Railway Project Work Implementation with Critical Path Method and Value Engineering

Sahala Boy Mangatur Manullang, Budi Susetyo, Agus Suroso

Abstract: Analysis on the maintenance of the railway track was performed in this study. The maintenance was conducted to replace the R.41/R42 bearing iron with the R.54 bearing concrete on the railway track. The railway track maintenance project was run based on the unit price contract as decided by the state – owned Infrastructure Maintenance Operation for Railway. The unit price contract was selected to utilize existing resources as much as possible. The problem of this study was to investigate the influence of the Critical Path Method and Value Engineering with analysis on of the railway tract project. The main objective of this study was to investigate the time and cost efficiency time and analyze the influence of the Critical Path Method and Value Engineering (VE) on this case study. The analysis resulted in the influencing factors such as activities stage process (RII =0.58021), project planning (RII=0.57176), Implementation (RII=0.58194), Support (RII=0.57250), Structural Planning (RII=0.64653) Supervision (RII=0.55556) External Conditions (RII=0.57222) and Railway Work (RII=0.59144). The Case study using critical path method with the variable score CPM(X1) to the railway track (Y) resulted in the significance limit value α = 1.995 more than the significance level of 0.824. The analysis showed that the variable CPM(X1) had significant influence on railway work (Y), while variable Value Engineering (X2) resulted in significance α = 1.995 more than the significance level of 0.001. Therefore, the variable VE(X2) influenced on railway work (Y).

Keywords: Railways, Critical Path Method, Value Engineering, Cost - Time Efficiency, Relative importance index.

I. INTRODUCTION

A construction project is a temporary activity that takes place over a limited period of time, with a specific allocation of resources and intended to produce a product or deliverable whose quality criteria have been clearly outlined. Every project contractor always wants to complete a construction project at the most efficient cost possible. However, the cost efficiency must be achieved with the tested techniques. The cost saving techniques used must still pay attention to the quality, reliability and usability of a building that is being worked on. If the project was run without proper analysis, it will cause harms to the project contractor and workers during the work process and endanger the building user when a project has been completed. Therefore, the project contractor

Sahala Boy Mangatur Manullang*, Department of Civil Engineering, Mercubuana University, Jakarta, Indonesia. Email: boysahala@gmail.com
Budi Susetyo, Department of Civil Engineering, Mercubuana University, Jakarta, Indonesia. Email: budi.susetyo@mercubuana.ac.id
Agus Suroso, Department of Civil Engineering, Mercubuana University, Jakarta, Indonesia. Email: agussrs@yahoo.com

must have good management on the construction project. Acceleration of project time is often performed when the project progress is considered to be delayed to the plan. In addition, the acceleration of time can also be performed at the time of planning. However, the acceleration of time has an impact on cost, quality, and risk. Therefore, this present study aims to find out the most optimal cost saving method but still pay attention to the quality, reliability, and main function of a building. So that construction service providers can still compete better in the construction world. So based on this background, the author reviewed the duration of project implementation using Critical Path Method (CPM) and Value Engineering with the aim to obtain a time and cost analysis on the Implementation of the Railway Track Project.

II. LITERATURE REVIEW

A. Critical Path Method

Critical Path Method (CPM) is a critical path method, a network-based method that uses a linear time-cost balance. Each activity can be completed faster than normal by bypassing the activity for a certain amount of cost. Thus, if the project completion time is not satisfactory, certain activities can be completed to be able to complete the project with less time. A critical path is a network of activities or jobs that traverse all critical activities, or that have a slack of 0. All existing work on a critical path cannot be completed without delaying the completion time of the project. And also, the critical path is the longest timeline that goes through the network. Using critical path analysis will help determine the project schedule. The critical path is important for the project contractor, because on this path lies the activities that when the implementation of the project. The nature or general condition of the critical path are:

1. In the first activity:
$EST = LST = 0$
Or
$EST - LST = 0$
2. At the end of the activity:
$EFT = LFT$
3. Slack is equal to zero

If only part of the activity is critical, then the activity is fully considered critical. To provide a clearer picture, it is necessary to know the definition of Value Engineering, such as follows: Value engineering is a problem-solving system implemented using a specific set of techniques, science, expert teams, organized creative approaches that aim to define and eliminate unnecessary costs such as costs that do not contribute to the quality, usability, age, and appearance of products and consumer appeal [1].

B. Value Engineering

Value engineering is a professional team approach that in its application is function-oriented and carried out systematically that is used to analyze and increase the value of a product, facility design, system, or service. Value engineering is a good methodology for solving and/or reducing costs while still improving established performance or quality requirements [2].

Value engineering is a systematic evaluation of the engineering design of a project to obtain the highest value for every dollar spent. Furthermore, value engineering reviews and thinks about various components of activities such as procurement, fabrication, construction, and other activities related to costs to its function, with the aim of getting a decrease in overall project costs. [3].

