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Web-Based Raw Material Inventory Forecasting System Using Double Exponential Smoothing Method

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ABSTRACT

Controlling raw material inventory is important in every production process, but Selera Baru Bakery has not received control over the raw material inventory procurement process, so business owner does not know when the right time to procure raw materials is. The research aims to develop a web-based raw material inventory prediction system designed specifically for New Taste Bakery. The system will use the Double Exponential Smoothing (DES) method to predict future raw material needs. Bakeries often have trouble managing the level of raw material supplies. This system is expected to improve the accuracy of forecasting raw material stocks, reduce stock exhaustion and storage costs, and improve bakery management decision-making related to raw material purchases. This causes bread production to be carried out in accordance with the availability of existing raw materials when the production process is carried out not based on sales needs. The production process that is not in accordance with these needs results in a shortage or excess stock so that the bread is moldy and not suitable for sale. Based on this condition, research is conducted using the Double Exponential Smoothing method with PHP programming language and MySQL uses database. System design uses UML and system development uses Waterfall, based on the categories of wheat raw materials, flour, yeast, sugar, eggs and margarine with alpha parameter testing of 0.2 showing effectiveness in using the Double Exponential Smoothing method with a MAPE value of less than 10%, this proves that the forecasting results are effective and accurate in controlling the raw material inventory procurement process in Selera Baru Bakery.

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1. INTRODUCTION

The world has experienced a very rapid development, especially in the field of technology which has provided many benefits in various ways. It is inseparable from the existence of the internet which is used as one of the methods in daily activities, especially in business and business activities. Currently, computer technology and the internet have been used in various companies as facilities to carry out their business activities online, be it sales, promotions, payments, production, and transactions.

At this time bread is a food that is familiar among the community and also its development is so rapid. So that bread is easy to get and many entrepreneurs have opened a bread-type manufacturing industry. The bakery industry is one type of industry engaged in food, there are three types of bread industry in Indonesia, namely the home industry, the mass bakery industry (industrial), and the Boutique Bakery industry.

Selera Baru Bakery is one of the manufacturing companies that produces bread with various types of flavors since 1991 until today, the production process is still running today. The location of Selera Baru Bakery is located in Manis Hamlet, Purwasari Village, Garawangi District, Kuningan Regency, West Java Province. Producing various types of different bread variants are generally divided into two, namely sweet bread and white bread known by the public with the label "Selera Baru". It has 10 types of bread produced so it needs to be considered optimally regarding the use of various existing resources.

Selera Baru Bakery experienced a decrease in production in February and April 2020 so that production results were unstable, especially in sweet bread variants. In February there was a decrease in production by 5,646 pcs and in April there was a decrease in production by 9,457 pcs. This decrease was caused by the Covid-19 virus outbreak so that the number of requests dropped dramatically and there were also some defective products but the use of raw materials, machine aids and energy was relatively the same as the previous month.

In 2022 the production process has slowly increased by 12,749 pcs in August so that it can be said that the production process began to run optimally as usual, and in 2023 the production process is said to run optimally as it should by increasing in several months with a total of 26,097 pcs, therefore to maintain the stability of the production process, it is necessary to estimate raw material control techniques so that the company can optimize the availability of raw materials that will be used in the future. The data used is 2023 data and will then be predicted to arrive in 2024.

Selera Baru Bakery has not received control of the raw material inventory procurement process, so business owners do not know when is the right time to procure raw materials. This causes bread production to be carried out in accordance with the availability of existing raw materials when the production process is carried out not based on sales needs. The production process that is not in accordance with these needs results in a shortage or excess stock so that the bread is moldy and not suitable for sale.

Regarding this, to solve the problem above, a raw material inventory control technique was proposed using the forecasting technique of the Double Exponential Smoothing method at Selera Baru Bakery. Forecasting the inventory of raw materials is quite important for companies to predict how much the inventory of bread raw materials in the next month. With this forecasting system, companies can estimate how much raw materials are needed without having to take a lot of time. The application that will be made is web-based that will help companies in controlling the inventory of bread raw materials using the Double Exponential Smoothing (DES) method. The DES method in this system aims to forecast or predict the inventory of bread raw materials in a certain period, so that it can help owners make decisions for some number of raw materials to be purchased in the next period.

