International Journal of Trends in Mathematics Education Research
Vol. 5, No. 3 (2022), pp. 261~267
ISSN 2621-8488 (online)
DOI: https://doi.org/10.33122/ijtmer.v5i3.162

SAINTIS publishing

Research Article

Factors affecting the grade point average students of FMIPA Universitas Negeri Padang with binary logistic regression model

Irma Surya Anisa✉ & Dony Permana

Universitas Negeri Padang, Padang, Padang, Indonesia, 25132
✉Coresponding Author: irma.surya41@sci.ui.ac.id

Received: 12 August 2022 *Revised: 19 September 2022* *Accepted: 23 September 2022* *Available online: 30 September 2022*

ABSTRACT

Today, everyone places a high importance on their education. Learning is how education is implemented, and learning allows people to reach their full potential. Since learning is a process and learning achievement is the end consequence of the learning process, learning and learning achievement are inextricably linked. Learning achievement levels are assessed using GPA (Grade Point Average). Allowance, gender, major, status of residence, school location, study time, admission type, duration of gadget use, and personality type are all factors that affect GPA. In order to identify the components that influence academic accomplishment, a model must be developed since it can be understood, explained, controlled, and forecasted. This study's goal is to identify the binary logistic regression model, which describes the variables influencing the faculty of mathematics and natural sciences at Universitas Negeri Padang's GPA. The aim of this study is to identify the logistic regression model that represents the variables that affect the GPA of the Faculty of Mathematics and Natural Sciences at Universitas Negeri Padang. Secondary and primary data were employed in this study, and questionnaires were used to collect the data. The 2020 students made up the study's sample, which included 293 respondents. According to the study's findings, factors such as gender, major, admission type, and duration of gadgets use may have an impact on students' GPAs at the Faculty of Mathematics and Natural Sciences at Universitas Negeri Padang. The percentage of correct predictions between the logistic regression model and training data is 70%.

Keywords: binary logistic regression; factors affecting; grade point average; prediction model;

1. INTRODUCTION

The major pillar on which the civilisation and values of the Indonesian nation are developed and elevated in the eyes of the international community is education. To attain education, one must be dedicated and honest. The application of education must therefore begin at a young age in order to produce quality human resources. Universities are one of the places where high-quality human resources are produced in educational institutions. Students must participate actively in the teaching and learning process at the university. It helps pupils succeed academically by getting assignments done well (Alfiani, 2013). Academic achievement is measured by the acquiring of the desired academic accomplishments. Each university controls accomplishment growth to produce highly qualified graduates. A transcript based on a student's Grade Point Average can show indicators of their academic performance in higher education (GPA). The Grade Point Average, or GPA as it is more often known, is a gauge of a student's academic performance, and the GPA itself measures performance from the first to the last semester taken (Tampil et al., 2017). Every semester, courses taken by students during the most recent semester are included in the evaluation of student learning success.

Students must actively participate in the teaching and learning process at the university level using the available media, such as libraries, publications, and the internet. In order to successfully complete tasks in higher education, students typically need to do literature searches and refine their own thought processes. Academic requirements in higher education include task completion, active engagement in other academic activities, and lecture attendance in addition to those two (Shaleh, 2016). The purpose and value of learning outcomes evaluation are also covered in Article 35, paragraphs (1) and (2) of the 2015 Universitas Negeri Padang Academic Regulations. This section evaluates learning outcomes in the form of the Cumulative Value Index (GPA). In other terms, student learning outcomes are demonstrated in a more general sense, such as by supplying information on the subject matter, examining various facets of topic learning, and evaluating learning outcomes that support the learning process and gauge student progress.

