Studying The Electrical System for The Needs of Electrical Energy at The Port of Kijing

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Abstract
Electricity is one of the most important aspects of human life. It is required in various sectors. To maintain stability, electricity providers need to accurately forecast the demand for electricity. This research utilizes the Simple Linear Regression method with the assistance of Excel simulation. Based on the calculations, the analysis reveals the estimated power requirement for industrial load at Pelabuhan Kijing, particularly for the next 10 years, with a minimum of 4,053,685 Watts (4.053685 MVA) based on the predicted power consumption for each year, which experiences an average annual increase of 11.28%. The projected load for the year 2033 is estimated to be 5.802129 MVA. This study employs the one-way ANOVA analysis method to examine the data on the increase in the number of connected power loads in the industrial sector at Pelabuhan Kijing. The data collected from 2023 to 2033 indicates that there is no significant difference between the groups based on the ANOVA analysis. Thus, the predicted total load increase for the next 10 years suggests that there is no need to add transformer capacity since the existing capacity is sufficient. This research provides a better understanding of the growth trends in connected power loads and transformer capacity requirements at Pelabuhan Kijing within the specified time frame.

Keywords:
Kijing Port
Prediction
Linear Regression
One-way Anova

1. INTRODUCTION
Electrical energy is one of the most important things in human life. Electrical energy is needed in several sectors, namely household, industrial, business, social, government office buildings, and public street lighting [1]. Along with the advancement of technology and the rapid development of development in the sector in Kijing Port, the need for electrical energy also increases. Therefore, the need for electrical energy is not the same every year. So the problem arises, namely how to meet the needs of electrical energy by forecasting the load. The demand for electricity must be matched with the supply of electricity by the power provider, in this case, PT. PLN (Persero) Mempawah, to ensure the stability of the electricity system and meet the energy needs at Pelabuhan Kijing. This is why electricity must be provided when it is needed because large-scale energy storage is not feasible. Failing to address the fluctuating electricity demand can lead to challenges in providing reliable power to meet the demand. [2]

The problem arises when the supply of electricity is not properly calculated, as it can affect the readiness of power generation units. The imbalance between supply and demand can result in losses for the electricity provider. Power generation units may produce excess energy if the generated electricity is greater than consumption, while consumers may face blackouts if the generated electricity falls short of demand. Therefore, a robust mechanism for electricity generation is necessary. To maintain this stability, electricity providers must forecast the magnitude of electricity demand accurately. [3]

Forecasting is a technique to predict the desired need for a product in the future period of time based on historical data and provide predictive results using some form of mathematical model. Forecasting is needed by a company, because every decision taken will affect the future. [4]

One way that can be used to prevent losses is with good and proper planning. Planning can be done by predicting electricity loads to provide information to PLN. In electrical load prediction, many methods can be used. One way that can be used is to use the linear regression method and with the anova method. Where this method can be used to forecast electricity loads from 2022 - 2032 in Kijing Change. From the prediction results, it can be seen that the existing plant is sufficient or needs to be added more plants. [5]
2. THEOTICAL BASIS

2.1 Understanding Prediction

Prediction is basically a guess or forecast of the occurrence of an event or event in the future. Prediction in the field of electric power is basically a prediction of energy needs and load prediction. The results of this prediction are used to make plans to meet the needs and development of electricity supply at any time adequately and well and continuously.

a. Regression Model

Regression models are divided into two, namely linear regression and non-linear regression.

1. Linear Regression

This linear regression model has only one independent variable.

\[ y = a + bx \] 

Where \( y \) is the predicted variable, \( x \) is the independent variable, and \( a \) and \( b \) are the regression parameters or coefficients. To get the values of \( a \) and \( b \), it can be obtained from the following formula:

\[ A = \bar{y} - b \bar{x} \] 
\[ B = \frac{\sum x \sum xy}{n \sum x^2 - (\sum x)^2} \]

where \( \bar{y} \) and \( \bar{x} \) express the average values of \( y \) and \( x \), and the values of \( x \) and \( y \) are taken from previous data that are used as sample data. [6]

2.2. Electrical Energy

Electrical energy is energy generated by electric charge (static) resulting in the movement of electric charge (dynamic).