The Double Exponential Smoothing method is a method used to provide forecasting results when a data has a certain trend data pattern. The Double Exponential method has the advantages of being able to use the majority of data that is small, fewer parameters in determining forecasting, and easier data management (no data changes are needed when non-stationary data and autoregression analysis do not need to be used in a forecasting) [1][10][11].

2. METHOD

This research uses data collection methods by conducting observations, interviews, and literature studies, methods for system development using Waterfall, for system design using UML with PHP and MySQL programming languages. As for solving the problem using the Double Exponential Smoothing forecasting method and finding the average error value using MAPE then assisted by Microsoft Excel tools to facilitate calculations.

Forecasting is a forecast about something that happens in the future. Forecasting is an effective and efficient tool that is used as a basis for planning or decision making both for the long and short term. In production and operations activities, forecasting results can be used for capacity planning, facilities, production, scheduling, and inventory control [2][7][9].

The Double Exponential Smoothing method is a forecasting / prediction method by giving weighted values in several periods or previous observations to predict values in future periods. There are two kinds of Double Exponential Smoothing methods, namely from Holt and Brown. Double Exponential Smoothing Brown is exponential smoothing that uses only one parameter, while Double Exponential Smoothing Holt uses 2 parameters (α and β or γ) which smooths trend values (consistent tendencies) with parameters that are different from the parameters used from the original series [2].

Therefore, the method that will be used by the author in predicting raw material inventory is using the Double Exponential Smoothing method from Brown, from several studies that have become a reference the author states that the Double Exponential Smoothing method from Brown has an accurate error value. The following is Brown's Double Exponential Smoothing formula that will be used in this study [2][8].

1. Determining The First Smoothing
   $S'_t = \alpha X_t + (1-\alpha) S'_{t-1}$ (1)
2. Determining The Second Smoothing
   $S''_t = \alpha S'_t + (1-\alpha) S''_{t-1}$ (2)
3. Define Constants α_t
   $\alpha_t = S'_t + (S'_t - S''_t) = 2S'_t - S''_t$ (3)
4. Define Constants b_t
   $b_t = \frac{\alpha}{1-\alpha} (S'_t - S''_t)$ (4)
5. Determining Forecasting Values (F_{t+m})
   $F_{t+m} = \alpha_t + b_t m$ (5)

Where:
S'_t = Single exponential smoothing value in the t period
S'_{t-1}= Single exponential smoothing value in the (t-1) period
S''_t = Double exponential smoothing value in the t period
S''_{t-1}= Double exponential smoothing value in the (t-1) period
X_t = Actual Data of time series in the t period
α = Exponential smoothing parameter 0<α<1
α_t, b_t= Smoothing constants in the t period
F_{t+m}= Forecasting results for the forecasted future period
m = Number of forecasted future periods

To use the formula, the values S'_t and S''_{t-1}must be available. But at t=1 these values do not exist because the values must be determined at the beginning of the period, so to overcome this can be done with the value X_1 (actual data). For initialization is the initial value used in exponential forecasting, initialization for Brown exponential smoothing is a α_t dan b_t , $\alpha_1 = (actual\ data)$ [3].

6. Determining MAPE Values
   $MAPE = \sum_{t=1}^{n} \left| \left(\frac{A_t - F_t}{A_t} \right) \right| \times 100\%$ (6)

Where n is the amount of data, A_t is the actual data and F_t is the predicted data. There are 4 categories of MAPE value that can be interpreted as in the following table [4]:

Table 1. Categories of MAPE

NILAI MAPE	Criteria/Curation Forecast
MAPE <10%	Forecasting model is excellent (High)
10% < MAPE ≤ 20%	Forecasting model is good
20% < MAPE ≤ 50%	Forecasting model are feasible (Reasonable)

MAPE > 50%	Forecasting model are bad (Low)

From the table above about the criteria for MAPE values, it can be explained that the smaller the MAPE value, the smaller the error of the estimation results and is declared good. Conversely, if the MAPE value is greater, the greater the estimation value and is declared bad [5].

3. RESULT AND DISCUSSION

After going through the design and implementation process, at this stage the results of the process that have been carried out will be briefly displayed.

