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Application of Data Mining to Measure the Level of Satisfaction with Public Facilities and Services at STMIK Kaputama Binjai Using Linear Regression Method

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Abstract

This study aims to analyze the level of satisfaction of STMIK Kaputama Binjai students with physical facilities (classrooms, laboratories, prayer rooms, wifi) and general services (administration, academic guidance, library, security, campus cleanliness) using multiple linear regression methods. Data were collected through questionnaires from students in the 2022/2023 academic year. The results showed that both variables have a significant effect on student satisfaction, with a regression coefficient of physical facilities of 0.40 and general services of 0.59, indicating that general services have a greater impact. Prediction of student satisfaction reached an accuracy level of 98% with a Mean Absolute Percentage Error (MAPE) value of 2%. Laboratory facilities and internet access (wifi) are the dominant factors affecting satisfaction. Based on these findings, improvements in both aspects are recommended to increase student satisfaction and institutional competitiveness.

Keywords: *Student satisfaction, educational facilities, general services, multiple linear regression, data mining, MAPE.*

1. Introduction

Higher education is currently experiencing rapid development in the digital era, with a shift in the learning paradigm driven by information and communication technology. Various interactive and adaptive learning methods have been introduced, yet higher education institutions must continue to innovate to enhance the quality of education and meet the increasingly diverse needs of students. In this effort, evaluating the effectiveness and efficiency of improving the learning process becomes very important. Adequate facilities, such as classrooms, laboratories, libraries, sports facilities, information technology, and other support services, along with good quality of service, play a crucial role in creating a positive learning experience for students. The quality of service includes the ability of educational institutions to meet the needs of students through effective teaching, academic support, guidance, and adequate administrative services. The relationship between facilities, service quality, and student satisfaction in the context of higher education has become a significant research topic. Previous studies have shown that students who have access to adequate facilities tend to feel more satisfied with their learning experiences. Additionally, good service quality, including interactions with lecturers, sufficient academic support, and smooth administrative processes, also positively impacts student satisfaction. Educational infrastructure includes all physical and non-physical facilities used in the teaching and learning process, such as school buildings, classrooms, libraries, laboratories, computers, sports equipment, and other supporting facilities. Thequality of educational services is the level of satisfaction of students and parents regarding the quality of teaching, guidance and counseling, facilities and infrastructure, as well as administrative services provided by educational institutions [1]. Student satisfaction is an important indicator in evaluating the quality of higher education, as satisfied students have higher motivation, active participation, and better academic performance. The importance of understanding the relationship between facilities, service quality, and student satisfaction has become a significant research topic, with studies showing that access to adequate facilities and services enhances learning satisfaction. However, further research is needed to deepen understanding, especially in the context of specific institutions such as STMIK Kaputama Binjai. This study aims to explore that relationship to provide guidance in improving service quality and creating a conducive learning environment. The application of data mining methods, particularly linear regression, is expected not only to enhance facilities and services but also to demonstrate STMIK Kaputama Binjai's commitment to adopting new technologies in support of efficiency and effectiveness, strengthening credibility, and increasing student satisfaction. This research is titled "The Application of Data Mining to Measure Satisfaction Levels with Facilities and Public Services at STMIK Kaputama Binjai Using Linear Regression Method."

2. Literature Review

2.1. Data Mining

Data mining is the process of extracting useful information and patterns from very large datasets. The data mining process consists of data collection, data extraction, data analysis, and data statistics. It is also commonly known as knowledge discovery, knowledge extraction, data/pattern analysis, information harvesting, and others. These four processes in data mining will produce models/knowledge that are very useful. Data mining can be defined as the complex extraction of a dataset into information that has implicit (not obvious/clear) potential that was previously unknown. It can also be defined as the excavation and analysis using automated or semi-automated tools, of a large amount of data with the aim of discovering patterns that have meaning or intent. The process of data mining includes the collection of raw data from basic data sources such as relations, data warehouses, information repositories, and more advanced repositories, object-oriented and object- relational data, transactions and spatial data, heterogeneous and legacy data, multimedia and streaming data, text, text mining, and web mining. This process involves data mining to generate insights that make the information more recognizable and understandable. The process is similar to knowledge discovery, information retrieval, pattern analysis, and knowledge extraction that allows for understanding of the data, leading to constructive measurement of the involved areas [2].

