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Forecasting the number of Politeknik Negeri Malang new student's enrolment using single exponential smoothing method

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Abstract. Forecasting the number of new student enrolments at Politeknik Negeri Malang offers the campus a good help to discover new innovations and good marketing strategies. Besides, it can be used as a reference in planning the teaching and learning process. This study used the Single Exponential Smoothing method as a forecasting method. Forecasting accuracy uses Mean Absolute Deviation (MAD), Mean Square Error (MSE), and Mean Absolute Percentage Error (MAPE). Based on the calculation results, the smoothing constant result is $\alpha = 0.9$ which means it has the smallest error values for the three forecasting accuracy calculation methods.

1. Introduction

Forecasting is the art and a science of estimating future events by involving the taking of historical data and projecting it into the future with a mathematical model [1]. Forecasting is the most important part for every company or business organization in every management decision making. Forecasting itself can be the basis for short, medium and even a long-term planning of a company.

Politeknik Negeri Malang (Polinema) is a vocational education in Malang which has several departments with different levels of interests. The departments are Electrical Engineering, Mechanical Engineering, Information Technology, Civil Engineering, Chemical Engineering, Accounting, and Business Administration. As seen from the number of applicants in Politeknik Negeri Malang, a massive number of applicants comes from both Malang and any other regions each year. This, obviously, requires a prediction or forecasting system to predict the number of applicants for new students which in turn become one of the references in planning the teaching and learning process and exploring good innovation and marketing strategies for the campus.

This study uses single exponential smoothing method. It is done by repeating the continuous calculations using the latest data. The data were taken from new student enrollments total number in 2011-2017 academic year.

2. Theoretical analysis

2.1. New student admission

New student admissions are routine activities carried out by universities every year. The new student admission process is used to screen qualified prospective students according to the criteria determined by the college [2]. By accepting qualified students, it will improve the quality of the University itself.

In general, the process of admitting new students is done through the stages of registration, file selection, and announcement of student admissions.

2.2. Single exponential smoothing

Exponential Smoothing Forecasting method or Exponential Smoothing (multilevel Smoothing) is widely used to predict the purchase of goods (the demand) which changes very quickly [3]. This method is not affected by trends or seasons. The formula is as follows [4]:

$$\boldsymbol{St+1 = \alpha\, Xt + (1 - \alpha)\, St} \quad (1)$$

Note:
St+1 : Prediction for t+1 period
Xt : Real value of t period
St : Forecast for t period
α : Weight which shows the smoothing constant

2.3. Forecast error measurement

2.3.1. Mean Absolute Deviation (MAD). MAD is a value calculated by taking the absolute total value of each forecasting error divided by the number of periods of data (n).

$$MAD = \frac{\sum(actual - forecasting)}{n} \quad (2)$$

2.3.2. Mean Squared Error (MSE). MSE is the average of squared forecasting error.

$$MSE = \frac{\sum(actual - forecasting)^2}{n} \quad (3)$$

2.3.3. Mean Absolute Percent Error (MAPE). MAPE is calculated as the average of the absolute differentiation between the predicted and actual value, expressed as a percentage of actual value. If we had predicted and actual values for n periods.

$$MAPE = \frac{\sum(absolute\ error\ percentage)}{n} \quad (4)$$

3. Algorithm analysis

3.1. System performance analysis

Block diagrams explain the interactions that occur between users and systems including entering what data is needed, the processes that occur, and the output data generated from the interactions. The data comes from the number of new student enrollments in 2011-2017 academic year.

The input data is in the form of diploma and academic year period options. System output data is a prediction based on input data that has been processed by the forecasting method.

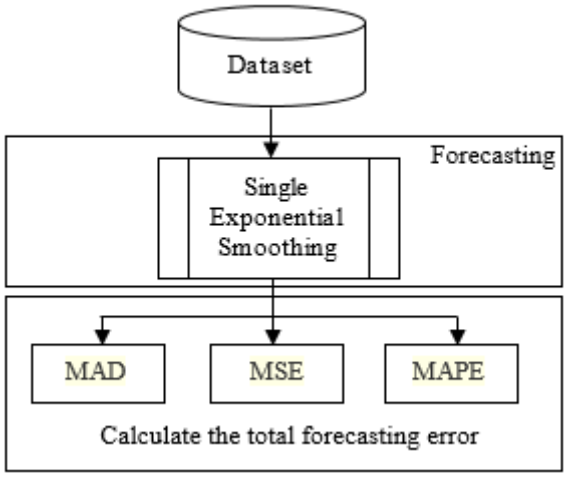

Figure 1. Block diagram.

3.2. The scope of research

This research was developed by developing an application that is used for calculating the forecasting number of new student admission in Polinema. The focus of this research is to predict the data in the next academic year using exponential smoothing based on data from 2011 to 2017 academic year. From the diagram as seen in Figure 1, the forecasting technique used in this study uses a single exponential smoothing to calculate error accuracy for forecasting using the MAD, MSE, and MAPE methods.