Value engineering is the systematic application to identify the functions of a good and service by providing value to each existing function, and developing a number of alternatives that allow the achievement of these functions at minimal total cost. [4].

Value engineering is one of the techniques to control costs that have considerable potential for success, using a value analysis approach to its function. This is done by emphasizing cost reduction as far as possible while maintaining the level of quality and resilience as expected [5]. Three elements can be interpreted through the relationship below:

$$Value = \frac{Function + Quality}{Cost}$$

Where:

Function = Certain jobs that a design/item must do

Quality= The needs, wants, and expectations of the owner or user

Cost = Lifecycle costs of a product/project

C. Research Methodology

The study was formulated using a combination of two research methods which consisted of quantitative methods – experiments for first part of the study and the qualitative method (with statistical analysis) for the second part of the study. Quantitative methods or the experiment in the first part of the study was conducted by conducting simulations of CPM and VE method on research objects (otherwise called a case study implementation), which is based on the implementation procedures obtained from Previous literature studies. Qualitative methods on the second part of the study was performed by using simulation tools in the form of RII analysis (Relative Importance Index) based on research instruments, in the form of questionnaires distributed to selected respondents. After the data were collected, the analysis was carried out so that the results are in accordance with the objectives of the study. In this study, Microsoft Excel 2016 was used to analyze data obtained from the questionnaire with RII (Relative Index Important) method. The analytical method used in this study was a descriptive statistical method to describe the basic characteristics of the data and the inferential statistics to draw conclusions from the data to more general conditions. Relative Importance Index (RII) is an analysis that allows a relative quantitative, where the higher rating means the higher influence is given. The analysis was performed to investigate various factors that affect worker productivity in construction related to project execution. The score for each factor was obtained through the sum of the respondent's answer scores. The results of this analysis calculation show the ranking of the overall factors and further determined the power influence of each factor. RII is calculated by the following equation [5].

$$RII\ Sub\ Factor = \frac{\Sigma W}{A \times N}$$

RII= Relative importance index

W = Weight (The score is multiplied by the weight of each score which is 1 to 6)

A= Highest weight (In this study 6)

N= Total respondents (41)

RII Main Factor = Average value of RII Sub Factor RII Variable = Average value of RII Main Factor

There are two variables in this study: independent variables and dependent variables. The independent variables consisted of two variables while the dependent variables consisted of a variable as follows:

– Independent variable (X): Manual Program Evaluation and Review Technique CPM and Value Engineering (VE)

- The dependent Variable (Y): Railway work

It is the main sub-dimension of the variable. The main variables are broken down into smaller sub-dimensions and each main factor has a sub factor component.

D. Population and sample

Table- I: CPM Variable Questionnaire

Position	Sum	Percentage (%)
Project Manager	5	13%
Site manager	5	13%
Head Engineering	11	28%
Site Engineering	9	23%
Cost Control Engineer	5	13%
Cost Estimate Engineer	5	13%
Total	40	100,00%

III. ANALYSIS AND DISCUSSION

Independent variable (x)= Critical Path Method (CPM) and Value Engineering (VE), Independent Variable(y)= Railway work.

Table 2 Independent variables (x)= Critical Method (CPM) and Value Engineering (VE), Railway works (Y).

34

Table- II: CPM Variable Questionnaire

VARIABLE	MAIN FACTOR	SUB FACTOR		CODE	SUB FACTOR		MAIN FACTOR		VARIABLE	
					RII	Rank	RII	Rank		Rank
Critical Path Method (CPM)	Activity Stage	1	Reduce large network calculations	X11	0.52917	43	0.58021	6	0.58021	2
		2	Network simplification	X12	0.5625	28				
		3	Correlation between activities	X13	0.54167	37				
		4	Incorporation of activities	X14	0.58333	17				
		5	Number of validation tests	X15	0.57917	20				
		6	Monitor job financing	X16	0.60833	11				
		7	Qualified leaders	X17	0.69583	1				
		8	Availability of labor	X18	0.54167	37				
Value Engineering (VE)	Project Planning	9	Good planning	X21	0.54167	37	0.56083	3	0.57176	3
		10	Working method	X22	0.55	33				
		11	Time of value engineering	X23	0.55	33				
		12	Activity information	X24	0.575	21				
		13	Organizational Structure of Work	X25	0.5875	13				
	Implementation	14	Development of value engineering	X26	0.5875	13	0.58194	2		
		15	Diagram FAST	X27	0.56667	27				
		16	Implementation Methods	X28	0.55417	32				
		17	Cost Efficiency	X29	0.58333	17				
		18	Support in implementation	X210	0.58333	17				
		19	Lack of regulation in the implementation of value engineering	X211	0.6125	9				
		20	Design Coordination Meeting	X212	0.525	44				
		21	Construction coordination meeting	X213	0.5875	13				
		22	Work program (work schedule)	X214	0.6375	7				
	Supporter	23	Support from the office (top management commitment)	X215	0.54583	36	0.5725	4		
		24	Knowledge and experience in *value engineering*	X216	0.5375	41				
		25	Good communication	X217	0.60417	12				
		26	Funding for the implementation of value engineering	X218	0.5625	28				
		27	Project conflict of interest	X219	0.6125	9				
Railway Work	Structural Planning	28	Picture Document	Y1	0.64167	6	0.64653	1	0.59144	1
		29	Implementation time	Y2	0.65	5				
		30	Activity specifications	Y3	0.67083	3				
		31	Job location	Y4	0.65417	4				
		32	Details of the analysis	Y5	0.575	21				
		33	Traffic planning	Y6	0.6875	2				
	Supervision	34	Labor experience	Y7	0.54167	37	0.55556	7		
		35	Productivity of labor	Y8	0.57083	25				
		36	Job value	Y9	0.5875	13				
		37	Quality of labor	Y10	0.575	21				
		38	Percentage of delays	Y11	0.52083	45				
		39	Materials used	Y12	0.5375	41				
	External Conditions	40	K3	Y13	0.55833	31	0.57222	5		
		41	Access to the location	Y14	0.5625	28				
		42	Weather conditions	Y15	0.575	21				
		43	Use of technology	Y16	0.61667	8				
		44	Social conditions	Y17	0.55	33				
		45	Economic conditions	Y18	0.57083	25				