3.1. Double Exponential Smoothing Calculation

The following are the results of the Double Exponential Smoothing calculation from Brown on the Selera Baru Bakery application, where the data used is data on bread raw materials for 2023-2024 which will forecast in the next month is presented in the table below:

Table 2. Results of the Double Exponential Smoothing calculation

Number	Month	Data Materials 2023-2024				
		Flour	Yeast	Sugar	Eggs	Margarine
1	23-Jan	3782	216	1785	565	429
2	23-Feb	3931	325	1834	685	563
3	23-Mar	3875	283	1791	592	517
4	23-Apr	3889	295	1793	601	526
5	23-May	3934	315	1836	697	591
66	23-Jun	3978	384	1856	711	663
7	23-Jul	3945	348	1849	694	620
8	23-Aug	3843	298	1796	702	618
9	23-Sep	3897	323	1801	736	641
10	23-Oct	3984	411	1943	786	672
11	23-Nov	3991	425	1936	793	702
12	23-Dec	4011	435	1946	841	713
13	23-Jan	4034	452	1987	837	746
14	23-Feb	4119	417	1992	876	766
15	23-Mar	3985	386	1812	782	702
16	23-Apr	3851	411	1876	824	731

From the table above, the manual calculation will be carried out is wheat raw materials, for further raw materials will be assisted using Microsoft Excel tools. Before the calculation is carried out, an approach will be made to determine the optimal value of α parameters. The specified value is from 0.1 to 0.9.

Based on journals or references that have become the author's reference that the alpha parameter 0.2 is proven to have an optimal value with the Double Exponential Smoothing method from Brown. So, then the forecasting in this study will use α=0.2. The value specified is from 0.1 to 0.9 [6].

1. Determining The First Smoothing

$$S'_t = \alpha X_t + (1 - \alpha) S'_{t-1} \quad (1)$$

- For t=1 (January 2023)
  $X_1 = 3782$
  Since S'_{t-1} is not available $S'_1 = X_1$
  $S'_1 = 3782$
- For t=2 (February 2023)
  $X_2 = 3931$
  $S'_2 = \alpha X_2 + (1-\alpha)S'_{2-1}$
  $S'_2 = \alpha X_2 + (1-\alpha)S'_1$
  $S'_2 = (0{,}2 \times 3931) + (1-0{,}2) \times 3782$
  $S'_2 = 3812$
- For t=3 (March 2023)
  $X_3 = 3875$
  $S'_3 = \alpha X_3 + (1-\alpha)S'_{3-1}$
  $S'_3 = \alpha X_3 + (1-\alpha)S'_2$
  $S'_3 = (0{,}2 \times 3875) + (1-0{,}2) \times 3812$
  $S'_3 = 3825$
- For t=4 (April 2023)
  $X_4 = 3889$
  $S'_4 = \alpha X_4 + (1-\alpha)S'_{4-1}$
  $S'_4 = \alpha X_4 + (1-\alpha)S'_3$
  $S'_4 = (0{,}2 \times 3889) + (1-0{,}2) \times 3825$
  $S'_4 = 3838$
- For t=5 (May 2023)
  $X_5 = 3934$
  $S'_5 = \alpha X_5 + (1-\alpha)S'_{5-1}$
  $S'_5 = \alpha X_5 + (1-\alpha)S'_4$
  $S'_5 = (0{,}2 \times 3934) + (1-0{,}2) \times 3838$
  $S'_5 = 3857$

  And so on until the value t=16 for April 2024
- For t=16 (April 2024)
  $X_{16} = 3851$
  $S'_{16} = \alpha X_{16} + (1-\alpha)S'_{16-1}$
  $S'_{16} = \alpha X_{16} + (1-\alpha)S'_{15}$
  $S'_{16} = (0{,}2 \times 3851) + (1-0{,}2) \times 3936$
  $S'_{16} = 3941$

