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Information System for Course Quotas Forecasting using Trend Analysis Method

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ABSTRACT

Determining the class quota at each period of filling out the KRS (Study Plan Card) at the beginning of the semester is often an activity that cannot be determined easily. It is due to several important factors in it, one of the most influential and difficult things is the uncertainty when determining the quota for the number of students who will take the course, if later there is an error in predicting the number of students who will take the course, then the class quota that is prepared will certainly be less so that it leads to the disruption of the ongoing Student KRS registration process. The method used in this study is predicting using trend analysis which aims to determine how much capacity or inventory is needed for decision-making, then a system will be designed that can be used to predict the number of predicting quotas for courses that will be provided. The system design applies the system development method with UML. The stages of the process are carried out from collecting and processing subject offer quota data several previous academic years. This research has succeeded in building a model to make predictions using the Trend Analysis method, so that it can be used as a recommendation for the number of quotas offered for the next academic year.

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1. INTRODUCTION

In educational institutions, determining the number of classes is an activity that must be carried out by the manager of the Study Program. Determining the number of classes and the quota of students in a class is also not easy if it is done manually. The research that has been carried out by [1] explains that the opening of classes must be supported by quantitative data analysis with measurable results. So that it can be used to produce an accurate number of classes.

Determining class quotas for each KRS filling period (Study Plan Card) at the beginning of the semester is often one of the activities that cannot be determined easily. It is due to several important factors in it, one of the most influential and difficult things is the uncertainty when determining the quota for the number of students who will take the course. If later there is an error in predicting the number of students who will take the course, then the class quota prepared will be less so that it will lead to disruption of the ongoing Student KRS registration process [2].

The conditions often occur when determining students who are required to take certain courses or students who are declared not to have passed the same course in the previous year so they have to repeat the course in the coming year, especially sometimes some students have passed but feel the grades achieved were not satisfied enough for him, which made him finally decide to repeat the course to have better grades. These conditions make determining the quota for the number of students who will take certain courses difficult to predict [3].

Efforts to produce the expected number of class quotas can be made by predicting the number of course participants based on historical data from the semester of the previous academic year. The prediction results are expected to be taken into consideration to determine how many classes should be provided for one course, so that class quota requirements can be met properly [4].

Therefore, predicting will be conducting to predict these conditions. Predicting is the basic input in the operations management decision-making process in providing information about future demand to determine how much capacity or inventory is needed to make staffing decisions, budgets to be prepared, and ordering goods from suppliers and supply chain partners needed to make a plan [5].

In this study, one of the classification techniques will be used in data collection. The classification technique aims to find the value of certain attributes, the variables used are the quota of courses in the previous semester and the distribution of scores obtained by the students. The classification method used is the Time Series method using Trend Analysis for predicting which can be used as material for consideration in determining participant quotas for certain courses and can be converted into rules that will be used to determine predictions of students repeating or not [6].

This research, an information system will be designed that can be used to predict the number of course quota using the Time Series method. The time series method is based on a series that is collected from time to time to describe the progress of an activity, for example, a set of data taken per minute, per hour, per day, per week, per month, and year [7]. According to [8], "Information systems are many components (humans, computers, information technology, and work procedures), something is processed (data becomes information), and are intended to achieve a goal".

This study aims to produce a system with the ability to recommend the number of students who will take the courses offered and to apply the Trend Analysis method in predicting the number of quotas to be opened in a class of courses at the Department of Industrial Engineering, Universitas Teknologi Yogyakarta.

2. RESEARCH METHOD

The stages in the research method are held by collecting data, methods and data analysis, and system design as follows:

2.1 Data collection

Data collection was held in two ways, including literature studies and interviews.

a. Literature Review

The literature review is used to get an initial description of the process of determining student quotas to take courses. This literature study is also useful for providing some examples of problems in the prediction system for the number of students taking courses and also the solutions.

b. Interview

The next step is to conduct interviews with Study Program staff to get a real picture of the system and find out the advantages and disadvantages of the current system.

2.2 Analysis of the Research Object

The object used in this research is the process of determining the number of students taking courses at the Department of Industrial Engineering, Universitas Teknologi Yogyakarta using Trend Analysis Method. Trend analysis is an analytical method that is intended to make an estimate of prediction. For a proper prediction process, quite a lot of information (data) is needed and observed over a long period of time, so that it can be seen how much fluctuation occurs and what factors influence these changes.

