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# PARAMETER OPTIMIZATION OF SINGLE EXPONENTIAL SMOOTHING USING GOLDEN SECTION METHOD FOR GROCERIES FORECASTING

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## ABSTRACT

Department of Agriculture and Food Security Malang City, especially in the Field of Food Supply Availability and Distribution requires a reference forecasting of food prices in Malang. The method used in the forecasting calculation is Single Exponential Smoothing. In the process of calculating the Single Exponential Smoothing method, it takes alpha parameters between 0 and 1. The problem is when to estimate the alpha value between 0 to 1 with trial error with the aim of producing minimal forecasting results. Therefore, this study aims to determine the optimal alpha value. The method used in this research is the Golden Section Method. The principle of Golden Section method in this study is to reduce the boundary area so as to produce a minimum MAPE (Mean Absolute Percentage Error) value The data used in this study is the price of 9 commodities of Groceries in Malang since January 1, 2016 until December 31, 2017. The results showed that the Golden Section method found that the optimal alpha value was 0.999 with MAPE average of 9 commodities is 0.79%. So with this golden section method researchers do not need a long time to determine alpha by trial error.

**Keywords**: groceries, forecasting, Exponential Smoothing, Golden Section

## INTRODUCTION

One of the tasks of the Department of Agriculture and Food Security of Malang City, especially the Field of Food Supply Availability and Distribution is to formulate groceries price policy. In formulating the policy formulation, it needs a reference for price forecasting of groceries od. The predictions made are generally based on the data contained in the past that were analyzed using certain methods. The method used for forecasting the price of groceries in Malang is Single Exponential Smoothing Method. The price of groceries used from 1 January 2016 to 31 December 2017.

In the process of calculating the Exponential Smoothing Single required alpha values between 0 to 1. In order to produce a small MAPE (Mean Absolute Percentage Error) then must input the value of the appropriate alpha parameter. The problem is the value of alpha parameters input by trial and error, so it takes a long time. Therefore in this study will discuss a method to determine the value of alpha parameters in Single Exponential Smoothing calculation process. The method used is the Golden section method.

Research on the method of Golden Section ever done Al Makhya et all **[1].** The results showed that after the calculation with the Golden Section, we get the optimum parameters for each method. Similarly, in the research of Prihatmono and Utami **[2]**, the

Golden Section method can also find the optimum parameter so as to produce minimum MAPE value. Therefore in this study, researchers applied the Golden Section Method to find the optimal variable in forecasting the prices of groceries in the Malang City.

## METHODS

### 2.1. Data of Groceries

The price of groceries in Malang is obtained from http://siskaperbapo.com/harga/tabel page **[3]**. The data analyzed in this research is data of 9 commodities of Groceries starting from January 1, 2016 - 31 December 2017, ie for 731 days. The types of food commodities studied are rice, sugar, cooking oil without brand / bulk oil, chicken eggs / laying eggs, broiler chicken, fine salt, indomilk, ordinary chili, and 3 kg LPG tube.

### 2.2. Data Analysis

The method used in forecasting the price of groceries in this study is Single Exponential Smoothing method. The equation used in calculating the forecast with the Single Exponential Smoothing method is

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

where $F_t$ = forecast result

$X_t$ = observation data

and $\alpha$ are parameters between 0 and 1**[4].** The parameter values in this study were determined using the Golden Section Method. Here are the steps for calculating the Golden Section Method, first determining the lower boundary (a) and the upper limit (b) and the tolerance iteration ceases (eps). Because the value between 0 to 1 then a = 0 and b = 1, then calculate the value of Golden Ratio (r). According to **[5]** the r values obtained from the Golden Section algorithm are $r_1 = \frac{-1+\sqrt{5}}{2} = 0{,}618$ and $r_2 = \frac{-1-\sqrt{5}}{2} = -1{,}618$. Since the parameter value is $0<\alpha<1$, then the r used is 0.618. Determine the initial price for the parameter alpha 1 = r * a + (1 – r) * b and alpha 2 = (1 – r) * a + r *b. Look for minimum MAPE from a combination of alpha 1 and alpha 2 calculation results. Reduce the interval limit based on Golden Section criteria. Repeat steps 4 and 5 to | alpha2 - alpha 1 | ≤ eps. Find the minimum MAPE between combinations a, b, alpha 1, alpha 2. Output alpha is the optimum **[2]**

## RESULTS AND DISCUSSION

Here is the result of the Golden Section Method iteration of each commodity :