2. Determining S''_t (The Second Smoothing)

$$S''_t = \alpha S'_t + (1-\alpha)S''_{t-1} \quad (2)$$

- For t=1 (January 2023)
  $X_1 = 3782$
  Since S''_{t-1} is not available $S''_1 = X_1$
  $S''_1 = 3782$
- For t=2 (February 2023)
  $X_2 = 3931$
  $S'_2 = 3812$
  $S''_2 = \alpha S'_2 + (1-\alpha)S''_{2-1}$
  $S''_2 = \alpha S'_2 + (1-\alpha)S'_1$
  $S''_2 = (0{,}2 \times 3821) + (1-0{,}2) \times 3782$
  $S''_2 = 3788$
- For t=3 (March 2023)
  $X_2 = 3875$
  $S'_3 = 3825$
  $S''_3 = \alpha S'_3 + (1-\alpha)S''_{3-1}$
  $S''_3 = \alpha S'_3 + (1-\alpha)S'_2$
  $S''_3 = (0{,}2 \times 3825) + (1-0{,}2) \times 3788$
  $S''_3 = 3795$
- For t=4 (April 2023)
  $X_4 = 3889$
  $S'_4 = 3838$
  $S''_4 = \alpha S'_4 + (1-\alpha)S''_{4-1}$
  $S''_4 = \alpha S'_4 + (1-\alpha)S'_3$
  $S''_4 = (0{,}2 \times 3838) + (1-0{,}2) \times 3795$
  $S''_4 = 3804$
- For t=5 (May 2023)
  $X_5 = 3934$
  $S'_5 = 3857$
  $S''_5 = \alpha S'_5 + (1-\alpha)S''_{5-1}$
  $S''_5 = \alpha S'_2 + (1-\alpha)S'_4$
  $S''_5 = (0{,}2 \times 3857) + (1-0{,}2) \times 3804$
  $S''_5 = 3815$

  And so on until the value t=16 for April 2024
- For t=16 (April 2024)
  $X_{16} = 3851$
  $S'_{16} = 3963$
  $S'_{16} = \alpha X_{16} + (1-\alpha)S'_{16-1}$
  $S'_{16} = \alpha X_{16} + (1-\alpha)S'_{15}$
  $S'_{16} = (0{,}2 \times 3963) + (1-0{,}2) \times 3936$
  $S'_{16} = 3941$

3. Define Constants (α_t)

$$\alpha_t = S'_t + (S'_t - S"_t) = 2S'_t - S"_t \quad (3)$$

- For t=1 (January 2023)
  $\alpha_1 = S'_1 + (S'_1 - S"_1)$
  $\alpha_1 = 2S'_1 - S"_1$
  $\alpha_1 = 2 \times 3782 - 3782$
  $\alpha_1 = 3782$
- For t=2 (February 2023)
  $\alpha_2 = S'_2 + (S'_2 - S"_2)$
  $\alpha_2 = 2S'_2 - S"_2$
  $\alpha_2 = 2 \times 3812 - 3788$
  $\alpha_2 = 3836$
- For t=3 (March 2023)
  $\alpha_3 = S'_3 + (S'_3 - S"_3)$
  $\alpha_3 = 2S'_3 - S"_3$
  $\alpha_3 = 2 \times 3825 - 3795$
  $\alpha_3 = 3853$
- For t=4 (April 2023)
  $\alpha_4 = S'_4 + (S'_4 - S"_4)$
  $\alpha_4 = 2S'_4 - S"_4$
  $\alpha_4 = 2 \times 3838 - 3804$
  $\alpha_4 = 3871$
- For t=5 (May 2023)
  $\alpha_5 = S'_5 + (S'_5 - S"_5)$
  $\alpha_5 = 2S'_5 - S"_5$
  $\alpha_5 = 2 \times 3857 - 3815$
  $\alpha_5 = 3899$

  And so on until the value α_t for t=16
- For t=16 (April 2024)
  $\alpha_{16} = S'_{16} + (S'_{16} - S"_{16})$
  $\alpha_{16} = 2S'_{16} - S"_{16}$
  $\alpha_{16} = 2 \times 3963 - 3841$
  $\alpha_{16} = 3985$

4. Define Constants (b_t)

$$b_t = \frac{\alpha}{1-\alpha}(S'_t - S"_t) \quad (4)$$

- For t=1 (January 2023)
  $b_1 = \frac{\alpha}{1-\alpha}(S'_1 - S"_1)$
  $b_1 = \frac{0,2}{1-0,2}(3782 - 3782)$
  $b_1 = 0$
- For t=2 (February 2023)
  $b_2 = \frac{\alpha}{1-\alpha}(S'_2 - S"_2)$
  $b_2 = \frac{0,2}{1-0,2}(3812 - 3788)$
  $b_2 = 5,96$
- For t=3 (March 2023)
  $b_3 = \frac{\alpha}{1-\alpha}(S'_3 - S"_3)$
  $b_3 = \frac{0,2}{1-0,2}(3825 - 3795)$
  $b_3 = 7,30$
- For t=4 (April 2023)
  $b_4 = \frac{\alpha}{1-\alpha}(S'_4 - S"_4)$
  $b_4 = \frac{0,2}{1-0,2}(3838 - 3804)$
  $b_1 = 8,42$
- For t=5 (May 2023)
  $b_5 = \frac{\alpha}{1-\alpha}(S'_5 - S"_5)$
  $b_5 = \frac{0,2}{1-0,2}(3857 - 3815)$
  $b_5 = 10,60$