The formula of electrical energy can be written:

\[ W = V \times I \times t \] 

Where:
- \( W \) = Electrical energy units Joules (J)
- \( Q \) = Electric charge unit Coulomb (C)
- \( V \) = Potential difference in volts (V)
- \( I \) = Strong current in units of Amperes (A)
- \( t \) = time in units of Second (s) [7]

2.3. Electric power

Electric power can be defined as electrical energy used in a unit of time. The electric power formula equation can be written as follows:

\[ P = \frac{W}{t} = \frac{V \times I \times t}{t} \] 

Then the electric power formula can also be written:

\[ P = V \times I \] 

Where:
- \( P \) = electric power in units of Watts (W)

2.4. Definition of Forecasting

Forecasting is predicting, giving an idea, or giving a forecast or estimate of something that might happen before a more definite plan can be carried out. [8]

2.4.1. Characteristics of forecasting

In forecasting there are several criteria that need to be considered, namely:
1. Accuracy
2. Cost
3. Convenience

2.4.2. Types of Forecasting

Based on the type, forecasting can be grouped into 2 categories, namely:
1. Qualitative Forecasting
   This type of forecasting is used based on the subject that issued it.
2. Quantitative Forecasting
   This type of forecasting depends on each method used. Because each method used will result in different forecasting. Whether or not the method used is determined based on the difference between the results of the forecast and the reality that occurs.
2.4.3. Uses and Roles of Forecasting
The purpose of forecasting is for decision making. In decision making must be based on several considerations and thoughts that will be experienced. To obtain good forecasting depends on the data factors and methods used. [9]

2.4.4. Forecasting Steps
In compiling forecasting, several steps are used, namely:
1. Analyze historical data
2. Determine the method used
In this thesis, forecasting is used with a quantitative approach. At Basically, this quantitative forecasting method can be distinguished from:
1. The Causal Method is used to analyze the pattern of relationship of variables to be predicted with variables that affect them. This method does not use time variables.
2. The periodic series method is used to analyze the pattern of variable relationships, between variables to be predicted with time variables.
3. Take into account past data using the method used and consider several factors [10]

2.5. Anova Test
Analysis of variance (ANOVA) is a method of statistical analysis that belongs to the branch of inference statistics. Analysis of variance or ANOVA is a multivariate analysis technique that serves to distinguish the average of more than two groups of data by comparing the variance. Analysis of variance belongs to the category of parametric statistics. As a parametric statistical tool, to be able to use the ANOVA formula, it must first be tested for assumptions including normality, heterokedasticity and random sampling (Ghozali, 2009). [11]

2.5.1. Steps in single-track anova analysis
1. Calculates the sum of total squares (SST), sum of treatment squares (JKA), sum of residual squares (SSR), treatment square mean (RKA), and error squared mean (RKD). To calculate each price is used the following formula:
   a. $SST = \sum y^2 - \frac{(\sum y)^2}{n}$
   b. $JKA = \sum (y_i - \bar{y})^2$
   c. $SSR = ss total - ss regresi$
   d. $RKA= JKA/k(n-1)$
2. Calculates the total degrees of freedom (DFT), average degrees of freedom (DFR), degrees of freedom reduced/corrected (DFTR), degrees of freedom between groups (DFA), and degrees of freedom in groups (DFD), with the following formula:
   a. $DFT = (n-1)$
   b. $DFR = k$
   c. $DFTR = df total - df regresi$
3. Calculate the F value with formula as follows : $F = ss regresi : ss residual$
4. Perform interpretation and significance tests by comparing Fcalculate test values with Ftables. The Ftable coefficient is obtained from the F distribution whose value is based on degrees of freedom between groups (dbA) and degrees of freedom in groups (dbD) at a significance level of either $\alpha = 0.05$ or $\alpha = 0.01$. If the value of Fcalculate is greater than Ftable, H0 is rejected and H1 is accepted which is interpreted as significant, meaning that there is a difference in the average of the groups being compared. Conversely, if the value of Fcalculate is smaller than Ftable, then H0 is accepted and H1 is rejected which is interpreted as insignificant, meaning that there is no difference in the average of the compared group. [12]
5. If there is a significant difference, further tests will be carried out. For the same number of data groups or the number of samples of each group is the same, the Tukey test can be used. Meanwhile, for data groups that are not the same in number or the number of samples of each group is not the same, the Scheffe test can be used. [13]
2.6. Research Methodology

2.6.1. Place and Time of Research
This research was conducted at PT. Pelabuhan Indonesia II Pontianak branch and it is planned that this research can be completed within 6 months.

2.6.2. Tools and Materials
The equipment used in this study includes:
1. Laptop and Assistance application program, namely AutoCad 2023.
2. Flasdisk used to store data.
3. Calculator and stationery.