3.3. Dataset

The data collection is done by collecting the data on new student admissions from 2011 to 2017 academic year in Polinema. The detailed data are shown in Tables 1 and 2.

Table 1. Diploma III student's data.

D3	D-III T. Elektronika	125
	D-III T. Listrik	80
	D-III T. Telekomunikasi	130
	D-III M. Informatika	187
	D-III T. Mesin	208
	D-III T. Sipil	139
	D-III Teknologi Konstruksi Jalan, Jembatan, dan Bangunan Air	54
	D-III T. Kimia	164
	D-III Akuntansi	192
	D-III Administrasi Bisnis	214
	D-III Bahasa Inggris	87
D3		1580

Table 2. Diploma IV student's data.

D4	D-IV T. Elektronika	130
	D-IV Sistem Kelistrikan	133
	D-IV Jaringan Telekomunikasi Digital	132
	D-IV T. Informatika	218
	D-IV T. Otomotif Elektronik	78
	D-IV T. Mesin Produksi Dan Perawatan	130
	D-IV Manajemen Rekayasa Konstruksi	188
	D-IV Teknologi Kimia Industri	105
	D-IV Akuntansi Manajemen	222
	D-IV Keuangan	91
	D-IV Manajemen Pemasaran	218
D4		1645

4. Results and discussions

4.1. Optimal value selection

In the Single Exponential Smoothing method, the forecasting result accuracy depends on the smoothing constants used [5]. There is one smoothing constant parameter (α) that must be evaluated in this method. The optimal α values selection approach is usually done by trial and error. In this forecasting, the value of α that will be used for trial is randomly assigned as the weight value (α = 0.2), (α = 0.5), (α = 0.7) and (α = 0.9). Forecasting calculations are performed repeatedly to produce the smallest MAD, MSE, and MAPE values.

4.2. Error prediction model

In evaluating the optimum α smoothing constant determination value, three forecasting error measure comparisons, i.e. Mean Absolute Deviation (MAD), Mean Squared Error (MSE) and Mean Absolute Error (MAPE) were used. From the three forecasting error measures, it will then be compared to find the error prediction method which produces good predictions according to the data used.

From various smoothing constants, the corresponding MAPE, MAD, and MSE values can be calculated for the experimental data. MAD is calculated using equation (2) and the results are given in Table 3.

Table 3. MAD Value for each α experimental smoothing constant.

Major	**0,2**	**0,5**	**0,7**	**0,9**
D-III T. Elektronika	12	0	3	3
D-III T. Listrik	57	68	72	73
D-III T. Telekomunikasi	23	10	4	1
D-III M. Informatika	21	10	7	7
D-III T. Mesin	18	28	28	28
D-III T. Sipil	1	25	27	26
D-III Teknologi Konstruksi Jalan, Jembatan, dan Bangunan Air	46	34	26	18
D-III T. Kimia	25	9	8	9
D-III Akuntansi	6	7	3	1
D-III Administrasi Bisnis	16	4	4	4
D-III Bahasa Inggris	72	49	33	18
D-IV T. Elektronika	31	5	1	3
D-IV Sistem Kelistrikan	30	5	15	18
D-IV Jaringan Telekomunikasi Digital	28	3	2	4
D-IV T. Informatika	20	32	38	37
D-IV T. Otomotif Elektronik	6	6	9	10
D-IV T. Mesin Produksi Dan Perawatan	69	21	7	2
D-IV Manajemen Rekayasa Konstruksi	36	1	9	14
D-IV Teknologi Kimia Industri	65	27	12	4
D-IV Akuntansi Manajemen	22	21	26	25
D-IV Keuangan	69	46	36	31
D-IV Manajemen Pemasaran	50	10	6	7
MAD	**33**	**19**	**17**	**16**

Based on table 3, the values of α which minimize MAD can be determined, which is 0.9. The MAD value generated by α = 0.9 is 16. Futhermore, MSE is calculated using equation (3) and the results are given in Table 4.

Table 4. MSE Value for each α experimental smoothing constant.

Major	**0,2**	**0,5**	**0,7**	**0,9**
D-III T. Elektronika	143	0	10	11
D-III T. Listrik	3246	4688	5146	5379
D-III T. Telekomunikasi	512	92	29	1
D-III M. Informatika	460	95	55	48
D-III T. Mesin	322	769	765	788
D-III T. Sipil	1	609	743	677
D-III Teknologi Konstruksi Jalan, Jembatan, dan Bangunan Air	2116	1156	676	324
D-III T. Kimia	602	81	67	76
D-III Akuntansi	35	45	9	2
D-III Administrasi Bisnis	270	14	13	20
D-III Bahasa Inggris	5127	2352	1096	313
D-IV T. Elektronika	992	25	1	12
D-IV Sistem Kelistrikan	923	29	215	322
D-IV Jaringan Telekomunikasi Digital	806	9	4	12
D-IV T. Informatika	411	993	1430	1398
D-IV T. Otomotif Elektronik	34	35	75	106
D-IV T. Mesin Produksi Dan Perawatan	4776	446	53	3
D-IV Manajemen Rekayasa Konstruksi	1324	2	73	183
D-IV Teknologi Kimia Industri	4226	702	146	17
D-IV Akuntansi Manajemen	495	443	679	649
D-IV Keuangan	4811	2093	1290	948
D-IV Manajemen Pemasaran	2524	110	42	54
MSE	**1552**	**672**	**573**	**516**

Based on table 4 above, the values of α which minimize MSE, which is 0.9, can be determined. The MSE value generated with α = 0.9 is 516.