  And so on until the value b_t for t=16
- For t=16 (April 2024)
  $b_{16} = \frac{\alpha}{1-\alpha}(S'_{16} - S"_{16})$
  $b_{16} = \frac{0,2}{1-0,2}(3963 - 3941)$
  $b_{16} = 5,83$

5. Determining 1 period forecasting values (F_{t+m})

$$F_{t+m} = \alpha_t + b_t\, m \quad (5)$$

- For t = 1, m = 1
  $F_{1+1} = \alpha_1 + b_1\, m$
  $F_{1+1} = 3782 + 0 \times 1$
  $F_2 = 3782$
  For t = 2, m = 1
  $F_{2+1} = \alpha_2 + b_2\, m$
  $F_{2+1} = 3836 + 5{,}96 \times 1$
  $F_3 = 3841{,}60$
- For t = 3, m = 1
  $F_{3+1} = \alpha_3 + b_3\, m$
  $F_{3+1} = 3854 + 7{,}30 \times 1$
  $F_4 = 3860$
- For t = 4 , m = 1
  $F_{4+1} = \alpha_4 + b_4\, m$
  $F_{4+1} = 3871 + 8{,}42 \times 1$
  $F_5 = 3879$
- For t = 5, m = 1
  $F_{5+1} = \alpha_5 + b_5\, m$
  $F_{5+1} = 3899 + 10{,}60 \times 1$
  $F_2 = 3910$

  And so on until t = 16, then the forecasting of flour raw materials for May 2024 can be carried out. The forecast for the amount of flour raw materials in May 2024 with the number of future periods predicted is 1 month, then m=1 and the value of the period used is the period in the last month, which is t=16:
- For t = 16 , m = 1
  $F_{16+1} = \alpha_{16} + b_{16}\, m$
  $F_{16+1} = 3983{,}68 + 5{,}38 \times 1$
  $F_{17} = 3898$

The following are the forecasting results of the five raw materials that have been processed and calculated to forecast in May 2024, can be seen in the table below:

Table 3. Results of the five raw materials to forecast in May 2024

Materials	Parameter Alpha (α)	Forecasting Value
Flour	0,2	3989,06
Yeast	0,2	447,80
Sugar	0,2	1916,79
Eggs	0,2	856,50
Margarine	0,2	766,60

6. Determining MAPE Values

$$MAPE = \left(\frac{100\%}{n}\right)\sum_t^n = 1\left|\frac{X_t - F_t}{X_t}\right| \quad (6)$$

$$MAPE = \left(\begin{array}{c}\left|\frac{3782-3782}{3782}\right| + \left|\frac{3931-3782}{3931}\right| + \left|\frac{3875-3841}{3875}\right| + \left|\frac{3889-3860}{3889}\right| \\ + \left|\frac{3934-3879}{3934}\right| + \cdots (until\ t = 16 \ldots + \left|\frac{3851-4058}{3851}\right|\end{array}\right) \times 100$$

$$\frac{1}{16} = (0 + 0{,}037 + 0{,}008 + 0{,}007 + 0{,}013 + \cdots until\ t16 + 0{,}053) \times 100$$

$$MAPE = 1{,}641\%$$

The MAPE value of each raw material can be seen in the following table:

Tabel 4. The MAPE value of each raw material

MATERIALS	Parameter Alpha(α)	Forecasting Value	MAPE Values (%)

Flour	0,2	3989,06	1,64
Yeast	0,2	447,80	11,33
Sugar	0,2	1916,79	2,62
Eggs	0,2	856,50	5,38
Margarine	0,2	766,60	5,92

It can be seen that the percentage of each raw material has a very good percentage when viewed from the MAPE criteria, Yeast raw materials have a MAPE value above 10%, meaning that the forecasting ability is still said to be good. With an alpha value of 0.2, the forecast value produced for each raw material has a range or percentage above ≤ 10%, meaning that the forecasting accuracy produced by the four raw materials produced from the calculation has high accuracy. So, it can be concluded that the Double Exponential Smoothing method from Brown is effective in forecasting the number of raw materials for Flour, Yeast, Sugar, Eggs, and Margarine.