Theoretically, in time series analysis what matters most is the quality or accuracy of the information or data obtained and the time or period from which the data was collected [9]. Time series analysis was introduced by Jenskin & Reinsel in their book entitled Time Series Analysis: Forecasting and control. [10] Since then time series began to be developed a lot. One method of time series analysis is trend analysis. Sometimes a scatter diagram is found where the spread of data is increasing. If that happens, the trend equation that is suitable to use is the exponential trend model. An exponential trend is a trend where the independent variable increases multiple times or is not linear. The exponential trend equation is as follows:

$$\hat{Y} = ab^x \qquad (1)$$

Where X is the exponential power of b to find the values of a and b, the natural logarithm of the equation gives $\ln \hat{Y} = \ln a + x \ln b$. If the notations $\ln \hat{Y}, \ln a,$ dan $\ln b$ are replaced with $Y^*, a^*, b^*,$ the result is

$$Y^* = a^* + b^* X \qquad (2)$$

This last equation is the linear trend equation discussed earlier. To determine the values of a^* and b^* the least squares method can be used. The Y values that have been transformed into $\ln \hat{Y}, \ln a,$ dan $\ln b$ replaced by Y^*, a^*, b^*, giving the formula:

$$a^* = \frac{\sum Y^*}{n} \; dan \; b^* = \ln \frac{\sum X \ln \hat{Y}}{\sum X^2} \qquad (3)$$

Thus the value of the Trend coefficient is obtained as follows

$$a^* = anti \ln \frac{\sum Y^*}{n} \; dan \; b^* = anti \ln \frac{\sum X \ln \hat{Y}}{\sum X^2} \qquad (4)$$

Where is:

$\hat{Y}$: Time Series Alleged Data Period X
X : Time (Day, Week, Month, Quarter, Year, etc.)
a, b : Trend Coefficient

2.3 System Design

1. System Analysis

In this case, to produce a system that can predict the number of students taking courses, it is necessary to pay attention to the analysis of system requirements, including:

a) A system is needed to predict the number of class quotas for courses that will be held each semester.
b) A system with a forecasting model is needed to predict the number of class quotas for courses using the Trend Analysis method.

2. System Architecture

The data architecture is taken from past data which includes the distribution of grades and quotas for the number of students in the past, then processed in the system program and stored in the database. The output results of the processed data will be informed to the operational division is shown in Figure 1.

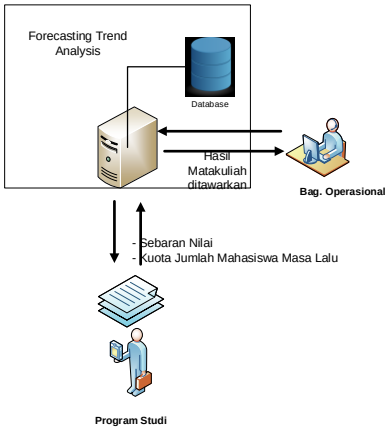

Figure 1. Program Architecture

3. Process Flow System

The system process flow that is built in general is shown in the Process Diagram in Figure 2.

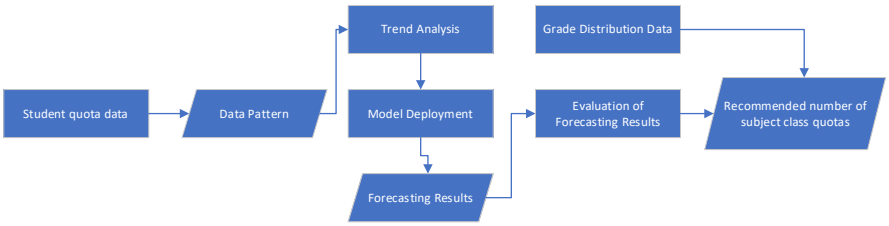

Figure 2. Process Diagram

Past data used includes data on the distribution of grades and data on the number of student quotas. Data on the number of student quotas for each subject in the previous academic year is used to predict the number of quotas for the following year, then by applying trend analysis using the Least Squares method to obtain a model, and the model is applied to obtain forecast results. The results of the data forecasting will be evaluated to test the accuracy of the data, taken into account the distribution of D and E scores of the previous year's students as an additional variable to obtain a recommendation for the number of class quotas for the course.

3. RESULTS AND ANALYSIS

In this research, a literature study process and interviews were carried out with the Head of the Industrial Engineering Study Program to obtain the required research object data. Based on the results of the interviews, it can be analyzed that the needs of the study program, namely the system can recommend predictions of the number of courses quotas that will be offered in the next academic year. From the analysis and design, it produces a Course Quota Forecasting Model, Use Case Diagrams, Activity Diagrams, Database Designs including Entity Relationship Diagrams and Table Relations as well as Interface Designs.

3.1 Course Quota Forecasting Model

In determining the forecasting model, it is carried out using trend analysis where the dependent variable (dependent) is the number of past quotas and the independent variable (independent) is a time series. In forecasting course quotas using course quota data in the past academic year, that is using course quota data in 2017-2020. The method used for time series analysis is the Least Square Method.

1. Least Square Method

A forecasting method uses linear equations to find the most appropriate line for old data sets to find out future data.

