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The Cost Comparative Analysis of Steel Frame Bridge Installation Work Methodology Between Using Cranes and Using Launching Gantry in Muara Karang Combined Cycle Power Plant 400-500 MW Project

Anjas Handayani, Fariz Gading Pangestyo
Faculty of Engineering, University Mercu Buana Jakarta, Indonesia
Anjas_handayani@yahoo.com, farizgadingp@gmail.com

Abstract

Electrical energy is one of the most important and vital human needs that cannot be separated from daily needs. The case study was taken from the Muara Karang Combined Cycle Power Plant 400-500 MW Project, which is part of a 35,000 MW governmental program that aims to fulfill electricity needs from Sabang to Merauke. In this project, a method of implementing steel-frame bridge installations will be sought in terms of cost. That way, later you will get an efficient installation implementation method. In this study, the authors used secondary data from literature and primary data that taken directly from field observations. Data processing uses statistical tests with the Stepwise method. The cost for the work method using the crane is IDR 367,212,450, while the cost for the work method using the launching gantry is IDR 321,868,085. In the percentage result of the steel frame bridge installation work method, the greatest effectiveness factor is Tool Reach (X11) of 94.5%. Whereas in the work method using launching gantry with the variable that has the greatest effectiveness is the Capacity of Tools Used 76.8%. Judging from these results the factors that have the highest effectiveness to influence the time performance in the implementation of the steel frame bridge installation work method are the tool factor and the material factor.

Keywords:
Effectiveness of Crane and Gantry Launching, Steel Frame Bridge Installationion and Work Implementation Methods,

1. Introduction

1.1. Background

Electrical energy is one of the most important and vital human needs that cannot be released from daily needs. Man can hardly do his existing work properly or meet his needs. Lack of electrical energy can interfere with human activity. Therefore the continuity and availability of electrical energy must be maintained. Currently, electricity needs are increasing as the population increases and technology and information advances.The use of electricity is no longer to meet social needs but also personal needs, therefore the power plant becomes the main focus of development as one of the most important infrastructures in meeting the shortage of electricity supply and needs attention to accelerate its development.(Widi Nugraha, 2018)

Muara Karang Hydroelectric Power Plant Project 400-500 MW, which is part of a government program of 35,000 MW that aims to meet electricity needs from sabang to merauke. In this project, electricity generated from the new plant (located in block 3) will then be flowed through the existing switchyard (in block 2 area) before being distributed out. The location of the new plant (block-3) and the old generator (block-2) are separated by a river with a span of ± 60m. Limited project locations and carrying out work among existing buildings. This steel frame bridge is a building structure that functions as a high voltage cable support from the project that is being built to the existing area of the switchyard which will later drain electricity for the needs of the community.Projects are organized efforts to achieve important goals, goals and expectations using budgets and available resources that must be completed within a certain period of time (Istimawan, 1996).On this basis, it is necessary to analyze the method of implementation. That way there will be a more efficient method of installation work.

Based on the above, the authors will conduct an assessment of the comparative analysis of the method of installation of steel frame bridges using cranes and launching gantry with limited land. The results of this study are expected to help to reverence and consideration of the method of installation of steel frame bridges on future projects.

1.2. Identify Problem

There are indications of problems related to the cost and limitations of the land used. In the selection of heavy equipment that should use a 150 ton crane with a lifted load of 23.26 tons spans 30 m on both segments of the steel frame bridge. But due to the range required on the method of implementing the installation of a long steel frame bridge, then for a crane 150 tons is not recommended because the angle is too large. So the selection of cranes to the west of block 3 is using a 300 ton crane and east of 360 tons with a rental of Rp 367,212,450 million already all in. Problems related to land limitations include material storage, range of bridge material and tool assembly in the implementation of steel frame bridge installations.

1.3. Problem Formulation

Based on the identification of the above problems, it can be formulated the following problems:

1. Which is the use of more economical installation equipment between crane and gantrylaunching on the implementation of steel frame bridge installation at Muara Karang Hydroelectric Power Plant Project 400-500 MW?
2. How effective are the two tools used in the installation of the steel frame bridge?

1.4. Research Objectives

The intentions and objectives of this study are:

1. Knowing the method of implementation of more economical installation between crane and gantry launching on the implementation of steel frame bridge installation in Muara Karang Hydroelectric Power Plant Project 400-500 MW.
2. Knowing the effectiveness of both tools used in the installation of steel frame bridges in Muara Karang Hydroelectric Power Plant Project 400-500 MW.

