IDENTIFY FACTORS AFFECTING STUDENT ACHIEVEMENT USING THE BINARY LOGISTIC REGRESSION ANALYSIS

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Abstract:
The success of students in completing their study program is indicated by the achievements reflected in their Grade Point Average (GPA). Grade Point Average (GPA) is expressed in numerical form and is an academic achievement calculated based on all courses taken in all semesters that have been passed by students. This study aims to obtain a model of external factors that affect Grade Point Average (GPA) and variables that affect Grade Point Average (GPA). The response variable in this study is Grade Point Average (GPA) which is categorical and divided into two categories. The method used is binary logistic regression analysis. This study used primary data with the research subjects being second, third, and fourth-semester students in the Mathematics Education Department of Alauddin Makassar State Islamic University. The indicators on the instrument can be categorized as valid and reliable to measure service variables, learning, facilities and infrastructure, and student interest in entering college. The results of binary logistic regression analysis show that service has a significant effect on Grade Point Average (GPA), besides that learning, facilities, infrastructure, and the number of students enrolling in college have an effect but are not significant on Grade Point Average (GPA).

Keywords: Grade Point Average (GPA), Regression, Logistic Biner

IDENTIFIKASI FAKTOR-FAKTOR YANG MEMPENGARUHI PRESTASI SISWA MENGGUNAKAN ANALISIS REGRESI LOGISTIK BINER

Abstrak:
Keberhasilan mahasiswa dalam menyelesaikan program studinya ditunjukkan dengan prestasi yang tercermin dalam Indeks Prestasi Kumulatif (IPK) mereka. Indeks Prestasi Kumulatif (IPK) dinyatakan dalam bentuk numerik dan merupakan prestasi akademik yang dihitung berdasarkan seluruh mata kuliah yang ditempuh pada semua semester yang telah dilalui mahasiswa. Penelitian ini bertujuan untuk mendapatkan model faktor eksternal yang mempengaruhi Indeks Prestasi Kumulatif (IPK) dan variabel yang mempengaruhi Indeks Prestasi Kumulatif (IPK). Variabel respon dalam penelitian ini adalah Indeks Prestasi Kumulatif (IPK) yang kategoris dan terbagi dalam dua kategori. Metode yang digunakan adalah analisis regresi

logistik biner. Penelitian ini menggunakan data primer dengan subjek penelitian adalah mahasiswa semester dua, tiga, dan empat pada Jurusan Pendidikan Matematika Universitas Islam Negeri Alauddin Makassar. Indikator pada instrumen dapat dikategorikan valid dan reliabel untuk mengukur variabel pelayanan, pembelajaran, sarana dan prasarana, serta minat mahasiswa memasuki perguruan tinggi. Hasil analisis regresi logistik biner menunjukkan bahwa pelayanan berpengaruh signifikan terhadap Indeks Prestasi Kumulatif (IPK), selain itu pembelajaran, sarana, sarana prasarana, dan jumlah mahasiswa yang mendaftar kuliah berpengaruh namun tidak signifikan terhadap Indeks Prestasi Kumulatif (IPK).

Kata Kunci: Indeks Prestasi Kumulatif (IPK), Regresi, Biner Logistik

INTRODUCTION

Education is one of the main focuses of every individual in this modern era. Therefore, education is a fundamental aspect that needs attention. The main purpose of education is to improve the quality of Human Resources (HR) both at the personal and community levels. Education, as a process of human interaction, exchanges knowledge, mentality, character, and morals. The development of education has a significant impact on various fields such as economics, politics, socio-culture, information technology development, and others. One reflection of the quality of superior Human Resources (HR) is shown by their achievements while studying basic to advanced education, one of which is higher education.

Universities are places for higher education, research, and community service. A university has specific criteria such as bachelor's, professional, master's, and doctoral degrees. Research is a rule-based learning activity in various disciplines to find truth and solve problems. Community service is the application of science to society to improve the quality of human resources (HR). Higher education is a level of higher education with various elements and organizes academic and professional education in various scientific disciplines (Indrajit & Djokopranoto, 2004).

The university's mission is to continuously improve the quality of education. Quality education means human resources (HR) that are ready to

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compete globally. Therefore, a quality university must constantly improve the quality of its activities. As a unique institution in the world of education, universities must have specific goals for the internal and external characteristics of the educational environment have their own goals and ideals, which are stated in the vision and mission, which are developed with stakeholders in the process of formation (Sayidah, Ady, Supriyati, Sutarmin, Winedar, Mulyaningtyas, & Assagaf, 2019).