Valid results are obtained in all jobs X1(CPM), X2 (VE), Y Railway Work The validity test is calculated by comparing the value of the table r, if r statistics the > of the r critical (at a significance level of 5%) then the statement is declared valid. Reliability test is the degree of accuracy as indicated by a measurement instrument. Reliability test use consistent intervals calculating alpha coefficients (α).

Table- III: Reliability Analysis

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,792	,795	18

Based on the table of reliability test results of variable Y above, the two indicator items have a Cronbach's Alpha value greater than 0.6 which is 0.795. Based on the above provisions, the indicators in this study are said to be reliable.

Hypothesis Test: regression analysis to determine the effect of independent variables: CPM (X1), and VE (X2), on railway work as the dependent variables (Y). Regression Equation

Y = a+b1X1+b2X2+e

Y = 2,893 + 0.025X1 + 0.258X2 + e

The t test is used to determine the effect of each independent variable individually (partially) on the dependent variable:

$$t_{statistics} = \frac{r.\sqrt{n}-2}{\sqrt{1-r2}}$$

t statistics = t value

r   = R statistics for correlation coefficient

n   = Number of respondents

then the research instrument (questionnaire results) is declared Valid.

The results of the calculation of correlation values in Table 7 show the correlation value between variables and correlation. A significance test was performed using the F test

Based on the table above, the following describes the effect of each partially independent variable:

Variable CPM (X1)

The results of the test with SPSS for variable CPM (X1) to Railway Work (Y) showed a t statistics value = 0.223 with a significance level of 0.824. With a significance limit (α) of 5% = 1.995, the significance limit value α (1.995) > the significance level of 0.824 then the H1 hypothesis is acceptable. This means that variable CPM (X1) has a significant influence on railway work (Y).

VE variable (X2)

The results of the test with SPSS for variable VE (X2) to Railway Work (Y) showed t statistics value of 3,486 with a significance level of 0.001. With a significance limit (α) of 5% = 1.995, the significance limit value α (1.995) > the significance level of 0.001, the H2 hypothesis is acceptable. This means that the VE (X2) variable has a significant influence on railway work (Y).

Based on the results of F statistics and F critical calculations and the rules of significance testing, it can be concluded that:

F statistics (23.95) > F critical (by 3.24), then H1 accepted - H0 rejected

This means that there is a significant influence between M-PERT &VE on long segment contract-based road work

IV. CONCLUSION

Based on the stages of the Relative Importance Index (RII) analysis method that researchers conducted, CPM (XI)

influenced on railway work (Y) with the significance value = 0.824 then the first hypothesis was accepted. Then the VE(X2) method of railway work with a value of 0.001 then the hypothesis of H2 is accepted.

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AUTHORS PROFILE

S Sahala Boy Mangatur Manullang * is a master student at the Civil Engineering Department, Mercubuana University, Jakarta, Indonesia. He is a professional at a construction company in Jakarta, Indonesia. He graduated from Universitas Negeri Semarang and still pursues his master's degree at Universitas Mercu Buana..

Budi Susetyo is an associate professor at Civil Engineering Department, Mercubuana University, Jakarta, Indonesia. His main expertise consists of architectural design and construction management. He graduated from Universitas Indonesia for his bachelor and master's degree program.

Agus Suroso is an associate professor at Civil Engineering Department, Mercubuana University, Jakarta, Indonesia. His main expertise consists of construction management and project cost estimation. He graduated from Brawijaya University for his bachelor degree and Universitas Indonesia for his master's degree.

36