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2. Methodology

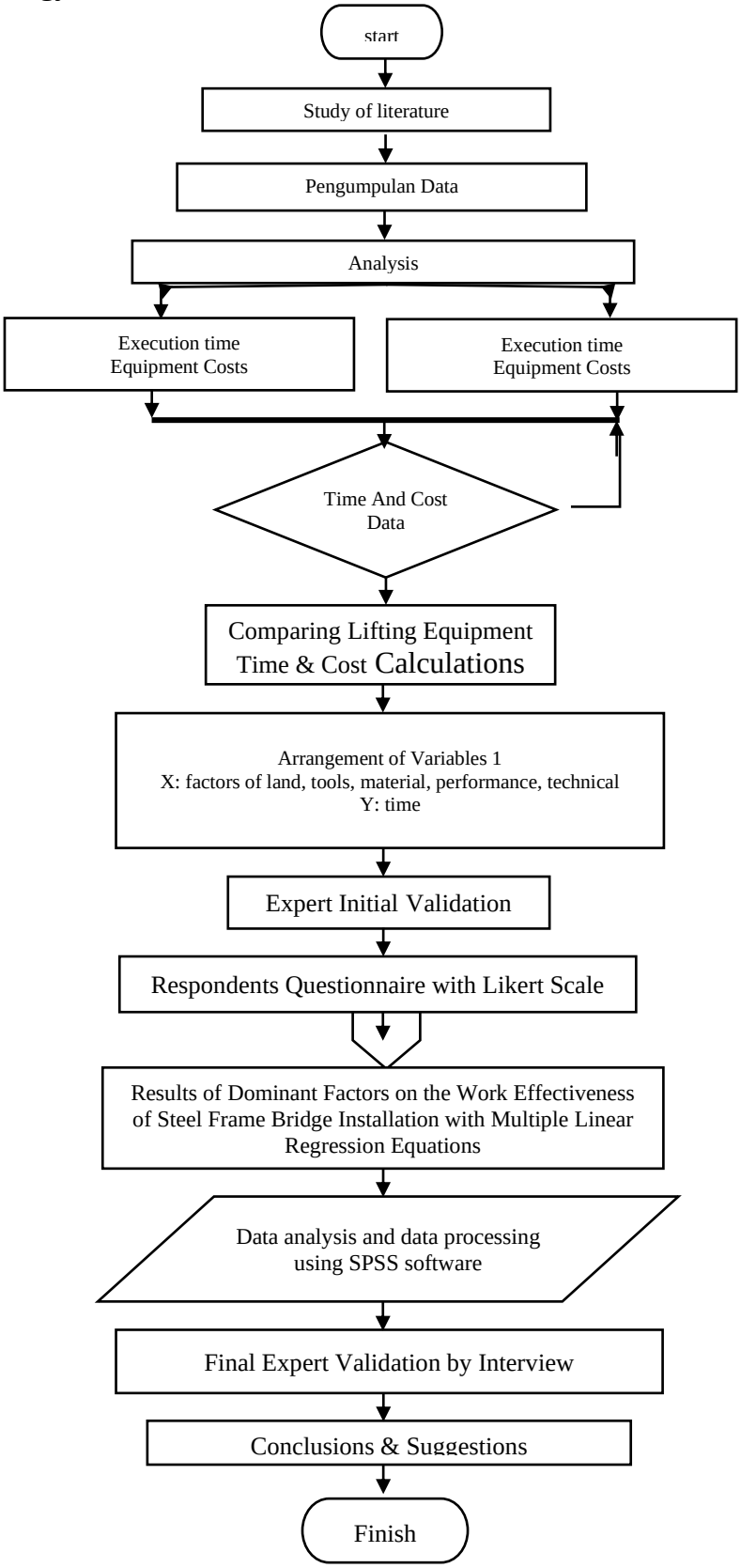

Figure .1 Research FlowChart
Source: Self-Processed Products, 2020

In general, the flow chart for the final task is:

1. Problem Overview
   Formula the problem from the background presented, then do a literature study on the problem that has been set. The next stage of the method will be used this research.
2. Data Collection
   Data collection is done at the research method stage. The data used in this study is primary and secondary data.
3. Primary Data and Secondary Data
   The primary data used in this study was field surveys and interviews, then questionnaires were conducted. Secondary data obtained from project data, journals and books.
4. Preparation of Questionnaire:
   a.Phase I Questionnaire: Preparation of phase l questionnaire intended to ask experts to review questionnaires that have been compiled by researchers.
   b. Phase II Questionnaire: The dissemination of phase 2 questionnaire was given to 35 respondents.
   c. Input questionnaire data: Here the researchers re-collected the questionnaire that has been filled in by the respondent to be further analyzed.
5. Data Processing
   After the questionnaire, the data that the questionnaire results are processed method with statistical analysis, namely using the help of statical program for social science (SPSS) software.
6. Data Processing Results
   The result of processing data from the help of spss software, can know the dominant variables.
7. Conclusions and Suggestions
   After getting the results of data processing, then the researchers make conclusions and suggestions.

