropping Prediction Chart

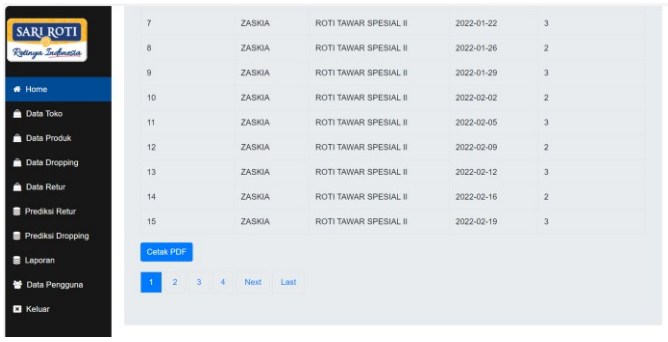
Figure 9. Sample pages of return predictions for all bread products and bread return graphs from Kardana store.

9. Dropping Data Report Page

On the bread drop data report page, there is bread drop data consisting of drop code, store name, product name, month-year, and quantity of bread (pcs). In this menu, users can display data based on store name, product name, start date, and end date. In this menu, users can print the displayed data in PDF format. The bread drop data report page can be seen in Figures 10.



a. Dropping Data Report (1)



b. Dropping Data Report (2)

Figures 10. The bread drop data report page

The following is the result of the drop data report that has been printed in PDF format, which can be seen in Figure 11:

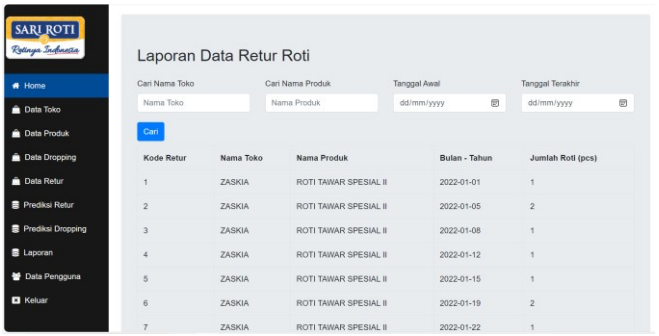
Daftar Data Dropping Roti Di Toko Zaskia

Kode	Nama Produk	Bulan - Tahun	Jumlah Roti (pcs)
1	ROTI TAWAR SPESIAL II	2022-01-01	3
2	ROTI TAWAR SPESIAL II	2022-01-05	1
3	ROTI TAWAR SPESIAL II	2022-01-08	3
4	ROTI TAWAR SPESIAL II	2022-01-12	1
5	ROTI TAWAR SPESIAL II	2022-01-15	3
6	ROTI TAWAR SPESIAL II	2022-01-19	2
7	ROTI TAWAR SPESIAL II	2022-01-22	3
8	ROTI TAWAR SPESIAL II	2022-01-26	2
9	ROTI TAWAR SPESIAL II	2022-01-29	3
10	ROTI TAWAR SPESIAL II	2022-02-02	2
11	ROTI TAWAR SPESIAL II	2022-02-05	3
12	ROTI TAWAR SPESIAL II	2022-02-09	2
13	ROTI TAWAR SPESIAL II	2022-02-12	3

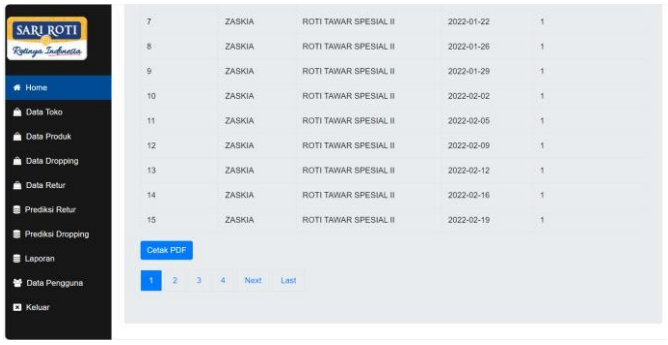
Figure 11. Printed Dropping Data Report

10. Return Data Report Page

    On the bread return data report page, there is bread return data consisting of return code, store name, product name, month-year, and quantity of bread (pcs). In this menu, users can display data based on store name, product name, start date, and end date. In this menu, users can print the displayed data in PDF format. The bread return data report page can be seen in Figures 12.



a. Return Data Report (1)



b. Return Data Report (2)

Figures 12. The bread return data report page

The following is the result of the drop data report that has been printed in PDF format, which can be seen in Figure 13:

