FORECASTING ANALYSIS OF NEW STUDENTS ACCEPTANCE USING TIME SERIES FORECASTING METHOD

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Abstract

New students admission (PMB) is a routine activities for education institution. Therefore, it was necessary for the institution to be aware of the mechanism of PMB to produce competent and qualified prospective students. Forecasting of PMB needed to predict the number of students and to prepare the institution infrastucture facilities to welcome the new freshmen. The research discussed the determination of forecasting number of Universitas Bina Sarana Informatika PSDKU Karawang students by using time series forecasting with three different method: moving everage, exponential smoothing and trend analysis. It also compare Mean Absolute Presentage Error (MAPE) calculated by QM for Windows. The result of the research showed that trend analysis was the most effective method which had 41.84 MAD, 2324.28 MAD, 4.99 % of MAPE and 557 students for next forecasting. The conclussion from data analysis processing showed that Universitas Bina Sarana Informatika should provide all of infrastructure facilities for the teaching and learning process with the number of 557 students in 2020.
Keywords: Demand forecasting, moving average, exponential smoothing, trend analysis.

Abstrak

Penerimaan siswa baru (PMB) adalah kegiatan rutin untuk institusi pendidikan. Karena itu, lembaga perlu mewaspadai mekanisme PMB untuk menghasilkan calon siswa yang kompeten dan berkualitas. Peramalan PMB diperlukan untuk memprediksi jumlah siswa dan untuk mempersiapkan fasilitas infrastruktur lembaga untuk menyambut mahasiswa baru. Penelitian ini membahas penentuan jumlah peramalan mahasiswa Universitas Bina Sarana Informatika PSDKU Karawang dengan menggunakan peramalan time series dengan tiga metode berbeda: moving everage, smoothing eksponensial, dan analisis tren. Itu juga membandingkan Mean Absolute Presentage Error (MAPE) yang dihitung oleh QM untuk Windows. Hasil penelitian menunjukkan bahwa analisis tren adalah metode paling efektif yang memiliki 41,84 MAD, 2324,28 MAD, 4,99% dari MAPE dan 557 siswa untuk peramalan berikutnya. Kesimpulan dari pengolahan analisis data menunjukkan bahwa Universitas Bina Sarana Informatika harus menyediakan semua fasilitas infrastruktur untuk proses belajar mengajar dengan jumlah 557 siswa pada tahun 2020.
Kata Kunci: *Demand forecasting, moving average, exponential smoothing, trend analysis.*

I. INTRODUCTION

Quality education is a necessity for modern society in every developing city (Tarnoto, 2017). Likewise, Karawang Regency, a city with a population of approximately 2,273,000 (Suhardi, 2019) according to the data from the statistical center of Karawang regency in 2015 as taken from https://karawangkab.bps.go.id is a developing city that has a large industrial estate in the south and productive agricultural land in the north. The city of Karawang has also become a destination city for job seekers from various cities. Thus the city of Karawang is an asset for business people, both in goods or services from various fields including educational service providers.

New student admission activities (PMB) are routine activities for education service providers roled by Universitas Bina Sarana Informatika (UBSI) Study Program outside the Main Campus (PSDKU) Karawang as a guarantor for ongoing teaching and learning activities on the campus. PMB is carried out through a number of processes and mechanisms in accordance with the applicable regulations according to the direction of the ministry of research, technology and higher education (RISTEKDIKTI) with the aim of standardizing PMB to produce competent and qualified prospective students. The PMB process starts in November and ends in September each year by dividing several registration periods and by varying the cost of the educational development contributions.

The availability of class quota at each university must be planned and measured carefully, so it can balance the ratio of lecturers and students. It aims to create high quality education and also related to the readiness of infrastructure for the teaching and learning process. This will definitely give powerful assurance that even students with low comprehension are able to understand the material that will be delivered by the lecturer.