Some strategic elements that require special attention in developing the university are the quality of academic programs, the quality of human resources (HR), the quality of services, and the quality of supporting facilities and infrastructure. To improve these strategic elements, an implementation method is needed, i.e. good and quality governance. Competition in the world of higher education in Indonesia is so great that all universities require fundamental changes to be able to compete and produce competent graduates in the era of advances in information and communication technology. One indicator of the quality and success of college graduates is the Grade Point Average (Suti, Syahdi, & Didiharyono, 2020).

The success of students in completing their study program is indicated by the achievements reflected in their Grade Point Average (GPA). Grade Point Average (GPA) is expressed in numbers and is an academic achievement calculated based on all courses taken in all semesters that have been passed by a student. Academic mastery will be proportional to the student's Grade Point Average (GPA). The better the student's academic mastery, the better the GPA, and vice versa. Many factors affect a student's grade point average (GPA).

The student achievement index is influenced by two factors, namely internal student factors and external student factors (Tampil, Komaliq, & Langi, 2017). Students' internal factors include attitude, interest, and learning motivation (Nadziruddin, 2006). Factors from external students include facilities and infrastructure of the campus or school environment, learning system, interaction or communication between lecturers and students, quality of technology, and campus internet (Rugutt & Chemosit, 2005). In addition, race and culture, the number of credits received, communication between students and teachers, organizational activities, and activities in the field of education (Semer & Harmening, 2015).

Other studies that examine the factors that influence the student achievement index include Modeling Factors Affecting the Achievement Index of ITS Undergraduate Program Students Using Ordinal Logistic Regression

(Dhania, 2010), Ordinal Logistic Regression Analysis of Factors Affecting Student GPA (Setyawati, 2020). Study of Factors Affecting Academic Achievement in Higher Education: A Structural Equation Modeling Approach (Rugutt & Chemosit, 2005). Exploring significant factors that impact the academic success of student veterans in higher education (Semer & Harmening, 2015).

From various studies that have been conducted by previous researchers, this study will describe the use of one method to identify factors that affect achievement. Data on the response variable is categorical which consists of two responses. The analysis used to determine the relationship between variables with the response variable consisting of two categories is logistic regression (Sweet & Martin, 2014). Logistic regression is a data analysis that is commonly used to detect relationships between variables with multicategorical responses (scaling data at various levels) (Hosmer & Lemeshow, 2000) or in special conditions in regression analysis where the response variable is not continuous and the predictor variables are qualitative or quantitative (Hair, Black, Babin, Anderson, Black, & Anderson., 2018; Peng, Lee, & Ingersoll, 2002). The term logistic regression is given based on the structure of the response variable in the form of a logit transformation (Bozpolat, 2016). Logistic regression analysis has assumptions, namely independence and multicollinearity tests (Senaviratna & Cooray, 2019). So, This research uses the binary logistic regression analysis method.

METHODS

This study used primary data, namely data on Mathematics Education students of Alauddin State Islamic University Makassar in semesters 2, 4, and 6.

Table 1. Variables research

Number	Variables	Description	Scale
1	Y	Grade Point Average (GPA)	Nominal
2	X_1	Service	Ordinal
3	X_2	Learning/Instruction	Ordinal
4	X_3	Facilities and Infrastructure	Ordinal
5	X_4	University entrance pathways	Nominal

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The response variable in this research is the student's Grade Point Average. GPA (Grade Performance academic) is the overall result of the grades obtained by students during the learning process, the greater the number obtained by students, the better the academic achievement they achieve (Yanti, Windarto, & Suhada, 2019). GPA is a measure that is conceptualized as a measure of academic achievement or an indication of how well students are doing during their studies in college. Four predictor variables influence the response variable, namely service, learning, facilities and infrastructure, and University entrance pathways. The composition of the data in this study is.

Table 2. Data structure

Response Variables	Predictor Variables				
	x_1	x_2	x_3	...	x_n
y_1	$x_{1.1}$	$x_{1.2}$	$x_{1.3}$	...	$x_{1.n}$
y_2	$x_{2.1}$	$x_{2.2}$	$x_{3.3}$	...	$x_{2.n}$
$\vdots$					
y_n	$x_{n.1}$	$x_{n.2}$	$x_{n.3}$	...	$x_{n.n}$

The application used to complete the data analysis is R Studio. The data analysis steps are as follows.