3.2. System Implementation

Here's a look at the Selera Baru Bakery system with an admin user who can manage calculation data.

1. *Admin Log In Page*

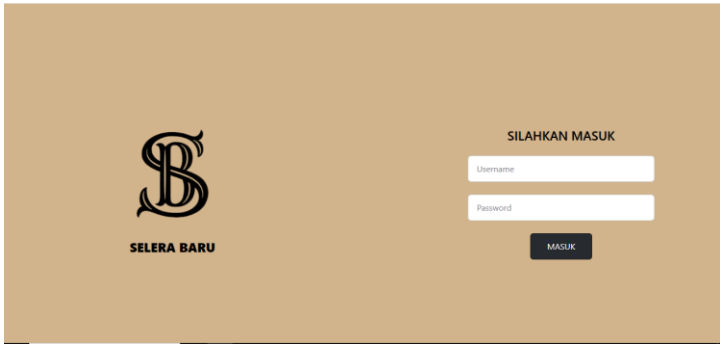

Figure 1. *Admin Log In Page*

The login page is the page that appears the first time accessed by the user. Here users must input their username and password in order to enter their respective dashboards.

2. *Admin Dashboard Page*

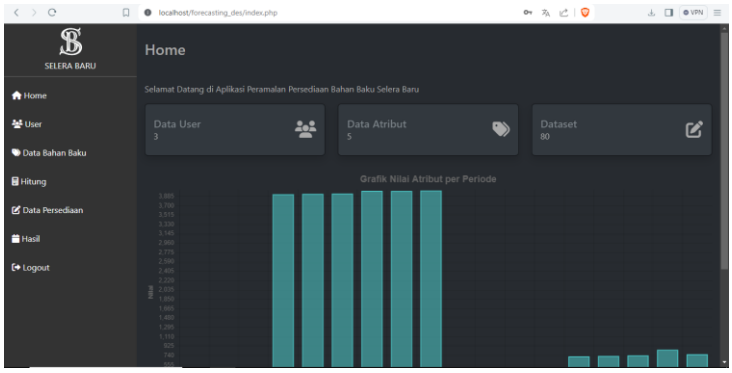

Figure 2. *Admin Dashboard Page*

This page is a special admin page consisting of several menus to manage master data ranging from user data, raw material data, inventory data, calculations, results, passwords, and so on.

3. *Calculation and Results Page*

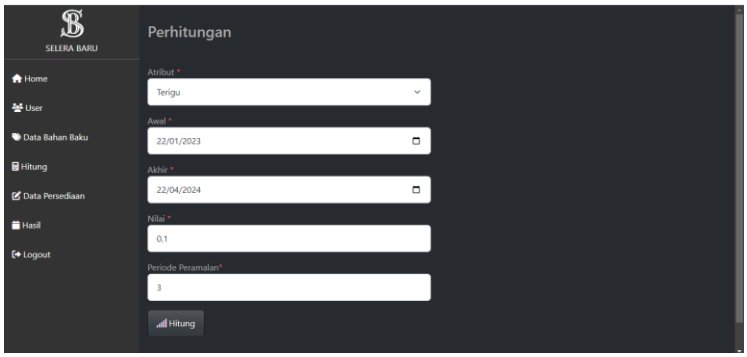

Figure 3. *Calculation*

The calculation page is a page for admins to perform calculations so that they can produce data and information for forecasting using double exponential smoothing, then admins can view or print the results in pdf file format.