Ability to understand the lesson being explained is an ability that must be possessed by every student (Sugandi & Bernard, 2018) in addition to that the education manager must ensure that there is no disturbances in the communication process between lecturers and students by ensuring the ratio of the lecturers and students to be educated within reasonable limits. Moreover, from the aspect of finance, an effective and efficient marketing process must produce a comparison between the costs incurred and the sales revenue obtained(Basri, Eko Indrajit, Studi Magister Ilmu Komputer,

& Nusa Mandiri Jakarta, 2017), or in this case new students who are enrolled in each period. Therefore, it is necessary to conduct a forecasting study to predict how many students will enter in the 2019-2020 school year. and also refering to general public's assessment of the level of trust in the campus which leads to corporate social responsibility and corporate reputation (Supriyatno, 2018). It can also be viewed from the perspective of needs analysis which is the first stage in the process of developing a product or program which is actually a systematic approach with the aim of assessing and studying the problems that will be faced by the institution (Suparti, 2018). Forecasting studies are not only limited to the needs of forecasting product demand, but forecasting can also be done by universities to predict new students who will register at a University by using the time series forecasting method.

The achievements of UBSI PSDKU Karawang in the number of new students admission are recorded in two campuses located at Jl. Banten no. 1 Karangpawitan and at Jl. Ir. H. Juanda No. 17 Kotabaru, Karawang Regency. Since the 2013-2019 school year it has fluctuated, and in the last two years it has experienced a significant decline. This has

become a concern for management. The following is the time series data PMB of UBSI PSDKU Karawang from the period 2013-2014 to 2018-2019.

From the figure 1, it can be seen that in the first three years the PMB showed a stable trend, in the 2014/2015 school year only 1.1% decreased, and there was an increase of 4.2% in the following year. UBSI PSDKU Karawang which in that year was still labeled Bina Sarana Informatics and Computer Management Academy or AMIK BSI Karawang, and it had two study programs namely the informatics management program and the accounting computerization program which were quite popular among the Karawang community, but in the last two years it experienced a trend of 12% decline from the previous year. This has made its own concerns in the ranks of the management or structural staff of UBSI PSDKU Karawang, so it is necessary to take some basic actions to significantly increase PMB in this year 2020. It also needs to improve the efforts of predicting PMB to become one of the considerations in determining the campus marketing strategy.

II. THEORITICAL REVIEW

The framework of this research is a description or proposition of the conceptual

framework of the problem solving that has been previously identified and formulated. It refers to the fact that the management of education service wants to significantly and continuously increase PMB, and also as a reference to prepare all needs related to teaching and learning facilities and infrastructure in the 2019/2020 school year. The Framework in this study can be illustrated in the following figure:
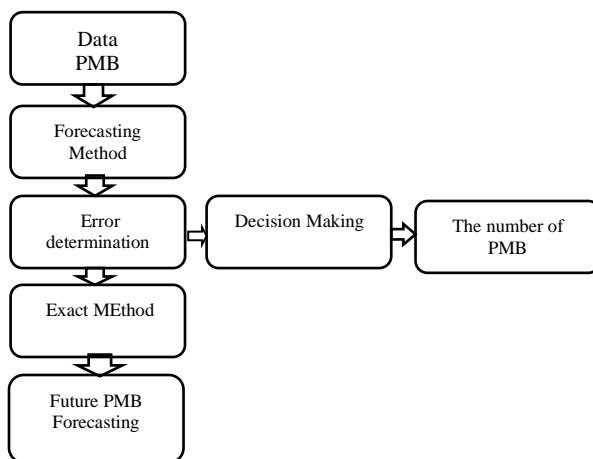

Figure 2: Framework of The Study
Source: Suhardi 2019

III. RESEARCH METHODOLOGY

This research design uses quantitative analysis methods using a variety of mathematical models with past data and also combined with causal variables (casual system) which mean that past events will recur or affect current events or better known as forecasting. It uses three methods, namely: forecasting with the moving average method, forecasting with the exponential smoothing method and forecasting by adjusting the trend (trend analysis).

1. Data Source

Every study needs data, both primary data, collected by researchers when the study is conducted, and secondary data, available data of the research object. This study uses secondary data obtained by PMB UBSI PSDKU Karawang through the web page http://pmb.bsi.ac.id from the 2013-2014 school year to the 2018-2019 school year.