Furthermore, MAPE is calculated using equation (4) and the results are given in table 5.

Table 5. MAPE Value for each α experimental smoothing constant.

Major	**0,2**	**0,5**	**0,7**	**0,9**
D-III T. Elektronika	0,10	0,00	0,02	0,03
D-III T. Listrik	0,71	0,86	0,90	0,92
D-III T. Telekomunikasi	0,17	0,07	0,03	0,01
D-III M. Informatika	0,11	0,05	0,04	0,04
D-III T. Mesin	0,09	0,13	0,13	0,13
D-III T. Sipil	0,01	0,18	0,20	0,19
D-III Teknologi Konstruksi Jalan, Jembatan, dan Bangunan Air	0,85	0,63	0,48	0,33
D-III T. Kimia	0,15	0,05	0,05	0,05
D-III Akuntansi	0,03	0,03	0,02	0,01
D-III Administrasi Bisnis	0,08	0,02	0,02	0,02
D-III Bahasa Inggris	0,82	0,56	0,38	0,20
D-IV T. Elektronika	0,24	0,04	0,01	0,03
D-IV Sistem Kelistrikan	0,23	0,04	0,11	0,13
D-IV Jaringan Telekomunikasi Digital	0,22	0,02	0,01	0,03
D-IV T. Informatika	0,09	0,14	0,17	0,01
D-IV T. Otomotif Elektronik	0,07	0,08	0,11	0,07
D-IV T. Mesin Produksi Dan Perawatan	0,53	0,16	0,06	0,04
D-IV Manajemen Rekayasa Konstruksi	0,19	0,01	0,05	0,11
D-IV Teknologi Kimia Industri	0,62	0,25	0,11	0,34
D-IV Akuntansi Manajemen	0,10	0,09	0,12	0,11
D-IV Keuangan	0,76	0,50	0,39	0,34
D-IV Manajemen Pemasaran	0,23	0,05	0,03	0,03
MSE	**0,29**	**0,18**	**0,16**	**0,14**

Based on table 5, it can be seen that α with a value of 0.9 can minimize MAPE. The MAPE value produced with α = 0.9 is 0.14.

4.3. Data analysis

Forecasting is done by predicting the number of new student admissions in each department of Polinema. By developing this application, it is expected that the application can be used as a reference by the academic staffs to prepare an effective and efficient learning process, to be used as one of the references in planning the teaching and learning process by the campus, as well as exploring good innovation and marketing strategies.

In general, the results of data analysis based on experiments that have been carried out using the three criteria of MAD, MSE, and MAPE give the results of smoothing constant values α which can be said to be the satisfactorily similar for each type of data. From Table 6 below, it can be seen that the best constant value for the three best error calculation methods is α = 0.9.

Table 6. MAPE, MAD, and MSE calculation results.

Error Accuracy	**α**			
	0,20	**0,50**	**0,70**	**0,90**
MAD	33	19	17	16
MSE	1.152	672	573	516
MAPE	0,29	0,18	0,16	0,14

In other words, the three criteria for MAD, MSE, and MAPE can be used interchangeably in forecasting the number of Polinema student's admissions.

5. Conclusion

- Based on the results of the data tested the accuracy calculation or error calculation in 2011 to 2017. The Single Exponential Smooting method with a value of α = 0.2 has a smaller average error result.
- Report the number of new students in one period needed to do forecasting the number of new students in the next period. This new student data will later be analyzed with the Single Exponential Smoothing Method for produce forecasting the number of new students in the next period.
- This application can be used to forecast the number of new students as well as for each new school year in accordance with the actual new student data report school so that it can save time in the forecasting process as well the results are quite accurate and can be accounted for.

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References

[1] Rakićević 2015 Focus Forecasting In Supply Chain: The Case Study Of Fast Moving Consumer Goods Company In *Serbia Serbian Journal of Management* **10**(1) 3 – 17
[2] Wikipedia, *University and Collage admission* [Online], retrieved from: https://en.wikipedia.org/wiki/University_and_college_admission
[3] Ferbar L 2016 Demand forecasting with four-parameter exponential smoothing *International Journal of Production Economics*
[4] Venezia 2013 Analisa Forecasting Untuk Data Penjualan Menggunakan Metode Simple Moving Average Dan Single Exponential Smoothing Universitas Indonesia
[5] Mu'azu H G 2014 New Approach for Determining the Smoothing Constant () α of a Single Exponential Smoothing Method *International journal of science and technology* **3**(11)