2.1.1. Measuring Satisfaction

Measuring satisfaction is an absolute right for students, so the campus must improve services and facilities. Because the success of an institution is measured by the level of satisfaction. One common challenge is how to measure customer satisfaction using unstructured text data. As a result, consumers find it difficult to achieve good results. Students have varying sentiments towards the quality of service, the learning process, and the facilities. Satisfaction is a person's perception of something that has met their expectations. Student satisfaction with learning can be seen from 5 dimensions of satisfaction, namely: tangible, reliability, responsiveness, assurance, and empathy. The first dimension of service quality is tangible. Tangible refers to the physical dimension. A service cannot be seen or touched, making physical evidence important as a measure of the service provided. Tangible refers to the ability to provide adequate physical facilities for the campus and teaching equipment, concerning the appearance of lecturers and general amenities, such as the availability of infrastructure. Students will assess the quality of learning based on all available resources and facilities, measuring the reliability of higher education in providing services to its students. There are two aspects of this dimension, namely the lecturer's ability to provide the promised teaching methods and how accurately the lecturer delivers the learning material [3].

2.1.2. Facilities

Facilities are all the necessary resources in the teaching and learning process, both movable and immovable, to ensure that the achievement of educational goals proceeds smoothly, orderly, effectively, and efficiently. Facilities are those that indirectly support the educational process, such as school grounds, gardens or school parks, roads leading to the school, school regulations, and so on. Facilities and infrastructure are tools or components that play a very important role in the success and smoothness of a process, including in the field of education. Facilities and infrastructure are essential provisions that must be met to facilitate the organization of an activity, even though they may not yet be fully adequate. Based on the National Government Regulation of the Republic of Indonesia, Article 1, Number 19 of 2005 concerning infrastructure standards, it states that: Infrastructure standards are national education standards related to the minimum criteria for learning spaces, sports facilities, places of worship, libraries, laboratories, workshops, play areas, creative and recreational spaces, as well as other learning resources necessary to support the learning process, including the use of information and communication technology. In terms of type, educational facilities can be classified into physical facilities and non-physical facilities. Physical facilities refer to anything that has a tangible form or can be materialized, which plays a role in facilitating or smoothing out an effort, such as vehicles, typewriters, computers, furniture, teaching aids, models, media, and so on. Non-physical facilities are those that are not tangible or cannot easily be classified as objects or materialized, which play a role in facilitating or smoothing out an effort, such as people, services, and money [4].

2.2. Public Services

In terms of the quality of academic services, the main focus of educational institutions is on the concept of quality that involves the responses and feedback from users regarding the services provided. Quality is an important foundation in building products, and in the context of services, services encompass immaterial aspects that provide tangible benefits and contribute to good performance without ownership. In an academic context, academic quality involves the evaluation of the educational process, curriculum, and facilities, which are reflected in the teaching abilities of lecturers, learning materials, and learning outcomes. The quality of academic services is linked to the ability of educational institutions to provide services that meet or exceed students' expectations in obtaining quality education. Factors such as student satisfaction, leadership, human resources, physical environment, and teaching quality influence the quality of academic services. The measurement of academic service quality includes indicators such as tangibles (physical factors), reliability, responsiveness, assurance, and empathy as part of efforts to ensure quality service for students [5].

2.3. Linear Regression

Regression is a measurement tool used to assess the presence or absence of correlation between variables. The linear regression method itself consists of 2 types, namely simple linear regression and multiple linear regression [6]. Multiple linear regression is a model equation that explains the relationship between one dependent/response variable (Y) and two or more independent/predictor variables (X1, X2,…Xn). The purpose of multiple linear regression testing is to predict the value of the dependent/response variable (Y) when the values of the independent/predictor variables (X1, X2,..., Xn) are known. In addition, it is also to understand how the direction of the relationship between the dependent variable and its independent variables works [7].