1. Conduct a validity test to find out the exact instrument to measure what want to measure (Syamsuryadin & Wahyuniati, 2017). The formula used is (Frankel, Wallen, & Hyun, 2020)

$$r_{xy} = \frac{n(\sum x_i y_i) - (\sum x_i)(\sum y_i)}{\sqrt{(n(\sum x_i^2) - (x_i)^2)(n(\sum y_i^2) - (y_i)^2)}} \tag{1}$$

which:

r_{xy} : coefficient , $-1 \leq r \leq 1$

n : Number of respondents

x_i : Score each item on the instrument

y_i : Score each item on the criteria

With the following test criteria:

H_0 : No relationship

H_1 : There is a relationship

The expected result is to receive H_1 with criteria $r_{statistic} > r_{table}$ or $p - value < \frac{\alpha}{2}$. After the validation test is carried out, a reliability test is carried

out to determine the extent to which the instrument can be trusted in making measurements (Syamsuryadin & Wahyuniati, 2017).

$$\alpha = \frac{k}{(k-1)}\left(\frac{\Sigma S_i^2}{S_t^2}\right) \qquad (2)$$

With

$$S_i^2 = \frac{JKi}{n} - \frac{JKs}{n^2} \qquad (3)$$

$$S_t^2 = \frac{\Sigma X_t^2}{n} - \frac{(\Sigma X_t)^2}{n^2} \qquad (4)$$

With:

α : Coefficient *Cronbach alpha,* $\alpha \geq 0.6$

k : number of item

S_i^2 : Variants of each item

S_t^2 : Total variance

JKi : The sum of the squares of the entire item score

JK_s : Number of squares of subjects

n : Number of respondents

X_t : Total Score

The test criteria used are:

H_0 : Inconsistent indicators used

H_1 : The indicators used are consistent

The expected result is to refuse H_0 with a criteria $\alpha > 0.6$

2. A multicollinearity test was carried out to test whether there is a relationship between predictor variables concerning value VIF

$$VIF = \frac{1}{1 - R^2} \qquad (5)$$

H_0 : There is no multicollinearity in predictor variables

H_1 : There is multicollinearity in the predictor variable

The expected VIF value is $VIF < 10$, so that multicollinearity does not occur in poetry (Oke, J. A. Akinkunmi, W. B., Etebefia 2019).

3. Using the Ordinal Logistic Regression method to model factors external that affect the Grade Point Average (GPA) of Mathematics Education students at Makassar State Islamic University.

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a. Independence test for both variables.

The hypotheses that can be tested are

$H_0 \; : P_{ij} = P_i.P_j$

$H_1 \; : P_{ij} \neq P_i.P_j$

The Statistics of the Pearson Chi-Square are as follows:

$chi \; squared \; \chi^2 = \sum_{i=1}^{I} \sum_{j=1}^{J} \frac{(n_{ij} - e_{ij})^2}{e_{ij}}$

with,

$$e_{ij} = \frac{n_i \times n_j}{n} \tag{6}$$

The result to be achieved is to reject H_0 with $\chi^2 > \chi^2_{df}$ or $p - value < \alpha$ (Agresti, 2019).

b. Test the significance of ordinary logistic regression analysis, either partially or simultaneously.

This test is used to determine the significance of the β coefficient as a whole or simultaneously if the test shows significant results. It is concluded that the resulting model is suitable and the response variable can be simulated significantly. The test concept is as follows.

$H_0 : \beta_1 = \beta_2 = \cdots = \beta_p = 0$

$H_1 :$ There is at least one $\beta_j \neq 0 \; ; j = 1,2, \dots, p$

The test statistics are

$the \; G = -2 \ln \left[\frac{\left(\frac{n_1}{n}\right)^{n_1} \left(\frac{n_2}{n}\right)^{n_2} \left(\frac{n_3}{n}\right)^{n_3}}{\prod_{i=1}^{n} [\pi_1(x_1)^{y_{1i}}(x_2)^{y_{2i}}(x_3)^{y_{3i}}]} \right]$

With G as *Likelihood Ratio Test*

$n_1 = \sum_{i=1}^{n} y_{1i} \; ; n_2 = \sum_{i=1}^{n} y_{2i} \; ; n_3 = \sum_{i=1}^{n} y_{3i} \; ; n = n_1 + n_2 + n_3$

$db = ((k+1) - 2) \times p$, with $(k+1)$ as the number of categories of response variables and p as the number of categories of predictor variables.