2. Population and Sample

a. Population

According to Sugiyono the population is a generalization area consisting of objects or subjects that have certain qualities and characteristics that are determined to be studied and then conclusions to be drawn(Herawati, 2014). Population is the entire measurement of data, objects or individuals to be studied. In this study, the data are based on PMB UBSI PSDKU time series data for the last 5 years.

b. Sample

The sample is strived to represent the population. The population can be very infinite in number and difficult to conduct research, so the researchers need to determine the

sample using a purposive sampling technique. Then, determined the five teaching year period PMB UBSI PSKDU Karawang as the sample.

3. Data processing techniques

The data used in this study is secondary data obtained from UBSI PSDKU in the form of PMB acquisition in five periods of the school year. Data analysis is defined as effort data that has already been available and then processed with statistics, and it can be used to answer the formulation of the problems in the research(Aqsa & Fitrasyah, 2017). The data processing technique can be interpreted as a way to process data to find out the results of the research. This research data processing technique uses forecasting analysis. Forecasting analysis used in this study is a time series forecasting method focus on the research on Moving Average, Exponential Smoothing and Trend Analysis models using computer program the QM for Windows.

4. Demand Forecasting

Forecasting is defined as the art and science of estimating future events (Heizer & Render, 2009). Some experts also view forecasting as the art and science in its invention as super forecasting (Tetlock & Gardner, 2016). Forecasting is also defined as a process for estimating some future needs which

include needs in terms of quantity, quality, time and location needed in order to meet the demand for goods or services (Hani'ah, 2015). Furthermore, demand forecasting is an activity to estimate the amount of demand for certain goods or services in a period of time and certain marketing areas(Sarjono, 2012).

From various forecasting theories it can be concluded that forecasting is the initial part of a decision making process. Forecasting is a prediction of the future related to demand by involving past data with a mathematical calculation. In forecasting analysis it is necessary to involve past data, and place it into the future with a form of mathematical model. It is also classified according to the future time horizon in accordance with the data obtained, including short-term forecasting that covers a period of up to one year but generally only less than three months, and this forecast is used for purchasing planning, work scheduling or job assignments. Medium-term or intermediate forecasting which covers a period of months to three years is often used for sales planning, production budgets, cash budgets or planning various operational activities. Meanwhile, long-term planning which generally covers a period of more than three years is often used for forecasting new product planning, capital

expenditure and including planning for admission of new students in an educational institution.

a. *Moving Average Method*

The moving average is the most commonly used method. This method uses a number of actual data from the past company performance or certain institutions that want to be examined to produce forecasting. The moving average method can be used if it is assumed that the demand or target market achievement will be stable over time, or in other words, this method is used if there is no mathematical trend. One of the main objectives of using the moving average method is to reduce or even eliminate random patterns in time series data. The use of the moving average method by using time series data is taking or recording a collection of values to be studied, and then calculating the average of these values as a prediction of the value to be achieved in the next period.

The moving average method in time series consists of taking a set of observed values, obtaining the average of the values, and then, using the average value as a forecast for the upcoming period (Iwan, Iviq, Eneng Rahayu, & Yulianto, 2018). The average value is calculated based on the number of values of the previous period divided by the number of the periods studied, or the average value is calculated based on the amount of data, and the moving average is determined from the price of 1 to N existing data. Simple moving averages are stated as follows:

$$S_{t+1} = \frac{xt+xt-1...xt-n+1}{n}.....(1)$$

Note:

S_{t+1} = *Forecasting* for the period t+1

Xt = Period data t

n = Time period of *moving everage*

In the above mathematical model shows that all observational data have the same weight which will form the average value, and this is the weakness of the moving average method because the latest observational data should have the most greater data compared to the past observational data. If the QM computer application for windows is used, the operational sequence after opening the application is firstly the user select the module / forecasting, then select the tool bar file / new / time series analysis, and then, enter the research data, next, select the research model, then click solve, and finally, the results will appear the calculation of the moving average method analysis (Yuwono & Istiani, 2007)

b. *Exponential Smoothing* **Method**

Exponential smoothing is a method of forecasting moving averages with sophisticated weighting, but it is still easy to be used. This method is also known as an easy and efficient forecasting method. This method uses very little recording of past data, and is also the weighting method which is usually symbolized by α as a smoothing constant determined by the researcher, which has a value between 0 and 1. The concept is adjusted to a portion of the differentiation of last period actual demand with the previous predictions. The basic exponential refining formula can be shown as follows:

$$F_t = Ft - 1 + \alpha \, (At - 1 - Ft - 1 \ldots . . (2)$$

Note:

Ft+1 = Forecasting for next period

α   = smoothing constant

At   = Previous sales demand

Ft   = Forecasting for period t

Smoothing constant α, for the application in business field the value of constant is approximately from 0.05 to 0.5. The constant can be changed to give more value to current data (when α is high) or more value to the previous data (when α is low).