The multiple linear regression equation is mathematically expressed as:
Y = a + b1 X1 + b2 X2 + … + bn Xn
which is:
Y = dependent variable (the value of the variable to be predicted)a = constant
b1, b2,…, bn = regression coefficient values
X1, X2,…, Xn = independent variables
When there are 2 independent variables, namely X1 and X2, the form of the regression equation is:
Y = a + b1X1 + b2X2

2.4. Python

Python is one of the programming languages widely used by large companies and developers to develop various types of desktop, web, and mobile applications. Python was created by Guido van Rossum in the Netherlands in 1990, and its name is derived from Guido's favorite television show, Monty Python's Flying Circus. Van Rossum developed Python as a hobby, and then Python became a programming language widely used in industry and education due to its simplicity, conciseness, intuitive syntax, and extensive libraries. The popularity of Python has made it a programming language that many students, especially those in IT-based campuses, are starting to learn in order to complete coursework, final projects, and research tasks. To tackle various programming assignments, one needs to understand algorithms, as fundamentally, computer programs are implementations of algorithms [8].

3. Analysis and Design

3.1. Research Methodology

1. Preparation for determining the background of the problem involves identifying the issues and obstacles that occur by gathering information directly from STMIK Kaputama Binjai.
2. Theoretical Study At this stage, a theoretical study will be conducted on the existing issues. The study is carried out to determine the concepts that will be used in the research, particularly regarding data mining, multiple linear regression methods, and Python, which will be utilized in the analysis process conducted in this research.
3. Data Collection This stage is intended to gather supporting data obtained from STMIK Kaputama Binjai regarding the direct observation of the questionnaire on student satisfaction levels.
4. Data Analysis At this stage, an analysis of supporting data will be conducted, specifically the data on the grouping of student satisfaction levels that were obtained in the previous stage. This measures the level of student satisfaction at STMIK Kaputama Binjai using data mining techniques with multiple linear regression as the problem-solving method.
5. Testing and Implementation At this stage, data variable testing and data implementation will be carried out, along with the development of the system program.
6. Final Stage This stage is the stage of drawing conclusions and suggestions that can be made in the preparation of a thesis.

3.2. Research Supporting Data

To analyze data in a research study, supporting data is needed so that the research can proceed as expected. The multiple linear regression method in measuring student satisfaction at STMIK Kaputama Binjai. The provided data pertains to the level of student satisfaction. Based on the research conducted at STMIK Kaputama Binjai, data has been obtained that will be used to analyze student satisfaction. The data is as follows.

After calculating or obtaining the average score from various aspects of facilities and public services, the next step is to determine the level of student satisfaction in learning based on that average score.

Table 1: Student Satisfaction Data

MAHASISWA	SEMESTER	FASILITAS	PELAYANAN	KEPUASAN MAHASISWA
A	GANJIL	5	5	5
B	GANJIL	3	3	3
C	GANJIL	4	4	4
D	GANJIL	3	4	5
E	GANJIL	2	2	2
F	GANJIL	4	4	4
G	GANJIL	1	4	3
H	GANJIL	3	3	3
I	GANJIL	2	2	2
J	GANJIL	3	3	3
K	GENAP	5	5	5
L	GENAP	4	4	4
M	GENAP	3	3	3
N	GENAP	3	3	3
O	GENAP	4	4	4
P	GENAP	3	3	3
Q	GENAP	4	4	4
R	GENAP	5	5	5

S	GENAP	1	5	3
T	GENAP	3	3	3

Description: description of the satisfaction point.

Table 2: Satisfaction Points

1	sangat kurang puas
2	kurang puas
3	cukup
4	puas
5	sangat puas

3.3. Application of the Method

Multiple linear regression is an algorithm used to identify the relationship between a response variable and at least two predictor variables.In regression methods, the predicted variable, such as student satisfaction levels, is referred to as the dependent variable. This variable is influenced by the magnitude of the independent variable. This regression model is chosen to predict the value of the dependent variable whenthe value of the independent variable increases or decreases, and to understand the direction of the relationship between the independent variable and the dependent variable, which is to measure student satisfaction levels.