For significance α, H_0 rejected if $G > \chi^2_{\alpha,db}$ with squared is the value of a random variable in the Chi-Square distribution table or p−value < α (Hosmer & Lemeshow, 2000). Simultaneous testing with β parameters on response variables has been carried out, the next step is to perform partial tests of β parameters on response variables. This test is performed to

identify the significance of the predictor variable influencing the variable. The testing hypothesis is as follows

$H_0 : \beta_1 = \beta_2 = \cdots = \beta_p = 0$
$H_1; \beta_j \neq 0 ; j = 1,2,\dots,p$

Dengan statistik uji

$$W = \frac{\widehat{\beta_J}}{[SE(\widehat{\beta_j})]} \tag{7}$$

with,

$$SE(\widehat{\beta_j}) = \sqrt{var\hat{\beta}}$$

The statistics of the W teis st follow the *chi-squared by rejecting H_0 if $W > \chi^2_{\alpha,1}$* or $p - value < \alpha$ (Hosmer & Lemeshow, 2000).

c. A model suitability test was carried out to find out whether the model obtained was appropriate or not.

This test is carried out to determine whether the model obtained using the parameter significance test has been feasible. The Goodness of Fit test is performed using the Goodness of Fit test Hosmer-Lemshow and the test hypothesis is as follows

H₀: There is no significant difference between the observations and the possible predictions of the model

H₁: There is a significant difference between the observations and the possible predictions of the model

With test statistics as follows

$$\hat{C} = \sum_{k=1}^{g} \frac{(o_k - n'_k \bar{\pi}_k)^2}{n'_k \bar{\pi}_k (1 - \bar{\pi}_k)}$$

With:

o_k : The value of the response variable in the k-th group

$\bar{\pi}_k$: average probability estimation

g : Number of category combinations in a concurrent model

n'_k : Many observations of the k-th group

The *Hosmer-Lemeshow* test statistics follow the Chi-Square distribution with a free degree of g−2 resulting in a decision to reject H_0 if $\hat{C} > \chi^2_{g-2}$ or $p - value < \alpha$ (Hosmer & Lemeshow, 2000).

d. Interpret the results that have been obtained.

The predictive coefficient of the predictor variable represents the change in the value of the response variable for each unit change in the predictor variable. The odds ratio is used to determine the functional relationship

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between response variables and predictor variables and to determine unit changes in response variables caused by predictor variables. The odds ratio for $Y \leq j$ to $Y > j$ is calculated at two values e.g. $x = a, x = b$ (Hosmer & Lemeshow, 2000).

$$\Psi(a, b) = \begin{bmatrix} \frac{P(Y \leq j | x=a)}{P(Y > j | x=a)} \\ \frac{P(Y \leq j | x=b)}{P(Y > j | x=b)} \end{bmatrix}$$

$$= \frac{\exp(\beta_{0j} + (\beta_i(a))}{\exp(\beta_{0j} + (\beta_i(b))}$$

$$= \exp\{(\beta_{0j} + (\beta_i(a)) - \exp(\beta_{0j} + (\beta_i(b))\}$$

$$= \exp[\beta_i(a - b)]$$

If $a - b = 1$ then $\Psi = \exp(\beta_i)$.

A classification system is an assessment of the probability of error that makes a classification using the measure of error rate (APER), ie. The value of the proportion of the sample is incorrectly indicated by the classification function (Agresti, 2019).

$$APER = \frac{n_{12} + n_{21} + n_{13} + n_{31} + n_{23} + n_{32}}{n_{11} + n_{12} + n_{13} + n_{21} + n_{22} + n_{23} + n_{31} + n_{32} + n_{33}}$$

Classification accuracy $= 1 - APER$.