1. Rice

*Table 1 :* Optimum analysis of rice using the golden section method

| Iterate | alpha 1 | alpha 2 | MAPE (alpha1) | MAPE (alpha2) | alpha1 - alpha2 | Forecast Price (Rp) |
|---|---|---|---|---|---|---|
| 1 | 0,3820 | 0,6180 | 0,5131 | 0,40691 | 0,2360 | 11072 |
| 2 | 0,6181 | 0,7639 | 0,4069 | 0,37227 | 0,1458 | 11070 |
| 3 | 0,7640 | 0,8541 | 0,3723 | 0,3562 | 0,0901 | 11078 |
| 4 | 0,8541 | 0,9098 | 0,3562 | 0,34753 | 0,0557 | 11086 |

| Iterate | alpha 1 | alpha 2 | MAPE (alpha1) | MAPE (alpha2) | alpha1 - alpha2 | Forecast Price (Rp) |
|---|---|---|---|---|---|---|
| 5 | 0,9099 | 0,9443 | 0,3475 | 0,34257 | 0,0344 | 11091 |
| 6 | 0,9443 | 0,9656 | 0,3426 | 0,33969 | 0,0213 | 11094 |
| 7 | 0,9656 | 0,9787 | 0,3397 | 0,33793 | 0,0131 | 11097 |
| 8 | 0,9787 | 0,9868 | 0,3379 | 0,33695 | 0,0081 | 11098 |
| 9 | 0,9869 | 0,9919 | 0,3369 | 0,33642 | 0,0050 | 11099 |
| 10 | 0,9919 | 0,9950 | 0,3364 | 0,3361 | 0,0031 | 11099 |
| 11 | 0,9950 | 0,9969 | 0,3361 | 0,3359 | 0,0019 | 11099 |
| 12 | 0,9969 | 0,9981 | 0,3359 | 0,33577 | 0,0012 | 11100 |
| 13 | 0,9981 | 0,9988 | 0,3358 | 0,3357 | 0,0007 | 11100 |
| 14 | 0,9988 | 0,9993 | 0,3357 | 0,33565 | 0,0005 | 11100 |
| 15 | 0,9993 | 0,9995 | 0,3356 | 0,33562 | 0,0003 | 11100 |
| 16 | 0,9995 | 0,9997 | 0,3356 | 0,3356 | 0,0002 | 11100 |
| 17 | 0,9997 | 0,9998 | 0,3356 | 0,33559 | 0,0001 | 11100 |
| 18 | 0,9998 | 0,9999 | 0,3356 | 0,33558 | 0,0001 | 11100 |
| 19 | 0,9999 | 0,9999 | 0,3356 | 0,33558 | 0,0000 | 11100 |

In table 1 can be observed that the optimum alpha for commodity of mentik rice is 0.9999 in the iteration 19, with MAPE 0,3356%.

2. Sugar

*Table 2* : Optimum analysis of sugar using the golden section method

| Iterate | alpha 1 | alpha 2 | MAPE (alpha1) | MAPE (alpha2) | alpha1-alpha2 | Forecast Price (Rp) |
|---|---|---|---|---|---|---|
| 1 | 0,3820 | 0,6180 | 0,4322 | 0,335 | 0,2360 | 11683 |
| 2 | 0,6181 | 0,7639 | 0,3346 | 0,303 | 0,1458 | 11673 |
| 3 | 0,7640 | 0,8541 | 0,303 | 0,288 | 0,0901 | 11680 |
| 4 | 0,8541 | 0,9098 | 0,2883 | 0,28 | 0,0557 | 11686 |
| 5 | 0,9099 | 0,9443 | 0,2803 | 0,276 | 0,0344 | 11691 |
| 6 | 0,9443 | 0,9656 | 0,2757 | 0,273 | 0,0213 | 11695 |
| 7 | 0,9656 | 0,9787 | 0,273 | 0,271 | 0,0131 | 11697 |
| 8 | 0,9787 | 0,9868 | 0,2713 | 0,27 | 0,0081 | 11698 |
| 9 | 0,9869 | 0,9919 | 0,2703 | 0,27 | 0,0050 | 11699 |
| 10 | 0,9919 | 0,9950 | 0,2697 | 0,269 | 0,0031 | 11699 |
| 11 | 0,9950 | 0,9969 | 0,2693 | 0,269 | 0,0019 | 11699 |
| 12 | 0,9969 | 0,9981 | 0,269 | 0,269 | 0,0012 | 11700 |
| 13 | 0,9981 | 0,9988 | 0,2689 | 0,269 | 0,0007 | 11700 |
| 14 | 0,9988 | 0,9993 | 0,2688 | 0,269 | 0,0005 | 11700 |
| 15 | 0,9993 | 0,9995 | 0,2688 | 0,269 | 0,0003 | 11700 |
| 16 | 0,9995 | 0,9997 | 0,2688 | 0,269 | 0,0002 | 11700 |

| Iterate | alpha 1 | alpha 2 | MAPE (alpha1) | MAPE (alpha2) | alpha1-alpha2 | Forecast Price (Rp) |
|---|---|---|---|---|---|---|
| 17 | 0,9997 | 0,9998 | 0,2687 | 0,269 | 0,0001 | 11700 |
| 18 | 0,9998 | 0,9999 | 0,2687 | 0,269 | 0,0001 | 11700 |
| 19 | 0,9999 | 0,9999 | 0,2687 | 0,269 | 0,0000 | 11700 |

Same as the results of iteration in rice mentik, iteration on sugar commodities stops at the 19th iteration, with alpha 0,9999 and MAPE 0,2687%.