3. Result and Discussion

In this chapter will be discussed about the results of research that has been done about the influential variables facing the use of more effective and economical tools in each method used in the installation of steel frame bridges.

3.1. Bridge Structure Data

The structure of the steel frame bridge to be built in muara karang hydropower project 400-500 MW has the following data:

Span length : 60 m
Structure Weight : ± 45 tons

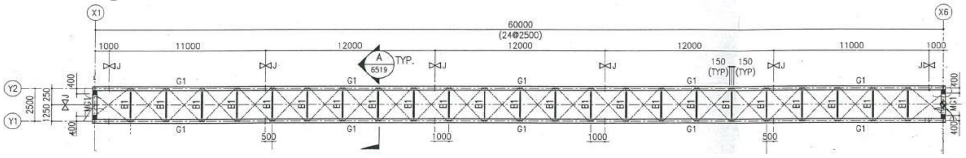

Figure 2. Steel Frame Bridge
Source: Self-Processed Products, 2020

3.2. Crane Time Analysis

Table 1. Total Time of Implementation of Crane Work

No	Job	Time	Unit
1	Mob Demobilization	480	Minutes
2	Crane Preparation and Setting	480	Minutes
3	Steel Frame Bridge Intalasi	275	Minutes
4	Welding	20	Minutes
5	Realease	25	Minutes
	Total	1280	Minutes

Source: Self-Processed Products, 2020

The total cycle time required to install a 60 meter span steel frame bridge using a crane is 1,280 minutes = 3 days with 8 working hours in 1 day. This process only includes erection work and does not include ironwork and casting work.

3.3. Time Analysis Using Launching Gantry

Table 2. Total Time of Work Using Gantry Launching

No	Job	Time	Unit
1	Mob Demobilization	960	Minutes
2	Gantry Launching Preparation and Setting	5280	Minutes
3	Steel Frame Bridge Intalasi	515	Minutes
4	Welding and Uninstall hydraulic jack	27	Minutes
5	Realease	25	Minutes
6	Realease gantry launching structure	5280	Minutes
	Total	12.087	Minutes

Source: Self-Processed Products, 2020

So the total time required on the installation of a 30-meter steel frame bridge using gantry launching is 12,087 minutes= 26 days, One day works 8 hours.

3.4. Cost Analysis Of Work Methods Using Crane

Table 3. Total Recapitulation of Cost Budget Plan

No	DESCRIPTION: 10	AMOUNT
No	Description	TOTAL PRICE (RP)
I	PREPARATORY WORK	
	Sign k3	
	MobDemob	
Ii	STEEL FRAME BRIDGE	
	Installation of steel frame bridges	
A	Total	333,829.500
B	ROUNDED	333,829.500
C	VAT 10 %	33,382.95
D	GRAND TOTAL	367,212.450

Source: Self-Processed Products, 2020

From the table above can be concluded that the result of the calculation of the cost of the construction of the bridge installation (RAB) is obtained amounting to IDR. 367,212,450.

3.5. Cost Analysis Of Work Method Using Gantry Launching

Table 4. Total Recapitulation of Cost Budget Plan

No	DESCRIPTION: 10	AMOUNT
No	Description	TOTAL PRICE (RP)
I	PREPARATORY WORK	
	Sign k3	
	MobDemob	
Ii	STEEL FRAME BRIDGE	
	Installation of steel frame bridges	
A	Total	292,607.350
B	ROUNDED	292,607.350
C	VAT 10 %	29,260.74
D	GRAND TOTAL	321,868.085

Source: Self-Processed Products, 2020

The above cost budget plan, totaling IDR. 321,868,085 requires 26 days implementation time (assuming that the number of working hours in 1 day is 8 working hours). When compared to the previous method of using cranes, the cost of installing a steel frame bridge using gantry launching is cheaper. This is because in the previous method the rental price of the tool was more expensive.

3.6. Phase I Data Collection And Analysis (Expert Validation)

3.6.1. Expert Profiles

This first stage data collection is done by distributing questionnaires to 5 experts with minimum experience ≥5 years for s2 and ≥10 years experience for bachelor's and good reputation.