RESULTS AND DISCUSSION

1. Test of Validity and Reliability

Validity and reliability tests are carried out on indicator items on the instruments used.

a. Service

Table 3. Test the validity of service variables

Number	Indicators	Output R			Cut-off	Information
		r	t	p-value		
1	X1.1	0.7	9.9	$1.392636e - 17$		Valid
2	X1.2	0.7	9.9	$1.29195e - 17$		Valid
3	X1.3	0.6	9.1	$1.085063e - 15$	r_{tabel}	Valid
4	X1.4	0.6	9.2	$7.11254e - 16$	$= 0.17$	Valid
5	X1.5	0.6	7.7	$2.240508e - 12$	$\frac{\alpha}{2} = 0.025$	Valid
6	X1.6	0.6	7.5	$6.748743e - 12$		Valid

There are six indicators in the service variable, namely ease of managing academic correspondence, friendliness and alertness in the

academic service process, the willingness of library staff to provide assistance in borrowing books, ease of students carrying out the mentoring process with lecturers, and well-arranged lecture schedules. Based on the validity test for each indicator on the service variable, it is known that the correlation value obtained or $r \geq r_{tabel}$ and $p - value < 0.025$. So it can be concluded that H_0 is rejected. So, there is a relationship between each indicator.

Table 4. Reliability test for service variable

Variable	Cronbach alpha	Conclusion
X1	0.71	Reliable

Reliability tests on service variables obtained Cronbach alpha = 0.71. The value is greater than 0.6. Thus, H_0. rejected. It can be concluded that the indicators used in service variables are reliable or consistently used as a measuring tool.

b. Learning

Table 5. Test the validity of the learning variable

Number	Indicators	Output R			Cut-off	Information
		r	t	*p-value*		
1	X2.1	0.7	10.1	$5.694397e - 18$		Valid
2	X2.2	0.7	9.5	$1.698009e - 19$	r_{tabel}	Valid
3	X2.3	0.7	11.7	$8.761606e - 22$	$= 0.17$	Valid
4	X2.4	0.8	16.0	$4.795794e - 32$	$\frac{\alpha}{2}$	Valid
5	X2.5	0.8	13.3	$8.13049e - 26$	$= 0.025$	Valid

There are five indicators in the teaching variable, namely the lecturer's attention to students who do not understand the lecture material, the lecturer's punctuality in starting and ending the lecture, the delivery of the material according to the plan for each meeting, the delivery of the material is given clearly and accompanied by examples of problems, the learning media used by the lecturer is very to help students in the learning process. Based on the validity test for each indicator on the Learning variable, it is known that the correlation value obtained or $r \geq r_{tabel}$ and $p - value < 0.025$. So it can be concluded that H_0 was rejected. So, there is a relationship between each indicator.

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Table 6. Reliability test for learning variable

Variable	Cronbach alpha	Conclusion
X2	0.7774	Reliable

Reliability tests on Learning variables obtained Cronbach alpha = 0.7774. The value is greater than 0.6. Thus, H_0 was rejected. which can be concluded that the indicators used in Learning variables are reliable or consistently used as a measuring tool.

c. Facilities and Infrastructure

Table 7. Test the validity of the Facilities and Infrastructure variable

Number	Indicators	Output R			Cut-off	Information
		r	t	p-value		
1	X3.1	0.7	9.2	$6.645999e-16$		Valid
2	X3.2	0.7	10.1	$5.548505e-18$	r_{tabel}	Valid
3	X3.3	0.6	8.1	$2.821359e-13$	$=0.17$	Valid
4	X3.4	0.7	9.8	$3.028153e-17$	$\dfrac{\alpha}{2}$	Valid
5	X3.5	0.8	14.7	$5.545768e-29$	$=0.025$	Valid

There are five indicators in the facilities and infrastructure variable, namely completeness of classrooms, facilities and completeness of books in the library, laboratory facilities, WIFI connection access, and completeness of learning media, Based on the validity test for each indicator on the variable of facilities and infrastructure, it is known that the correlation value obtained or $r \geq r_{tabel}$ and $p-value < 0.025$. So it can be concluded that H_0 was rejected. So, there is a relationship between each indicator.

Table 8. Reliability test for Facilities and Infrastructure variable

Variable	Cronbach alpha	Conclusion
X2	0.7181	Reliable

Reliability tests on facilities and infrastructure variables obtained Cronbach alpha = 0.7181. The value is greater than 0.6. Thus, H_0. rejected. It can be concluded that the indicators used in the variables of facilities and infrastructure are reliable or consistently used as measuring instruments.