3. Cooking oil without brand/bulk oil

*Table 3* :. Optimum analysis of cooking oil using the golden section method

| Iterate | alpha 1 | alpha 2 | MAPE (alpha1) | MAPE (alpha2) | alpha1-alpha2 | Forecast Price (Rp) |
|---|---|---|---|---|---|---|
| 1 | 0,3820 | 0,6180 | 0,4843 | 0,391 | 0,2360 | 11766 |
| 2 | 0,6181 | 0,7639 | 0,3911 | 0,357 | 0,1458 | 11760 |
| 3 | 0,7640 | 0,8541 | 0,3571 | 0,34 | 0,0901 | 11753 |
| 4 | 0,8541 | 0,9098 | 0,3403 | 0,331 | 0,0557 | 11749 |
| 5 | 0,9099 | 0,9443 | 0,3313 | 0,326 | 0,0344 | 11745 |
| 6 | 0,9443 | 0,9656 | 0,3262 | 0,323 | 0,0213 | 11743 |
| 7 | 0,9656 | 0,9787 | 0,3232 | 0,321 | 0,0131 | 11742 |
| 8 | 0,9787 | 0,9868 | 0,3214 | 0,32 | 0,0081 | 11741 |
| 9 | 0,9869 | 0,9919 | 0,3205 | 0,32 | 0,0050 | 11741 |
| 10 | 0,9919 | 0,9950 | 0,3199 | 0,32 | 0,0031 | 11740 |
| 11 | 0,9950 | 0,9969 | 0,3196 | 0,319 | 0,0019 | 11740 |
| 12 | 0,9969 | 0,9981 | 0,3195 | 0,319 | 0,0012 | 11740 |
| 13 | 0,9981 | 0,9988 | 0,3194 | 0,319 | 0,0007 | 11740 |
| 14 | 0,9988 | 0,9993 | 0,3193 | 0,319 | 0,0005 | 11740 |
| 15 | 0,9993 | 0,9995 | 0,3193 | 0,319 | 0,0003 | 11740 |
| 16 | 0,9995 | 0,9997 | 0,3193 | 0,319 | 0,0002 | 11740 |
| 17 | 0,9997 | 0,9998 | 0,3193 | 0,319 | 0,0001 | 11740 |
| 18 | 0,9998 | 0,9999 | 0,3193 | 0,319 | 0,0001 | 11740 |
| 19 | 0,9999 | 0,9999 | 0,3193 | 0,319 | 0,0000 | 11740 |

Iteration on cooking oil without brand/bulk oil commodities stops at the 19th iteration, with alpha 0,9999 and MAPE 0,3193%.

4. Chicken eggs/laying eggs

*Table 4* : Optimum analysis of eggs using the golden section method

| Iterate | alpha 1 | alpha 2 | MAPE (alpha1) | MAPE (alpha2) | alpha1-alpha2 | Forecast Price (Rp) |
|---|---|---|---|---|---|---|
| 1 | 0,3820 | 0,6180 | 1,084 | 0,838 | 0,2360 | 23737 |
| 2 | 0,6181 | 0,7639 | 0,838 | 0,767 | 0,1458 | 23680 |
| 3 | 0,7640 | 0,8541 | 0,7674 | 0,735 | 0,0901 | 23648 |