3.6.2. Crane Multiple Linear Regression Analysis

Once known the dominant variables of the correlation value in the next factor analysis are performed regression analysis. Regression analysis is a way or technique to find a relationship between one variable and another expressed in the form of mathematical equations in a functionary relationship

Table 5. Crane Simultaneous Test Results (F-Test)

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	125.767	1	125.767	70.578	.000[b]
	Residual	58.804	33	1.782		
	Total	184.571	34			
2	Regression	148.158	2	74.079	65.101	.000[c]
	Residual	36.413	32	1.138		
	Total	184.571	34			
3	Regression	158.283	3	52.761	62.218	.000[d]
	Residual	26.288	31	.848		
	Total	184.571	34			

a. Dependent Variable: Y
b. Predictors: (Constant), X11
c. Predictors: (Constant), X11, X7
d. Predictors: (Constant), X11, X7, X1

Source : Processed Results Software processed statistical data

From table 5, The calculated F value obtained in model 3 is 62,218 and the value of F table with a confidence level of 95% obtained from table F with a significant rate of 5%. For (df1) k-1 = 3-1 = 2 and (df2) n-

k = 35-3 = 32, the meal shows the table's F value of 2,911. This indicates F count > F table then the signification value is definitely smaller than 0.05 which is 0,000 which means significant influence.

Table 6. Crane Partial Test Results (T-Test)

Coefficients a

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	Q	Sig.
1	(Constant)	4.317	.876		4.927	.000
	X11	1.830	.218	.825	8.401	.000
2	(Constant)	3.463	.726		4.769	.000
	X11	1.325	.208	.598	6.368	.000
	X7	.770	.174	.416	4.436	.000
3	(Constant)	3.218	.631		5.101	.000
	X11	.945	.211	.426	4.490	.000
	X7	.574	.160	.310	3.582	.001
	X1	.667	.193	.340	3.455	.002

a. Dependent Variable: Y

Source : Processed Results Software processed statistical data

In table 6, model 3 indicates there is an independent variable that affects the depeden variable i.e. signification value < 0.05 or the value of T count > T table, i.e. table Value T = 2,037. The above data shows that k=3 and n=35. Inserted into the formula it will generate a number (0.05/2; 35-3-1) = (0.025;31). Obtained table T value of 2,037, it is concluded that variable Y (Crane Method) is affected 1 by variables X11 (Tool Range), X7 (Steel Frame Bridge Structure Length) and X1 (Project Entrance Access). The size of the T value indicates the amount of correlation of each variable. For the more dominant variable is variable X11 because it has a greater T value in comparison to the others. From table 4. 34 get regression equations, namely:

Y1 = 3.218 + 0.945 X11 + 0.574 X7 + 0.667 X1

A constant of 3,218 indicates that if there is no X data value then the Y data value will be 3,218. A positive sign (+) indicates that the effect of X data on Y is directly proportional which means that if the X data value is enlarged then the value of the Y data will increase as well, and vice versa.

The explanation of the regression equation above is as follows:

a. 1 Constant of 3,218 means that if all variables are constant value then the value of Y1 will change by itself as big as the constant value.
b. Tool Range variable regression coefficient (X11) of 0.945 means that if X11 experiences a one-unit increase, then performance (Y) with crane method will increase by 94.5%.
c. Variable regression coefficient of Steel Frame Bridge Structure Length (X7) of 0.574 means that if X7 experiences a one-unit increase, then performance (Y) with crane method will increase by 57.4%.
d. Project Entrance Access variable regression coefficient (X1) of 0.667 means that if X1 increases by one unit, then performance (Y) with crane method will increase by 66.7%.

3.6.2. Gantry Launching Linear Regression Analysis

Once known the dominant variables of the correlation value in the next factor analysis are performed regression analysis. Regression analysis is a way or technique to find a relationship between one variable and another expressed in the form of mathematical equations in functional relationships.

Table 7. Summary Launching Gantry Capital Results

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.827[a]	.683	.674	1.23709
2	.901[b]	.811	.799	.96998
3	.920[c]	.846	.831	.88971

a. Predictors: (Constant), X28
b. Predictors: (Constant), X28, X12
c. Predictors: (Constant), X28, X12, X7

Source : Processed Results Software processed statistical data

In Table 7, it shows there are 3 regression models resulting from the determination coefficient test, but the best regression modal is the number 3 regression model consisting of 3 variables because it has a greater R2 value than other models which is 0.846 meaning of depeden variable variability that can be explained by

variability. The independent variable is 84.6 so the model is quite good, while the remaining 15.4% is explained by other variables that are not included in the regression model.