2. Multicollinearity Test

The results of the multicollinearity test for predictor variables can be seen in the following table.

Table 9. Multicollinearity test result

Variable	X1	X2	X3	X4
VIF	1.525965	1.691927	1.457727	1.098585

Based on the table above, information is obtained that the VIF score for variables *X1, X2, X3, X4 < 10*. So receive H_0. It can be concluded that there is no multicollinearity or relationship between predictor variables.

3. Modeling Using Binary Logistic Regression Method

a. Independence Test

The hypotheses used to determine the relationship between predictor variables and response variables are as follows.

$$H_0 \quad : P_{ij} = P_i.P_j$$
$$H_1 \quad : P_{ij} \neq P_i.P_j$$

Here is a table of independence test results for each predictor variable

Table 10. Independence test results

Variables	Df	$p - value$	Keterangan
X1	12	0.02	Significant
X2	11	0.34	Not Significant
X3	9	1.00	Not Significant
X4	4	1.00	Not Significant

Based on the table above, information is obtained that the predictor variable that has a significant relationship with the response variable is X1. This is indicated by the p−value < α score, with α = 5%. The variables X1, X2 and X3 have a relationship but are not significant.

b. Concurrent tests

Concurrent tests were conducted to determine the influence of predictor variables on response variables with hypothesis tests as follows

$$H_0 : \beta_1 = \beta_2 = \cdots = \beta_p = 0$$
$$H_1: \text{there is at least one } \beta_j \neq 0 \; ; j = 1,2,\dots,p$$

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Table 11. Concurrent test results

G^2	$McFadden$	χ^2
13.23	0.07	9.48

Based on the table simultaneous test results can be subscript rejected that H_0 rejected and subscript accepted, there is at least one $\beta_j \neq 0$; $j = 1,2,\dots,p$ that has a significant effect, with the conclusion criterion $G^2 > \chi^2$.

c. Partial test

Partial tests were conducted to find out which predictor variables had a significant effect on the response variable, the hypothesis is as follows.

$H_0 : \beta_1 = \beta_2 = \dots = \beta_p = 0$

$$H_1; \ \beta_j \neq 0 \ ; j = 1,2,\dots,p$$

The criteria test is reject H_0 with The test W statistic follows a *chi-squared distribution* with reject H_0 if $W > \chi^2_{\alpha,1}$ or $p - value < \alpha$.

Table 12. The results of the first partial test

Variables	Estimation	Standard Error	$p - value$
X1	0.214	0.09	0.029
X2	−0.012	0.102	0.901
X3	−0.042	0.09	0.662
X4	−0.138	0.21	0.517

Based on the table, the results of the first partial test are that variable X1 has an effect in a manner significant to variable Y. Variables X2, X3, and X4 have an effect but are not significant to variable Y. The resulting model is as follows.

$$g(x) = -1.397 + 0.211X1 - 0.012X2 - 0.042X3 - 0.138X4$$

The next step is looking for a second logit model with the removed variable predictor of having p_{value} that more tall and other.

Table 13. The results of the second partial test

Variables	Estimation	Standard Error	$p - value$
X1	0.206	0.089	0.024
X3	−0.046	0.091	0.609
X4	−0.136	0.213	0.522

Based on the table, the results of the second partial test are That variable X1 has an effect in a manner significant to variable Y. Variables X3 and X4 have an effect but are not significant to variable Y. The resulting model is as follows.

$$g(x) = -1.451 + 0.206X1 - 0.046X3 - 0.136X4$$

The next step is looking for a third logit model with the removed variable predictor of having p_{value} that more tall and other.

Table 14. The results of the third partial test

Variables	Estimation	Standard Error	$p - value$
X1	0.189	0.082	0.021
X4	−0.117	0.211	0.575

Based on the table, the results of the third partial test are The variable X1 has an effect in a manner significant to variable Y. Variable X4 has an effect but is not significant to variable Y. The resulting model is as follows.

$$g(x) = -1.594 + 0.189X1 - 0.117X4$$

The next step is looking for a fourth logit model with the removed variable predictor of having p_{value} that more tall and other.