| Iterate | alpha 1 | alpha 2 | MAPE (alpha1) | MAPE (alpha2) | alpha1-alpha2 | Forecast Price (Rp) |
|---|---|---|---|---|---|---|
| 4 | 0,8541 | 0,9098 | 0,7354 | 0,719 | 0,0557 | 23629 |
| 5 | 0,9099 | 0,9443 | 0,7187 | 0,709 | 0,0344 | 23618 |
| 6 | 0,9443 | 0,9656 | 0,7091 | 0,703 | 0,0213 | 23611 |
| 7 | 0,9656 | 0,9787 | 0,7034 | 0,7 | 0,0131 | 23607 |
| 8 | 0,9787 | 0,9868 | 0,7 | 0,698 | 0,0081 | 23604 |
| 9 | 0,9869 | 0,9919 | 0,698 | 0,697 | 0,0050 | 23603 |
| 10 | 0,9919 | 0,9950 | 0,6968 | 0,696 | 0,0031 | 23602 |
| 11 | 0,9950 | 0,9969 | 0,6961 | 0,696 | 0,0019 | 23601 |
| 12 | 0,9969 | 0,9981 | 0,6956 | 0,695 | 0,0012 | 23601 |
| 13 | 0,9981 | 0,9988 | 0,6954 | 0,695 | 0,0007 | 23600 |
| 14 | 0,9988 | 0,9993 | 0,6952 | 0,695 | 0,0005 | 23600 |
| 15 | 0,9993 | 0,9995 | 0,6951 | 0,695 | 0,0003 | 23600 |
| 16 | 0,9995 | 0,9997 | 0,6951 | 0,695 | 0,0002 | 23600 |
| 17 | 0,9997 | 0,9998 | 0,695 | 0,695 | 0,0001 | 23600 |
| 18 | 0,9998 | 0,9999 | 0,695 | 0,695 | 0,0001 | 23600 |
| 19 | 0,9999 | 0,9999 | 0,695 | 0,695 | 0,0000 | 23600 |

While on chicken eggs/laying eggs commodities, it is optimal in the 19th iteration with alpha 0,9999 and MAPE 0,695%.

5. Broiler chicken

*Table 5* : Optimum analysis of broiler chicken using the golden section method

| Iterate | alpha 1 | alpha 2 | MAPE (alpha1) | MAPE (alpha2) | alpha1-alpha2 | Forecast Price (Rp) |
|---|---|---|---|---|---|---|
| 1 | 0,3820 | 0,6180 | 1,241 | 0,954 | 0,2360 | 31492 |
| 2 | 0,6181 | 0,7639 | 0,9541 | 0,862 | 0,1458 | 31459 |
| 3 | 0,7640 | 0,8541 | 0,8621 | 0,819 | 0,0901 | 31424 |
| 4 | 0,8541 | 0,9098 | 0,8191 | 0,797 | 0,0557 | 31409 |
| 5 | 0,9099 | 0,9443 | 0,7974 | 0,785 | 0,0344 | 31403 |
| 6 | 0,9443 | 0,9656 | 0,785 | 0,778 | 0,0213 | 31401 |
| 7 | 0,9656 | 0,9787 | 0,7779 | 0,774 | 0,0131 | 31400 |
| 8 | 0,9787 | 0,9868 | 0,7736 | 0,771 | 0,0081 | 31400 |
| 9 | 0,9869 | 0,9919 | 0,771 | 0,769 | 0,0050 | 31400 |
| 10 | 0,9919 | 0,9950 | 0,7694 | 0,769 | 0,0031 | 31400 |
| 11 | 0,9950 | 0,9969 | 0,7686 | 0,768 | 0,0019 | 31400 |
| 12 | 0,9969 | 0,9981 | 0,7682 | 0,768 | 0,0012 | 31400 |
| 13 | 0,9981 | 0,9988 | 0,7679 | 0,768 | 0,0007 | 31400 |
| 14 | 0,9988 | 0,9993 | 0,7678 | 0,768 | 0,0005 | 31400 |
| 15 | 0,9993 | 0,9995 | 0,7677 | 0,768 | 0,0003 | 31400 |

| Iterate | alpha 1 | alpha 2 | MAPE (alpha1) | MAPE (alpha2) | alpha1-alpha2 | Forecast Price (Rp) |
|---|---|---|---|---|---|---|
| 16 | 0,9995 | 0,9997 | 0,7676 | 0,768 | 0,0002 | 31400 |
| 17 | 0,9997 | 0,9998 | 0,7676 | 0,768 | 0,0001 | 31400 |
| 18 | 0,9998 | 0,9999 | 0,7676 | 0,768 | 0,0001 | 31400 |
| 19 | 0,9999 | 0,9999 | 0,7675 | 0,768 | 0,0000 | 31400 |

Broiler chicken commodities is optimal in the 19th iteration with alpha 0,9999 and MAPE 0,7675%.