Exponensial smoothing with the trend adjustment is deemed to be applied if it is assumed that the data being analyzed has an upward and downward trend, so that the forecasting will be getting stronger and more precise. The mathematic formula of this method is as follows:

$Tt = \beta \, (\, Ft\text{-}F_{t\text{-}1}) + (\, 1\text{-}\beta) \, T_{t\text{-}1} \ldots . . (3)$

Note:

Ft = The value of Exponential Smoothing by trend

Tt = trend Exponensial Smoothing

At = Actual demand period t

β = Constant of Exponential trend ($0 \leq \beta \leq 1$)

c. *Trend Analysis* **Method**

The third method that will be used in this study is a method that separates the basic time series data patterns, but it includes trend factors that occur in the data. This method is a technique to match the trend lines to a series of past data, and then, project the lines in the future for forecasting the medium and long term (Heizer & Render, 2009). If it is drawn a straight trend line with a statistical method, the least square method can be applied. The least square method is a method often used in regression analysis techniques that aims to minimize the square of error 'e' so that the regression value approaches the true value (Bee, Weku, & Rindengan, n.d.). This approach produces a straight line that minimizes the

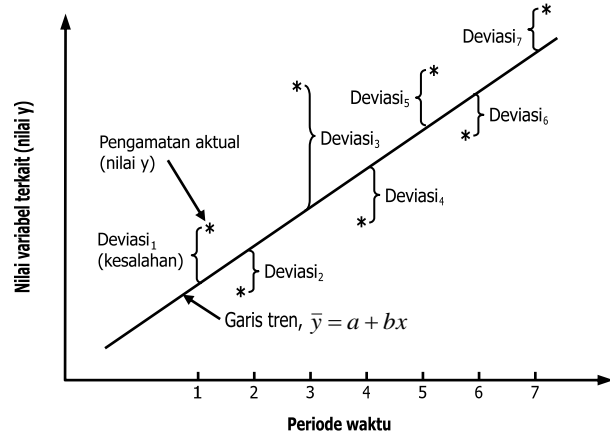sum of the squares of the vertical deviations of the line on each actual result.

Figure 3: Smallest Quadran Method

It can be seen from Figure 2 that the smallest quadrant line is explained by the y-intercept axis and its slope. Then, it can be mathematically expressed the line with the formula:

$$\gamma = a + bx .....(4)$$

Note:

γ = the value of the variable calculated to predict (the dependent variable)

a = Y axis intersection

b = slope of the regression line

x = free variable / time

To find the values of a and b, equations can be used for each regression line. The slope b can be calculated by the formula:

$$b = \frac{\sum xy - nx'y'}{\sum x2 - nx'2} ....(5)$$

Note:

b = Slope of the regression line

$\sum$ = total sales mark

x = value of independent variable

y = value of dependent variable known

x' = the average value of x

y' = the average value of y

n = the number of data

Where as to calculate *y-intercept* the following mathematic formula can be used:

$$a = y' + bx' ....(6)$$

Note:

a = y –intercept

y = the average value of y

b = The slope of regression line

x' = the average value of x

5. Calculating Forecasting Errors

The accuracy of forecasting results is determined by the error level of each method used by the researchers, or in other words, the size of the error level of the difference between forecasting results with actual requests. In this study, three error sizes were used, as follows:

a. Mean Absolute Deviation (MAD)

MAD is defined as the average absolute deviation over a certain time period or the first measure of forecasting error overall forecas-

ting data. Mathematically the formula for determining MAD is as follows:

$$MAD = \frac{\sum(Aktual - Peramalan)}{N} .....(7)$$

Note:

MAD = Mean Absolut Deviation

N = The number of Forecasting Period

In the computer application *QM for windows* MAD has been calculated in each of the research module, including the forecasting module.

a. Mean Squer Error (MSE)

MSE is another method to measure the whole forecasting errors. In other words, MSE is the average difference between the predicted and observed quadratic values. The following is mathematical formulation of MSE:

$$MSE = \frac{\sum(Aktual - Peramalan)2}{N} ......(8)$$

Similar to MAD, MSE automatically calculated in every forcasting time series module in *QM for windows* application.

b. Mean Absolute Presentage Error

(MAPE)

MAPE is the solution of the value of MAD dan MSE that occasionally have highest forecasting value if the observed data in thousands or more. MAPE is calcualted as the average and stated in the form of percentage.