In general, achieving good grades gives students a lot of advantages, such as accelerating their learning process and even enabling them to apply for scholarships. In the age of globalization, many businesses hunt for candidates who fit their standards, one of which is that the applicant's grade point average must be at least a specific level. It makes sense that employers include a pretty high Grade Point Average (GPA) among the qualifications for applying for positions in connected agencies when discussing the GPA that is necessary when applying for a job. (Utami et al., 2021). The effectiveness of learning reflects the learning effort. Performance improves in direct proportion to how well each individual learns. According

to Slameto (2015), both internal and external factors affect how well students learn. Internal factors are those that come from within the individual, such as student attention, interests, talents, intelligence, motivation, ambition, concentration, and students' capacity to learn skills, including media literacy, in critically reexamining all subject content. Additionally, there are external influences, or factors that affect students from outside themselves. The first of these is the environment itself, which includes things like the air quality, tem-perature, and weather. Second, the individual's social environment can directly and indirectly affect the academic success of students such as the way parents educate, the atmosphere of the house or boarding house, cultural background and friends in the association. Third, there is the environment in universities such as teaching methods applied by lecturers, learning methods used by students, learning media used in class and so on. While Suryabrata (2018) shows that learning success can be influenced by the following factors, namely external factors such as temperature, weather, time, place. Such internal factors include physiological or physical conditions, psychological conditions or mental states. In other words, internal and external factors automatically determine the success of a student's learning. In a study conducted by Santoso et al., (2020) that the factors that affect the Grade Point Average are internal and external factors of students

The following studies explain the factors that influence GPA. The first, based on research conducted by Erdem et al., (2007) and Putpuek et al., (2018) explained that gender affects student GPA when According to research by Iskandar, (2018), gender has an impact on a person's degree of intelligence, with the female group scoring 24.06% higher than the male group. The second is that there is a study conducted by Tampil et al., (2017) and Nisa et al., (2021), the results that have the opportunity to affect the Grade Point Average are majors. The third is research from according to Marna et al., (2020) and Rifai et al., (2018) study time is also included in one of the factors that affect the Grade Point Average. The fourth research that has been carried out by Santosa & Chrismanto (2017) that from high school affects the Grade Point Average. Subsequent research from Setyawati et al., (2020) explains that the factors that influence the Grade Point Average are high school majors and students' areas of origin. According to Kemendikbud (2019) in a study of the use of devices by high school students in the DKI Jakarta area and its surroundings, it was found that 31.6% of respondents said that they used their devices more than 5 hours a day and then the duration of gadget use is one of the elements that has a detrimental impact on the Grade Point Average, according to research by Rifai et al., (2018).

2. RESEARCH METHOD

The elements that may have an impact on the performance index can be located and explained using a method. The statistical approach is one of them. A scientific approach known as the statistical technique gathers, characterizes, presents, evaluates, and analyses research data to help decision-making and arrive at reasonable findings. In this study, the researcher employed a binary logistic regression technique, where binary logistic regression is a way to identify the affecting elements. According to Kuncoro (in Rukini, 2016), logistic regression is extremely effective and frequently used because it offers a number of advantages over other regressions. Since the dependent variable in logistic regression is a dichotomous one, the assumptions of normality, heteroscedasticity, and autocorrelation are not necessary. The association between several factors and a binary variable is examined using binary logistic regression, a mathematical model technique. Binary logistic regression is used in logistic regression when there are two categories in the response variable, such as Y=1 for "successful" outcomes and Y=0 for "failed" results. (Hosmer et al., 2013). Some of the previous studies that used binary logistic regression were the first research conducted by Daruyani et al., (2013), Marna et al., (2021) and Tampil et al., (2017)to determine the factors that influence the GPA

Binary Logistic Regression

There aren't many differences between the strategies and procedures used in the logistic regression method and those used in linear regression. If the Ordinary Least Squares (OLS) approach is frequently employed in the linear procedure to estimate parameter values, the Maximum Likelihood Estimation (MLE) method is then utilized to estimate the parameter values in logistic regression. To find the logistic equation, the model used is:

$$\pi(x) = \frac{e^{(\beta_0+\beta_1 x_1+\cdots+\beta_p x_p)}}{1+e^{(\beta_0+\beta_1 x_1+\cdots+\beta_p x_p)}} \quad (1)$$

where p = number of predictor variables x_i
So the logit equation is as follows:

$$g(x) = \ln\left(\frac{\pi(x)}{1-\pi(x)}\right) = \beta_0 + \beta_1 x_1 + \cdots + \beta_p x_p \quad (2)$$