6. Salt

*Table 6* : Optimum analysis of salt using the golden section method

| Iterate | alpha 1 | alpha 2 | MAPE (alpha1) | MAPE (alpha2) | alpha1-alpha2 | Forecast Price (Rp) |
|---|---|---|---|---|---|---|
| 1 | 0,3820 | 0,6180 | 2,5352 | 2,17 | 0,2360 | 4887 |
| 2 | 0,6181 | 0,7639 | 2,1699 | 2,076 | 0,1458 | 4879 |
| 3 | 0,7640 | 0,8541 | 2,076 | 2,036 | 0,0901 | 4876 |
| 4 | 0,8541 | 0,9098 | 2,0359 | 2,013 | 0,0557 | 4875 |
| 5 | 0,9099 | 0,9443 | 2,0125 | 1,998 | 0,0344 | 4875 |
| 6 | 0,9443 | 0,9656 | 1,9984 | 1,99 | 0,0213 | 4875 |
| 7 | 0,9656 | 0,9787 | 1,9899 | 1,987 | 0,0131 | 4875 |
| 8 | 0,9787 | 0,9868 | 1,9871 | 1,987 | 0,0081 | 4875 |
| 9 | 0,9737 | 0,9787 | 1,9879 | 1,987 | 0,0050 | 4875 |
| 10 | 0,9837 | 0,9900 | 1,9864 | 1,989 | 0,0062 | 4875 |
| 11 | 0,9799 | 0,9837 | 1,987 | 1,986 | 0,0038 | 4875 |
| 12 | 0,9876 | 0,9923 | 1,9876 | 1,99 | 0,0047 | 4875 |
| 13 | 0,9847 | 0,9876 | 1,9864 | 1,988 | 0,0029 | 4875 |
| 14 | 0,9876 | 0,9876 | 1,9876 | 1,988 | 0,0000 | 4875 |
| 15 | 0,9923 | 0,9953 | 1,9895 | 1,991 | 0,0029 | 4875 |
| 16 | 0,9905 | 0,9923 | 1,9888 | 1,99 | 0,0018 | 4875 |
| 17 | 0,9923 | 0,9923 | 1,9895 | 1,99 | 0,0000 | 4875 |

Salt commodities is optimal in the 17th iteration with alpha 0,9923 and MAPE 1,9895%.

7. Milk

*Table 7 :* Optimum analysis of milk using the golden section method

| Iterate | alpha 1 | alpha 2 | MAPE (alpha1) | MAPE (alpha2) | alpha1-alpha2 | Forecast Price (Rp) |
|---|---|---|---|---|---|---|
| 1 | 0,3820 | 0,6180 | 0,1782 | 0,16 | 0,2360 | 9861 |
| 2 | 0,6181 | 0,7639 | 0,1597 | 0,154 | 0,1458 | 9860 |
| 3 | 0,7640 | 0,8541 | 0,1539 | 0,151 | 0,0901 | 9860 |
| 4 | 0,8541 | 0,9098 | 0,1515 | 0,15 | 0,0557 | 9860 |

| Iterate | alpha 1 | alpha 2 | MAPE (alpha1) | MAPE (alpha2) | alpha1-alpha2 | Forecast Price (Rp) |
|---|---|---|---|---|---|---|
| 5 | 0,9099 | 0,9443 | 0,1503 | 0,15 | 0,0344 | 9860 |
| 6 | 0,9443 | 0,9656 | 0,1497 | 0,149 | 0,0213 | 9860 |
| 7 | 0,9656 | 0,9787 | 0,1493 | 0,149 | 0,0131 | 9860 |
| 8 | 0,9787 | 0,9868 | 0,1491 | 0,149 | 0,0081 | 9860 |
| 9 | 0,9869 | 0,9919 | 0,149 | 0,149 | 0,0050 | 9860 |
| 10 | 0,9919 | 0,9950 | 0,1489 | 0,149 | 0,0031 | 9860 |
| 11 | 0,9950 | 0,9969 | 0,1489 | 0,149 | 0,0019 | 9860 |
| 12 | 0,9969 | 0,9981 | 0,1488 | 0,149 | 0,0012 | 9860 |
| 13 | 0,9981 | 0,9988 | 0,1488 | 0,149 | 0,0007 | 9860 |
| 14 | 0,9988 | 0,9993 | 0,1488 | 0,149 | 0,0005 | 9860 |
| 15 | 0,9993 | 0,9995 | 0,1488 | 0,149 | 0,0003 | 9860 |
| 16 | 0,9995 | 0,9997 | 0,1488 | 0,149 | 0,0002 | 9860 |
| 17 | 0,9997 | 0,9998 | 0,1488 | 0,149 | 0,0001 | 9860 |
| 18 | 0,9998 | 0,9999 | 0,1488 | 0,149 | 0,0001 | 9860 |
| 19 | 0,9999 | 0,9999 | 0,1488 | 0,149 | 0,0000 | 9860 |

Milk commodities is optimal in the 19th iteration with alpha 0,9999 and MAPE 0,1488%.