Materials or data needed include:
1. Drawings or floor plans of Kijing Port
2. Load data on Kijing Port
3. Installation data at Kijing Port [14]

2.6.3. Research Methods
This final project predicts or estimates the need for electrical energy in the future to estimate the development of electrical loads using data on electrical installations and non-industrial loads, connected power, substation data is calculated using the linear regression method by estimating the development of electrical energy in the Kijing Port area until 2032. [15]

2.6.4. Variable or Data
The causal variable used is the period of year (x) to be predicted and the consequent variable is the industrial load (y) on Kijing Port. [12]

Determine the value of the constant (a) and the regression coefficient (b). The values of a and b can be calculated using the formula below:

\[ a = \frac{\left( \sum y \right) \left( \sum x^2 \right) - \left( \sum x \right) \left( \sum xy \right)}{n \left( \sum x^2 \right) - \left( \sum x \right)^2} \]  \hspace{1cm} (2.7)

\[ b = \frac{n \left( \sum xy \right) - \left( \sum x \right) \left( \sum y \right)}{n \left( \sum x^2 \right) - \left( \sum x \right)^2} \]  \hspace{1cm} (2.8)

Where:  \( n = \text{amount of data} \) [15]

2.6.5. Flow chart

![Flow Chart]

**Figure 1. Flow Chart**
3. Calculating and Analysis

3.1. Calculation and Forecasting of Linear Regression Methods

From the recapitulation of electricity load data at Kijing Port obtained from the PT PELINDO company, 2023 data can be carried out linear regression analysis to determine the value of constant a and regression coefficient b in linear equations by calculating data as in table 4.2. Calculation to obtain Constant a and Regression Coefficient b Electrical Load at Kijing Port.

Based on equations 2.7 and 2.8, the calculation of the value of constant (a) and regression efficient (b) is as follows:

\[
a = \frac{(\sum y)(\sum x^2) - (\sum x)(\sum xy)}{n(\sum x^2) - (\sum x)^2}
\]

\[
a = \frac{18(2109) - (171)^2}{18(1.748.444) - (171)^2} = -112.031
\]

\[
b = \frac{n(\sum xy) - (\sum x)(\sum y)}{n(\sum x^2) - (\sum x)^2}
\]

\[
b = \frac{18(27.277.699) - (171)(1.748.444)}{18(2109) - (171)^2} = 22.017
\]

maka telah didapat konstanta a dan koefisien regresi b. Dengan menggunakan Persamaan Regresi Linear sesuai dengan persamaan 2.2 maka:

\[y = -112.031 + 22.017x\]

**Figure 1. Calculation to obtain Constant a and Regression Coefficient b of Electrical Load at Kijing Port**

**Figure 2. results of simple linear regression calculations on MS. Excel**

**Figure 3. Regression Line Graph**

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### Table

<table>
<thead>
<tr>
<th>Tahun</th>
<th>Periode</th>
<th>Beban Listrik (Watt)</th>
<th>Selisih</th>
<th>Kenianan Pertahun (%)</th>
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<tr>
<td>2024</td>
<td>19</td>
<td>306,792</td>
<td>22.017</td>
<td>7.18</td>
</tr>
<tr>
<td>2025</td>
<td>20</td>
<td>328,099</td>
<td>22.017</td>
<td>6.70</td>
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<td>2026</td>
<td>21</td>
<td>350,826</td>
<td>22.017</td>
<td>6.28</td>
</tr>
<tr>
<td>2027</td>
<td>22</td>
<td>372,543</td>
<td>22.017</td>
<td>5.91</td>
</tr>
<tr>
<td>2028</td>
<td>23</td>
<td>394,360</td>
<td>22.017</td>
<td>5.58</td>
</tr>
<tr>
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<td>24</td>
<td>416,777</td>
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<tr>
<td>2033</td>
<td>28</td>
<td>504,445</td>
<td>22.017</td>
<td>4.36</td>
</tr>
</tbody>
</table>

Total Kenianan Beban Listrik (Watt) 228,170
Kenianan Pertahun (%) 5.96

Figure 3. Results of Prediction of the Number of Electricity Loads at Kijing Port from 2024 to 2033

Figure 4. Kijing Port Electricity Load Growth Graph from 2023 to 2033

Based on figure 3 is a graph of electricity load growth at Kijing Port from 2023 to 2033, from the graph above we can see the growth of electricity load at Kijing Port from year to year. Which in 2023 the electricity load is 1,748,444 to 2033, which is 2,848,031.

Figure 5. Kijing Port Electricity Load Difference Graph from 2024 to 2033

Figure 6. Graph of Electricity Load Increase (%) of Kijing Port from 2024 to 2033

3.2. Analysis of Prediction of Electrical Energy Demand in Kijing Port with Ms. Excel Using Anova Regression

From the calculation results, the load increase from 2023 to 2033 uses the Linear Regression method of 5,802,129 Watt or 5.802129 MVA with a total load capacity of 9 substations of 24.5 MVA at Kijing Port.
Based on the prediction results for the next 10 years with a total load of 5.802129 MVA while the transformer load capacity at Kijing Port is 24.5 MVA consisting of 9 transformers, so that at Kijing Port for the next 10 years, the need for electrical energy is still sufficient. Based on the calculation results, in 2033 Kijing Port will not need to add insert transformers.