Mathematically, MAPE can be calculated using the following formula:

$$MAPE = \left(\frac{100}{n}\right)\sum \left| At \frac{Ft}{At} \right| .....(9)$$

Note:

At = Actual demand

Ft = Forecasting in period t

N = The number of forecasting period

IV. RESULT AND DISCUSSION

Research on the forecasting of PMB UBSI PSDKU Karawang uses the time series data by calculating with DS for windows computer applications through three research models; and afterwards, comparing which method is the closest to perfect or at least the value of error percentage by looking at the smallest MAD and MSE values. The method which has the smallest percentage of MAD and MSE values will be used as a reference in the marketing strategies as an effort to improve the results of the 2019 PMB acquisition. The following is the time series data of the PMB UBSI PSDKU:

Table 1
PMB UBSI PSDKU Karawang Year 2013-2019

NO	School Year	PMB
1	2013/2014	820
2	2014/2015	811
3	2015/2016	845
4	2016/2017	743
5	2017/2018	611
6	2019/2020	598

Source: data pmb.bsi.ac.id

1. Moving Everage Method

The calculation of the research data using computer application is as follows:

Table 2. The Calculation Result Using QM for Windows Moving Average Method periode 1

Measure	Value
Error Measures	
Bias (Mean Error)	-44,4
MAD (Mean Absolute Deviation)	58
MSE (Mean Squared Error)	5846,8
Standard Error (denom=n-2=3)	98,715
MAPE (Mean Absolute Percent Error)	8,53%
Forecast	
next period	598

Source: data calculated in 2019

Based on the calculation using computer application *QM for windows* above, it shown that the value of *forecasting* PMB for period 2019/2020 as many as 598 students, the value of MAD reaches 58; MSE is 5846,8; and MAPE 8.53 %. Referring to the result, it can be predicted that for the following period the number of PMB will reach in the number of 598 mahasiswa with consideration of having a certain level of error, so it can not be used as a reference for forecasting, closest to the accuracy of forecasting with the actual data in the future because it will be compared with other methods.

Table 3
The Calculation Result Using DS for Windows Moving Average Periode 2

Measure	Value
Error Measures	
Bias (Mean Error)	-79,375
MAD (Mean Absolute Deviation)	94,125
MSE (Mean Squared Error)	11956,31
Standard Error (denom=n-2=2)	154,637
MAPE (Mean Absolute Percent Error)	14,52%
Forecast	
next period	604,5

Source: data calculated 2019

The results of subsequent calculations using the same method in the second period with the same computer application generated forecast values of 604 students with a MAD value of 94,125, MSE 11956,31 and MAPE value of 14.52%. With the results of the calculation in period 2 the forecast value for PMB 2019 is stated at 604, and has an error rate of 14.96%. MAPE period one is smaller than period 2; then, the forecasting using the average method that approximates the actual data is in the number 589.

2. Exponential Smoothing Method

Exponential smoothing method is a method that emphasizes weighting. It can be observed from the data examined the weighting in this method. The results of calculations using computer applications are summarized in the following table:

Tabel 4
The Calculation Result of Exponential Smoothing Method using QM for Windows

Measure	Value
Error Measures	
Bias (Mean Error)	-68,638
MAD (Mean Absolute Deviation)	80,438
MSE (Mean Squared Error)	9914,223
Standard Error (denom=n-2=3)	128,545
MAPE (Mean Absolute Percent Error)	12,39%
Forecast	
next period	648,406