Parameter Estimation

The solution for estimating unknown parameters can use the Maximum Likelihood Estimation (MLE) method. Basically, the maximum likelihood method provides an estimated β value to maximize the likelihood function. Systematically, the likelihood function for the binary logistic regression model is as follows.

$$l(\beta) = \prod_{i=1}^{n} f(x_i) = \prod_{i=1}^{n} \pi(x)^{y_i}\left(1-\pi(x_i)\right)^{1-y_i} \quad (3)$$

The likelihood function has been maximized in the form of log $l(\beta)$ and is expressed by $L(\beta)$.

$$L(\beta) = \sum_{j=0}^{p}\left(\sum_{i=1}^{n} y_i x_{ij}\right)\beta_j - \sum_{i=1}^{n} \ln\left(1 + e^{\sum_{j=0}^{p}\beta_j x_{ij}}\right) \quad (4)$$

to get the value of the interpretation of the logistic regression coefficient ($\hat{\beta}$) is done by making the first derivative $L(\beta)$ to β and equated with 0.

Parameter Estimation Test

After the parameter estimation results are obtained, then the significance of the β coefficient is tested univariately on the response variable, namely by comparing the maximum likelihood result parameter, the estimated β with the standard error of the parameter. The tests carried out are as follows.

1. *Likelihood Ratio Test*

Likelihood Ratio Test is carried out to determine the significance of the β parameters as a whole or simultaneously. The tests carried out are as follows.

$$G = -2\ln\frac{\left(\frac{n_1}{n}\right)^{n_i}\left(\frac{n_0}{n}\right)^{n_0}}{\sum_{i=1}^{n}\hat{\pi}^{y_i}(1-\hat{\pi})^{(1-y_i)}} \quad (5)$$

where: $n_1 = \sum_{i=1}^{n} y_i$, $n_0 = \sum_{i=1}^{n}(1-y_i)$, $n = n_1 + n_0$

2. *Partial Test or Wald Test*

In this partial test, testing is done by testing each β_j individually. Individual test results will indicate whether a predictor variable is eligible to be included in the model or not.

$$W = \frac{\hat{\beta}_i}{SE(\hat{\beta}_i)} \quad (6)$$

Goodness of Fit Test

In matching a logistic model, it is necessary to choose a model with a linking function and explanatory variable whose results are the most suitable. For this reason, the Goodness of Fit statistical test is used to compare the fit in different models. For this test, Hosmer and Lemeshow tests can be used.

$$\hat{C} = \sum_{r=1}^{g}\frac{(o_r - n_r\bar{\pi}_r)^2}{n_r\bar{\pi}_r(1-\bar{\pi}_r)} \quad (7)$$

Parameter Coefficient Interpretation

The interpretation of the coefficients of this parameter is carried out to determine the trend/functional relationship between the predictor variables and the response variables and to show the effect of changes in the value of the variables concerned. In this case, the Odds ratio or e^{β} is used and is expressed by Odds ratio is defined as the tendency of the response variable to have a certain value if it is given $x = 1$ and compared to $x = 0$. The decision that there is no relationship between the predictor variable and the response variable is taken if the Odds ratio $(\psi) = 1$. If the Odds ratio $(\psi) < 1$, then between the predictor variable and the response variable there is a negative relationship every time the value of the independent variable (x) changes and if the Odds ratio $(\psi) > 1$ then between the predictor variable and the response variable there is a positive relationship every time. change in the value of the independent variable (x).

3. RESULTS AND DISCUSSION

The data used in this study are secondary and primary data on students of FMIPA UNP class 2020. The sampling technique used in this study was proportionate stratified random sampling with a sample of 293 respondents. Allowance, gender, major, status of residence, school location, study time, admission type, duration of gadget use, and personality type are all factors that affect GPA. The variables in this study can be seen in **Table 1**.