8. Chili

*Table 8*: Optimum analysis of chili using the golden section method

| Iterate | alpha 1 | alpha 2 | MAPE (alpha1) | MAPE (alpha2) | alpha1-alpha2 | Forecast Price (Rp) |
|---|---|---|---|---|---|---|
| 1 | 0,3820 | 0,6180 | 4,088 | 3,13 | 0,2360 | 29670 |
| 2 | 0,6181 | 0,7639 | 3,1298 | 2,805 | 0,1458 | 28872 |
| 3 | 0,7640 | 0,8541 | 2,8052 | 2,658 | 0,0901 | 28555 |
| 4 | 0,8541 | 0,9098 | 2,658 | 2,583 | 0,0557 | 28440 |
| 5 | 0,9099 | 0,9443 | 2,5834 | 2,544 | 0,0344 | 28402 |
| 6 | 0,9443 | 0,9656 | 2,5437 | 2,52 | 0,0213 | 28392 |
| 7 | 0,9656 | 0,9787 | 2,5204 | 2,506 | 0,0131 | 28392 |
| 8 | 0,9787 | 0,9868 | 2,5063 | 2,498 | 0,0081 | 28394 |
| 9 | 0,9869 | 0,9919 | 2,4977 | 2,492 | 0,0050 | 28396 |
| 10 | 0,9919 | 0,9950 | 2,4924 | 2,489 | 0,0031 | 28397 |
| 11 | 0,9950 | 0,9969 | 2,4892 | 2,487 | 0,0019 | 28398 |
| 12 | 0,9969 | 0,9981 | 2,4872 | 2,486 | 0,0012 | 28399 |
| 13 | 0,9981 | 0,9988 | 2,4859 | 2,485 | 0,0007 | 28399 |
| 14 | 0,9988 | 0,9993 | 2,4852 | 2,485 | 0,0005 | 28400 |
| 15 | 0,9993 | 0,9995 | 2,4847 | 2,484 | 0,0003 | 28400 |
| 16 | 0,9995 | 0,9997 | 2,4844 | 2,484 | 0,0002 | 28400 |

| Iterate | alpha 1 | alpha 2 | MAPE (alpha1) | MAPE (alpha2) | alpha1-alpha2 | Forecast Price (Rp) |
|---|---|---|---|---|---|---|
| 17 | 0,9997 | 0,9998 | 2,4842 | 2,484 | 0,0001 | 28400 |
| 18 | 0,9998 | 0,9999 | 2,4841 | 2,484 | 0,0001 | 28400 |
| 19 | 0,9999 | 0,9999 | 2,484 | 2,484 | 0,0000 | 28400 |

Chili commodities is optimal in the 19th iteration with alpha 0,9999 and MAPE 2,484%.

9. 3 kg LPG tube

*Table 9* : Optimum analysis of LPG using the golden section method

| Iterate | alpha 1 | alpha 2 | MAPE (alpha1) | MAPE (alpha2) | alpha1-alpha2 | Forecast Price (Rp) |
|---|---|---|---|---|---|---|
| 1 | 0,3820 | 0,6180 | 0,0972 | 0,078 | 0,2360 | 17600 |
| 2 | 0,6181 | 0,7639 | 0,0782 | 0,072 | 0,1458 | 17600 |
| 3 | 0,7640 | 0,8541 | 0,0718 | 0,069 | 0,0901 | 17600 |
| 4 | 0,8541 | 0,9098 | 0,0687 | 0,067 | 0,0557 | 17600 |
| 5 | 0,9099 | 0,9443 | 0,0669 | 0,066 | 0,0344 | 17600 |
| 6 | 0,9443 | 0,9656 | 0,0659 | 0,065 | 0,0213 | 17600 |
| 7 | 0,9656 | 0,9787 | 0,0653 | 0,065 | 0,0131 | 17600 |
| 8 | 0,9787 | 0,9868 | 0,065 | 0,065 | 0,0081 | 17600 |
| 9 | 0,9869 | 0,9919 | 0,0647 | 0,065 | 0,0050 | 17600 |
| 10 | 0,9919 | 0,9950 | 0,0646 | 0,065 | 0,0031 | 17600 |
| 11 | 0,9950 | 0,9969 | 0,0645 | 0,064 | 0,0019 | 17600 |
| 12 | 0,9969 | 0,9981 | 0,0645 | 0,064 | 0,0012 | 17600 |
| 13 | 0,9981 | 0,9988 | 0,0644 | 0,064 | 0,0007 | 17600 |
| 14 | 0,9988 | 0,9993 | 0,0644 | 0,064 | 0,0005 | 17600 |
| 15 | 0,9993 | 0,9995 | 0,0644 | 0,064 | 0,0003 | 17600 |
| 16 | 0,9995 | 0,9997 | 0,0644 | 0,064 | 0,0002 | 17600 |
| 17 | 0,9997 | 0,9998 | 0,0644 | 0,064 | 0,0001 | 17600 |
| 18 | 0,9998 | 0,9999 | 0,0644 | 0,064 | 0,0001 | 17600 |
| 19 | 0,9999 | 0,9999 | 0,0644 | 0,064 | 0,0000 | 17600 |

Three kg LPG tube commodities is optimal in the 19th iteration with alpha 0,9999 and MAPE 0,0644%.