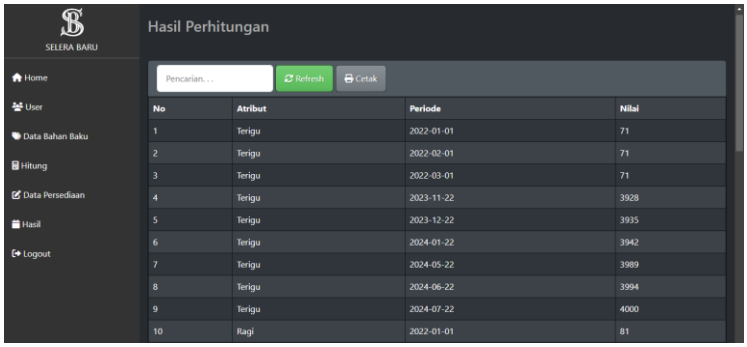

Figure 4. *Results Page*

7. CONCLUSION

After conducting research using the Double Exponential Smoothing method from the forecasting information system for bread raw materials in New Tastes, Bakery can or is able to show good forecasting based on each raw material, namely Flour, Yeast, Sugar, Eggs, and Margarine. From this method, it was found that 4 out of 5 raw materials produced a smaller MAPE value with an average value below 10%, so it can be concluded that Brown's Double Exponential Smoothing method shows effectiveness in controlling raw material inventory.

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REFERENCES

[1] Caesar D.K, Hidayatus S, L. Hodgson, and M.Fuat A, "Aplikasi Prediksi Persediaan Barang Pada Toko Gudang ACC Wonosobo Dengan Metode Double Exponential Smoothing Berbasis Web," Journal of Information System and Computer, vol. 2, no. 1, Juli 2022, e-ISSN : 2809-5995.

[2] Muhammad Hilmy, Badie'ah, Hud Munawar, "Implementasi Metode Double Exponential Smoothing Untuk Memprediksi Kebutuhan Produksi Pada CV. Pusaka Indah Furniture Jepara" Prosidid Seminar Nasional, Konstelasi Ilmiah Mahasiswa UNISULLA 5, 2021.

[3] M.J.B.N.S. Andini D.P, "Implementasi Metode Double Exponential Smoothing Dalam Memprediksi Pertambahan Jumlah

Penduduk di Wilayah Kabupaten Karawang," ULTIMATICS, vol. 12, pp. 95-103, 2020.

[4] M.Hasibiyalloh and D. Ahmad Jakaria, "Aplikasi Penjualan Barang Perlengkapan," Jumantaka, vol.1, no.1. pp. 61-70, 2018.

[5] Riyadul Fajri, Teuku Muhammad Johan, "Implementasi Peramalan Double Exponential Smoothing Pada Kasus Kekerasan Anak di Pusat Pelayanan Terpadu Pemberdayaan Perempuan dan Anak," Jurnal Ecotipe, vol.4, no.2, Oktober 2017, ISSN : 2355-5068.

[6] Albert Stephano, Shantika Martha, Syahru Rahmayuda,"Sistem Peramalan Tren Pelanggan Dengan Menggunakan Double Exponential Smoothng Di Mess GM," Jurnal Komputer dan Aplikasi, vol.8, no.1, pp. 237-246, ISSN : 2338-493X, 2020.

[7] Cahya A.U, Yan Watequlis S, "Pengembangan SI Stok Barang Dengan Peramalan Menggunakan Metode Double Exponential Smoothing Studi Kasus PT. Tomah Jaya Elektrikal," Jurnal Informatika Polinema, vol.2, no.4, Agustus 2016, ISSN : 2407-070X, 2020.

[8] Hasmin, Erfan & Aini, Nurul. (2020). Data Mining For Inventory Forecasting Using Double Exponential Smoothing Method. 1-5. 10.1109/ICORIS50180.2020.9320765.

[9] Sudiatmika, Anop & Indrawan, Gede & Divayana, Dewa. (2022). Optimasi Nilai Parameter pada Metode Brown's Exponential Smoothing dengan Algoritma Multiple Genetik. Jurnal Nasional Pendidikan Teknik Informatika (JANAPATI). 11. 39. 10.23887/janapati.v11i1.34627.

[10] Sinaga, Hommy & Irawati, Novica. (2018). PERBANDINGAN DOUBLE MOVING AVERAGE DENGAN DOUBLE EXPONENTIAL SMOOTHING PADA PERAMALAN BAHAN MEDIS HABIS PAKAI.

[11] Falani, Ilham. (2018). PENENTUAN NILAI PARAMETER METODE EXPONENTIAL SMOOTHING DENGAN ALGORITMA GENETIK DALAM MENINGKATKAN AKURASI FORECASTING. CESS (Journal of Computer Engineering, System and Science). 3. 10.24114/cess.v3i1.8268.