Equation (2) is used in the least squares method is as follows:

$$Y = a + bX$$

Then to find out the coefficients a and b are found by equation 3.

$$a = \frac{\sum y}{n} \quad dan \quad b = \frac{\sum xy}{\sum X^2}$$

where:

Y= Periodic data (time series)

a = Trend values in the base year

b = The average trend value changes each year

X = time variable (year)

In determining the value of X which is a time variable, it can be expressed in units of work with a variable value of 0, for odd periods the value of X, namely the distance between times, is given a value of one unit, for example, X = -n…-3, -2, -1, 0, 1, 2, 3…n. Whereas for even periods the value of X, the distance between times is given a value of 2 units, for example, X = n…-5, -3, -1, 1, 3, 5…n.

An example of forecasting one of the Information Technology Applications courses by calculating the XY value and X^2

Table 1 Calculation of XY values and X^2

Year	***Quota (Y)***	***X***	***XY***	X^2
2017	101	-3	-303	9
2018	180	-1	-180	1
2019	251	1	251	1
2020	235	3	705	9
Total	**767**		**473**	**20**

Calculation of Constant Values a and b using equation 3.

$$a = \frac{\sum y}{n}$$

$$a = \frac{767}{4} = \mathbf{191.75}$$

Explanation:

$\sum y$ = actual quota amount

n = number of periods

$$b = \frac{\sum xy}{\sum X^2}$$

Explanation:

$\sum xy$ = the sum of the multiplication of X and Y

$\sum X^2$ = the sum of the squares of the variable X

$$b = \frac{473}{20} = \mathbf{23.65}$$

Calculation of Trend Value (Least Square)
Calculation of the value of variable X, (a), and (b) used to find the trend value can be done using equation (1), that is:

$$(Y = a + bX)$$

It can be seen in Table 2 that the trend value is obtained from the Least Square method.

Table 2 The trend value results from the Least Square method

Year	***Quota (Y)***	***X***	***XY***	X^2	**Trends**
2017	101	-3	-303	9	120.8
2018	180	-1	-180	1	168.1
2019	251	1	251	1	215.4
2020	235	3	705	9	262.7
4	**767**		**473**	**20**	**767**

Year 2017 = 191.75 + (23.65 x -3) = 120.8
Year 2018 = 191.75 + (23.65 x -1) = 168.1
Year 2019 = 191.75 + (23.65 x 1) = 215.4
Year 2020 = 191.75 + (23.65 x 3) = 262.7
Year 2021 = 191.75 + (23.65 x 5) = **310**

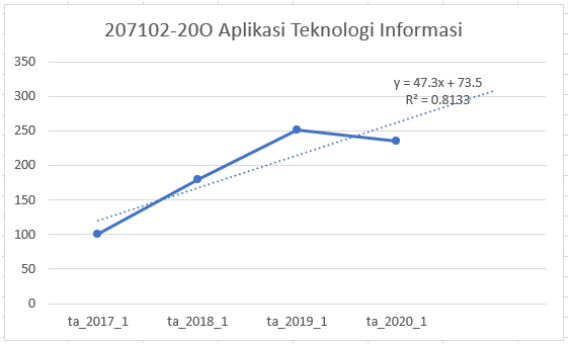

Figure 3. Example of a Trend Prediction chart

From the model that has been obtained, the estimated number of student quotas in the *Aplikasi Teknologi Informasi* course in 2021 is 310, that is, by calculating the value of X, the period is 5.

Furthermore, the results of the prediction that have been calculated can be used as a recommendation to determine the number of quotas offered, and the variable number of D and E values in the previous academic year can also be taken into account in addition to considering the number of quotas.

Table 3 Data on the distribution of D and E values

courses code	**courses**	**grades_D**	**grades_E**	**total**
207102-20O	Aplikasi Teknologi Informasi	13	8	21

So that when added to the number of D and E quota values, it can be recommended, that is (310+21) = **331 quota**.

2. Use Case Diagrams

Use case diagrams are used to describe the behavior of the system to be built so that users can find out who can use the functions in the system. In the use case design there are users of the Study Program and the Operations Section who have their respective roles. The role of the study program can access class quota data and grade distribution and can see forecasting results from the modeling that has been made, while the Operations Section can only see recommendations for the number of class quotas for courses. You can see the Use Case diagram in Figure 4

Figure 4. Use Case Diagram

3. Activity Diagrams

To be able to show the system's business processes in general, it can be described through an Activity Diagram. The activity process in general begins with the collection and processing of past class quota data and the distribution of past values as the basis for data reference. Past class quota data is used to predict class quotas for the following year by applying a trend analysis model, then for past value distribution data is used as additional data to produce recommendations for future class quota predictions.