From the nine tables above, it can be observed that the optimum alpha for commodity of mentik rice, sugar, cooking oil without brand/bulk oil, chicken eggs/broiler, broiler chicken, condom sweet milk indomilk, ordinary chili, and LPG 3 kg is 0.9999. As for the optimum alpha of salt is 0.9923. The smallest MAPE of each commodity obtained from the optimum alpha is less than 2.5%. Here are the figure of the actual price and forecasting price of each commodity with optimum alpha

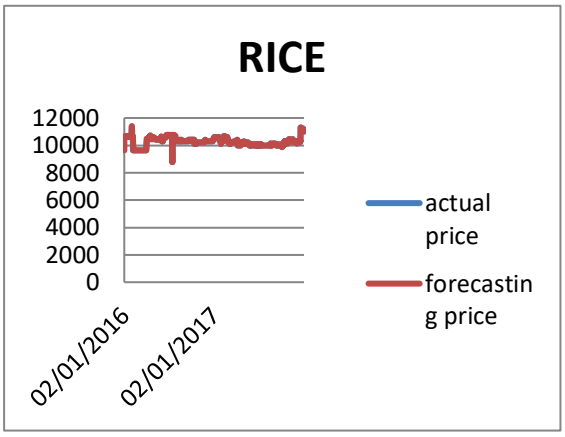


**Figure 1.** Actual and Forecasting Price of Rice

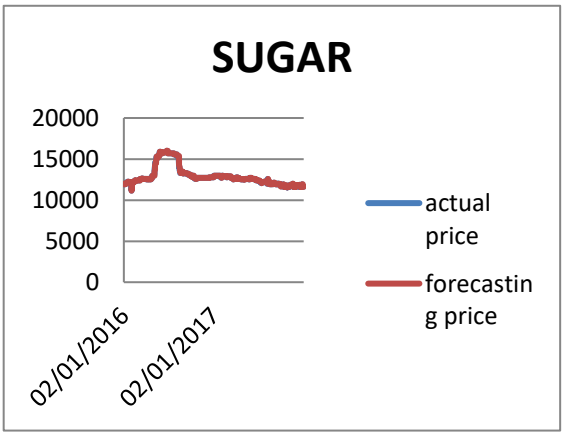


**Figure 2.**Actual and Forecasting Price of Sugar

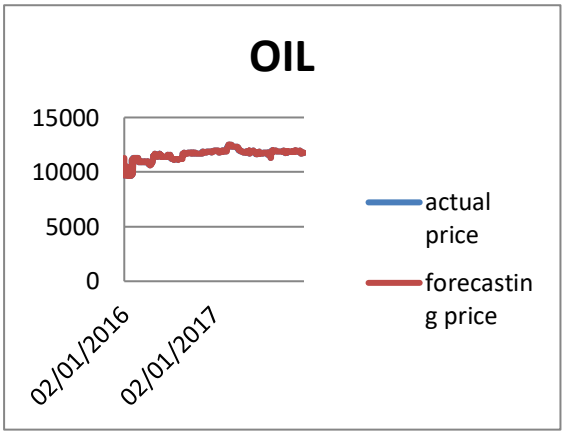


**Figure 3.** Actual and Forecasting Price of Oil

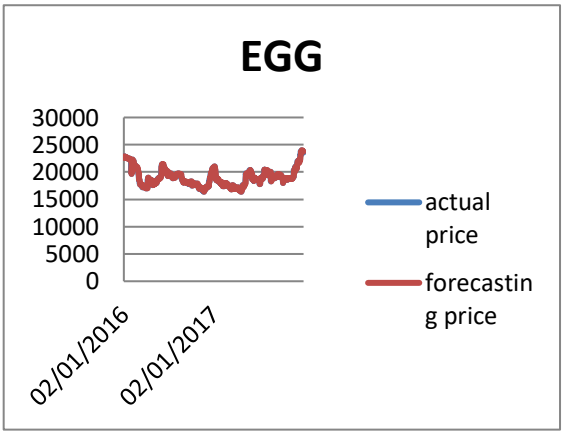


**Figure 4.**Actual and Forecasting Price of Egg

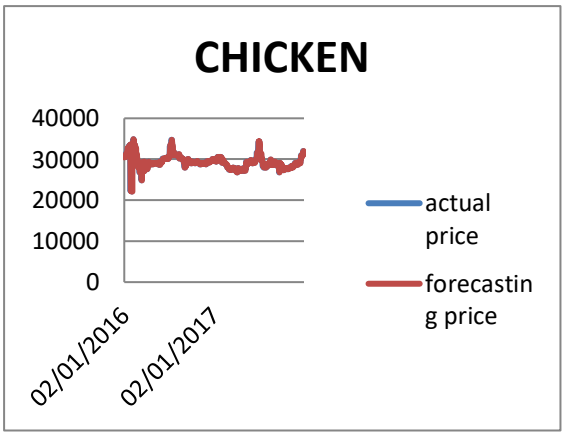


**Figure 5.** Actual and Forecasting Price of Chicken

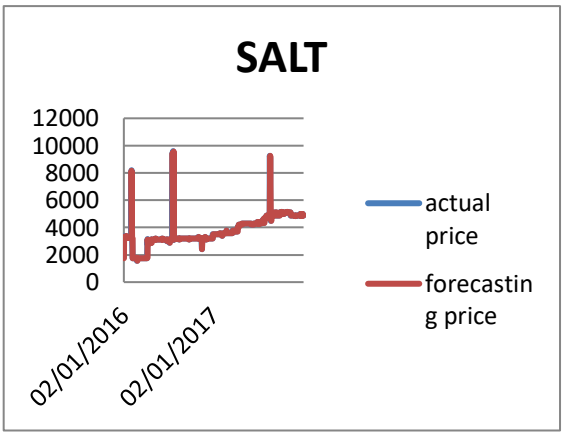


**Figure 6.**Actual and Forecasting Price of Salt

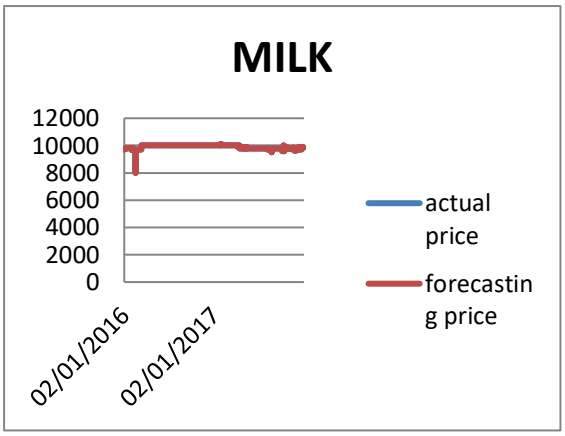


**Figure 7.** Actual and Forecasting Price of Milk

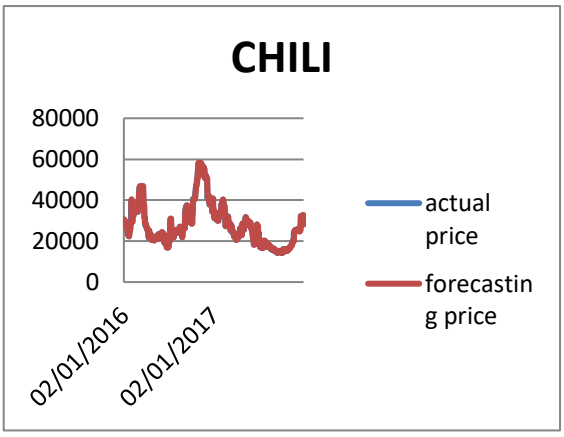