Source: data calculated in 2019

The results of the study calculated using computer applications with the exponential refinement method that can be seen from the table above are the results of PMB forecasting as many as 648 students with a MAD value of 80,438, an MSE value of 9914,223,719, and for a MAPE value of 12.39%. Thus it can be predicted that in 2020 PMB of UBSI PSDKU Karawang will be at 648 with an error rate of 12.39%. It also be compared with the subsequent calculations which will include trend elements as follows:

Tabel 5
The Calculation Result using QM for Windows *Exponential Smoothing with trend*

Measure	Value
Bias (Mean Error)	-55,05
MAD (Mean Absolute Deviation)	67,75
MSE (Mean Squared Error)	7344,577
Standard Error (denom=n-2=3)	110,639
MAPE (Mean Absolute Percent Error)	10,22%
Forecast	
next period	596,578

Source: data calculated in 2019

Furthermore, it can be seen from the table above that PMB forecasting using the exponential refinement method by adjusting the trends in the time series data showed that the results of PMB forecasting will reach 596 students, considering MAD 67,75; MSE 7344 and MSE at 10.22%. Thus the forecasting results can be taken by using this method as many as 596 students. It can be concluded that using the exponential refinement method with trend adjustments have smaller MAPE with exponential smoothing methods without trends.

3. Trend Analysis Method

This following research calculation uses the trend analysis method. The results are calculated using computer application that is presented in tabular form below:

Tabel 6
The Calculation Result using QM for Windows
Analisis Trend Method

Measure	Value	Future Period	Forcasting
Error Measures		7	**556,8**
Bias (Mean Error)	0	8	505,029
MAD (Mean Absolute Deviation)	37,333	9	453,257
MSE (Mean Squared Error)	2058,514	10	401,486
Standard Error (denom=n-2=4)	55,568	11	349,714
MAPE (Mean Absolute Percent Error)	4,993%	12	297,943
Regression line		13	246,171
Demand(y) = 919,2		14	194,4
-51,771 * Time		15	142,629
Statistics		16	90,857
Correlation coefficient	-,89	17	39,086
Coefficient of determination (r^2)	,792	18	-12,686
		19	-64,457
		20	-116,229

Source: data calculated in 2019

The table showed that PMB forecasting results in 2020 were 557 students with consideration of the MAD value 37.333, the MSE score 2058.514; and the MAPE score 4.993%.

After this research carried out by implementing several different methods; moving average method, exponential refinement and trend analysis, the next step is to determine the best and most effective method implementation by looking at the smallest error rate and the highest forecast value. To compare the process of selecting the results of research is presented in the following table:

Tabel 7. Comparison of the Three Forecasting Method

No	Method	MAPE	Forcast
1	*MovingAverage*	8.53 %	598
2	*Exponential Smoothing*	10.22 %	596
3	*Trend Analysis*	4.99 %	557

Source: data calculated in 2019

The table above showed the comparison of three time series forecasting methods that display the smallest MAPE values. The Moving Average method has a forecast value of 598 with a MAPE value of 8.53%; the Exponential Smoothing method has a forecast value of 596 and a MAPE of 10.22%; and Trend Analysis method has a forecast value of 557 students and a MAPE of 4.99%. Then, it can be stated that the best and most effective

method in this research is to use the Trend Analysis method.

V. CONCLUSION

In forecasting research several methods namely Moving Average, Exponential Smoothing and Trend Analysis can be used to get the best and most effective research results showed by looking at the smallest error rate and the greatest forecast value. Based on the data processing and analysis, it can be compared that the aspects of the highest forecasting level is the exponential refinement method, which has a forecast value of 598 students compared to other methods, moving average 596 students and trend analysis 556 students. Meanwhile, if it viewed from the aspect of the percentage of error rate, trend analysis methods is the smallest compared with other methods, moving average 8.53% and exponential 10.22%. In other words, PMB UBSI PSDKU Karawang should use the trend analysis method in predicting the number of students acceptance. Therefore, PMB UBSI PSDKU Karawang is predicted to be at 556 students in 2020, so that the campus can prepare the facilities and infrastructure of teaching and learning activities earlier, and as a consideration for the campus to determine marketing strategies that are suitable to be applied during the new student admission period for next year. Because of degreasing of UBSI new students acceptance, a suggestion to the management of UBSI Karawang by considering the results of the research it is necessary to open an S1 level, remembering the diploma study program has begun to not be interested in prospective students.

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