Table 15. The results of the fourth partial test

Variable	Estimation	Standard Error	$p - value$
X1	0.198	0.08	0.013

Based on the table, the results of the fourth partial test are The variable X1 has an effect in a manner significant to variable Y. The resulting model is as follows.

$$g(x) = -2.238 + 0.198X1$$

There are 4 models obtained, then the best model with notice score AIC. The model with the AIC lowest score is the best.

Table 16. Values of AIC

Logit Model	AIC
Model 1	177.2703
Model 2	175.2856
Model 3	173.5479
Model 4	171.8654

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Based on the table above, it can be stated that model 4 is the best because it obtains the smallest AIC.

1) Model Fit Test

The hypothesis that will tested on model fit is as follows

H_0 : There is no significant difference between the observed results and the possible prediction results of the model

H_1 : There is a significant difference between the observed results and the possible prediction results of the model

Table 17. Uji Goodness of fit

$\hat{C}$	χ^2_{tabel}
7.613	9.487

Because $\hat{C} < \chi^2_{tabel}$ it is H_1 accepted, it can be concluded that There is a significant difference between the observed results and the possible prediction results of the model.

2) Interpretation of Models and Parameters

Interpretation is done on the best model, which is model 4. The value of Pseuduo-R^2=0.038 or 3.8% is obtained, meaning that 3.8% of the variation in the response variable can be explained by the model formed.

Table 18. Prediction

Classification		Predictions	
		1	2
Actual	1	30	31
	2	28	37

$$APER = \left(\frac{30 + 37}{126}\right) \times 100\% = 53.1\%$$

Based on the predicted information, from 126 observations, 58 students obtained GPAs with classification 1, where the model managed to correctly predict 30 people, and the rest were predicted by classification 2. There were 68 students with a GPA with classification 2, where the model can correctly predict as many as 37 while the rest are predicted by classification 1. The results of the APER calculation can be concluded that the model can correctly predict by 53.1%.

Table 19. Odds Ratio

Variables	Ψ
X1	1.235
X2	0.987
X3	0.958
X4	0.871

Based on table 19, it can be known the value of the odds ratio for all predictor variables. The odds ratio value in the variable X1 is 1.235, this means that the better the quality of service (X1), the more likely it is to affect the GPA of 1.235. The odds ratio value in the variable X2 is 0.987, this means that the better the quality of learning (X2), the more likely it is to affect the GPA of 0.987. The odds ratio value in the variable X3 is 0.958, this means that the better the quality of Facilities and Infrastructure (X3), the possibility to affect the GPA of 0.958. The odds ratio value in the variable X4 is 0.871, this means that the university entrance path (X4) is likely to affect the GPA of 0.871.

CONCLUSION

Based on the results of the analysis and interpretation that have been carried out, the following conclusions are obtained. The Model obtained to determine the factors that affect the Grade Point Average (GPA) of Mathematics Education students of UIN Alauddin Makassar is as follows:

$$g(x) = -1.397 + 0.211X1 - 0.012X2 - 0.042X3 - 0.138X4$$
$$g(x) = -1.451 + 0.206X1 - 0.046X3 - 0.136X4$$
$$g(x) = -1.594 + 0.189X1 - 0.117X4$$
$$g(x) = -2.238 + 0.198X1$$

Factors that affect the Grade Point Average (GPA) of Mathematics Education students of UIN Alauddin Makassar are Services, Learning, Facilities and Infrastructure, and campus entrance routes. Services have a significant effect on the Grade Point Average (GPA) and Learning, Facilities and Infrastructure, and campus entrance pathways have an effect but not significantly on the Grade Point Average (GPA).

REFERENCES

Agresti, A. (2019). *An introduction to categorical data analysis* (Third; R. S. T. David J. Balding, Noel A. C. Cressie, Garrett M. Fitzmaurice, GeofH. Givens, Harvey Goldstein, Geert Molenberghs, DavidW. Scott, Adrian F.

Nursalam[1), Qardawi Hamzah[2), Baharuddin[3), Andi Kusumayanti[4), A. Sriyanti[5)

M. Smith, Ed.). Florida: John Wiley & Sons, Inc.

Bozpolat, E. (2016). Investigation of the self-regulated learning strategies of students from the faculty of education using ordinal logistic regression analysis. *Kuram ve Uygulamada Egitim Bilimleri*, *16*(1), 301–318. https://doi.org/10.12738/estp.2016.1.0281.