Table 1. Research Variables for Binary Logistic Regression

Variables	Description
Y_0	$GPA < 3{,}50$
Y_1	$GPA \geq 3{,}50$
$X_{1(0)}$	Female gender
$X_{1(1)}$	Male gender

Variables	Description
$X_{2(0)}$	Non education major
$X_{2(1)}$	Education major
$X_{3(0)}$	In family house
$X_{3(1)}$	On boarding house
$X_{4(0)}$	School from district
$X_{4(1)}$	School from city
$X_{5(0)}$	< 6 hours for study time
$X_{5(1)}$	≥ 6 hours for study time
$X_{6(0)}$	Admission type: Mandiri selection
$X_{6(1)}$	Admission type SNM/SBM selection
$X_{7(0)}$	≤ 5 hours of gadgets use
$X_{7(1)}$	> 5 hours of gadgets use
$X_{8(0)}$	Extroverts personality type
$X_{8(1)}$	Introverts personality type

Parameter Estimation Test

1. *Likelihood Ratio Test*

This test was conducted to determine the role of all independent variables in the model.

Table 2. Log-Likelihood Logistic Regression

Step	-2 *Log likelihood*
1	324,549

In **Table 2** the value of G is 324,549 where the value of $G > \chi^2_{(8;0.05)}$ is $324{,}549 > 15{,}5073$ then H_0 is rejected and it can be concluded that the independent variables used together affect the student GPA or there is at least one independent variables that affect the dependent variable.

2. *Partial Test*

This test was conducted to determine the effect of each variable $X_1, X_2, X_3, X_4, X_5, X_6, X_7$ and X_8 on students' GPA. The following is the estimate obtained by the SPSS output which contains 8 parameters.

Table 3. Partial Test Results

Variable	Wald	*p-value*
Gender (X_1)	9,777	0,002
Major (X_2)	9,197	0,002
Status of residence (X_3)	0,068	0,795
School location (X_4)	0,752	0,386
Study time (X_5)	0,038	0,845
Admission type (X_6)	5,360	0,021
Duration of gadgets use (X_7)	4,526	0,033
Personality type (X_8)	0,464	0,496

Based on **Table 3**. it is known that $\alpha = 0.05$ so it can be concluded that the four significant independent variables are gender (X_1), major (X_2), admission type (X_6) and duration of gadgets use (X_7) on the dependent variable, namely GPA.

Binary Regression Logistic Analysis

Based on the value of the beta coefficient, it is known that only four independent variables have a significant influence on the dependent variable so that these four variables are included in the logistic regression as shown in **Table 4**.

Table 4. β Value Logistics Regression Model

Parameter	Estimasi	*p-value*
β_0	−1,280	0,018
β_1	−1,186	0,002
β_2	0,877	0,002
β_6	0,698	0,021
β_7	−0,604	0,033

In **Table 4**, the logistic regression model obtained with the dependent variable $\boldsymbol{Y = \pi(x)}$ is the Grade Point Average with the independent variables being gender ($\boldsymbol{X_1}$), Major ($\boldsymbol{X_2}$), admission type ($\boldsymbol{X_6}$) and duration of gadgets use ($\boldsymbol{X_7}$). So that the logistic regression model is obtained as follows.

$$\pi(x) = \frac{e^{(-1{,}280-1{,}186X_1+0{,}877X_2+0{,}698X_6-0{,}604X_7)}}{1+e^{(-1{,}280-1{,}186X_1+0{,}877X_2+0{,}698X_6-0{,}604X_7)}}$$

where the logit value of $\pi(x)$ is
$g(x) = -1{,}280 - 1{,}186X_1 + 0{,}877X_2 + 0{,}698X_6 - 0{,}604X_7$

Goodness of Fit Test

This test is carried out to see whether the model fits the data or not. The suitability of the logistic regression model was assessed using the Hosmer and Lemeshow Test.