Figure 7. The result of the calculation of anova

3.3 Analysis of Prediction of Electrical Energy Demand at Kijing Port with Ms. Excel Using One-Way Anova Method

3.3.1 Test Statistics

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>F-value</th>
<th>F crit</th>
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</thead>
<tbody>
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<td>Between Groups</td>
<td>3249</td>
<td>2</td>
<td>1624.50</td>
<td>0.036078</td>
<td>0.96459</td>
<td>3.178799</td>
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<tr>
<td>Within Groups</td>
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<td>51</td>
<td>45,027.38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2.299654</td>
<td>53</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 8. One-Way Anova Formula

Figure 9. One-Way Anova Analysis Calculation

Figure 10. Excel Calculation Results

In the ANOVA (Single Factor) analysis, there are three groups of data compared by year (2023, 2024, and 2025). Here are the ANOVA analysis results for the data: Summary: Number of observations (Count): Each group had 18 observations. Total number (Sum): The total of each group is 1,748,444 for 2023, 1,919,865 for 2024, and 2,090,146 for 2025. Average: The average of each group is 97.13577778 for 2023, 106.63577778 for 2024, and 116.13577778 for 2025. Variance: The variance of each group is 43724.88144 for 2023, 45008.3792 for 2024, and 46348.87697 for 2025.

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3.4. Analysis of the calculation results of one-way linear regression and anova methods

After doing the calculation, an analysis of the results of the calculation is obtained based on estimates that have been carried out to meet the needs of electrical energy for industrial loads, the amount of power that needs to be prepared by PLN, especially Kijing Port for the next 10-year period, is at least 4,053,685 Watt (4.053685 MVA) from the results of the amount of connected power each year that has been predicted, which has an average annual increase of 7.85%. From the calculation results, the load increase from 2023 to 2033 using the Linear Regression method of 5,802,129 Watt or 5.802129 MVA with a total load capacity of 9 substations of 24.5 MVA at Kijing Port.

Based on the prediction results for the next 10 years with a total load of 5.802129 MVA while the transformer load capacity is 24.5 MVA so that Kijing Port for the next 10 years prediction is still sufficient to accommodate the current load capacity. Based on the calculation results, in 2033 Kijing Port will not need to add transformers because the transformer capacity still meets the applicable standards, namely the capacity is still less than 80%.
2,603,117, in 2029 the linear regression analysis is 3,916,451 and the anova analysis is 2,774,031, in 2030 the linear regression analysis is 4,354,845 and the anova analysis is 2,945,650. In 2031 the linear regression analysis is 4,815,256 and the anova analysis is 3,287,410, in 2032 the linear regression analysis is 5,297,684 and the anova analysis is 3,858,256. Based on figure 6 can make some conclusions: The variables "Anova" and "Regression" show an increase over time from 2023 to 2033. This can be seen from the value that is increasing from year to year for both variables. There is a positive relationship between the year and the variables "Anova" and "Regression". This can be seen from the results of regression analysis which shows a significant positive regression coefficient. That is, with increasing years, the values of "Anova" and "Regression" tend to increase as well. The "Regression" value tends to be higher than the "Anova" value for the same year. This indicates that the "Regression" variable has a faster growth or higher rate of improvement compared to the "Anova" variable. Using the obtained regression line equation, we can predict future values of "Anova" and "Regression" by year. Keep in mind that these predictions are based on the assumption of a linear relationship between the year and that variable. In conclusion, the data showed a consistent upward trend from year to year for the variables "Anova" and "Regression". There is a positive relationship between the year and the two variables.

### 4. CONCLUSION

From the results of the analysis carried out, the following conclusions can be drawn: Predicted total increase in the amount of power connected to industrial loads after existing at Kijing Port of 4.0537 MVA (average annual growth of 11.28. Prediction of total increase in expenses in the next 10 years from 2023 to 2033 of 5,8021 MVA. At Kijing Port the power capacity of 24.5 MVA consists of 9 transformers. At Kijing Port, there is no need to increase transformer capacity because the transformer capacity at Kijing Port is still meeting for the next 10 years. Before the existing data of Kijing Port is 1,748,444 in 2023 and after being carried out the existing using the anova method is 3,458,256 in 2033 and with the linear regression method is 5,802,129. Calculations using the anova method tend to be smaller because there is no significant difference between groups based on the results of anova analysis, while calculations using the slinier regression method the coefficient of determination is 0.316, thus explaining that the real (significant) effect indicates the accuracy of the linear regression model used to predict the load on Kijing Port.

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[14] Ryan septyan Universitas Islam Indonesia : Analisis peramalan kebutuhan energi listrik PLN aream batam menggunakan metode regresi linier skripsi ryan septyan Universitas islam Indonesia


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