Dhania, D. R. (2010). Pengaruh stres kerja, beban kerja terhadap kepuasan kerja (studi pada medical representatif di kota kudus). *Jurnal Psikologi Universitas Muria Kudus*, *1*(1), 15–23.

Frankel, J. R., Wallen, N. E., & Hyun, H. H. (2020). *How to design and evaluate research in education* (2nd ed., vol. 21; v. malinee & v. b. associates, eds.). New York: The McGraw-Hill Companies, Inc.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., Black, W. C., & Anderson, R. E. (2018). *Multivariate data analysis*. https://doi.org/10.1002/9781119409137.ch4.

Hosmer, D. W., & Lemeshow, S. (2000). *Applied logistic regression by David W.* New York: John Wiley & Sons, Inc.

Indrajit, R. E., & Djokopranoto, R. (2004). *Manajemen perguruan tinggi moderen*.

Nadziruddin, U. (2006). Faktor internal yang berkontribusi terhadap pencapaian indeks prestasi kumulatif pada mahasiswa program A FIK unpad. *Ilmu Pendidikan*.

Oke, J. A.Akinkunmi, W. B, Etebefia, S. O. (2019). Use of correlation, tolerance and variance inflation factor. *Global Scientific Journal*, *7*(5), 652–659.

Peng, C. Y. J., Lee, K. L., & Ingersoll, G. M. (2002). An introduction to logistic regression analysis and reporting. *Journal of Educational Research*, *96*(1), 3–14. https://doi.org/10.1080/00220670209598786.

Rugutt, J. K., & Chemosit, C. C. (2005). A study of factors that influence college academic achievement: a structural equation modeling approach. *Journal of Educational Research & Policy Studies*, *5*(1), 66–90. Retrieved from https://eric.ed.gov/?id=EJ846830.

Sayidah, N., Ady, S. U., Supriyati, J., Sutarmin, Winedar, M., Mulyaningtyas, A., & Assagaf, A. (2019). Quality and university governance in Indonesia. *International Journal of Higher Education*, *8*(4), 10–17. https://doi.org/10.5430/ijhe.v8n4p10.

Semer, C., & Harmening, D. S. (2015). Exploring significant factors that impact the academic success of student veterans in higher education. *Journal of Higher Education Theory & Practice*, *15*(7).

Senaviratna, N. A. M. R., & A. Cooray, T. M. J. (2019). Diagnosing multicollinearity of logistic regression model. *Asian Journal of Probability and Statistics*, *5*(2), 1–9. https://doi.org/10.9734/ajpas/2019/v5i230132.

Setyawati, D. (2020). Analysis of perceptions towards the rooftop photovoltaic solar system policy in Indonesia. *Energy Policy*, *1444*, 111569. https://doi.org/10.1016/j.enpol.2020.111569.

Suti, M., Syahdi, M. Z., & Didiharyono. (2020). Tata kelola perguruan tinggi dalam era teknologi informasi dan digitalisasi. *JEMMA (Journal of Economic, Management and Accounting)*, *3*(2), 203. https://doi.org/10.35914/jemma.v3i2.635.

Sweet, S., & Martin, K. G. (2014). *Data Analysis with SPSS: A first Course in Applied Statistics*. Boston.

Syamsuryadin, S., & Wahyuniati, C. F. S. (2017). Uji validitas dan reliabilitas instrumen penelitian kuantitatif. *Jorpres (Jurnal Olahraga Prestasi)*, *13*(1), 53–59. https://doi.org/10.21831/jorpres.v13i1.12884.

Tampil, Y., Komaliq, H., & Langi, Y. (2017). Analisis regresi logistik untuk menentukan faktor-faktor yang mempengaruhi indeks prestasi kumulatif (IPK) mahasiswa FMIPA Universitas Sam Ratulangi Manado. *D'CARTESIAN: Jurnal Matematika Dan Aplikasi*, *6*(2), 56–62. https://doi.org/10.35799/dc.6.2.2017.17023.

Yanti, R., Windarto, A. P., & Suhada, S. (2019). Analisis faktor yang mempengaruhi ipk mahasiswa terhadap penentuan kualitas proses pembelajaran dengan metode electre II. *KOMIK (Konferensi Nasional Teknologi Informasi Dan Komputer)*, *3*(1), 36–41. https://doi.org/10.30865/komik.v3i1.1696.