Table 8. Gantry Launching Simultaneous Test Results (F-Test)

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	109.040	1	109.040	71.250	.000[b]
	Residual	50.503	33	1.530		
	Total	159.543	34			
2	Regression	129.435	2	64.718	68.785	.000[c]
	Residual	30.108	32	.941		
	Total	159.543	34			
3	Regression	135.004	3	45.001	56.850	.000[d]
	Residual	24.539	31	.792		
	Total	159.543	34			

a. Dependent Variable: Y
b. Predictors: (Constant), X28
c. Predictors: (Constant), X28, X12
d. Predictors: (Constant), X28, X12, X7

Source : Processed Results Software processed statistical data

From table 8, the calculated F value obtained in model 3 is 56,850 and the value of F of the table with a confidence level of 95% obtained from table F with a significant level of 5%. For (df1) k-1 = 3-1 = 2 and (df2) n-k = 35-3 = 32, the meal shows the table's F value of 2,911. This indicates F count > F table then the signification value is definitely smaller than 0.05 which is 0,000 which means significant influence.

Table 9. Gantry Launching T-Test Results

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	Q	Sig.
1	(Constant)	5.528	.694		7.965	.000
	X28	1.564	.185	.827	8.441	.000
2	(Constant)	4.251	.609		6.974	.000
	X28	1.051	.182	.556	5.764	.000
	X12	.915	.196	.449	4.656	.000
3	(Constant)	3.993	.567		7.038	.000
	X28	.694	.215	.367	3.234	.003
	X12	.768	.189	.377	4.072	.000
	X7	.574	.216	.304	2.652	.012

a. Dependent Variable: Y

source : Processed Results Software processed statistical data

In table 9, model 3 indicates there is an independent variable that affects the depeden variable i.e. signification value < 0.05 or the calculated T value > T of the table, i.e. table Value T = 2,037. The above data shows that k=3 and n=35. Inserted into the formula it will generate a number (0.05/2; 35-3-1) = (0.025;31). A table T value of 2,037 is obtained, so it is concluded that variable Y (Gantry Launching Method) is affected 1 by variables X28 (Natural Conditions), X12 (Tool Capacity Used) and X7 (Length of Steel Frame Bridge Structure). The size of the T value indicates the amount of correlation of each variable. For the more dominant variable is variable X12 because it has a greater T value in comparison to the others. From the table is obtained regression equations, namely:

Y1 = 3.993 + 0.694 X28 + 0.768 X12 + 0.574 X7

A constant of 3,993 indicates that if there is no X data value then the Y data value will be 3,993. A positive sign (+) indicates that the effect of X data on Y is directly proportional which means that if the X data value is enlarged then the value of the Y data will increase as well, and vice versa.

The explanation of the regression equation above is as follows:

a. A constant of 3,993 means that if all variables are constant value then the value of Y1 will change by itself as big as the constant value.

b. Natural Condition variable regression coefficient (X28) of 0.694 means that if X28 experiences a one-unit increase, then performance (Y) with gantry launching method will increase by 69.4%.
c. Variable regression coefficient of Used Tool Capacity (X12) of 0.768 means that if X7 experiences a one-unit increase, then performance (Y) with gantry launching method will increase by 76.8%.
Variable regression coefficient of Steel Frame Bridge Structure Length (X7) of 0.574 means that if X1 experiences a one-unit increase, then performance (Y) with gantry launching method will increase by 57.4

4. Conclusions and Suggestions

4.1. Conclusions

Based on the analysis that has been done in this study, it can be concluded that the method of installation work using cranes is superior to the method of work using launching gantry in terms of time. Meanwhile, in terms of the cost of working methods using launching gantry is cheaper than using cranes.

Table 10. Cost and Time Analysis Results

No	Variable	Installation Work Method		Difference
		Crane	Launching Gantry	
1	Cost	(T&B)	Average price per night	Average price per night
2	Time	3 Days	26 Days	23 Days

Source : Processed Results Software processed statistical data

Based on the analysis that has been done in this study that the effectiveness that affects the implementation of the method of installation of steel frame bridges using cranes against time is tool factor (X11) by 94.5% and effectiveness that affects the implementation of steel frame bridge installation method using gantry launching against time is Tool Factor (X12) by 76.8%.

4.2. Suggestion

The advice that can be given for the method of installation of steel frame bridge based on the results of this study is as follows:

1. The method of implementation with gantry launching can be used as a reference on the implementation of bridge construction work in certain projects, especially in limited locations or land that can not be reached by large capacity cranes, but must still be carried out analysis according to the conditions in the field.
2. Further research can be continued about K3 in the process of carrying out work especially on bridge building.

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