The variables used as benchmarks to measure the level of student learning satisfaction at STMIK Kaputama Binjai are as follows:

Table 3: Variables

No	Variable	Variable Name
1	X1	Facilities
2	X2	Public Services
3	Y	student satisfaction

Calculating the regression coefficient can be done by computing the mathematical equation from the formula pattern that has beenestablished in the guidelines for Multiple Linear Regression as follows:

Table 2: Analysis of the Application of Linear Regression

NO	x_1	x_2	Y	x_1^2	x_2^2	y^2	x_1y	x_2y	x_1x_2
1	5	5	5	25	25	25	25	25	25
2	3	3	3	9	9	9	9	9	9
3	4	4	4	16	16	16	16	16	16
4	3	4	5	9	16	25	15	20	12
5	2	2	2	4	4	4	4	4	4
6	4	4	4	16	16	16	16	16	16
7	1	4	3	1	16	9	3	12	4
8	3	3	3	9	9	9	9	9	9
9	2	2	2	4	4	4	4	4	4
10	3	3	3	9	9	9	9	9	9
11	5	5	5	25	25	25	25	25	25
12	4	4	4	16	16	16	16	16	16
13	3	3	3	9	9	9	9	9	9
14	3	3	3	9	9	9	9	9	9
15	4	4	4	16	16	16	16	16	16
16	3	3	3	9	9	9	9	9	9
17	4	4	4	16	16	16	16	16	16
18	5	5	5	25	25	25	25	25	25
19	1	5	3	1	25	9	3	15	5
20	3	3	3	9	9	9	9	9	9
∑	65	73	71	237	283	269	247	273	247

After we calculate the values of ∑x_1^2, ∑x_2^2, ∑y^2, ∑x_1y, ∑x_2y, and ∑x_1x_2, we will form the following linear equation:

$\sum x1^2 = \sum x1^2 - (\sum x1)^2 / n$ $\sum x2^2 = \sum x2^2 - (\sum x2)^2 / n$ $\sum y^2 = \sum y^2 - (\sum y)^2 / n$

$\sum x2^2 = 283 - (73)^2 / 20$ $\sum x1^2 = 237 - (65)^2 / 20$ $\sum y^2 = 269 - (71)^2 / 20$

$= 25{,}75$ $= 16{,}55$ $= 16{,}95$

$\sum x1y = \sum x1y - (\sum x1)(\sum y) / n$ $\sum x2y = \sum x2y - (\sum x2)(\sum y) / n$ $\sum x1x2 = \sum x1x2 - (\sum x1)(\sum x2) / n$

$\sum x1y = 247 - (65).(71) / 20$ $\sum x2y = 273 - (73).(71) / 20$ $\sum x1x2 = 247 - (65).(73) / 20$

$= 16{,}25$ $= 13{,}85$ $= 9{,}75$

Next, find a, b1, and b2 using the following equations:

$b1 = (\sum x2^2 * \sum x1y) - (\sum x1x2 * \sum x2y) / (\sum x1^2 * \sum x2^2) - (\sum x1x2)^2 b1 = (16{,}55 * 16{,}25) - (9{,}75 * 13{,}85) / (25{,}75 * 16{,}55) - (9{,}75)^2$

$= 0{,}40$

b2 = $(\sum x1^2 * \sum x2y) - (\sum x1x2 * \sum x1y) / (\sum x1^2 * \sum x2^2) -$
$(\sum x1x2)^2$b2 = (25,75 * 13,85) – (9,75 * 16,25) / (25,75 * 16,55) – $(9,75)^2$
= 0,59

a = $(\sum y/n) - (b1 * (\sum x1/n)) - b2 * (\sum x2/n)$

a = (71/20) – (b1 * (65/20)) – b2 *(73/20)

= (3,5) – (0,40 * (3,25)) – (0,59 * (3,65))

= 0,05

Linear Regression Equation Y = 0,05 + 0,40.X1 + 0,59.X2

Then it is tested using the equation above to predict student satisfaction in learning regarding the facilities and services at STMIK KaputamaBinjai, with X1 (Facilities) valued at 5 and X2 (Public Services) valued at 5, it can be calculated as follows:

Y = a + $b_1X_1 + b_2X_2$

Y = 0,05 + 0,40*5 + 0,59*5

= 5 (Very Satisfied)

Conclusion:

From the example calculation of the multiple linear regression algorithm to measure student satisfaction with facilities and general services atSTMIK Kaputama Binjai, it yields a score of 5, which means that students are very satisfied with the learning facilities and general services at STMIK Kaputama Binjai.