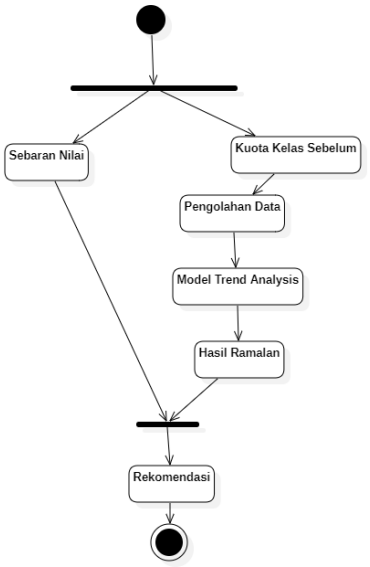

Figure 5. Activity diagrams

4. Entity Relationship Diagrams

ERD or Entity Relationship Diagram is a diagram that is used to describe data in an abstract way with the aim of describing the structure of the data used. In the ERD diagram figure 6, there are 4 entities namely Courses, Grade Distribution, Course Quotas, and Predictions.

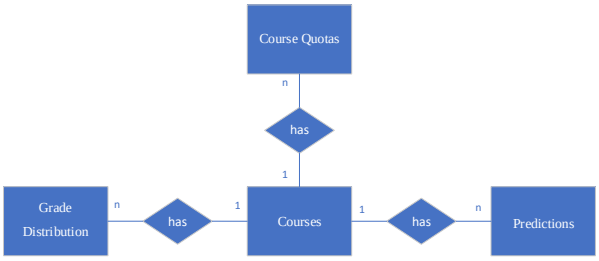

Figure 6. Entity Relationship Diagram

5. Table Relations

Each table is connected or related based on the connecting field key in each table, it can be seen in Figure 7.

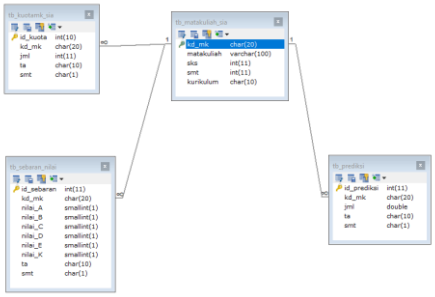

Figure 7. Table Relations

3.2 System Implementation

On the course quota prediction page, users can obtain information regarding the results of calculating the predicted number of course quotas for the next academic year offered.

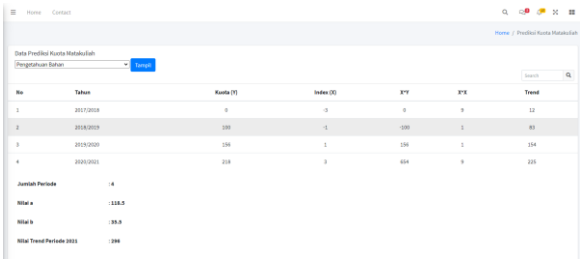

Figure 8. Course Quota Prediction Page

The recommendation page is used to display information on course recommendations that have predicted trends in the number of quotas, as well as information on the number of students who scored D and E in the previous school year as additional data in decision making.

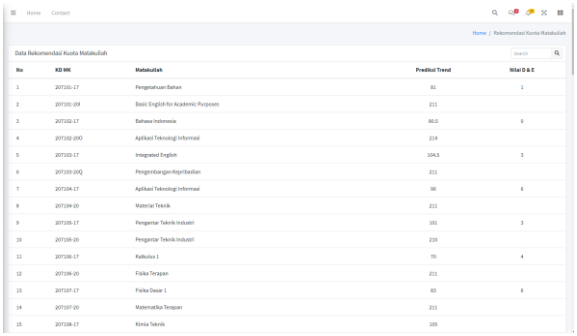

Figure 9. Quota Recommendation Page

The following are some examples of trend analysis predictions in graphical form:

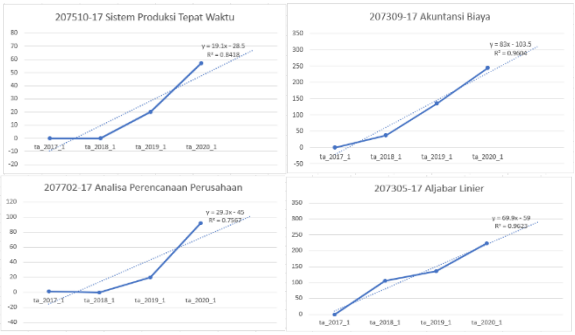

Figure 10. Prediction Graph

4. CONCLUSION

This research has succeeded building a model to make predictions using the Trend Analysis method. The stages of the process are carried out from collecting and processing course offering quota data from the previous academic year, the number of student data that still got D and E grades in the previous academic year, then applying the trend analysis method to produce graphic images predicting the number of trends in the next academic year and additional variable is the number of D and E scores in a course. So that it can be a recommendation for the number of quotas offered for the next academic year.

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