Table 5. Hosmer and Lemeshow Test

Step	*Chi-Square*	*Df*	*p-value*
1	9,262	8	0,321

In **Table 5**. it is known that the p-value of Hosmer and Lemeshow Test is $0.321 > \alpha = 0.05$ or $\hat{C} = 9.262 < \chi^2_{(0.05;8)} = 15.51$ then H_0 is not rejected so it can be it was concluded that there was no difference between the observed results and the estimated value or the logistic regression model used according to the data.

Parameter Coefficient Interpretation

The trend value between one category and another on the qualitative independent variable is expressed by the Odds Ratio. The interpretation of the coefficients is carried out to determine the meaning of the estimated parameter values in the independent variables. In the results in SPSS, the Odds Ratio can be seen in the $Exp(\beta)$ column and can be simplified as Table 6. as follows.

Table 6. Odds Ratio Values

Parameter Estimation	*Odds Ratio* (ψ)
Gender (X_1)	0,306
Major (X_2)	2,403
Admission type (X_6)	2,010
Duration of gadgets use (X_7)	0,547

In **Table 6**. it can be concluded as follows.

1. The Odds Ratio value for the gender variable is 0.306, which means that women are 0.306 times more likely to get a GPA 3.50 than men.
2. The value of the Odds Ratio in the major variable is 2.403, which means that students majoring in education have the opportunity to get a GPA 3.50 by 2.403 times compared to students from non-educational majors.
3. The Odds Ratio value for the entry path variable is 2.010, which means that students who enter through the SNM/SBM selection are more likely to get a GPA score of 3.50 compared to students who enter through mandiri selection.
4. The Odds Ratio value for the variable duration of gadgets use is 0.547, which means that students whose duration of gadgets use is ≤ 5 hours are more likely to get a GPA score of 3.50 compared to students whose duration of gadgets use is > 5 hours.

Sensitivity and Specificity

The percentage of classification accuracy is the ratio between the number of observations correctly classified by the model (according to the actual group) and the total number of observations. Table 7. shows that the logistic regression model formed can make a classification in the Y estimation, which is 70%, which means that the logical regression equation model can predict $GPA < 3.50$ or $GPA \geq 3.50$ and from 293 observations, there are 205 correct observations. The classification is expressed by the logistic regression model.

Table 7. Classification Table

Observed			Predicted		
			GPA		Percentage Correct
			GPA < 3.50	GPA >= 3.50	
Step 1	GPA	GPA < 3.50	181	22	89.2
		GPA >= 3.50	66	24	26.7
	Overall Percentage				70.0

a. The cut value is .500

4. RESULTS AND DISCUSSION

Following the completion of the logistic regression study, a logistic regression model was produced that could be used to explain the variables that influence FMIPA UNP students' GPA in the manner described below.

$$\pi(x) = \frac{e^{(-1{,}280-1{,}186X_1+0{,}877X_2+0{,}698X_6-0{,}604X_7)}}{1+e^{(-1{,}280-1{,}186X_1+0{,}877X_2+0{,}698X_6-0{,}604X_7)}}$$

where $\pi(x)$ is the logit value,

$$g(x) = -1{,}280 - 1{,}186X_1 + 0{,}877X_2 + 0{,}698X_6 - 0{,}604X_7$$

The following factors have an impact on FMIPA UNP students' GPAs: gender, major, admission method, and duration of gadget use. It is influenced by FMIPA UNP students who have trend values of 0.306 for the gender variable, 2.403 for the major variable, 2.010 for admission type, and 0.547 for the variable duration of gadget use. The percentage of correct predictions between the logistic regression model and training data is 70%.

ACKNOWLEDGEMENTS

The author expresses his deepest gratitude to Magister department Mathematics of Education, Universitas Negeri Padang, and the reviewers who have provided many inputs for the perfection of this article.

AUTHOR'S CONTRIBUTIONS

The authors discussed the results and contributed to from the start to final manuscript.

CONFLICT OF INTEREST

There are no conflicts of interest declared by the authors.

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