Daftar Data Retur Roti Di Toko Zaskia

Kode	Nama Produk	Bulan - Tahun	Jumlah Roti (pcs)
1	ROTI TAWAR SPESIAL II	2022-01-01	1
2	ROTI TAWAR SPESIAL II	2022-01-05	2
3	ROTI TAWAR SPESIAL II	2022-01-08	1
4	ROTI TAWAR SPESIAL II	2022-01-12	1
5	ROTI TAWAR SPESIAL II	2022-01-15	1
6	ROTI TAWAR SPESIAL II	2022-01-19	2
7	ROTI TAWAR SPESIAL II	2022-01-22	1
8	ROTI TAWAR SPESIAL II	2022-01-26	1
9	ROTI TAWAR SPESIAL II	2022-01-29	1
10	ROTI TAWAR SPESIAL II	2022-02-02	1
11	ROTI TAWAR SPESIAL II	2022-02-05	1
12	ROTI TAWAR SPESIAL II	2022-02-09	1
13	ROTI TAWAR SPESIAL II	2022-02-12	1
14	ROTI TAWAR SPESIAL II	2022-02-16	1
15	ROTI TAWAR SPESIAL II	2022-02-19	1
16	ROTI TAWAR SPESIAL II	2022-02-23	1
17	ROTI TAWAR SPESIAL II	2022-02-26	1

Figure 13. Printed Return Data Report

1. Manual Calculation of Single Exponential Smoothing Method
   The following is a manual calculation using the Single Exponential Smoothing method from one sample of drop prediction data over a one-year period from one store, namely Rafa Jaya Store with the Chocolate Sandwich II product:

Table 1. Manual Calculations

Bulan	Data	Data
2022-01-02	25	24,71
2022-01-05	29	24,797
2022-01-09	30	26,058
2022-01-12	25	27,241
2022-01-16	30	26,568
…..	…	…….
…..	…	…….
…..	…	…….
…..	…	…….
…..	…	…….
2022-12-21	20	19,731
2022-12-24	25	19,812
2022-12-28	15	21,368
2022-12-31	20	19,458
Next Month		19,620

The estimated data above is calculated using the Single Exponential Smoothing method based on the actual data from the previous month and previous estimated data. To obtain the initial data for the estimated data, namely the date 02/01/2022, this formula can be used:

$$\text{Total drop data} \,/\, \text{number of drop data}$$

Next is the calculation to obtain the estimated data for the subsequent date period with an alpha value of 0.3:

$$0{,}3 * 25 + (1 - 0{,}3) * 24{,}71$$

Where:

0,3 : Alpha value (Alpha parameter that has been determined previously)

25 : Drop data (Previous actual data)

24,71 : Estimated data value (Estimated data from the previous period)

The calculation above produces estimated data for the next date period, which is = 24.797. This process can be continued to obtain estimated data for the following months until December 2022. For each subsequent month, the actual drop data value and previous estimated data are replaced sequentially according to the actual data in the calculation table. Thus, we can forecast the estimated data for the entire time period in the 2022 time series using the Single Exponential Smoothing method.

1. MAD Error Evaluation Testing
   In this error evaluation, there are 2 parameters that must be calculated to obtain the error value, namely error and abs error. Error is the difference between actual data (Drop Data) and estimated data (Estimated Data) for each time period. The formula is:

$$Error = Retur\ Data - Estimation\ Data$$

   Abs Error is the absolute value of error (the absolute difference between actual data and estimated data) for each time period. The formula is:

$$Abs\ Error = |Error|$$

Table 2. MAD Error Evaluation

error	abs *error*	
0,29	0,29	
4,203	4,203	
3,942	3,942	
-2,241	2,241	
3,432	3,432	
-2,598	2,598	
3,181	3,181	
-2,773	2,773	
-6,941	6,941	
0,141	0,141	
……	…….	…….
……	…….	…….
……	…….	…….
……	…….	…….
……	…….	…….
……	…….	…….
5,188	5,188	
-6,368	6,368	
0,542	0,542	
error	abs error	
-16,96541437	598,24941	TOTAL
-0,169654144	5,9825	Avg

From the Table 2, a MAD error value of 5.982 is obtained.

4. Conclussion

The system can predict return and drop data by checking the sales visit schedule, so that data can be processed according to the Single Exponential Smoothing method. These prediction results are displayed on the return prediction and drop prediction pages according to the selected store. The use of the Single Exponential Smoothing method to predict returns and drops for the 10 most common Sari Roti products from each store in North Aceh, using an alpha value of 0.3, shows fairly good results. Error evaluation using Mean Absolute Deviation (MAD) shows that the average error value is below 10%. However, error evaluation using Mean Absolute Percentage Error (MAPE) is still inadequate, because the average error value is below 40%.

To understand the error rate in predicting the quantity of Sari Roti that will be returned using the Single Exponential Smoothing method, evaluation needs to be conducted using Mean Absolute Percentage Error (MAPE) and Mean Absolute Deviation (MAD) calculations.

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