After obtaining the linear regression equation, the next step in making predictions is to use it to estimate the value of facilities and services tomeasure satisfaction levels. The calculations for the difference and MAPE are as follows:

Table 3: Application of Prediction Data Calculation, Difference, and MAPE Error

Mahasiswa	Fasilitas	Pelayanan	Kepuasan	Data Prediksi	Selisi	Eror Mape
	x1	x2	Y	(Y')	(Y-Y')	(Y-Y')/(Y)
A	5	5	5	5	0	0
B	3	3	3	3,02	-0,02	0,006666667
C	4	4	4	4,01	-0,01	0,0025
D	3	4	5	3,61	1,39	0,278
E	2	2	2	2,03	-0,03	0,015
F	4	4	4	4,01	-0,01	0,0025
G	1	4	3	2,81	0,19	0,063333333
H	3	3	3	3,02	-0,02	0,006666667
I	2	2	2	2,03	-0,03	0,015
J	3	3	3	3,02	-0,02	0,006666667
K	5	5	5	5	0	0
L	4	4	4	4,01	-0,01	0,0025
M	3	3	3	3,02	-0,02	0,006666667
N	3	3	3	3,02	-0,02	0,006666667
O	4	4	4	4,01	-0,01	0,0025
P	3	3	3	3,02	-0,02	0,006666667
Q	4	4	4	4,01	-0,01	0,0025
R	5	5	5	5	0	0
S	1	5	3	3,4	-0,4	0,133333333
T	3	3	3	3,02	-0,02	0,006666667
				$\sum \frac{(Y-Y')}{Y}$		0,563833
				$\sum \frac{\frac{(Y-Y')}{Y}}{N} \times 100\%$		0,028191667

Calculation of MAPE:

MAPE: $\frac{0{,}563833 \times 100\%}{20} = 0{,}02\ \%$

Based on the MAPE value of 0.02% with an accuracy level of 98%. The conclusion is that the overall MAPE value is 0.02, which means 2%, indicating that the value (Y-Y') is quite accurate, achieving an accuracy level of 98%.

3.4. Flowchart of Linear Regression Process Design

A flowchart is a visual representation of a series of steps or processes in the form of a diagram. The steps in a workflow or algorithm aredepicted using graphical symbols. To make complex processes easier to understand, both for expert and non-expert users, flowcharts canbe used. The following is a flowchart of the linear regression algorithm.

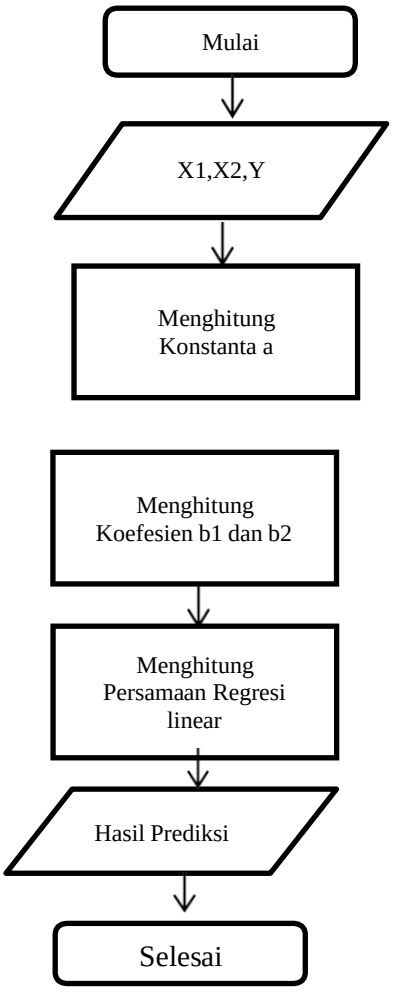


Fig. 1: Flowchart of the Linear Regression Algorithm

4. Implementation and Discussion

4.1. Discussion

The steps taken for the implementation of data mining to measure the level of satisfaction with facilities and public services using linear regression methods, in order to predict student satisfaction with facilities and public services. This knowledge provides conclusions that can be used as further strategies to improve the quality of facilities and services, but it also demonstrates STMIK Kaputama Binjai's commitment to adopting new technologies to support efficiency and effectiveness.