**Figure 8.**Actual and Forecasting Price of Chili

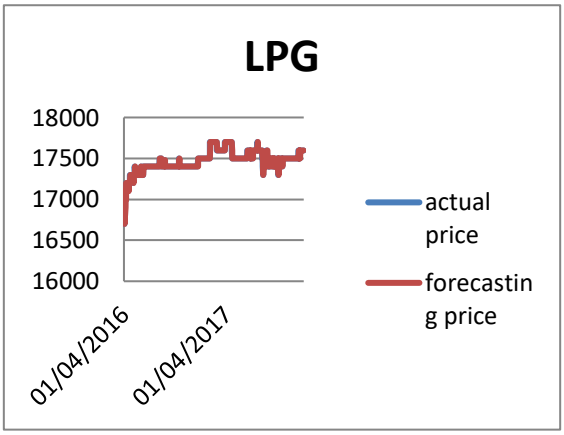


**Figure 7.** Actual and Forecasting Price of LPG

From the figures above it can be observed that the line between the actual price and the forecast price is very close. It is shows that by using the optimum alpha, error between actual price and the forecast price is very small, which is less than 2.5%

## CONCLUSION

From the results of the above research can be concluded that the Golden Section method can be used to determine the optimum alpha with MAPE average is 0.79% and the accuracy is 99.21%, so by using the Golden Section method, the researcher can shorten the time in the process of calculating the price forecasting using Exponential Smoothing Method.

The suggestion from the researcher is to make a application of Single Exponential Smoothing parameters optimization on price forecasting of Sembako in Malang city using Golden Section method web based. So that the people of Malang can also see information about the price forecast of food in Malang quickly without having to input the parameters by trial error.

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