4.1.1. Discussion on the Program Interface

In this discussion of the interface, the results of the program design using Python software will be presented and explained as follows:

1. Data Set Sample Regression
   The features in the data set include facilities that represent the value of the services provided. The service represents the value of service quality. Satisfaction This is a measured target that represents the level of satisfaction based on the dataset displayed in the Python JupyterNotebook:

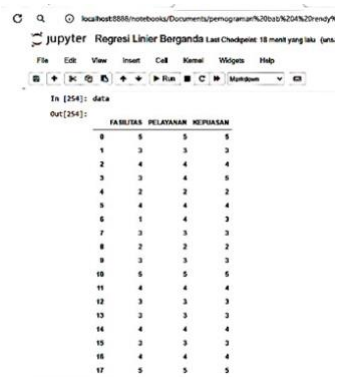


Fig. 2: Display of the Data Set Table

2. Displaying MAPE
Predictions are made using a trained multiple linear regression model, where the prediction results are compared with the test data to calculate the model's accuracy. This accuracy is measured by the Mean Absolute Percentage Error (MAPE), which indicates how close the model's predictions are to the actual values, with a lower MAPE indicating more accurate predictions as follows:

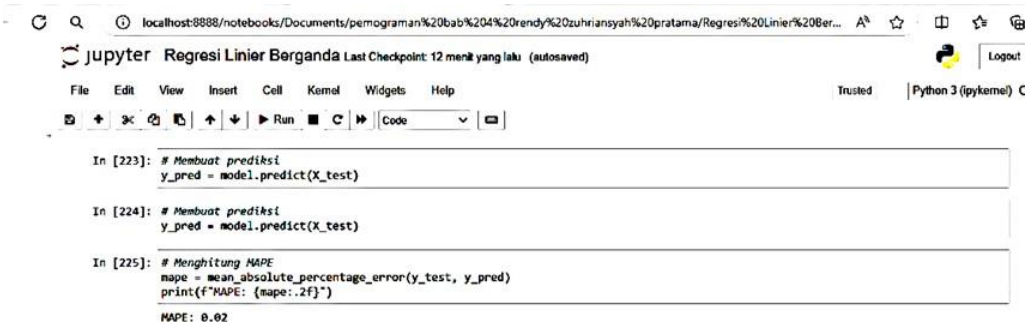


Fig. 3: Display of Mape Results

3. Displaying Regression Coefficients
The regression coefficients indicate the contribution of each feature, "FACILITIES" and "SERVICE," to the prediction of the target variable "SATISFACTION." This coefficient is generated after the model is trained, and its value reflects how much changes in satisfaction are influenced by changes in facilities or services. A higher coefficient indicates that the feature has a stronger impact on the level of satisfaction, as shown by the results:

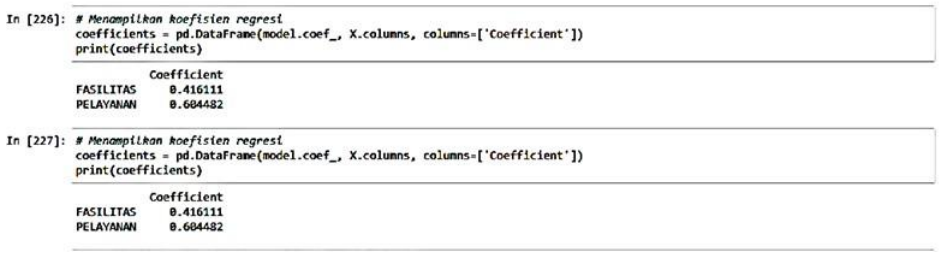


Fig. 4: Display of Regression Coefficient Results

4. Displaying Satisfaction Graph
After the data has been calculated, it is important to understand the extent to which improvements in facilities and services affect student satisfaction. Additionally, the graph showing the increase in student satisfaction also needs to be analyzed in the following year. Here is the graph on satisfaction:

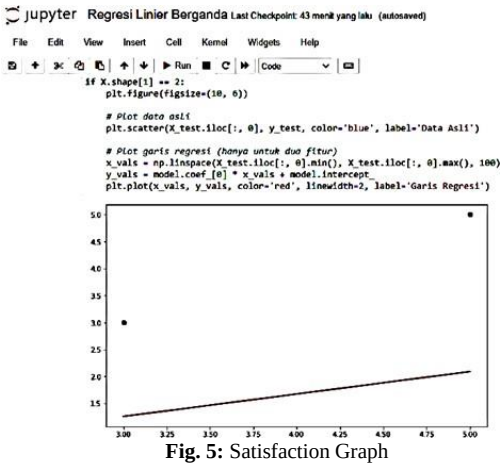
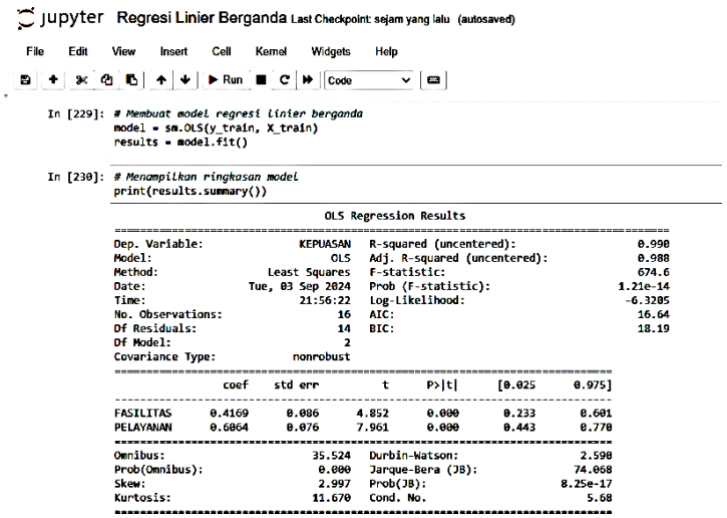


Fig. 5: Satisfaction Graph

5. Presenting the Model Summary
The summary of the student satisfaction model regarding facilities and services is a brief presentation of the analysis results thatillustrates the relationship between the quality of the provided facilities and services and the level of student satisfaction.



jupyter Regresi Linier Berganda Last Checkpoint: sejam yang lalu (autosaved)

File Edit View Insert Cell Kernel Widgets Help

Run Code

```
In [229]: # Membuat model regresi linier berganda
          model = sm.OLS(y_train, X_train)
          results = model.fit()

In [230]: # Menampilkan ringkasan model
          print(results.summary())
```

OLS Regression Results

Dep. Variable:	KEPUASAN	R-squared (uncentered):	0.990
Model:	OLS	Adj. R-squared (uncentered):	0.988
Method:	Least Squares	F-statistic:	674.6
Date:	Tue, 03 Sep 2024	Prob (F-statistic):	1.21e-14
Time:	21:56:22	Log-Likelihood:	-6.3205
No. Observations:	16	AIC:	16.64
Df Residuals:	14	BIC:	18.19
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
FASILITAS	0.4169	0.086	4.852	0.000	0.233	0.601
PELAYANAN	0.6864	0.076	7.961	0.000	0.443	0.770

Omnibus:	35.524	Durbin-Watson:	2.598
Prob(Omnibus):	0.000	Jarque-Bera (JB):	74.068
Skew:	2.997	Prob(JB):	8.25e-17
Kurtosis:	11.670	Cond. No.	5.68

Fig. 6: Model Summary

4.2. Implementation

In this chapter, the results of the trial of the program to predict student satisfaction levels for the academic year 2022/2023 in both the odd and even semesters will be explained, using the linear regression method. This method was chosen for its ability to integrate information without significantly compromising the visual quality of the document. In the initial stages, this program was developed using the Python programming language. It is important to remember that these prediction results are merely estimates, so there may be an increase or decrease in student satisfaction regarding facilities and general services in the learning process at STMIK Kaputama.

5. Conclusion

1. Student satisfaction at STMIK Kaputama Binjai is significantly influenced by the quality of facilities and general services. The analysis shows a significant positive relationship, where the quality of facilities has an influence value of 0.40 and general services have a value of 0.59 on student satisfaction. The better the facilities and services provided, the higher the level of student satisfaction achieved.
2. The satisfaction prediction shows a very satisfied score. From the calculations made, the prediction of student satisfaction at the maximum score (value 5) for facilities and services indicates that student satisfaction is at the "very satisfied" level. (skor 5). This emphasizes that the optimization of facilities and good services has a direct impact on increasing student satisfaction.

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